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The Licensing and Interpretation of Coronality:

A New Approach

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Abstract

This thesis presents a new approach to the behavior of coronal segments. It examines seven aspects of coronal uniqueness: (i) the interaction of coronal consonants with front vowels, (ii) the confinement of liquids to coronal Place, (iii) the preference of "weak" syllabic sites for coronal Place, the processes of (iv) palatalization and (v) coronalization of coronal and non-coronal consonants by palatal glides and front vowels, (vi) the confinement of consonant harmony processes to consonants of coronal Place, and finally, (vii) the frequency and subplace richness of the coronal Place.

It is argued that this range of behavior can be given a unified analysis if coronality is represented by the Government Phonological element [I]. Further, this element is argued to be the head of a Resonance Phrase in an element-geometric tree which is divided into a Resonance, Manner and Laryngeal Phrase. The headship of [I] gives this element greater powers to license other (Place, Manner and Laryngeal) elements, so deriving the behavior noted. This is contrasted with approaches which underspecify coronal Place, or try to capture coronal anomalies by recourse to phonetic context.

The headship or dependency of elements drives element combinations, and thus derives the structure of phonemic inventories. This is traced to functional underpinnings, drawing on phonetic theories which argue for the optimality of segments based on the acoustically integrative effects of the articulations by which they are executed. The interpretation of [I] is thus investigated in some detail. At the level of segment generation, therefore, it is argued that there are formal and functional constraints operating.

Finally, the distribution of coronal segments in the word is looked at in a broad range of typologically diverse languages. This is modeled using the above tools, in conjunction with a Government Phonology approach to syllabic structure and licensing.

Contents

Chapter 1 Introduction

This thesis presents a new approach to the subject of coronality in a Government Phonology (GP) framework. The aim of this brief introduction is firstly to outline what coronality is and why the study of it is significant phonologically, and secondly to say why it still awaits an adequate modeling and why GP is the framework to fulfil this aim.

1.1 Coronality

The name coronal refers etymologically to segments executed with the *corona*, or crown, of the tongue. For phonetic purposes the tongue is divided into three portions: the tip (or apex), blade (or lamina) and dorsum (cf. Chomsky & Halle 1968, Hall 1997). The tip and blade together, which constitutes the front c.15-20 mm portion of the tongue, is also called the corona, so coronals are tongue-tip (or apical) and tongue-blade (or laminal) sounds. In standard articulatory phonetics, the corona is the active articulator, which needs to be pressed against a passive articulator: for coronals this can be the teeth, alveolum and various portions of the palate. This combination produces respectively dentals, alveolars, alveopalatals, palatoalveolars and according to some, (e.g. Blumstein 1986), palatals. As we will see in chapter 2, this articulatory classification according to two variables is highly simplified; various other factors influence the shape of a sound, such as jaw-height, size of sublingual cavity and length of oro-pharyngeal tract. The latter is extendable by lip-protusion or tongue-lowering or -backing. Only the last two articulations have really been given phonological feature status in characterizing consonants: so Gnanadesikan 1993 uses [αback] to divide among coronals, and Clements & Hume 1995 use [low]. Strictly speaking, however, even this added detail is lacking in phonetic accuracy. A better place to start in characterizing coronals is actually sound spectra: thus coronals are also referred to as "acute" (or [-grave]) sounds (Jakobson, Fant & Halle 1952, Stevens & Keyser 1997, Stevens 1998 among others): acute sounds are characterized by a preponderance of energy in the higher, as opposed to the lower, frequencies. Because different articulations can combine to produce this effect, the problem of trying to capture variable and detailed articulations as constant discrete features is solved. Paradoxically, therefore, we will use the articulatory term coronal, while in fact referring to sounds whose phonetic unity comes from this acoustic property.

Having given a brief phonetic description of coronals we must ask: why are they phonologically significant? There are seven properties listed by Paradis & Prunet 1991 (Introduction:8-16):

(1)

(i) *Assimilation*: "coronals are the consonants most likely to assimilate in Place features (ibid.9)".

(ii) *Neutralization*: neutralization involving manner happens in the coda, and the coda seems to prefer coronal Place so that this preference can be seen as a neutralization of Place (ibid.9).

(iii) *Frequency*: a) inventory frequency – the number of coronals in the inventory of a given language is greater than that of non-coronal segments; b) typological inventory frequency – the number of coronals attested in a universal phonemic inventory is greater than that of non-coronals; c) occurrence frequency – the number of coronals produced in a representative speech corpus is greater than that of non-coronals (ibid.10-11).

(iv) *Transparency*: coronals are unique in not blocking vowel harmony processes, unlike non-coronals.

(v) *palatalization and Coronality*: coronals change their subplace features under palatalization, but non-coronals just add secondary palatal articulation; also, palatalization usually targets coronals.

(vi) *Coronals and laterality*: nearly all laterals are articulated at the coronal Place, and velar laterals pattern phonologically with coronals.

(vii) *Coronals and consonant harmony*: only coronal consonants partake in consonant harmony; labials, velars and pharyngeals do not.

Another source, Hall 1997 (pp. 1-2), which is the major recent study of coronality, notes that point (iii) has been especially neglected in the literature. That work is devoted to a modelling of inventory structure and size. I too will concentrate on this aspect of coronality in depth (and compare my own account with that of Hall 1997) in Chapters 3 and 4. Hall also points out that another facet of coronality which has received attention in recent years is the patterning of coronal consonants with front vowels (e.g. Clements 1976, Hume 1992/6), a dimension of coronality which overlaps with point (v) above. This will be discussed here in Ch.2. The only points of (i) to (vii) that I will not address in this thesis is (i) and (iv). Point (ii), neutralization, will be looked at in detail in chapters 5 and 6: from a GP perspective, the phenomenon of neutralization will need considerable reworking as the crucial notion of "coda" has been struck off that theory's conceptual repertoire. In these chapters, I will add a new perspective to the notion of coronal neutralization, and look at a range of languages to test my assumptions. Finally, point (vi), the coronal relationship with laterality, and indeed rhoticity, will be examined in chapter 4.

Points (i) to (vii) are all listed as if they were disparate and unrelated properties of coronal sounds. The present approach to modelling coronality, however, holds that they are all (bar for the moment the two we will not examine) related. This is the contribution of the present work. The theory put forward in the coming pages holds that the headship of the coronal element [I] explains why coronals are so frequent (point (iii)), why they are preferred in certain syllabic sites (this will capture point (ii)), why they have a special relationship with laterality (point (vi)), and why they have a special relationship with palatality (point (v)). The point about frequency, which as stated in (iii) seems like no more than a matter of number-crunching, provoking the question, "So what if there are more coronals than non-coronals in an inventory/corpus?", will be decomposed. Frequency of coronals will be analyzed as arising from the coronal element's greater powers to license combination with other, Place and Manner, elements. This superior licensing power has the predictable outcome that a greater range of element combinations (and thus segments) will be licensed that involve coronality than any other Place. The same property explains why laterals and rhotics are always coronal, but also why affricateness and stridency, two properties involving the *manner* of articulation of segments, is always or more frequently associated with the coronal Place. This is not included in the points above, but is a natural corollary of them in the theory that will be put forward here. The above then is intended to show why coronals are interesting, and why they can still be studied in an original light. (Comparisons with previous Underspecification Theory, Feature Geometry and Optimality Theory accounts of coronality will be made when necessary – with a view to highlighting why these accounts are in need of improvement).

In the next section I will say a few words about Government Phonology and the approach to it adopted here.

1.2 Government Phonology in this thesis

As far as theoretical basics are concerned, I adopt assumptions about elements, constituent structure and licensing found in GP as outlined in the following works: Brockhaus (1992, 1995, 1999), Charette (1989, 1990, 1991, 1992), Cyran & Gussman (1999), Dresher & van der Hulst (1995, 1998), Gussman & Kaye (1993), van der Hulst & Ritter (1999), Kaye (1990a, 1992, 1996), Kaye, Loewenstamm & Vergnaud (1985, 1990), Harris (1994, 1996, 1997, forthcoming), Harris & Lindsey (1995, 2000). Thus the only constituents I countenance are the onset, nucleus and rhyme (no coda and no syllable, *pace* Kaye 1990a). The nucleus can be empty, and this is regulated by the Empty Category Principle (cf. Brockhaus 1992). Government can also take place between onsets, a situation known as InterOnset Government (*pace* Cyran & Gussman 1999). The relationship between the licensing powers of heads and dependents is assumed to be (optimally) asymmetric, *pace* Dresher & van der Hulst's Head Dependent Asymmetry Principle (the HDA), and Harris 1997's theory of Licensing Inheritance. This much has become standard in the last 10 years of the development of GP. However, this thesis presents new developments.

These developments are mainly in the subsegmental arena. In the version of Element Theory (ET) which this thesis assumes as a starting point, segments in GP consist of combinations of elements, of which one can be the head element and any number of the others can be dependents or operators (KLV (1990), Charette & Goksel (1994, 1996), Harris (1994)). The head licenses the operators. This highly economic approach to segment structure is unable, however, to capture the basic asymmetry among Place elements which is at the heart of the coronal phenomenon. So for this, I start by assuming that the coronal element is a head while the non-coronal elements are dependents (nonheads is the preferred term here) under a Place node in an element-geometric tree. Later on (chapters 3-5), I assume a Manner node and a

Laryngeal node which not only groups together the manner and larygeal elements, but also introduces a head-dependent asymmetry among them too. In addition, the Manner node is dependent to the Place node and the Laryngeal node is dependent to the Manner node. These nodes are familiar from Feature Geometry, where their motivation derives from the natural classhood of the features concerned. The motivation for my nodes, the headship of each node, and the head of each element class, however, is somewhat different. My nodes reflect the respective importance, or indispensability, of each element class and the licensing relations that pertain between Place, Manner and Voicing in the construction of a segment. So optimal (consonantal) segments will preferentially contain an element each from the Place and Manner node. The preferentially selected Place element will be the head of the Place node, and the preferentially selected Manner element will be the head of the Manner node. (As will be seen, the result of such selection will be a coronal stop). This difference between feature geometry and the present element geometry should be kept in mind to avoid confusion.

Finally, I should say a word about form and function. The above system reflects a hierarchy of phonetic compatibility between elements in segment construction (and the subsequent phonotactic distribution of segments throughout the phonological word). Phonetic compatibility refers to the degree to which the acoustic signatures of the relevant elements enhance each other, that is, combine to form a robust signal. (The term "enhancement" is used in the sense of Stevens 1972, Kingston 1993, Lindblom and Maddieson 1988; cf. Ch.3-4). The licensing of element combinations (and so the creation of segments) is thus phonetically driven. The coronal element has the property that it combines in a phonetically fruitful way with many other elements; also, elements themselves, which are acoustic signatures, are the product of specially chosen and adjusted mutually enhancing articulatory gestures – though generally, such articulations are the means and not the ends and so are not accessed in phonological processes. These two points mean that (i) an element and (ii) an element combination are quite abstract, sophisticated, *deliberately manufactured* objects. The principles that regulate the manipulation of elements are thus also quite abstract, generalized and discrete. In other words, at this level phonetics has become phonologized, in that asymmetries which have a basis in quite low level phonetics (the shape and flexibility of the tongue, the relative receptability of the auditory system to different types of sound frequency) and which at that level may be quite variable, have become categorical and generalized for whole classes of elements and segments. Thus the various principles which I put forward as regulating element combination, while they have their origin in phonetic laws and tendencies, are formulated as, to take one example, constraints on the licensing powers of heads, i.e. in *phonological*[1] language. Certain physical-phonetic properties (e.g. optimal perceptibility) have percolated up to the phonology, as it were, where they are manipulated along with other abstract cognitive units like timing x-slots, feet, nuclei and so on in a basically linguistic way.

Thus the above represents a specific approach to the problem of the relationship between form and function, and between the formalist and functionalist approach to linguistic description and analysis. It lies somewhere between a wholly abstract, autonomous approach to language, such as that advocated by Chomsky most recently in the Minimalist Program, where any connection between external reality and internal (I-) language is denied, and wholly functionalist approaches to language, in which all linguistic phenomena are held to be ultimately derivable from and traceable to extra-linguistic causes and effects (on formalism and functionalism and generative grammar see e.g. Newmeyer (2000), Burton-Roberts, Carr & Docherty (2000)). The latter approach can be seen in phonology in, for example, Hayes 1999, who wants to derive the distribution of voiced stops in languages by a "landscape of difficulty" calculated according to articulatory effort. The problem with this approach becomes quite evident: Hayes soon discovers that most of his proposed "grounding constraints" are "too logically complex to appear in natural languages", and he thus speculates that languages favour bans on "symmetrical regions of phonological space" which are "statable...with a small conjunction of feature predicates." However, to get the distributions he requires, Hayes has to demote the majority of his constraints to undominated status (he is working with in Optimality Theory) – so that we get the strange scenario whereby an acquirer has to systematically flout phonetic naturalness before s/he arrives at real-language distribution. Another problem is that the minute articulatory variables (such as [lowered jaw]), while contributing to phonetic grounding, cannot be give feature status as this would swell the number of feature

[1] Actually, this language is *syntactic*, as is much of the language of GP; the name and aims of the theory, after all, derive from Chomsky's syntactic Government & Binding theory. The operations I propose in this thesis are also syntactic in flavor, but my use of them differs from GB and GP in that I hold that they are ultimately if indirectly traceable to functional underpinnings and so are not autonomous and internalist in the sense discussed in the next paragraph.

combinations to computationally unmanageable proportions. Hayes' notion of "inductive grounding" is problematic for those reasons, anyway. But finally, even if these problems could be overcome, Hyman (2000) shows clearly that there are distributions in languages which run counter to the distributions that Hayes 1999 predicts. A similar situation holds for the attempt of Hamilton 1996 to derive distributions in Australian Aboriginal languages using acoustic and articulatory constraints (I will briefly critique this account in Ch.7). For all these reasons, an approach in which the clear phonetic underpinnings of certain patterns have already been phonologized seems preferable. This point will become clearer through example in the relevant chapters. (The problems of the first, formalist approach are discussed in Ch.2).

Finally, another innovation in GP put forward here is the elimination of the "post-rhymal complement", which itself was intended to replace the coda (Kaye 1990a, Harris 2001). In fact, a whole new theory of the nature and licensing of the coda will be developed in chapters 5 and 6.

We will begin the investigation into coronality by looking at palatality, laminality and the phonetic nature of the elements.

Chapter 2 The element-theoretic modeling of coronalization, palatalization and laminality

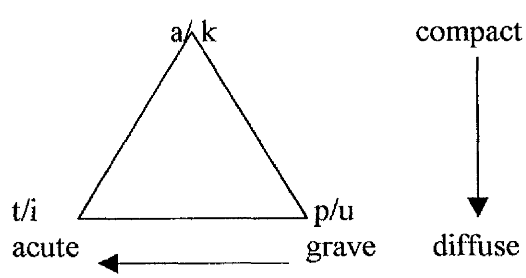
This chapter will examine 5 major topics:

1. The acoustic-cognitive interpretation of elements, specifically elements modeling coronality.
2. The nature of headedness in element theory (ET).
3. The relationship between coronality and palatality and its consequences for the ET representation of coronals.
4. The nature of laminality/ "distributedness" and its consequences for the ET representation of complex coronal stops.
5. The nature of the phonology-morphology interface, as it intersects with the above two points.

2.1 Basic assumptions concerning Place elements

We will broadly[1] adopt J. Harris & G. Lindsey's (hereafter abbreviated to H & L) approach to the phonetic nature of elements (H & L 1995, 2000). This holds that phonological features are primarily acoustic in nature, though even these acoustic patterns are more abstract "gestalt" patterns than exact mental records of wave frequencies. However, unlike H & L, we will adopt the Jakobsonian equation of consonantal and vocalic place, schematized in the following triangle (cf. Jakobson & Waugh 1978 for example):

(1) [I] = coronality, [U] = labiality, [A] = velarity.



Motivations for why labial stops and round vowels should be represented by the same feature can be found in van der Weijer 1994, for example. The same source can be used for documentation as to why dorsal consonants and back vowels should be represented by a single feature, as well. As this is strictly outside the topic of coronality, I will not review the evidence here. Of course, the most important equation, that of coronality in consonants with frontness in vowels, will be examined in some detail below.

Here too is not the immediate place for examining why an acoustic-auditory basis for elements is superior to an articulatory one, or a completely abstract one (which posits no interface with any phonetics). Evidence for this assumption will be adduced as and when the occasion arises, throughout this chapter.

The topic which will now occupy us, building on these basic assumptions, is that of the construal of headedness throughout this thesis.

2.2 Some theories of headedness and element combination

I take the line that:

(i) the headship of an element is universally fixed, and

(ii) headship does not contribute to the phonetic interpretation of an element – rather it serves to delimit the combinability of elements; finally

(iii) the "fixed head" elements in vocalic and consonantal expressions are different: in vowels the universal head for vowels is [A], in consonants it is [I]. This preference can be summed up by the slogan: "vowels prefer to be compact, consonants prefer to be acute".

If we look at other construals of headship in the GP literature, we will see what these assumptions mean.

With regard to point (i), some theorists use headedness as an abstract device to limit the number of phonological expressions (p.e.s) which are generated by free combination of elements in different head/dependent roles. Thus the headship of elements differs from language to language. Headship of an element is often decided for a particular language by constraints having to do with dynamic phonological or

[1] I differ with respect to the concept of headedness, as 2.2 will discuss.

even morphophonological processes in that language. An example of this is Charette & Göksel 1996's modeling of the Turkish vowel system. On the assumption that all elements can be heads and dependents[2], and that all of them can combine with each other, nineteen possible p.e.s can be generated. Turkish, however, only has eight vowels. To narrow nineteen p.e.s down to the required eight, C & G list the following statements, which they call Licensing Constraints:

(i) Operators must be licensed

(ii) A is not a licenser.

(iii) U must be head.

Given the form that Licensing Constraints can take (ibid. p.2), this is only one set among many. (C & G, for example, list six alternative Licensing Constraints, ibid. p.8.). How then do C & G choose among the set of constraints which limit element combination? For them, it is the behaviour of vowels in the Turkish vowel harmony processes which forces the choice: "The constraint on the headhood of [U] will be seen to account for the absence of "o" and "ö" in recessive positions....Such a statement ([A] is not a licenser) not only helps reduce the number of vocalic expressions in the language, but also explains the absence of A-harmony. Thus both constraints are directly tied in with the nature and behaviour of harmony...." (ibid.9). In discussing the representation of vowels in Vata (an Ivory Coast language), C & G make the vowel /u/ headed as well: here, however, the motivation is that this vowel is ATR and contrasts with non-ATR /ʊ/. ATRness, which also behaves harmonically in Vata, is said to be the correlate of headedness. But headedness in Turkish is not interpreted as ATRness. Thus, for C & G headedness does not have a unique phonetic interpretation; rather, vowels are assigned a headed representation firstly on an arbitrary basis, in order to narrow down the set of p.e.s, and this choice is confirmed if headed p.e.s are in some sense phonologically dynamic.

A second construal of headedness comes from those who would see headedness as having a particular phonetic interpretation. Thus Ritter 1996 argues that stops are universally headed, because headedness in vowels and consonants signals constriction. Constriction in vowels is manifested as tenseness, in consonants as occlusion. A similar view can be found in Harris 1994, where the vowel /ae/ in

[2] C & G's term is "operator".

English is modelled as headless on the basis that it is lax and short; by contrast, long vowels are headed, because they are tense. However, in Harris 1994 (and in more detail in Harris & Lindsey 1995) we also find the view that headedness is a measure of phonetic salience: the vowel /i/ is [I]-headed as its palatality is (acoustically) more prominent than its openness, while /ae/ is an essentially open vowel with secondary palatality.[3]

Putting all these construals together, headedness can represent phonological (non-phonetic) "dynamism" (here, tendency to spread); it can be one phonetic property, tenseness; or it can be relative phonetic salience of an element's phonetic property. The last two proposals are not fully coherent, in that it remains undecided whether the phonetic correlates of headedness are relative salience or an absolute property, tenseness. But the first proposal is unsatisfactory in that any element can be headed or not; moreover in this approach, even the phonetic interpretation of elements themselves has a tendency to drift, with representations being decided by what makes morphophonological alternations easiest to state in Licensing Constraint form. Cobb 1996 for example represents /e/ in Basque as headed [A], (<u>A</u>). This is because, lacking a feature [high] to unify the vowels /i, u/ she must model the conversion of suffixal /a/ to /e/ after root /u/ as headedness harmony. The problem with this approach, then, is that elements have a very loose mapping onto phonetic objects. In principle, without some theory of the core phonetic characteristics of each element (such as that provided by H & L 1995, which is why this theory of element interpretation is so important), p.e.s can have all and any phonetic interpretation. The actual interpretation is determined at convenience on a language-by-language basis. But if in addition headedness is used to capture phonological dynamism, this predicts that across languages all elements and segments have an equal chance of behaving dynamically. In other words a range of unattested processes become easy to state. For example, one could imagine a process whereby a back, round, high vowel lowers to a back, round, mid vowel before a high, front vowel:

(2) u → [o] / i ___

= (U) → (<u>U</u>) / (<u>I</u>) ___

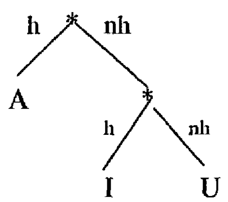
[3] This means that /ae/ is (<u>A</u>.I) on the first construal and (A.I) on the second.

Here the mid vowel, /o/ is represented as headed (just as mid /e/ was headed in Cobb 1996). The vowel /u/ is headless (pace nonATR vowels in Vata), while /i/, behaving dynamically, is headed. It then becomes straightforward to model the change in (2) as vowel harmony, or in the terms developed in Cobb 1996, as head-alignment.

2.3 The present theory of headedness

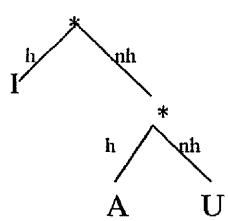
In this thesis I will thus reject the view that any element can be headed. Rather, for vowels the element [A] is always head and {I, U} are always non-heads, and as we will see soon, for consonants [I] is always head and {A, U} are always nonheads. This state of affairs is captured by assuming that the elements group together in an element-geometric tree given by UG[4]:

(3) element-geometric tree for vowels



(h = head; nh = nonhead)

(4) element-geometric tree for consonants



What then is the meaning of headedness in this theory. It translates as two things:

(i) heads have greater powers of generation and selection: they are generated before nonheads, and they can select nonheads to combine with. Thus, for vowels, a p.e. consisting of [A] will be generated before one consisting of [I]. And a complex p.e. which contains [A], such as (A.I) or (A.U), will be generated before one which does not contain [A], such as (I.U).

[4] This tree with similar motivations is argued for by Ewen & van der Hulst 1988.

(ii) There is a phonetic motivation for (i), but not in the sense that the headed elements are more salient or "tenser". Rather the vocalic head [A] always translates as the template for compactness[5]. The theory of headedness encodes that this compact template is the preferred one for vowels: that is, vowels prefer to be compact. Vowels which lack this signature are only generated after ones which contain it. Headedness thus captures well-known markedness implicationals about vowel and consonant systems across languages, such as that /a/ is the least marked vowel and that front vowels are preferably unrounded and back ones are preferably rounded (Maddieson 1986). This holds for consonants too, as we will explore in depth throughout this thesis.

The first point to note is that I have posited different trees for consonants and vowels. The markedness of back unrounded vowels and front rounded vowels is captured by making [A] a head. A different markedness phenomonon has been observed for consonants, though. Making the coronal element [I] head has similar consequences for consonants: [I] will be able to license dependent [A] and [U], but not vice versa, the underlying motivation being that [I] is in some sense a desirable phonetic property to incorporate into consonantal representations. The distributional repercussions of this are that coronals will be more common than noncoronals, and also that coronals with secondary labial and velar subplace (whatever the interpretation of this may be) will occur, while labials or velars with secondary coronal subplace will not. We can advance the view that the preferable property which coronals possess is that "they are especially tied to the fundamental capabilities of the auditory system for processing temporal and spectral aspects of sound", as Stevens and Keyser 1989 phrase it. As for subplace richness and coronal frequency, along with other points of coronal unmarkedness, the rest of this thesis will explore these aspects in some detail.

The task now, though, is to motivate the choice of [I] as the element representing coronal consonants.

2.3 Front vowel-coronal consonant interactions

[5] These qualities are relative: that is, compactness in language A is compact with respect to all the non-compact vowels; but a compact vowel of language A may have the same acoustic shape as a non-compact vowel in another langauge, language B. Cf. Jakobson & Waugh 1979, Liebermann & Blumstein 1989 for discussion.

The idea that alveolar consonants and front vowels share a phonetic property (acuteness) is, as we have seen, Jakobsonian. There has also been investigation into the expected phonological patterning between acute vowels and consonants; the most recent expositions date from Clements 1976 and Hume 1992/1996's in-depth investigation into the topic. In order to establish that the front vowels and coronal consonants are a phonological class (i.e. that acuteness really is manipulated in discrete phonological terms) I will give some examples from Clements 1976 and Hume 1992.[6]

2.3.1 Fe?fe?-Bamileke vowel reduplication

In Fe?fe-Bamileke (Western Cameroon, Hyman 1972), the set of consonants can be divided into two natural classes as regards the process of reduplication:

(5) a.{p,b,f,v,m,w}
b.{t,d,s,z,n,l}

The second set cause the following alternation in reduplication:

(6) [ɨ] → [i] / __ {t,d,s,z,n,l} + front vowel

That is the high, unrounded central vowel [ɨ] becomes a high front vowel if followed by a "coronal" consonant and a front vowel of any height. (The fronting takes place without the presence of Set 1 consonants if the vowel is /i/). The same vowel becomes rounded to [u] if followed by any set 1 consonant and a rounded vowel of any height (again the vowel /u/ serves to round [ɨ] alone):

(7) [ɨ] → [u] / __ {p,b,f,m,w} + rounded vowel

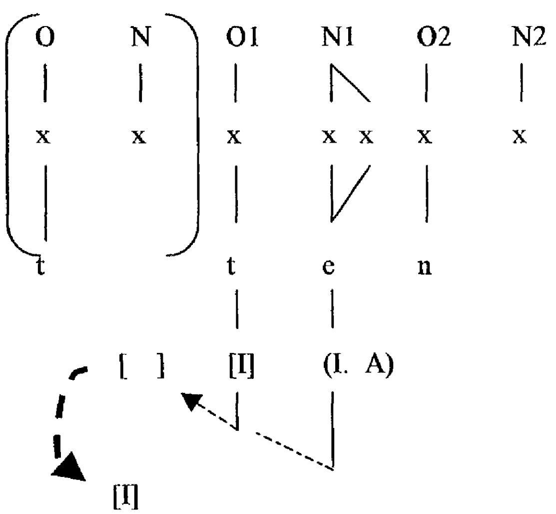
Some examples will illustrate:

[6] Our general reasoning (*pace* H&L) is that distributional data (phonological processes) alert the investigator to the existence of patterns which are manipulated categorically by the mind, i.e. to the existence of elements. The next step is to discover what the phonetic manifestation of these patterns is – on the assumption –which we take to be the logically default one – of phonetics-phonology non-arbitrariness. Phonology is thus a key to what is significant in phonetics. A methodologically wrong inferential step is from physical-phonetic properties to phonological classhood.

(8)	a.	za	ziza	"to eat"
		to	tito	"to punch"
	b.	kuum	kukuu	"to carve"
		ko	kuko	"to take"
	c.	siim	sisii	"to spoil"
		teen	titee	"to remove"
		cen	cicen	"to moan"

As Hyman 1972 points out, the SPE characterization of alveolars as coronal and of /i/ as a high, front vowel means that the patterning of /t/ with /i/ is unaccounted for. If one assumes that /t,i/ share a common property, here the element [I], the alternations become transparent (cf. van der Weijer 1994 who also posits that front vowels and coronal consonants share [I]). The Feʔfe-Bamilike vowel alternation before coronal consonants or vowels will then look as follows:

(9) /teen/ → /titeen/



Here we will not worry too much about the formal representation of spreading, or the conditions necessary for spreading to take place. Rather the point of melodic content is the relevant one. The mid, front vowel /e/ by itself does not cause the default vowel to surface as /i/: the help of another [I] element in the alveolar consonant is necessary for this. We represent this high, central unrounded vowel as the realization of an empty nucleus (cf. Charette & Göksel 1994 for this approach to the Turkish default vowel, Harris 1994 for this representation of English schwa – though Harris includes the neutral element [@] which is said to "inhere in every intersection between a skeletal tier and autosegmental tier that is not filled by some other element (ibid.181)", only receiving an interpretation, if it is not headed, if no other element is present). Then [I] spreads into this empty slot of the reduplicative suffix iff

(10) a. [I] is present in O1 and in combination with [A] in N1, or
b. [I] is present in isolation in N1.

The latter condition of course derives the fact that the default vowel surfaces as /i/ before the following root vowel /i/ with or without the presence of an alveolar consonant. It is condition (a) on [I]-spreading which is impossible to state if we do not assume that /t/ contains the same element as front vowels (which in GP are united by the presence of [I] – again cf. Charette & Göksel 1994, 1996 for transparent and economical accounts of Turkish palatal harmony using the element [I]).

2.3.2 Front vowel~coronal consonant alternations in other languages

There are other examples of similar patternings:

Hume 1991 and 1992 shows a similar alternation exists in Maltese Arabic (MA). In MA, the imperfective prefix vowel is usually a copy of the following stem vowel, but surfaces as /i/ if the root-initial consonant is coronal:

Maltese Arabic:

(11)	a.	forok	yo-frok	"to limp"
		kotor	yo-ktor	"to abound"
		?asam	ya-?sam	"to break"
	b.	dahal	yi-dhol	"to enter"
		siket	yi-skot	"to be silent"
		talab	yi-tlob	"to pray"
		dalam	yi-dlam	"to grow dark"
		cahad	yi-chad	"to deny"

Again, if {d,s,t,c} contain [I], the provenance of the prefixal vowel is immediately obvious.

Hume 1992:15 gives an example of a sound change from Latin to Romanian:

(12) Latin nos > noi Romanian

vos > voi

ad post > apoi

das > dai

habes > *has > ai

*dos > doi

tres > trei

Given the above, Hume's assumption that the dropped coronal consonant is replaced by a vowel of the same quality (coronal) makes good sense.

An example from another unrelated language group backs this up (cf. Clements 1976, Ohala 1979). It involves a vowel shift between Tibetan which can be recovered by comparing written Tibetan with the modern Lhasa dialect:

(13) Written Tibetan Lhasa Tibetan

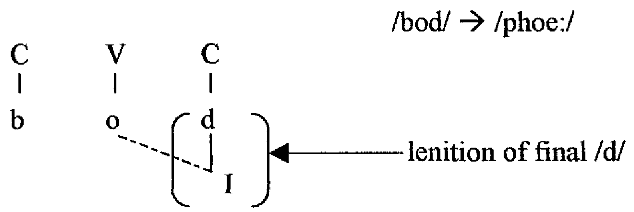
Written Tibetan	Lhasa Tibetan	
a	ɛ	before written Tibetan /d, n, l, s/
o	oe	
u	y	

In addition, final consonants of Written Tibetan are dropped in Lhasa Tibetan; however, dropped coronal consonants effected the quality of the preceding vowel, lengthening it and fronting it:

(14)	bdud	[ty:]	"demon"
	bod	[p^hoe:]	"Tibet"
	bal	[p^he:]	"wool"
	yul	[jy:]	"country"

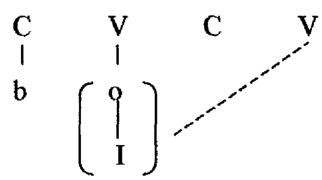
This can be seen as the spreading of the element [I] from the consonant before it dropped into the preceding vocalic expression, which can be represented as the following:

(15)



The vowel /o/ has elemental representation (A.U), which with the addition of (I) results in (A.U.I) or /oe/. The loss of /d/ would have allowed the new vowel to spread into an adjacent V-slot (if we posit a CVCV structure), giving the extra vowel length:

(16)



The same influence of /t/ on preceding vowels is seen in modern Burmese languages (Thurgood & Javkin 1975, and discussion in van der Weijer 1994). Some examples follow (I have omitted tones):

(17)

Reconstructed	written Burmese	Lahu	Lisu	Akha	
*k-r-wat	krwat	veʔ	we	yɛ	"leech"
*cat	tshat	cheʔ	chwe	tsɛ	"to break"
*se-wat	wat	si-veʔ	si-we	yɛ	"flower"

Once again, where /t/ is lost in Lahu, Lisu and Akha the remaining vowel (while not lengthened as in Tibetan) is fronted.

All the above processes provide good evidence that front vowels and coronal consonants share a phonological feature. This gives phonological justification to our decision to equate t/i on grounds of acoustic phonetic similarity, *pace* Jakobson.
Let's now look at a more familiar process whereby a non-coronal consonant turns into a coronal under the influence of a front vowel. This is known as velar fronting, or velar softening. (Later we will see that a similar phenomenon exists for labials too).

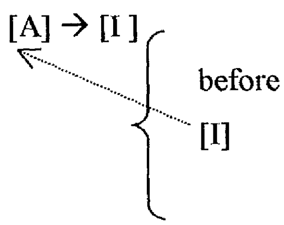
2.4 Palatalization and coronalization

In schematic form, velar fronting/softening looks as follows:

(18) /k/ → [ch] /__ /i/

There are differences in its occurrence across various languages, which we will examine later but for the point at hand this schematic rule will suffice.
It would seem that velar fronting can be captured by positing the same representational mechanism that we used to capture the fronting influence of coronals on vowels, i.e. by incorporating [I] into coronal structure.
Then we would get:

(19) /k/ → [ch] /__ /i/



Here, the [I] element present in the front vowel, spreads into the velar and displaces it to form a stop whose Place is represented by [I] – a coronal affricate. We would seem to have a clinching argument for [I] being the coronal element. Note that none of the other proposed elements for coronality, [A] (as per Ploch 1999, for example, among many others) or [R] (as per Harris 1994, who is also representative of a "school" of coronal representation in GP), or [@] as per Brockhaus 1998 (ditto) will capture these two important facts about coronality. Only if the palatal element and the coronal element are one and the same can velar fronting and coronal consonant vowel fronting be captured.

Indeed the identity of coronality and palatality has already been assumed in the work of at least one element theorist, van der Weijer 1994 (cf. also Smith 1988). However, unfortunately, this work plainly shows that a representation which equates palatality and coronality in a straightforward manner eventually leads to contradictions. This is because, while velar fronting and coronal vowel fronting can be modelled transparently, there exists another common process which cannot: palatalization. This process can be schematically represented as follows:

(20) /t/ → [c] / __ /i/.

Here our symbol [c] represents a palatal stop. (The phonetic and phonological characteristics of this segment will be discussed in detail later). For van der Weijer 1994, as for other theorists (such as Kiparsky 1986 and Blumstein 1986, who will be discussed shortly), palatals are segments intermediate between coronals and velars. So van der Weijer represents them as containing coronality, or [I], and velarity, or [A]. The case he uses as an example is that of Polish, in which the alveolar strident coronal fricative /s/ becomes a palatal fricative /ɕ/ before the vowel /i/. This is modelled as follows[7]:

(21) was "moustache" wa[ɕ]ik "little moustache"

(22)	[s] →	[ɕ] /	__ [i]
	(I) →	(I.A)/	__ (I)

The problem becomes clear. Given the assumptions regarding the make-up of palatals, and the make-up of coronals and velars, where does the element [A] come from in (22)? Van der Weijer comments (ibid 111): "with respect to the shift of the alveolars, the source of the A element that turns these into palatals is not so clear." He speculates that possibly all vowels, and thus [i] too, are dorsal (*pace* Sagey 1986a).

[7] For further details of Polish palatalization, see below.

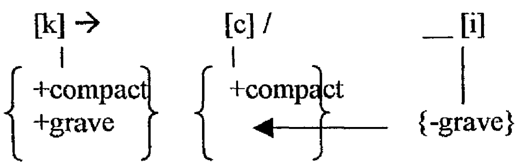
However, this makes a range of odd predictions, namely that all vowels can have this velarizing effect and not just [i] (this same critique was made by Lahiri & Evers 1993). This is patently false.

This problem was foreshadowed in a debate between Blumstein 1986 and Kiparsky 1986, about the best way to represent Hungarian velar fronting:

(23) Hungarian velar fronting: [k] → [c] / __ [i]

Contrary to the schematic representation of velar softening that I gave in (18)[8], Blumstein 1986 posits on spectrographic evidence that /c/ is partly compact, partly acute. Thus for her the process will look in featural terms as follows:

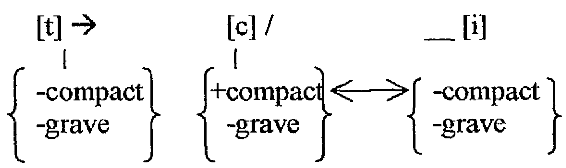
(24)



Here, the acuteness of [i] makes [c] acute.

Kiparsky 1986 critiques this approach on the grounds that Blumstein's featural representations mean that the process of coronal palatalization, which we just looked at, will have to be treated as dissimilatory if the features [grave, compact] are assumed:

(25)



As [i] and [t] have the same value for compact and grave, the change to [c] can only be seen as a result of dissimilation between adjacent occurences of [+compact]. And

[8] If one was looking for a case where /k/ fronts to a segment which is unambiguously coronal rather than palatal, one could cite English /k/ → /s/ changes in pairs such as /electric/~/electri[s]ity/. The question of whether this "deep-lexicon" morphophonological process should be modeled in the phonology is important, and will be discussed later on.

yet palatalization is just as common (if not more common, and certainly less marked) a process as velar fronting, and to all intents and purposes is the same. Modelling one as assimilation and the other as dissimilation is thus undesirable. The undesirability of modeling palatalization as dissimilation shows up in van der Weijer's element-based model as unwanted element insertion (in 22).

Kiparsky proposesd to capture both processes using the SPE feature [high]. The vowel [i] is high and changes nonhigh [t] to high [c] in palatalization. It changes nonhigh [k] to [c] in velar fronting. While use of [high] works, it makes recourse to a variable articulatory feature, so that this solution is ruled out (the reasons why articulatory features are unsuitable will be discussed at length below).

2.5 Solving the palatalization~coronalization conundrum using [I] in head and nonhead role.

The problem for van der Weijer and Blumstein comes from assuming that the palatals [c/ ç] contain velarity or compactness. I will argue shortly that while there are phonetic indications of velarity in palatals, phonologically these segments are coronal and contain no velarity, or A-ness. Here I will take this as given. The assumption will unravel the paradox of modeling palatalization as well as coronalization, and lead to a novel representation of coronals and coronal subplace.

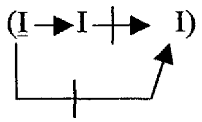
As we have seen, both /t/ and /k/ coverge on [c] under the influence of /i/. We assume that [c] is a coronal segment, whose coronality is represented by [I] in head role (underlined), which also contains an overlay of palatality, represented by [I] in non-head role. Then the step from /t/ to [c] is quite clear. The step from /k/ to [c] involves slightly more than the mere entry of the element [I] into the representation of /k/ (which is [A.?]). [I] must not only enter [A.?]; it must also displace [A], giving [I.?], and then copy itself over, to give [$\underline{\text{I}}$.I.?]. Schematically, we have:

(26) /t/ —+ /i/→ [c] ←+ /i/— /k/

(27) ($\underline{\text{I}}$.?) —+[I]→ ($\underline{\text{I}}$.I.?) ←+[I]— (A.?)

There are two obvious questions to ask about these representations, one theory-internal and one theory-external. Firstly, if we allow two occurrences of the same element to occur in a phonological expression (p.e.), surely that opens the door to an infinite array of p.e.s, each one differing from the next in having one more occurrence of a resonance element: (I.I), (I.I.I), (I.I.I.I) ....and so on[9]. That question has an easy answer. In the p.e. (I.I), one [I] is in head role and the other in dependent role, and we say that the former licenses the latter. If we say that there is a strictly binary licensing relationship between elements in a p.e., a sequence like (I.I.I) will be ruled out on the basis that the second non-head [I] is unlicensed. For the head, [I], can license at most one dependent, and (we add) a dependent has no licensing powers at all. This looks as follows:

(28)



(The question of how [?] is licensed in (I. I. ?) will be taken up in the coming chapters). Thus by assuming that head-dependent licensing relations prevail in p.e.'s, we curtail the overgeneration of representations. We will develop this notion in more detail in later parts of this thesis.

The second question about the representations in (27) is: a lot more is required to get from /k/ to /c/ than from /t/ to /c/. In the latter vocalic [I] spreads into (I.?) forming (I. I. ?), while the full representation of the /k/ → /c/ change must be:

(29) (A.?) + (I) → (<A>.I.?) → (I.<<I.?) = (I.I.?)

[A] delinked [I] copies itself as head (" << ")

Far from being a disadvantage, however, this is desirable. As Spencer 1994 points out, coronalization of a velar segment is attested only as morphophonological change, occurring under affixation. That is, it has the characteristics of a cyclic structure-changing lexical process, in the terms developed in the theory of Lexical Phonology

[9] This criticism can be directed at Schane's (1984a) Particle Phonology representation of segments,

(LP). Palatalization, however, is attested as an allophonic, structure-preserving alternation, which can be placed at the post-lexical level of derivation. One need not adopt the derivational framework of LP to appreciate these insights[10]. But some such encoding of the difference between the two processes is needed, I believe. I will give a modelling of this when I discuss Polish palatalization in the next section.

2.6 Differences in the process of palatalization

In (27) we gave a schematic representations of coronalization (/k/ → [c]) and palatalization (/t/ → [c]). However, I believe there are two separate processes which are subsumed under the name palatalization. One is where an alveolar segment becomes a palatoalveolar segment, the other is where an alveolar segment becomes a palatal segment. At this point it is necessary to give examples from specific languages. Our first example is from English, where an alveolar obstruent is followed by a palatal glide. In different dialects, the realization of the sequence is different (the realizations seem to vary with age, and other factors which are not relevant here). In one realization the coronal preserves its identity, in the other the coronal and the palatal glide fuse into a different segment, which is already phonemic in English:

(30) alveolar to palatoalveolar:

ti[sj]u:	→	ti[ʃ]u:	"tissue"
[tj]u:n	→	[tʃ]u:n	"tune"

In our representation this is the simplest transformation possible, mere addition of an element.

(31) /s/ ($\underline{I}.\underline{h}$) + /j/ (I) → /ʃ/ ($\underline{I}$.I.$\underline{h}$)

which also allows multiple occurrence of elements in segmental representations.

[10] Goad & Narasimhan 1994 model coronalization as a two-step process and palatalization as a 1-step process for the same reasons.

The representation in which palatoalveolars are p.e.s with two instances of [I] makes this transparent.[11]

From this English case, let's turn to the case of Polish palatalization. In this language, the situation is far more complex.

There are 4 fricatives in Polish: /s, ʃ, ç, x/, i.e. alveolar, palatoalveolar, palatal and velar. And there are two processes whereby alternations take place (van der Weijer 1994:108):

(32) [s] → [ç] } ___ / [i]
     [x] → [ʃ]

For example:

(33)	a. osa "wasp-NOM-SG"	o[ç]ie "wasp-DAT-SG"
	b. muxa "fly-NOM-SG"	mu[ʃ]e "fly-GEN-SG"

Earlier, I maintained that velar to coronal shifts involved more structural change than coronal to coronal shifts involving only subplace changes. But here we have a phonological change triggered by a morphosyntactic suffix, namely the case ending. If we were to pursue Lexical Phonology assumptions seriously, we would have to say that the /x/ to /ʃ/ shift is more complex than the /s/ to /ç/ shift, and this would imply that suffixation of the genitive marker takes place before suffixation of the dative marker, perhaps in an earlier stratum of the grammar. But this would be circular: after all it is only on the evidence of shifts in other languages that we assume that /ç/ is coronal, so that an alveolar to palatal shift is more minimal than a velar to palatal shift; there is no independent evidence that the dative suffix attaches before the genitive suffix, which would support this assumption for Polish. In fact the default assumption should be that all case markers are attached at the same level. And this indicates that an alveolar to palatal shift is the same as a velar to alveopalatal shift.

We have another problem, if we continue with only the assumptions we have made so far. For conversion of /x/ to /ʃ/ will look as follows:

[11] Though for this simple case, A or @ or R would suffice too.

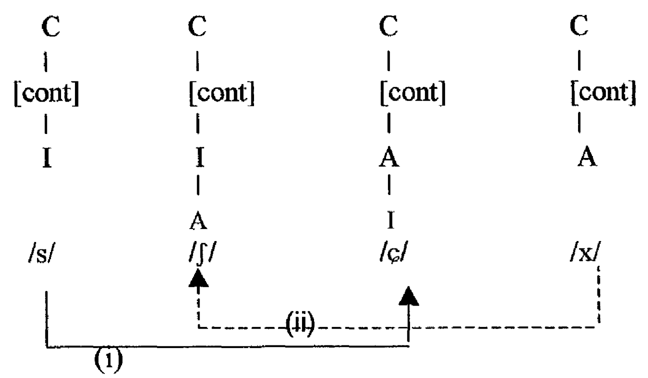
(34) /x/ (A.h) + /i/ (I) ➔ /ʃ/ (I.I. h)

[I] enters from the vowel and then dislodges [A]. It then copies itself over as head. But the conversion of /s/ to /ç/ will look as follows, presumably:

(35) /s/ (I.h) + /i/ (I) ➔ /ç/ (I.I.h.)

The question is, if (I.I) is the Place representation of both /ʃ/ and /ç/, what distinguishes them? Palatalization in Polish seems to confound our theory that palatals are coronals, best represented as having two occurrences of [I] in their Place representation. But going back to van der Weijer's system of representation does not help us. He represents the conversions as follows:

(36)



(An element drawn above another element means that the upper element is head to the lower one).

We saw that conversion (ii) was easy for van der Weijer: [I] enters /x/, which is [A] and yields /ʃ/ (I.A).[12] However conversion (i) involved the problematic introduction of [A] *ex nihilo*.

The way to differentiate /ç/ and /ʃ/, while maintaining they both have the same Place composition, (which obviates the need for [A]-introduction), is to say that the former

---

[12] Even for this shift, though, some switching of headship of elements will be needed to get the correct outcomes.

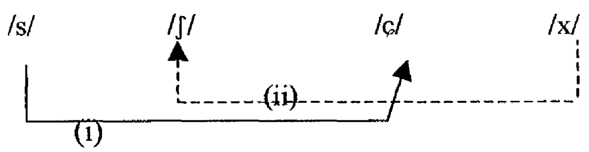
is non-strident while the latter is strident. In element terms, that is, in one expression [h] is headed, in the other it is not:

(37) /ç/ = ($\underline{\text{I}}$. I. h) /ʃ/ = ($\underline{\text{I}}$. I. $\underline{\text{h}}$)[13]

These representations may seem odd if one is used to articulatory labels, which differentiate between an alveolar, palatoalveolar, alveopalatal and finally palatal[14] Place. The fact is though that for stops, no language makes contrasts at the alveopalatal and palatal place, while the palatoalveolar Place does not exist for stops. Phonologically, these last three regions can be collapsed into one for stops, therefore. For fricatives, there is a maximum of 2 contrasts in any language for the last three subplaces: these two contrasts always involve stridency, as well as Place.[15] This means we can do what we did for stops: collapse the 3-way distinction into one, which we can give the blanket name "post-alveolar". The greater flexibility of fricative types can then be ascribed to the option of making their noise strident or non-strident. The slight difference in location of the passive articulator is, we maintain, a matter of phonetic implementation and is not phonologically significant. We will see in 2.7 and 2.8 that even phonetically, these passive place labels are inaccurate and so not a sound basis for classification. A host of additional articulatory variables combine to give a sound its acoustic structure, so that it is the latter which is invariable and thus phonologically significant. We will return to the question of how to define and limit the generation of elements to produce p.e.s which model all and only the segments attested in languages in Chapters 3 and 4. Later in this chapter, we will also look at the phonetic characteristics of the "post-alveolar" place.

Given our representation of the palatal and palatoalveolar fricative, the sound shifts in Polish will now look as follows:

(38)



[13] The p.e. for /ʃ/ now contains 2 heads. A detailed theory of heads and dependents at the subsegmental level will be outlined in this and coming chapters.

[14] The term "prepalatal" is also found in the literature.

[15] For further details of this, cf. Van der Weijer 1994:107 and here in Ch.4.

(i) $(\underline{I}.\ \underline{h})$	+ I	→	$(\underline{I}.\ I.\ h)$	[loss of h-headedness]
(ii) (A.h)	+I	→	$(\underline{I}.I.\underline{h})$	[loss of A, promotion to head of (h)]

If [I] had merely entered the p.e. for /s/, *tout court,* in (38i), we would have expected the production of $(\underline{I}.I.\underline{h})$ or /ʃ/, as in the palatalization process we saw in English. Likewise if [I] had simply entered the representation of /x/ in (ii), we would have expected something like /x^j/. In both cases, however, some extra detail is present. We can call the English-type /s/-to-/ʃ/ process palatalization-1 and the /s/-to-/ç/ process palatalization-2. Meanwhile the /x/-to-/ʃ/ process is "coronalization": conversion of a non-coronal segment to a coronal one by a front vocoid. As per LP, palatalization-1 is a more "natural" process than palatalization-2 and coronalization. The latter involve idiosyncratic changes to segment structure that palatalization-1 does not. It is not necessary to assume rigid strata, or even a lexical/post-lexical distinction to incorporate this assumption[16]. In chapter 3, once more precise details about the internal structure of segments has been worked out and more information added about the differential licensing powers of elements, we will give a formal representation of the constraints and representations which can model these different processes. Briefly, this will involve the licensing powers of the [I] element in the suffixal vowel which triggers a change in the affected consonant. A statement will be given which determines whether the [I] in the suffix spreads, and if it spreads, how much restructuring it is licensed to carry out in the root-final consonant. (Details can be found in 3.7). This statement will be encoded in the representation of the morphological suffix, along with information about morphosyntactic and semantic nature of the suffix.

In the above sections, then, we differentiated out among certain sound changes involving coronals and palatals. We proposed a new representation of palatal obstruents which would allow palatal alternations with alveolars and velars to be stated perspicuously. We will address the phonetic interpretations of these representations in 2.8. In the next section, however, we will address the highly

[16] Cf. Kaye & Gussman 1993 (K&G) for a non-derivational reanalysis of Polish data given an LP treatment by Rubach 1984/7. K&G also model the facts without recourse to the dubious notion of Strict Cyclicity (SC). They show that many of the arguments for levels and SC are unmotivated. But some

pertinent question of whether alternations of the alveolar~palatal type (palatalization-2), which take place under morphological affixation, should even come within the remit of phonology at all. If they shouldn't, then developing perspicuous connections between these segments in the phonology is a waste of time. This ties in to the question of the phonology/morphology interface and the nature of phonological constraints, representations and levels.

2.7 The relationship between morphology, phonology and morphophonology

Looking at (38), we see that it is only the dative suffix /i/ which turns /s/ into [ɕ]: that is, word-internal [si…] strings exist, which escape palatalization-2. But this means that if the statement regulating the spread of [I], which we referred to above, was completely in the phonology, as it were, such [si…] strings would not emerge unshifted. So this means that such a statement must either be assigned to a separate level from the "pure" phonology (LP-style), or that it must be part of a separate morphophonology component. How does this tie in with assumptions about the morphology/phonology interface currently countenanced in GP?

These assumptions date back to Kaye (1995), which sets out a minimalist view of the phonology-morphology interface, in which the only information phonology has about upper level grammatical domains is access to morphological bracketing. This is in contrast to the complex levels and conditions on phonological rules posited by Lexical Phonology. I agree with Kaye's critique of LP. I especially think the post-cyclic lexical component blurs the distinctions between the lexical and post-lexical components, making the assignments to levels arbitrary. Nor do I think that "predictable" phonetic effects like aspiration should be inserted post-lexically, with underlying representations being underspecified. For ease of retrieval and processing, surface and underlying forms should be as close as possible. However, it seems a solid result that some sound shifts are only triggered by affixation, and these sound shifts are often the culmination of a series of natural phonetic shifts, which is why they permute one sound into another phonetically non-adjacent one. To preserve a strict Kaye-style phonological minimalism, one would have to store /oɕie/ as an

more explicit notion of the different sound changes triggered by different affixes is needed. I attempt to unstructured simplex form, related only by suppletion to /osa/ (though happening to share the same ending as all other dative forms in the language). This is not impossible, though to a mainstream generative phonologist it would seem perverse. The question in the end links up to some very fundamental questions in phonology and morphology about where, how and even whether to capture sound alternations in roots and affixes. Kaye 1995, for example, argues that the English [k~s] alternation in electri[k]~electri[s]ity is not evidence that English has a rule of velar softening. Rather the adjective and the noun are stored as separate phonological items which happen to share a meaning. In the case of derivational morphology, this seems plausible. Also, the Latinate suffix –ity has a limited distribution, attaching only to a small set of (also) Latinate roots. Another similar and more explicit approach is that of Spencer 1988a's "morpholexical phonology", which discusses an interesting set of facts concerning secondary velar palatalization ("2VP") in Czech. This is a process whereby a hard (velar) consonant turns into a soft (coronal) one before a soft vowel. It is thus similar to the rule we have seen in Polish. However, 2VP interacts with another rule of Czech phonology, whereby stems ending in "hard" consonants select hard allomorphs of case affixes, and soft consonants select soft suffixes. The plural prepositional case has two such allomorphs, "ech" (hard) and "ich" (soft). Problems arise when a hard root like "zvuk" (/k/ is a hard sound) exhibits the following alternation:

(39) zvuk zvucich "sound"

Here it is impossible to maintain that both rules of Czech apply. This is because, to get the surface output in (39), we would have to assume the following derivation:

(40) /zvuk-/ + [ich] ➔ /zvucich/ (where /k/ → [c] ___ / [i] by 2VP)

The problem is that /zvuk/, being hard, should select the hard allomorph of the affix, [-ech]; in which case the rule of 2VS, which applies before /i/ would be bled. Thus */zvukech/ would be derived. To solve this, Spencer proposes that at stake here is not (just) *suffix* allomorphy, but *root* allomorphy. In effect /zvuk-/ has a (soft) allomorph

---

provide it here.

/zvuc- $_{prep.pl.}$/. That is, hard velar stems shift into the soft stem category for one inflectional form, and thereafter select a soft suffix. (This root allomorphy is captured by a "morpholexical" rule operating on roots in the lexicon). Furthermore, Spencer maintains that morpholexical rules, relating two root allomorphs, rather than cyclic phonological rules in which suffixes condition changes on a single base form of a root, should be the default way to model all such alternations.

Applying this to our Polish case would lead us to assume two allomorphs, os – and oç$_{dative}$—, the latter an exception derived by morpholexical rule. Spencer 1988a is thus close to Kaye 1995 in the modeling of allophony/allomorphy.

However, the Czech case differs from Polish in that there is a regular productive process (to which the Prepositional Plural seems to be, on the surface at least, a clear exception) whereby the root-final consonant is involved in selection of the suffix allomorph. This makes it clear that Czech root-final consonants are the trigger for allomorph selection (involving allomorphy of the suffix, that is) i.e. that they are "grammatically active". Making this sound shift a function of root allomorphy is clearly justified here, therefore. In this case, 2VP really seems to have stopped acting as a phonological rule: the co-occurrence of soft root-final consonant and soft suffix in /zvucich/ must be, as Spencer shows, agreement between two allomorphs, one a root allomorph and the other a suffix allomorph. Both the latter exist separately in the lexicon and are paired together by the rule of root-suffix agreement. The two processes of "soft/hard suffix selection" and 2VP seem to have collapsed into one: suffix selection.

However in our Polish example, a sound change must have originally shifted /s/ to /ç/. The latter is, after all, not just another randomly selected segment, which could have been /p/ or /f/, for example. True, /ç/ is also phonemic in Polish. But then so is /ʃ/ in English, and that is the result of a process which takes place within the word, and so cannot be a result of root allomorphy. In our Polish case, the dative /e/ suffix has no allomorphic alternant but is uniform when appearing after labial, coronal or velar consonants. And it is the realization of the velar or coronal consonants which is variable in the context of this invariable suffix. I would thus argue that here, change should still be modeled as proceeding from the invariable suffix to the varying root consonant[17].

[17] I thus posit that there are morpholexical as well as "cyclic" phonological processes.

Thus, the change in a root-final consonant which is affected by a suffixal vowel is a phonological event, in the present construal of the interface. However, the phonological constraint that encodes it is included idiosyncratically in the morphophonological specifications of the suffix – which means that not all vowels containing [I] will trigger this phonological event. This in turn means that the constraint does not need to be relegated to another level to prevent it taking place in inappropriate contexts. So the need for levels or rule-ordering is dispensed with.

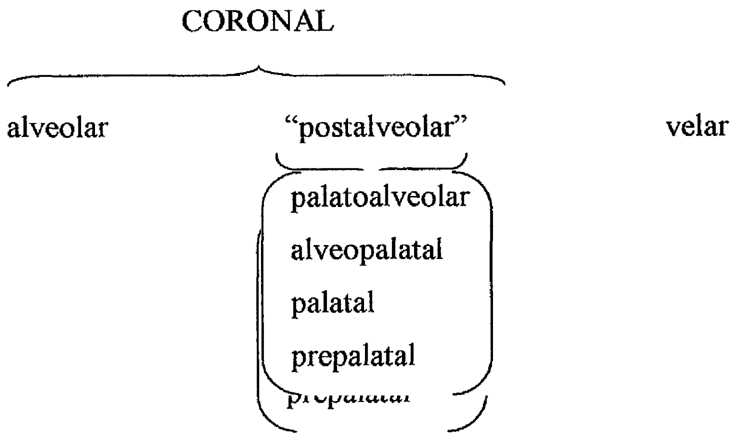
In sum, I reject the GP, ML and LP approach to modeling different types of sound change – or rather, take points from all three approaches. Unlike LP, I posit no strata or strata-ordering. Unlike GP/LP, I do not assume all structure-changing alternations are automatically outside the remit of phonological constraints. Like LP, though, I assume there are rules which are more powerful (alter more structure) than others. But like GP I assume these rules should be modeled as a raft of constraints which apply simultaneously rather than serially. (The specifics of this will become clear when the formalism is given in 3.7).

We will now return in more detail to the question of the phonetic interpretation of [I] in head and non-head role.

2.8 The phonetic interpretation of [I] in head and non-head role

In the previous section, I argued that in order to capture both palatalization and coronalization facts, as well as front vowel~coronal consonant interaction, we have to assume that palatal and palatoalveolar fricatives and palatal stops are coronals. Obviously, alveolar stops are coronal as well. This means that I assume the following division of Place:

(41) The phonological division of Place (coronal and velar only):



Alveolars are simply I-headed, and post-alveolars contain [I] in complement role as well. If we translate this proposal into the tree formalism for heads and non-heads that we posited in 2.3, this will look as follows:

(42) alveolar Place postalveolar Place

Before, we posited that elements [A] and [U] were nonheads. This remains. (In this tree these elements are included in brackets merely to mark the possible positions). But the tree now encodes that the head node itself subdivides into a head and nonhead node.

At the beginning of this chapter, we assumed that phonological features are acoustic, with articulation serving as a means to produce the relevant acoustic target. The term "post-alveolar" thus serves a short-hand for a set of acoustic effects, and as we would expect, there might be sub-place variations in the general post-alveolar region which yet converge on the same acoustic target. This is backed up by phonetic studies and distribution facts.

Take the case of Malayalam. This language has a stop which is represented variously as /c/ (Goad & Narasimhan 1994) or /t̠/ (Mohanan & Mohanan 1984). In traditional sources it is described as being palatal. Mohanan & Mohanan 1984 describe it as palatoalveolar, Goad & Narasimhan as prepalatal. We thus have three of the four possible labels I noted under "postalveolar". Dart & Nihalani (to appear) took linguograms and palatograms of nine Malayalam speakers with simultaneous audio recordings, and found that the passive place of articulation for this segment was: alveolar! It differed from the so-called "real" alveolar stop in having a longer constriction and different formant transitions, indicating a higher tongue position behind the place of constriction. It is thus best described as a lamino-alveolar[18].

Dart 1993 looked at stops and fricatives in O'odham (a Uto-Atzecan language). Here there are segments normally represented as /c/ and /ɟ/, labels which in the IPA chart signify voiceless and voiced palatal stops. Again these segments were normally lamino-alveolar. However one speaker produced /ɟ/ with a lamino-*dental* articulation which was similar to that used by other speakers for their dental stops. But, to quote Dart: "the formant transitions cues for the two different segments were not the same and resembled more the transition values of the other speakers for each specific segment, although produced with different constriction types. Thus two segments may have the same articulatory description in terms of place of articulation and apicality and yet be very different acoustically because of other differences (e.g. pharynx width, jaw opening, tongue height behind the constriction) (ibid. 30)".

Meanwhile Maddieson 1984 and Kingston 1993 (among others) point to the non-occurrence of palatoalveolar affricates (/tʃ/) with palatal stops (/c/) in single languages. And we have seen how there is a maximum of two fricatives in this region, which always contrast in stridency. The above adds to this picture that these articulatory distinctions are not even the criteria by which contrasts are created (hence it is not surprising that contrasts along these lines are not created). But the question then is: what are these criteria? That is, in our terms, what acoustic property defines segments in this region, or, what is the phonetic interpretation of the structure we have argued on phonological grounds to be (I̲.I.ʔ) ?

The key to this is realizing that palatality and coronality are two sides of the same coin phonologically *and* phonetically. In standard element theory the palatal glide and high vowels front vowels contain [I]. Palatalization-1 and –2, coronalization and coronal vowel fronting meant that we made coronal consonants contain [I] as well. The phonetic property which [I] in head and non-head role share is acuteness (pace

[18] The articulatory property of laminality is also flawed as a phonological label, as I discuss shortly.

Jakobson, Fant & Halle 1952), or as Stevens and Keyser 1989 phrase it, coronal can be defined as "whether or not the speech stream is punctuated by a region in which the high frequency energy (as represented in the auditory system) stands out from its immediate context." This characterizes the palatal glide as well as the alveolar stop. Stevens & Keyser 1989 adds a further interpretation to this phonetic characterization of the alveolar stop and palatal glide.

In the theory put forth in this paper, there is a set of three primary features ([coronal], [sonorant] and [continuant]) which, being bivalent, combine to generate eight segment types. The feature matrices for these segment types are then enhanced by secondary features [high], [back] and [anterior]. The primary features of the palatal glide and coronal stop have the following values:

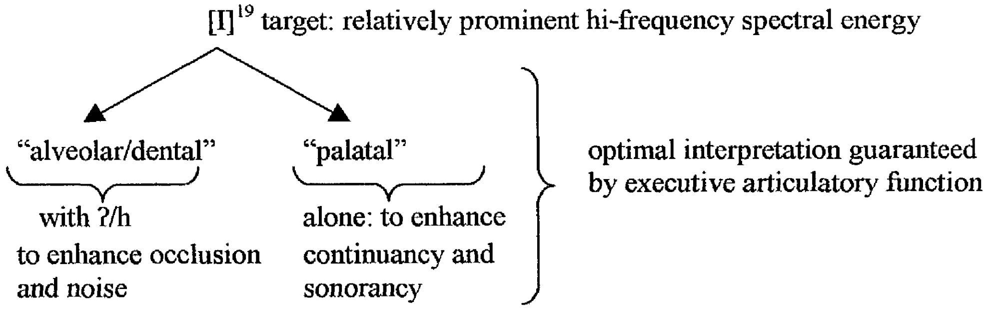
(43)

	[cont]	[son]	[cor]	segment type
1	+	+	+	J
7	-	-	+	T

Enhancement of these primary feature combinations depends on the manner and place of articulation. Thus a coronal continuant will have different enhancing features than a coronal stop. The quality of continuancy is enhanced by making the constriction used in forming continuant segments longer and their release slower, while the opposite holds for non-continuants, whose best method of execution is a short constriction with abrupt release. For coronal segments, long constriction and slow release are best achieved in the posterior [-anterior] region of the mouth, while short constriction and abrupt release cueing occlusion are best achieved in the anterior region. Pronunciation of the basic configuration for /t/ will thus be "enhanced" by addition of the secondary feature [+anterior]. Pronunciation of the basic configuration for /j/ (which is [+coronal, +sonorant, +continuant]) will be enhanced by the addition of [-anterior].

Articulatory enhancement, as far as we are concerned, is not a phonological matter, but rather the duty of phonetic interpretation. But Stevens & Keyser's theory explains how J and T can be phonologically the same, while being in articulatory phonetic terms seemingly different. In element-theoretic terms, we are saying that the phonetic interpretation of [I] varies depending on what other elements it combines with; schematically:

(44)



So-called palatals (palatoalveolars, alveopalatals, prepalatals, "post-alveolars", or lamino-alveolars) are then segments which combine properties of [I] in its headed phonetic interpretation, and in its non-head interpretation: that is, if they are stops, they will be slowly released stops, articulated partly in the anterior and partly in the posterior region of the palate. And indeed, Dart comments on how the "palatal" stop in Malayalam and in O'odham has a slower release than other coronal segments, which has the effect of affrication. This is partly a function of the long and heavy laminal constriction which characterizes these stops. In English of course the palato-alveolar /tʃ/ is always referred to as an affricate.[20] The slight differences in execution of these different segments does not obscure their phonological unity.

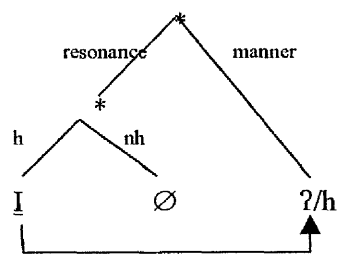
This modeling solves one final conundrum noted in the phonetic literature on palatal stops. As we saw, Blumstein 1986 considered palatals to be phonetically intermediate between coronals and velars, being both compact and acute. Dart & Nihilani (to appear) comment that the laminal alveolars of their Malayalam subjects display a slight convergence of F2 and F3, and comment that this makes these segments intermediate between alveolars and velars. Van der Weijer 1994 adopts a similar modeling in making palatals consist of A and I. However, convergence of F2 and F3 does not invariably cue velar place. Stevens 1998 notes a general raising of all the formants for the palatal glide (cueing coronality, according to Stevens and Keyser 1989's definition). Yet he also notes (ibid: 528): "the higher frequency dominance [of /j/] is achieved because F3 is adjusted to be higher and closer to F4 (*or in some cases lower and close to F2...*)"(Italics mine). That is, as long as F4 is high, there is some

[19] We can call (I) the "corono-palatal" element, therefore.

freedom in the transition shapes of the middle formants; a closing in of F3 and F2 does not obscure the cues of the palatal glide. Detection of these cues in the palatal stop is thus consistent with its classification as a coronal (= high energy) segment.

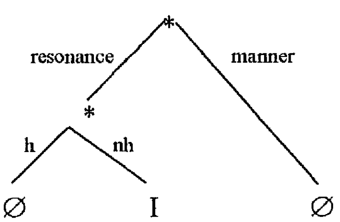
Thus [I] in head and non-head role has a slightly different articulatory and acoustic interpretation. This depends on the other elements which it combines with. We can translate this into the notion of licensing relations holding between [I] (and ultimately the other resonance elements) and the manner elements it combines with. In tree form this looks as follows:

(45)



= T/ S

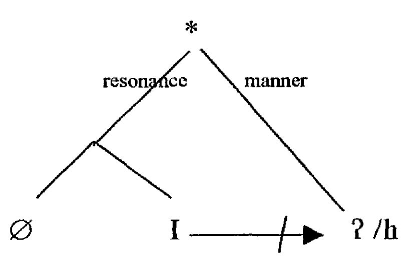
(46)



= J

In (45), [I] is in head position, so that it can govern the manner elements, [ʔ] or [h]. In (46), [I] is in non-head position, as there is nothing in the manner phrase to govern. A tree in which non-head [I] occurs with manner elements, as in:

(47)

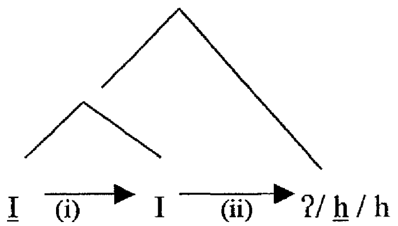


[20] On the modeling of affricates, cf. Ch.3.

can be ruled out on the grounds that these manner elements are not governed by the resonance element. That is, there are conditions on the well-formedness of subsegmental trees. These conditions will be explored at greater length in chapters 3 and 4.

Finally, our various "palatal" segments will look as follows:

(48)



= /c, ç, tʃ /

Here, nonhead [I] is licensed by head [I], and having been so licensed, it in turn licenses the manner elements. In our above modeling of the /s/ → /ç/ change in Polish, we said that nonhead [I] failed to license the noise element as head, being empowered only to license it in nonhead interpretation. Details of this will be given in Chapter 3, where the manner-resonance relationship will be explored more fully. However, it can be seen more clearly now that this involves the licensing relationship labeled (ii) in (48).

2.9 Laminality

In the previous sections, I gave a modelling of palatalization phenomena. Since S.P.E., generative phonologists have held that recourse to the feature [+/- distributed] is necessary to capture natural classes among coronals (e.g. Steriade 1986, Lahiri & Evers 1991, Gnanadesikan 1993, Goad & Narasimhan 1994). This feature refers to whether coronal consonants are articulated using the tongue-tip, in which case they are apical, or the tongue-blade, in which case they are laminal. Hamilton 1993 uses two monovalent features, [apical] and [laminal], to capture the same distinction. From our point of view, it is somewhat dubious to make recourse to these features as they are articulatory, and we argued that phonological features are "audio-cognitive". Earlier we mentioned how Dart's investigations showed that passive Place is tangential to a true characterization of invariant properties of stops in Malayalam and O'odham. The same is true of laminality and apicality. Let's briefly see why. Standardly, dentals and palatals are said to be laminal, while alveolars and retroflexes are apical:

(49) standard classification of coronals by laminality:

<u>laminality:</u>	laminal /t̪/	apical /t/	apical /ʈ/	laminal /c/
<u>passive place</u>:	dental	alveolar	retroflex	palatal

Yet, Dart & Nihilani (to appear) show that in Malayalam the dental is apico-laminal (and not just laminal) and the retroflex is either sublaminal or apico-sublaminal (not simply apical). Thus segments are articulated with a mixture of blade, tip and underside of the tongue. A feature like [laminal] seems to crude to capture this. There is greater correlation between mean tongue length constriction and the dental/palatal vs. alveolar/retroflex distinction. The "laminal" dental and palatal have constrictions of 12.33mm and 10.33 mm respectively, while the "apical" alveolar and retroflex have constrictions of 6.44mm and 3.5mm. But is this really significant phonologically? The mean closure duration for the retroflex and palatal is 250 ms and 230 ms, while that for the alveolar and dental is 165 ms and 210 ms. Likewise in terms of VOT, the palatal stop is in a class of its own with respect to the other coronals, having by far the highest value for this variable (ibid 16). In other words, it is possible to make quite different groupings among the four coronal stops if we select other articulatory dimensions. Dart 1991, which compares French and English coronal stops, found that while there is some statistical truth in the traditional contention that French stops are lamino-dental and English ones apico-alveolar, at the individual level there is much variation in laminality and apicality. However, importantly, there is no *acoustic* variation at the individual level. Again, we see that the acoustic percept rather than the articulatory means is what is crucial in classifying sounds.[21]

Before we start modeling alternations among coronals, we will give our own representations of the various coronal stops.

These are:

(50)

/t̪/	/t/	/ʈ/	/c/
(I̲.U.?)	(I̲.?)	(I̲.A.?)	(I̲.I.?)

We have already motivated our representation of the "palatal" and the plain alveolar stop. Having only two more resonance elements in our repertoire, the simplest assumption to model further coronal subplace distinctions is to make one stop "U-ful" and the other "A-ful".

Several facts show that this modeling is along the right lines, though it must be admitted that assigning [A] to the retroflex and [U] to the dental, rather than the other way round is somewhat arbitrary at present. The facts are: in Lardil, alveolars become dentals before /u/ and /a/ (Gnanadesikan 1993). In Kodagu, a Dravidian language, the vowels /i/ and /e/ developed back, unrounded alternants when they preceded the retroflex stop (ibid). And in Malayalam, the retroflex and the dental are the only coronal stops not to front the epenthetic neutral vowel (Goad & Narasimhan 1994). This can be modeled transparently if we assume there is something blocking the spread of the coronal stop's frontness/coronality or I-ness onto this vowel (as I will show later in more detail). However, there is evidence that retroflexes are also linked to the vowel /u/: in Walmatjari (an Australian Aboriginal language), retroflexes become alveolars after word or morpheme boundaries, unless followed immediately by /u/ or /a/ (cf. Gnanadesikan 1993). While this might suggest that dentals and retroflexes both contain [A] and [U], perhaps in different head/complement roles, we will stick to the present assignations here. What's important is that the "central" coronals, the alveolar and retroflex, are no longer defined as a class against the

[21] This means that we will not spend time discussing the validity of [back], [high], and [anterior], which have been proposed as secondary features to model the properties of the alveopalatal, retroflex, dental and so on (cf. Gnanadesikan 1993 for discussion).

"peripheral" coronals, the dental and palatal. We will thus have to find alternative, convincing modelings of processes said to motivate such a division.

2.10 Australian and Malayalam

Examples involving laminal and apical patterning generally come from Dravidian or Australian Aboriginal languages (e.g. Gnandesikan 1993, Goad & Narasimhan 1994, Hamilton 1993, Dixon 1982), not surprisingly as these languages display the typologically rare property of supporting four coronal subplace contrasts, namely those shown in (54). We will look at Australian first.

2.10.1 Australian

The best summary of laminal versus apical distribution comes from Hamilton 1993. He states the distribution of these segment types as markedness statements. Following Dixon 1982, Hamilton identifies five consonantal sites in the Australian word, each of which has its own phonotactic properties. These five sites are: initial consonant (C_{init}), intervocalic consonant (C_{inter}), final consonant (C_{fin}), and consonants in word-internal clusters, which are referred to as C_1 and C_2.

We will ignore C_{inter} here and concentrate on the other sites. The phonotactics of C_{init} and C_2 recapitulate each other, as do those of C_1 and C_{fin}. They are manifested as a hierarchy of Place preference, as follows:

(51)
(i) C_{init} and C_2 : labial > velar > [laminal > apical]$_{coronal}$
(ii) C_1 and C_{fin} : [apical > laminal]$_{coronal}$ > velar > labial

An additional Place preference hierarchy gives rise to the following order of elaboration in internal clusters:

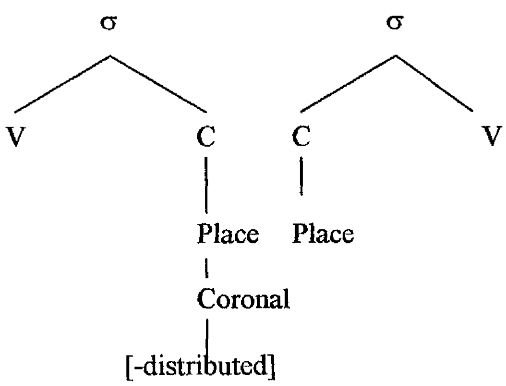
(52)

...V	C_1	C_2	V....	
	apical	noncoronal		↓ increasing markedness
	apical	laminal		

In 51i (to illustrate) the > means that across the Australian Aboriginal language group, any one language will not have an apical in C_{init} or C_1 if it does not already allow a laminal in this site, and so on. (That is, these are Jakobsonian markedness implicationals). In 52, we see that the preferred place for C_1 is an apical, while C_2 prefers noncoronals followed by laminals. Now coronals group together in Australian (for example some languages only allow coronal consonants word-finally, whether apical or laminal), so these patterns are evidence of a further natural division among coronals into laminal and apical, which are manipulated differently by the phonology.

In Feature Geometry accounts, it is easy to state a constraint banning laminals or apicals in the relevant site. For example, Gnanadesikan 1993 proposes the following constraint for languages like Toda and Yidinyi:

(53)



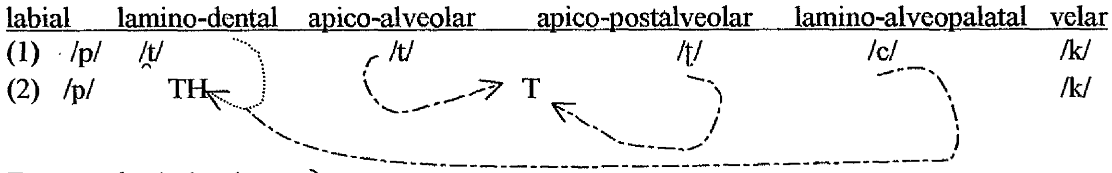
But in our element-theoretic representations, laminals are not a natural class:

(54)	dental + palatal: [+distributed];	alveolar + retroflex: [-distributed]
	dental + palatal: [I.U], [I.I]	alveolar + retroflex: [I.], [I.A]

Further evidence of the relatedness of laminals as a class versus apicals is said to come from the phenomenon of Mittelding[22] in Australian Aboriginal languages, whereby in langauges with only 2 of the 4 coronal stops apicals are intermediate between retroflex and alveolar articulation, and laminals are intermediate between dental and alveopalatal articulation (cf. Butcher 1982, Hamilton 1993). This table illustrates the situation:

[22] The term, roughly meaning neutralization, comes from Trubetzkoy 1938.

(55)



T = neutral apical series
TH = neutral laminal series

If one assumes that dentals and palatals are both [+distributed] and differ only for the value of another subplace feature [back] (*pace* Gnandesikan 1993), then one can derive this pheonomenon by saying that 2-coronal languages do not specify for back, so that only one [+distributed] and one [-distributed] coronal stop emerges.
However, the situation is not so simple, and adequate generalizations can be made with the representations we have posited.
Firstly, in Tamil there is a ban on word-initial apicals, and a word-initial apical is realized as a dental (Christdas 1988). This process, shown here

(56) */t/ → /t̪/

would have the following representations. In a model using the coronal subplace features [anterior] and [distributed] (pace Steriade 1986) we get:

(57) [+anterior, -distributed, coronal] → [+anterior, +distributed, coronal]

With Ganadesikan's features, [distributed] and [back], we get:

(58) [-distributed, -back] → [+distributed, +back]

Both these modelings have to state a constraint enforcing the appearance of [+distributed] word-initially. The question is how to stop the alveolar being realised as a palatal stop; Steriade can do this by recourse to [anterior]. However, use of this feature predicts that [-anterior] coronals, the palatal and the retroflex, form some sort of a natural class, which does not seem to be the case. Gnanadesikan can get the change by use of [distributed]; however to avoid the same outcome, the feature of [back] must change as well. Thus we end up stating a constraint stating [coronal] → [+distributed, +back] word-initially. In element-theoretic terms we would have to state a constraint introducing [U] as a secondary resonance element on all word-initial alveolars, getting:

(59) * (I.?) → (I.U.?)

All three options seem as arbitrary as each other; perhaps this alternation is indeed arbitrary (bar the preservation of coronal place).

If this is the case, then we can propose the same modelling for the phonotactics of C_2 in (52). Here we can state a constraint:

(60) (I.) in C_2 → (I.U) or (I.I).

Despite Hamilton's contentions, there are in fact Australian languages (for example, Kayardild, Hamilton 1996) which allow all coronals to start a word except the alveolar. Again, this contravenes any simple constraint making recourse to [distributed]. A constraint in these languages would look as follows:

(61) (I) in C_{init} → (I.A) or (I.I) or (I.U)[23]

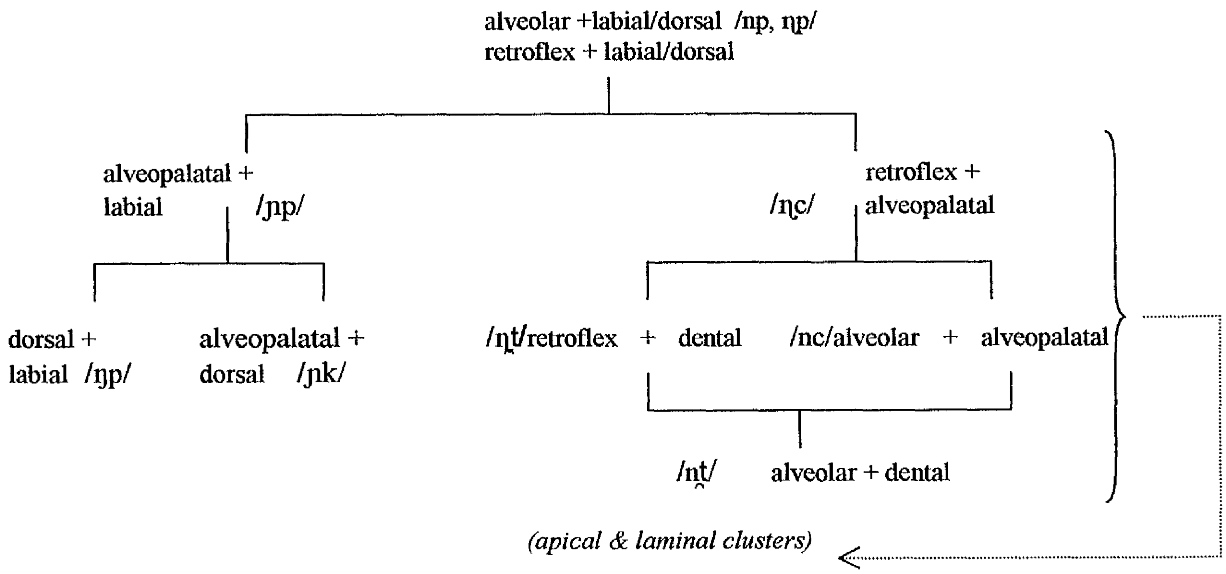
But the situation is more complex than this. Hamilton 1996 gives a precise table of C_1C_2 place phonotactics as follows, repeated here as (62) below.

As can be seen from the table, the reputedly natural class of laminals once again do not seem to pattern together. Alveopalatals are allowed in C_1, if followed by a noncoronal. Dentals, however, do not appear in C_1, unless they are dental nasals which have assimilated to dental oral stops in C_2. As far as apicals are concerned, neither retroflexes or alveolars can appear in C_2 – unless, that is, they are preceded by homorganic nasals in C_1. We will capture this situation not by assuming that there is a blanket ban on alveolars and retroflexes in C_2, but rather by assuming that these segments lose their identity to preceding segments of different subplace specifications. Likewise, we will not state a ban on alveopalatals in C_1 (of the type

[23] This could be reformulated a constraint banning an I-headed segment from appearing in C_{init} without licensing a resonance complement. This would be plausible if we imagine C_{init} to be a stong prosodic site which favors strong subsegmental content.

*[+distributed] in C1), as they do appear before noncoronals in C_2, but only a ban on dentals (which never appear regardless of the following consonant type).

(62) Path of elaboration of consonant clusters: place contours (Hamilton 1996:111):



Finally, there will be no need to ban alveolars from C_2, only retroflexes. Our constraints and their effects will look as follows.

Dentals are banned from C1 and retroflexes are banned from C2 by the following constraints:

(63) *U in C_1

*A in C_2

Languages on the right hand side of the chart will also have a constraint

(64) spread I from C_1 where possible

This will have the effect that where an alveopalatal is followed by another coronal, that coronal will surface as an alveopalatal:

(65) (i) (I. I) + (I) → (I.I) + (I.I) [ɲ.t → ɲ.c]

(ii) (I. I) + (I <U>) → (I.I) + (I.I) [ɲ.t → ɲ.c]

In 65i, nonhead [I] simply spreads into the vacant nonhead Place node; in 65ii it spreads and displaces [U], which is lexically specified to be there. This means that alveopalatals only appear as homorganic pairs, and never followed by another laminal or apicals. However, alveopalatals will be allowed to precede *non*-coronals, because the elements [A] and [U] in their head roles (i.e. velarity and labiality) are unable to license a secondary Place element: [I] must "dock" on a licensed node[24]. In other words, the constraint is to be interpreted that [I] spreads if and when it can.

In the present analysis, then, there is not a blanket ban on laminals in C_1 – this would make a generalization about the patterns on the left hand side of the chart impossible; rather the alveopalatal is modeled as having particularly dynamic secondary Place, which overrides any heterorganic subplace element.

One more constraint needs to be stated for the distributions on the right hand side of the chart. The constraints in (63) barring dentals from C_1 and retroflexes from C_2 still allow heterorganic apical + laminal clusters, such as an alveolar in C_1 and a dental in C_2. But languages only allow such clusters (at branching 3 on the right hand side, for the aforementioned example) if they already have the other apical-laminal clusters shown (such as retroflex + alveopalatal). To derive this, we can assume that any dental or alveopalatal in C2 spreads its secondary element leftwards, so that an alveolar or retroflex segment in C1 surfaces as homorganic to the following stop. That is, such languages have the following constraint:

(66) spread I and U leftwards from C_2 to C_1

Then only "apical" + noncoronal sequences will be permitted (such as we see at line 0). For a language which allows a retroflex + alveopalatal or dental, spread of [I] or [U] is blocked if the secondary Place node is filled, as it is in the case of the retroflex – with [A]. Such languages, we can say, do not countenance delinking of lexical elements to make way for the incoming spread element. Finally, if constraint (66) is absent, dentals and alveopalatals will be allowed in C_2, and they will be preceded by retroflexes and alveolars in C_1.

The elaboration of Place in C_1 and C_2 can thus be derived using the representations of coronals we have argued for, plus 5 simple constraints, 3 of which hold for all the Australian languages, and 2 of which are subject to parametric variation.

(67) Universal: (i) *U in C_1
(ii) *A in C_2
(iii) spread I from C_1 to C_2

(68) Parametric: (iv) I and U spread from C_2 to C_1: Y(default)/N
(v) delink A: Y(default)/N

The modeling is simple and economic, and does not need to make recourse to the [+/-distributed] feature (indeed is better off without it). Rather, it depends on making the alveolar the structurally simplest coronal, which can assimilate to other coronal subplaces, and stating simple constraints on the occurrence of the other subplace elements.

Note that these constraints are stated on the occurrence of [A] or [U] in certain sites; [I] is free to appear anywhere and is outstanding for its dynamic behavior. This is in keeping with the fact that [I], whether in head (coronal) or nonhead (palatal) role belongs to the head phrase of the Resonance phrase for elements, unlike [A] or [U]. Heads of course are expected to have greater powers than nonheads. We will return to this in coming chapters.

2.10.2 Malayalam

In this section, we will see how our representations of coronal subplace also captures a process of central vowel fronting in Malayalam, described by Goad & Narasimhan 1994 (G & N). They give the data as follows (table taken from their paper; the phonetic classification will be commented on shortly):

---

[24] More on the motivations and modeling of this in Ch. 3.

(69)

a. Epenthic /ɨ/:

CORONALS

Lamino-dental	Retroflex	Apico-alveolar	Prepalatal
kat̪t̪ɨ "letter"	kaʈʈɨ "show"	kaatti "wind"	wačči "watch"
an̪n̪ ɨ "that day"	kaɳ (ɨ) "male"	ponni "gold"	
	awaɭɨ "she"	kalli "stone"	

Lamino-alveolar

wayaṟɨ	taa_ ɨ "bend"		kuliř i "cold"
paasɨ	maaʂ ɨ		ka š̃i "cash"

PERIPHERALS

Velar	Labial
paakkɨ "betel nut"	parippɨ "lentil"

b. Fronted a:

CORONALS

Lamino-dental	Retroflex	Apico-alveolar	Prepalatal
kut̪t̪-al "to stab"	k'eʈʈ-al "to tie"	aatt-ɛl "to cool"	
			řema "Rama" (rama *in Tamil*)

PERIPHERALS

Velar:	Fronted velar
wikk-al "to have a lisp"	wek'k'-ɛl "keep"

As can be seen, the following process occurs:

(70) a. [ɨ] → [i] after /t,c,k'/

b. [ɨ] → [ɨ] after /t̪ , ʈ, p, k/.

In Goad & Narasimhan's classification, that is, the central vowel fronts and raises after the apico-alveolar, the prepalatal stop and the fronted velar. Peripheral stops, lamino-dentals, lamino-alveolars and retroflexes all fail to front [ɨ]. Without going into their proposals in detail, G & N derive this by saying that only apical coronals share a quality with front vowels, while laminal and other coronals do not. (This is a modification of Hume & Clements' contention that *all* coronals are linked to frontness in vowels). However, G & N's classification of coronal subplace is inaccurate: they want the retroflex to be non-apical; but we saw that according to Dart & Nihilani's measurements, the retroflex is in fact non-distributed and as "apical" as the alveolar. The so-called prepalatal stop [c], on the other hand, which D & N classify as front/ apical (exchangeable terms in their framework), is in fact phonetically *lamino*-alveolar. The correlation between ability to front vowels and apicality/laminality is thus false.

We can represent the relevant segments of Malayalam much more accurately phonetically, and we can also give a simple and transparent account of the vowel fronting process.

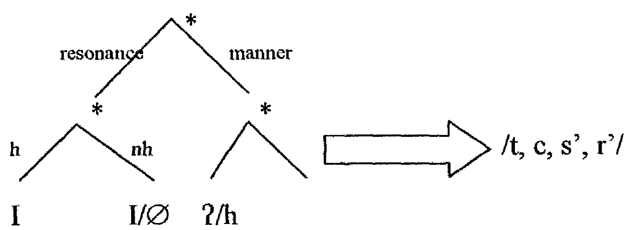
Our representation of the various segments in Malayalam, will look as follows, divided into a fronting and non-fronting class on the basis of the evidence in G&N:

(71)

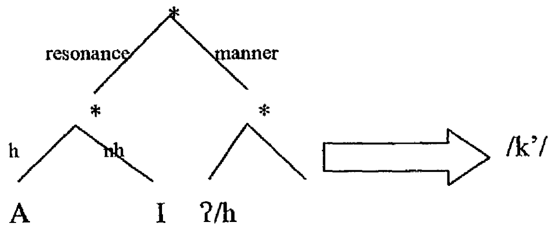
Fronting class	Non-fronting
/tt/ (I.ʔ)	/t̺/ (I.U.ʔ)
/c/ (I.I.ʔ)	/ʈ/ (I. A.ʔ)
[/r'/ (I.A)	/r/ (A.I)]
/s'/ (I.I.h)	/s̺/ (I.U.h)
	/ʂ / (I.A.h)
/k'/ (A.I.ʔ)	/k/ (A.ʔ)
	/p/ (U.ʔ)

What unites the fronting class can be seen most clearly by representing the internal structure of the segments in tree-form:

(72)

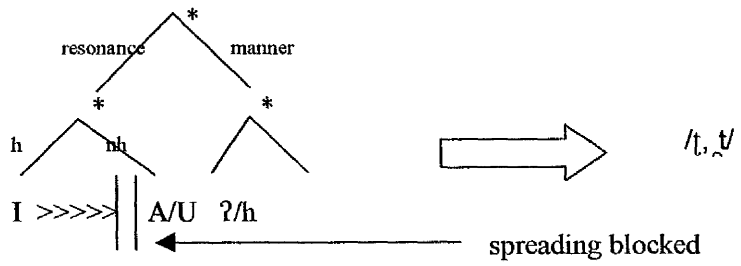


(73)



The non-fronting class, meanwhile, have a [A] or [U] in non-head of resonance, will look as follows:

(74)



These representations allow us to state the conditions of /i/-fronting in Malayalam in simple autosegmental terms:

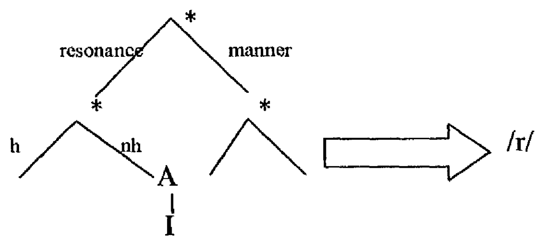
(75) I-spreading in Malayalam:

I spreads from head or nonhead position into a following empty nuclear expression. Its spreading is blocked by any resonance element non-identical to itself.

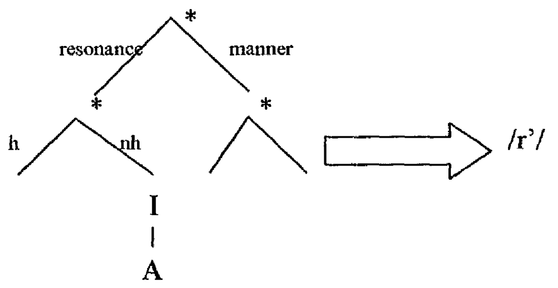
Thus the dental and retroflex stops and fricatives have secondary elements which serve to block the spread of [I] into the next nuclear expression.

The representation of rhotics will be dealt with in Chapter 4 at length, but in anticipation, Malayalam rhotics will be assigned the following structure:

(76) *regular rhotic:*



(77) *palatalized rhotic:*



In (76) [A] is written above [I], meaning that it is head compared to [I]. The opposite is true in (77). We say that [I] only spreads out of the palatalized rhotic where it is dominant over [A].

Our representations thus make /i/-fronting in Malayalam easy to state; moreover they are based on sound phonetics, rather than the incorrect articulatory categorizations of Goad & Narasimhan 1994.

So, once again, as with Gnanadesikan's and Hamiltion's modeling of Australian using [αdistributed] and [laminal], we have found that a feature inventory which omits these features produces just as economical and in some cases a more economical modeling of the facts said to require these features.

Conclusion

In this chapter, we have analyzed several issues involving coronality. Firstly, we saw that the invariable component of segments is their acoustic properties. We thus dismissed analyses in frameworks based on articulatory features, such as the use of [high] by Kiparsky 1986 or [laminal] by Hamilton 1996. The former was to be included in the representation of coronal stops to capture coronalization and palatalization before front vocoids. The latter was deemed necessary to capture differential distributions among coronals in Australian Aboriginal languages. Our task was to replace these analyses using acoustically based elements. We captured

1. how both alveolars and velars could converge on palatals, without the need to introduce a(n articulatory) feature ex nihilo.

2. how all non-alveolar coronal subplaces could and should be collapsed into a single phonological "post-alveolar" subplace;
3. how the phonetics and phonology of this "post-alveolar" place could be captured by assuming it was represented by two occurrences of [I] as head and nonhead;
4. finally, for both the Malayalam and the Australian data we came up with phonologically economic and phonetically accurate analyses that dispensed with the need for [laminal] or [αdistributed].

In the next chapter, we will explore some of the assumptions about headedness and the geometrical grouping of features that to a certain extent were merely stipulated in the present chapter.

Chapter 3 Generating Inventories: Obstruents

In the last chapter, we dealt with how element theory could capture phonological processes such as coronalization, palatalization and so-called laminal~apical patternings. For the first two processes, it was necessary to posit that the coronal element was headed [I̲], with a nonhead congener [I] representing palatality. In 2.3 and 2.6 we commented briefly that [I] was the "natural head" of an element-geometric tree, but we did not encounter any need to explore the repercussions of this. In this chapter, we will look at the shape of obstruent inventories, and note two phenomena which can be modelled by drawing on this headedness of the coronal element:

(1)

a. there are clear evolutionary trajectories along which consonant inventories develop, which concern the Place and Manner of consonants – and Coronality has a privileged status in these trajectories.

b. consonants which are selected preferentially for consonant inventories (or paradigms) – and these are the coronal consonants – have a special status in phonological or morphophonological processes that occur within words and between words and their affixes: the syntagmatic, that is, recapitulates the paradigmatic (*pace* Trubetzkoy).

It is the "paradigmatic" and "syntagmatic" optimality of the coronal place which we will investigate and model using headedness in this chapter. In looking at syntagmatic optimality, we will return to some of the facts concerning palatalization and coronalization that we only mentioned in passing in the previous chapter, and give a full modelling of various phenomena. Firstly, though, we will change the focus somewhat and look at inventories.

3.1 The structure of inventories

Kingston 1993 conducted a statistical analysis of the occurrence of Place and Manner among obstruents in the inventories collected in UPSID (the UCLA Segment Inventory Database, Maddieson 1984). His intention was to show that large inventories differ from small ones not merely in having more segments, but in having entire blocks of segments absent in smaller ones; and also that the segments which are selected to enlarge basic inventories are chosen because they are an optimal mixture of articulation and perceptual effect. That is, for these complex segments the different articulatory gestures are deliberately combined so as to produce a maximally perceptible outcome. In Kingston's terminology, the different gestures "enhance" each other. This theory of enhancement or integration of gestures continues work such as Ohala 1979, Ladefoged and Maddieson 1988 and Stevens and Keyser 1989. Kingston 1993's work is interesting for the patterns that his statistical analysis of UPSID throws up. The functional explanation and even the categorization of some of the data may be incorrect or at least open to interpretation, but some clear tendencies in inventory construction and elaboration stand out.

I will summarise Kingston's findings here, and then discuss how headedness can model them (as well as what this says about the concept of headedness).

Kingston's findings can be summarised in the following table (a format I have chosen to recap his statistics as well as to comment on his terms and methods):

Table 1. Kingston 1993: asymmetries in Place and Manner elaboration in UPSID inventories

1. Major Places and the nature of Place elaboration:

312/317 UPSID languages have stops at the 3 major PoA's (labial, coronal, dorsal)[1]. For languages with more stops, Place expansion can happen in 2 main ways: (i) specialized use of major articulators, where only one major articulator is used, but smaller adjustments are made to the articulation (cf. 2 below); (ii) combination of major articulators, which can take place in 2 ways: (a) both major articulators attain complete closure (e.g. /kp/), or (b) only one does with the secondary articulation incomplete, as in

[1] Feature Geometry (FG) and Element Theory (ET) capture this by making these three Places basic features/elements. Beyond this, as we will see, FG and ET are inadequate in capturing trends in inventory structure.

/k^w/ (labialized velar stop). Kingston introduces a new convention whereby (ii)a and b are both called double articulations, rather than (ii)b being called stops with secondary articulation. See (3) for generalizations about double articulations.

2. <u>Place asymmetries among specialized articulations:</u>

This taxonomy derives from the Feature Geometric categorization and description of Place according to primary features (representing the "major articulators" Coronal, Labial, Dorsal) to which are added secondary features (back, anterior, laminal, etc). Specialialized articulations thus refer to dentals, palato-alveolars, palatals, uvulars and retroflexes. The clear tendency to emerge here is that the number of coronal specialized articulations is double that of velar ones, while labial subspecializations are non-existent. A further order of preference for elaboration occurs within Coronal Place. The palatal stop is the most common addition to an inventory, followed by a retroflex and then a dental. However, the uvular stop (/q/) is preferred over these last two coronal specializations, so the order of preference which emerges can be summarized as: palatal stop >> (uvular stop) >> retroflex >> dental (c >> q >> ʈ >> t̪). Kingston notes that these tendencies go uncaptured by a Feature Geometry approach, which predicts that labial, coronal or dorsal specialized additions should be equally common. We will be discussing and modelling this result later.

3. <u>Place asymmetries among double articulations (ibid. S.3.5: 89 ff.):</u>

a. palatalized alveolars and velars (/t^j, k^j/) do not occur with true palatal stops in the 20 UPSID languages that have these segments, again suggesting that these are different phonetic manifestations of the same underlying phonological entity, or at least have very similar phonological structures (we will take up the nature of this structure later).
b. Such segments are rare: 6 palatalized velars and 12 palatalized alveolars are the figures for UPSID – suggesting that incomplete secondary articulations have a marked phonological structure.
c. On the other hand, incomplete doubly articulated segments involving primary [dorsal] and secondary [labial], or labialization, are relatively common: labialized velars and uvulars (both [dorsal] in FG and in the present version of element theory) together

make up 0.947 of the total of such doubly articulated segments, compared to 0.053 total for labialized alveolars and labials. (Secondary velarization and pharyngealization are so rare as to be statistically insignificant). The reasons for these patterns will be commented on below.

4. The patterning of sibilant palato-alveolars and palatal stops (ibid. S.4.2, p.96 →):

a. palato-alveolar affricates tend not to co-occur with true palatals (/c/); cf. ibid. p.97 proof that statistically there is "less than expected co-occurrence". This implies that phonologically the two segments are phonetic variants of the same place, with the palato-alveolar affricate vastly favored (occuring in 170/317 of UPSID languages). Note that this would explain the relative rarity of an alveopalatal stop at this Place as noted in 1B. In combination with the comments in (3) above, it looks as if there is one phonological space which can support a variety of phonetic options, among which there is the following preferred order of realization: /tʃ/ >> /c/ >> /t^j,k^j/.

   In addition, there is another asymmetry regarding affricates: 0.88 of all affricates in UPSID are coronal, which is another indication of the special status of the coronal place in building and elaborating inventories.

5. Conditions on the occurrence of coronal sibilants (ibid. S.4.2.3, p.99 →):

a. the palato-alveolar affricate (/tʃ/) co-occurs with a palato-alveolar fricative (/ʃ/) and another sibilant affricate (most likely /ts/) more than statistically expected.

b. Regarding /s/: i) it is extremely common in UPSID (occurring in 0.86 of the sample languages); (ii) it is rarely absent in languages that have another sibilant – i.e. the presence of a non-/s/ sibilant implies the presence of /s/ in an inventory; (iii) it is absent 3 times more often in languages with neither /ʃ/ nor /tʃ/. (That is, once /s/ is present, there is a strong pressure to include another sibilant).

c. Regarding b(iii), there is a clear order in which a second sibilant is preferred; however another fact emerges, which is that a 4-sibilant block is the most common tendency in the world's languages. This table (ibid:102) illustrates:

One	Two	Three	Complete
	/s,ts/(31)/	s,ts,ʃ or tʃ/(16)	
/s/(55)	/s,tʃ/(39)		
	/s,ʃ/(18)	/s,tʃ,ʃ/(51)	/s,tʃ, ʃ,ts/(62)

Clearly all-or-one sibilant inventories are more common than intermediate inventories. Further, as Kingston puts it (ibid:102), the intermediate inventories give us "a likely evolutionary course for filling in the sibilant contrast block a segment at a time. The occurence of /tʃ/ does not apparently depend on the prior occurrence of the corresponding fricative /ʃ/, and either of the affricates are more likely to occur as the second sibilant than /ʃ/ and the presence of /ʃ/ implies the presence of /tʃ/." This development trajectory is thus: /s/ >> /tʃ/ >> /ts/ >> /ʃ/. What's interesting about this is what it says about common conceptions of the palato-alveolar affricate /tʃ/. Its IPA notation would lead us to think that it was a combination of /t/ and /ʃ/. This is encoded in the standard (Sageyian) contour representation of affricates as consisting of (homorganic) stop and fricative segments linked to a single timing or C-slot. From this notion, one would think that /t/ and /ʃ/ would be independently needed to build the affricate; Kingston is telling us that inventories more frequently have the palato-alveolar affricate without having the supposedly corresponding palato-alveolar fricative. This necessitates a rethink of the structure of affricates[2].

6. The fricative contrast block (ibid. S.4.2.5: 105 ff.):

a. Kingston shows that the occurrence of non-coronal fricatives /f, x/ relies to a statistically greater than expected extent on the prior presence of a contrast between coronal sibilants /tʃ, ʃ/: "once /tʃ/ and /ʃ/ contrast in a language, slots apparently open up for fricatives contrasting with stops made with the labial and dorsal articulators

[2] Kingston suggests affricates are phonologically stops, backing this up by showing that statistically they pattern with stops in terms of their preference for voicelessness (ibid: 92). We will see other reasons for their phonological stopness later.

(ibid:108)". So, to the trajectory in (5c) can be added /f, x/: /s/ >> /tʃ/ >> /ts/ >> /ʃ/ >> /f,x/.

These results can be further summarised in the following implicational rules (which will be used for ease of reference):

Table 2: Hierarchies and tendencies derived from Kingston 1993

Generalization	**Where derived in Table 1**
(A) <u>sibilant-fricative hierarchy</u>: /s/ >> /tʃ/ >> /ts/ >> /ʃ/ >> /f, x/	[5,6]
(B) <u>[coronal] specialization hierarchy:</u> /c/ >> /ʈ/ >> /t̯/	[2]
(C) <u>nature of phonological alveopalatal place (for stops):</u> (i) alveopalatal place /S/ → tʃ, → c (ii) /tʃ/ a better realization than /c/ (iii) if /t^j,k^j/ not /c/	[4]
(D) <u>double articulation preference hierarchy</u>: (i){/tʃ/ >> /c/ >> /q/} >> (ii){ /k^w, q^w/ >> /t^j/ >> /k^j/ >> /p^w,t^w/ >> /$p^ɣ$,$t^ɣ$,$k^ɣ$/} (i) "complete secondary closure" (ii) "incomplete secondary closure"	[1, 2, 3]
(E) <u>preferred subplace specialization:</u> Coronal >> Dorsal (>> Labial) 2 1 0	[1]

All these tendencies add weight to what has been noted in the phonological literature, that coronals have a privileged status cross-linguistically. We can see more precisely from these results the two areas where this status is manifested: (i) subplace specialization, and

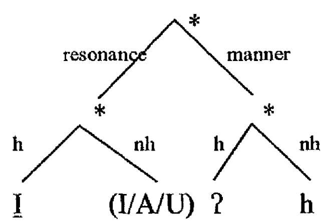
(ii) manner elaboration, where coronal fricatives are a prerequisite in an inventory, laying the ground for non-coronal fricatives.

Later, I will briefly consider Kingston's own explanations and modellings of these findings regarding inventory size and structure, but firstly let us look at how the headedness of [I] now comes into play.

3.2 Element Licensing

In Chapter 2, we said that [I] was head of an element geometric tree and, when discussing Malayalam vowel fronting, we posited representations in which the Manner elements were also arranged under a node, divided into head and nonhead accordingly[3]:

(2)



The headship of [I], we decided, modelled formal licensing properties of the relevant element rather than substantive-phonetic ones (though these properties followed from the unchangeable substantive interpretation of [I]). To recap, the headship of [I] means:

a. [I] is generated first, on the assumption current in syntax and phonology that heads are objects which are more essential/ less dispensable than non-heads. A language will start generating objects which are filled with [I].
b. [I] has greater licensing powers than [A] or [U]; that is, [I] can take [A] or [U] as complements, but not vice versa.

The headship of [I] thus buys us the frequency of coronals and the richness of coronal sub-place, which we will see go together. This is because

[3] More evidence for this Manner node will be looked at later.

(3) a. as noted in (a), a language will generate (I.?) (= /t/) before (A.?) (=/k/), and

b. objects such as (I.A.?) and (I.U.?) and (I.I.?), (retroflex, dental and "palatal" coronals respectively) are possible, whereas (U.A.?) and (A.I.?) are not[4].

In other words, the Place elements (and the Manner and Laryngeal elements, which I will not examine till later) have differential licensing powers, observable in the relative markedness of segments in inventories. Let's expand on this idea, first of all by looking at why (I.?) will be generated before (A.?) and how [A] or [U] as nonheads get into head position. We will also start to examine why the head [I] can license [h] as head (giving stridency), while [A] and [U] cannot.

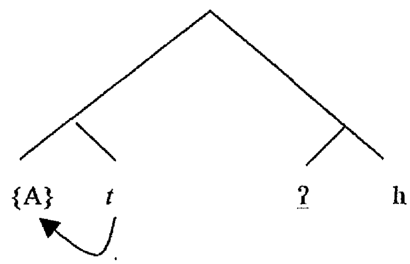
3.3 Natural heads and derived or moved heads

It can be seen in the above tree that [I] appears in head and non-head position. As argued in the last chapter, this gives the difference between [I] in its alveolar stop and palatal glide realization. This is another aspect of the greater flexibility of the "corono-palatal" element . However, [A] and [U] can also fill the head-position of the Place Phrase. If we adopt the metaphor of "movement" from Government & Binding syntax (Chomsky 1986, Haegman 1994), we can say that {A,U} have to move in order to fill this position. This is a way of capturing in our phonological grammar that labials and velars are more marked than, or are generated later than, coronals (and as we will see in later chapter that coronals can appear in positions in the word barred to peripheral segments). One may object that as {p, t, k} are basic segments, there is no motive for assuming that /t/ appears before /p, k/. It is well know, however, that /t/ behaves in an unmarked way compared to /k/: for instance, it can appear as the second member of a coda in stop-stop sequences in English (so /apt/ but */atk/, cf. Yip 1991, for example). One can argue that there are many other instances where the coronal stop behaves in a less marked way than the non-coronal stops, and I will do just this in Chapters 5 and 6. Taking this somewhat on faith here though, we are justified in assuming the unmarkedness of /t/ versus /k, p/ from prosodic

[4] see below for why exactly not.

distributional evidence, and thus motivating the prior generation of the coronal stop which making it a "natural head" gives. The representation of a non-coronal stop with "movement" will look as follows (I will ignore the manner phrase for the moment):

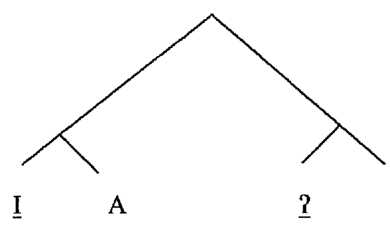
(4)



→ representation of /kʰ/

The curly bracket round {A} indicates a moved element. Now, if [I] is already filled [A] cannot move into it. But [I] can dominate [A] or [U] from its natural (base-generated, one might say, following the GB parallel further) head position. This will give us, for example, the retroflex coronal that we encountered in Chapter 2:

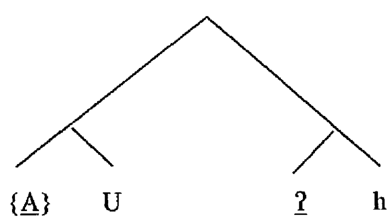
(5)



→ representation of /ʈʰ/

Also possible under this schema is the following object:

(6)



→ labiovelar stop /kp/

Here [A] has moved and dominates, or governs, unmoved [U]. If we look at (6), we see that [A] is to [U] as [I] is to {A,U} – namely, there is a head-nonhead asymmetry among the peripheral (velar and labial elements). This asymmetry, which the system seems to predict on purely formal grounds, does seem to be motivated empirically: there is a labio-velar stop, but not a stop with the reverse ordering: *pk. We also predict the existence of an object ($\underline{A}$.I.ʔ.h), where [A] dominates non-head [I]. Given that in the last chapter we decided that the palatal glide was phonologically a coronal, we want IPA /c/ to be ($\underline{I}$.I.ʔ.h): the question then arises what possible interpretation ($\underline{A}$.I.ʔ.h) might have. In chapter 2 we saw a prime candidate: the fronted velar /k^j/ of Malayalam – which is one of those statistically rare languages supporting a palatal stop as well as a palatalized velar.

Thus we have seen that an element geometry incorporating different headship and thus selectional properties of elements, coupled with a notion of element-"movement" can derive some simple patterns concerning (a) markedness and (b) subplace richness. We will return to the patterns in inventories later on.

As a last point, the advantages of this element geometry are that the unmarkedness of [I] is not derived through making [coronal] underspecified in a segment, to be inserted by redundancy rule at a later point in a serial derivation (*qua* Underspecifcation Theory, cf. contributions in Paradis & Prunet 1991). This has the disadvantages, noted in the literature (cf. McCarthy & Taub 1992) of creating derivational paradoxes, and increasing the distance between underlying and surface forms. A GP theory-internal reason for eschewing this approach is that the Projection Principle (cf. Chapter 1) is compromised. This was of course advocated to avoid such problems and make GP a more restrictive theory.

Another advantage is that the geometric Licensing Constraints developed here are constrained by the preset structure of the tree. Regular Licensing Constraints, which we looked at briefly in Chapter 2, in principle predict all and any element combinations for vowels and especially consonants. But as we have seen, there are clear trajectories of development within consonantal inventories which belie this (for Licensing Constraints applied to consonants cf. Kula & Marten 1998).

The next point to take up is the special role of coronals in manner elaboration.

3.4 Coronality and the special relationship with Manner

The second manifestation of coronal uniqueness, we saw in Tables 1 and 2, was the special propensity this Place displayed in Manner elaboration: coronal fricatives are chosen in preference to non-coronal fricatives in building an inventory. To this we can add that coronals have a greater variety of friction open to them: strident and non-strident. Finally, 0.88 of all affricates were coronal in manner, so that the "affricate manner" seems a special prerogative of the coronal Place as well – though we must examine the nature of affricatehood in more detail, which we will do now.

We saw how affricates fitted in in the elaboration of inventories. The line of development, according to Kingston, is for inventories to choose firstly "simple" stops, /p, t, k/. No surprise there, as stops are the optimal obstruents: no inventories lack stops, but there are inventories which lack fricatives (and fricatives often develop from stops). However, Kingston then shows that inventories introduce a "sibilant block" (which contains all or most possible sibilants), rather than simply introducing a stop: fricative contrast for all stops. This line of development may be schematized as follows:

(7)

(i){p,t,k} >> || {s} >> {tʃ} >> {ʃ} >> || || {f,x} } *actual inventory development*

sibilant block (bracketing {s} >> {tʃ} >> {ʃ})

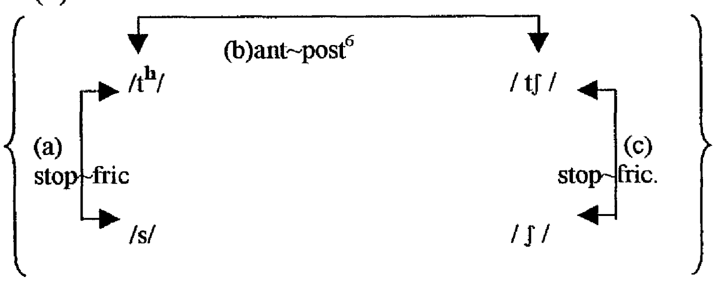
(ii)* {p,t,k} >> {f, s, x} >> { ʃ, tʃ} } *unattested inventory development*

Now there is a transparent way of understanding this line of development, if we take affricates to be simple stops phonologically. Then the introduction of an affricate is merely another instance of the preference for stops in inventories. Then we can see a series of contrasts in sub-place and manner developing in the coronal range, before they develop in the non-coronal range. The first contrast is between a simple coronal stop and a simple coronal fricative, giving /t/ vs. /s/. Then a specialized coronal stop is introduced, which differs from the primary coronal stop in being "posterior"[5]: this is the contrast of

[5] That is, presumably articulated in the [-anterior] region. However, this label is merely mnemonic, as we saw in Ch.2 that it fails to capture accurately the actual phonetics of this segment.

/t/ with /tʃ/ (or /ts/). After this, the same Manner contrast is introduced on this coronal specialization, giving the "posterior" coronal fricative /ʃ/. All this can be schematized in the following diagram:

(8)i.



ii.Introducing contrasts in the coronal range

(a): primary coronal contrast: anterior manner contrast [stop~(strident) fricative]

(b): secondary coronal contrast: anterior vs. posterior subplace [stop]

(c): tertiary coronal contrast: posterior manner contrast [stop~fricative]

This gives the line of development in (7i).

This crucial analysis of affricates as stops is also followed by Kehrein 1999, who gives the following four reasons (which can be added to Kingston's contention regarding their propensity for voicelessness) for the analysis as independent support:

(9) A.Contrast: Affricates never contrast with stops at any given place.

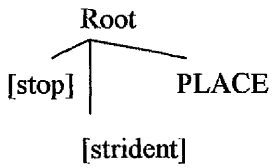
B. Natural class: Stops and affricates form a natural class.

C. Fricatives and affricates do not form a natural class.

D. Affricates do not form a natural class of their own.

Kehrein points out that the only exception to (A) and (D) involve strident affricates, which is evidence that stridency rather than affricateness is the distinguishing feature (an argument put forward by Rubach 1994). This viewpoint leads Kehrein to see affricates as having the phonological structure of strident stops, with the two-part stop-friction articulation being merely a means to make both features recoverable by the hearer (he draws on Silverman 1995's theory of the phasing and recoverability of features). That is, affricateness is a phonetic by-product of the implementation of the following phonological structure:

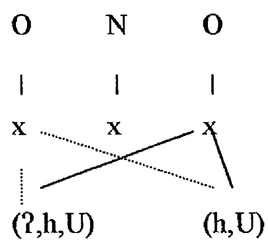
(10)



→ /S/ = /ts/

This certainly goes some way towards normalizing the representation of affricates. For what Kingston's survey of UPSID shows is that coronal affricates are preferred even to non-coronal fricatives. Yet, standard generative phonology has adopted Sagey 1986's contour representation of affricates, which suffers in this respect on several counts: it assumes extra structure which is lacking in stops and fricatives; there is no inherent ordering between the parts of a contour segment (so that /pf/ could just as well be interpreted as /fp/); finally geminate affricates would violate Goldsmith's No Crossing convention of autosegmental phonology, looking as follows:

(11)



→ /pf: /

(See Rennison 1998 for elaboration of these arguments).

In 3.3 we encoded in our geometry the priority of coronal stops over non-coronal stops, as a privilege of the headedness of [I]. In 3.5 we will now develop "normalized" representations of coronal affricates, so that Coronal's special relationship with Manner and stridency can be captured in phonological representations.

6 cf. fn.4.

3.5 An element-geometric modeling of affricates (or, specialized coronal stops)

3.5.1

In this section I will take Rennison 1998's revision of the representation of affricates as a starting point. Rennison represents affricates as follows (taking the labial affricate as an example[7]):

(12) O
|
x
|
(U, (h) , ʔ) [head of the phonological expression on the right, lazy element bracketed]
/pf/

The key to Rennison's system is that p.e.s can consist of lazy as well as lexical elements. The former are elements which are late in being interpreted: they are interpreted after the lexical elements, but also in conjunction with the lexical elements (which are interpreted a second time). The result in (12) will thus be that (U ʔ) are interpreted first, and then the expression (U ʔ h) is pronounced. In Rennison's system of elements this is the p.e. for the labial fricative[8]. Details aside, this system goes some way to normalizing affricates, primarily because all and any elements can be lazy.

Another convention in Rennison is that of head-replacement, whereby the head on one round is replaced by an incoming head. This allows the representation of doubly articulated segments whose secondary part has incomplete closure. Thus the difference between /kp/ and /k^w/ would look as follows[9]:

(13) /kp/ /k^w/
((U), ʔ) ([ʔ] (U))

[7] I also translate Rennison's version of element theory into the Harris-Lindsey system adopted as a starting point in this thesis, for ease of presentation.
[8] It is of course important that for Rennison fricatives contain stopness, otherwise one would get something like /pp/, however we will not investigate these details here.

(i) (ʔ) = /k/ (ʔ) = /k/

(ii) (ʔ , U) = /p/ (U) = w

Here the [ ] notation signifies that the element in question, which is head on "round one", is replaced by the incoming lazy element, which in head role necessarily creates a head-head clash when it comes to be interpreted on round two.

I will draw on Rennison's basic idea to develop a theory of affricates here; however there are problems with that theory as it stands: Because all elements can be heads, and can be replaced, the theory predicts the existence of a vast amount of non-existent complex segments. In fact in 8b of his paper Rennison makes it a point of principle that "there are no licensing contraints or requirements between phonetic parts of a contour segment", as all elements are freely combinable. But as we will see in Chapter 5, and as we have seen above, there are clear limits on the structure and content of complex segments. To construct some random samples of possible p.e.s that are generated by Rennison's system, consider the following:

(14) 1) ((R), ʔ) = kt[10] 2) ([R],ʔ,(U)) = tp[11] 3) ([U],ʔ) = pk[12]

4) ((I), ʔ) = kɟ 5) ([R],ʔ) = tk[13] 6) (U,(I)) = w^j

I briefly anticipated this problem and its solution in 3.2, when I remarked that /kp/ and /c/ can be generated within the head/nonhead restrictions placed on elements, while /pk/ could not be. One could argue that the p.e.s given above have a different phonetic interpretation from the ones given (perhaps some of them map onto click sounds), but these are at least an obvious possibility. One might also object to the need to cut down on generating such objects by pointing out that sequences such as /tp/ and /tk/ in 14.2 and 5 do exist (in, for example, Georgian and Margi, as I will discuss at greater length in Chapter 6) – but it seems that there is good evidence that these are sequences of

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[9] In Rennison's system velarity is the absence of Place.

[10] On round (i), /ʔ/ = /k/; as in Harris 1994 the null expression maps onto velarity.

[11] Round (i): /R,ʔ/ = /t/, then round (ii) R is replaced by U, hence [ ], which is interpreted with ʔ as /p/.

[12] Round (i): /U.ʔ/ = /p/; then round (ii) U is replaced by ʔ, hence [ ], which is interpreted as /k/; so /pk/.

[13] Round (i): /R/; round (ii), R is replaced by ʔ, = /k/; hence /tk/.

individual segments (as argued by Ladefoged & Maddieson 1996 for Margi and Maddieson 1983 for Bura) rather than complex singleton segments. As Kingston 1993 remarks in his own discussion of the matter: "The other means of producing additional places is to combine two articulators; the most common example of such double articulations use the [labial] and [dorsal] articulators. Other combinations where a complete closure is made with two articulators, such as labio- or dorso-coronals, are vanishingly rare..." We thus have an onus to explain, or at least model, the absence (or what I'll treat as the same thing here, the extreme rarity verging on possible non-existence) of such doubly articulated segments involving coronality. In Chapter 6 I will examine evidence that these double articulations are sequences of segments, rather than units. This is in clear contrast to how Rennison views affricates, and must I think be taken as a drawback of his approach as it stands.

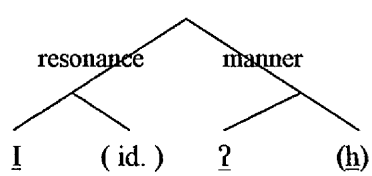
What we want therefore is a modeling of affricates as specialized coronal stops which occupy one timing slot, and whose internal structure encodes the special status that coronality confers.

3.5.2 The licensing and interpretation of affricate structure

Just such an object is given in (15):

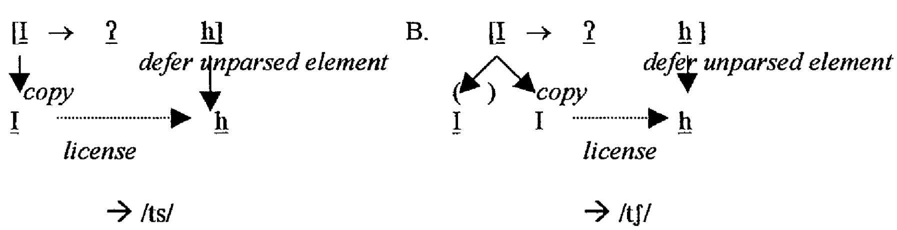
(15) Phonological structure and interpretation of an affricate:

(i) structure:



key: (E): lazy element
id. = identical (copied element)

(ii) interpretation:



The interpretation of this is as follows: We adopt Rennison's notions of head-replacement and lazy versus lexical elements to model the "contour" nature of these complex segments. In (15i) there are two lexical elements (distinguished by being unbracketed): [I̲] and [ʔ̲][14]. It is very important for the current modeling, however, that there be clear licensing relationships between elements and headship status of certain elements, to prevent the reversibility of element combinations and the generation of unwanted p.e.s. So in (15) we introduce the notion that the head resonance element licenses the head manner element: this is represented in (15ii) by a → between [I̲] and [ʔ̲][15]. In our convention, we say that the lexical elements are interpreted first, and the lazy elements undergo a delayed interpretation. So the first part of the structure to be interpreted is (I̲. ʔ̲), or /t/. The lazy elements, however, must be interpreted in conjunction with the head element of the whole tree, which is [I̲]. This would give delayed (I̲.h̲), or /s/. But there is one further point: the lazy manner element (here the noise element [h̲]) needs to be licensed; this is a consequence of our extension of the Licensing Principle to the subsegmental level: this states that all elements bar the head need to be licensed. Now the head of the tree [I̲] is already licensing [ʔ̲]; on the assumption that licensing is binary, it will not be able to license [h̲][16]. The solution is for [I̲] to copy over, so that it can license [h̲] on "round ii". Rather than marking [I̲] again, I have signalled this copy-over of the head element by (id.) to mean there is a lazy copy of the head element[17]. Furthermore, in (15ii) we see that [I̲] can copy over in head or non-head role, i.e. as [I̲] or [I]. This in fact gives slightly different outcomes: the former copy leads to (I̲. h̲) or /s/ on the second round[18], the latter to (I̲. I. h̲) or /ʃ/. In other words two different affricates are generated, /ts/ and /tʃ/. Put another way, there is one phonological structure (I̲. ʔ̲. h̲), which is a

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[14] We continue the convention of square-bracketing elements in the text, to distinguish their citation from the surrounds.

[15] The repercussions of this Place-Manner licensing will become evident shortly.

[16] Even though [I̲] is interpreted on round ii, this is just a matter of well-formedness; in this capacity [I̲] does not carry out any licensing functions.

[17] Other reasons why a copied element is required will be seen when we look at other double articulations.

[18] We should note that, with the obligatory interpretation of the head of Resonance on round ii as well, it is thus really (I̲. I̲. h̲) on round ii. However, where there are two heads in one phrase (here two [I̲]'s in Resonance) one of them is replaced, giving (I̲.h̲) (by Head-Replacement). /tʃ/ does not need head-replacement; we can thus say it is a less marked realization of /TS/((I̲.I.ʔ̲(h̲)) than /ts/, which tallies with Kingston's findings (cf. Table2, A).

strident coronal stop which can be interpreted as "posterior" or "anterior" (or, in the terms established in Ch.2, coronal or corono-palatal).

As I have indicated with the italic labeling in 15ii, the mechanisms posited here for affricate structure and interpretation recapitulate Kehrein 1999 and Silver 1995 quite closely: there is one phonological structure (15i), but in order to get a well-formed interpretation of it (that is, to parse all the elements), certain operations must be effected: here, copying and head-replacement.

Later, I will formalize the principles which govern the interpretation of structures with lazy elements (once double articulations with incomplete secondary closure have been modelled).

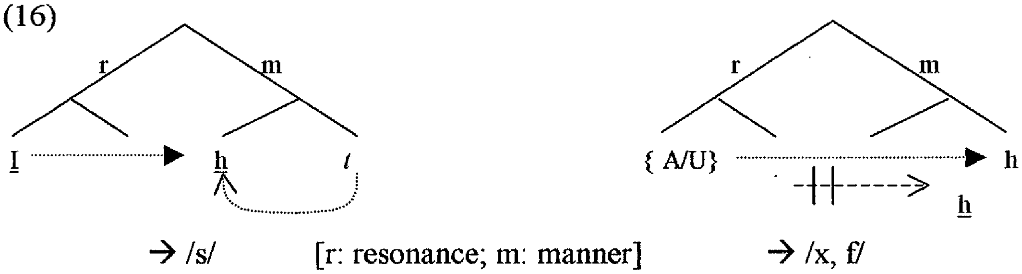
What we have achieved so far is to give a unit representation of affricates, using mechanisms which will also be used in the representation of other delayed features like aspiration and labialization. That is, affricates are modelled using mechanisms which are fundamental in the theory, as in Rennison's reworking.

3.6 Coronality, stridency and more manner-place relations

In the last section, we introduced the notion that Resonance heads license Manner heads. (We already saw how licensing took place between the head and dependent elements within Resonance in the representation of specialized stops). There is one further aspect to this, as noted: Only coronal fricatives can be strident. This is already implicit in the system we have been developing. Let's make it explicit.

In ET, the element [h] can be head or non-head. As head, it is interpreted as stridency, as non-head as normal friction or aspiration.

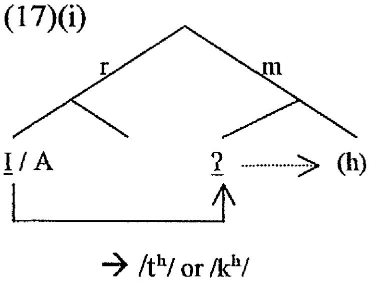
(16)



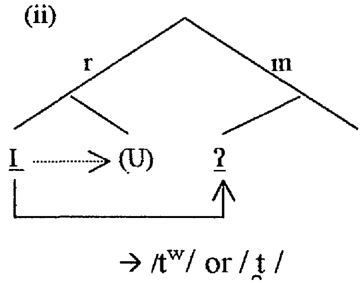
So far the headedness of [I̲] has allowed us to encode that the coronal Place can license more secondary Place elements than labial or velar Place (cf. 3.3). With the idea that Place licenses Manner, we can encode the greater variety of Manner that Coronal can sustain. In (16) we assume that Manner has the same structure as Resonance: that is, there is a head and non-head phrase and the natural occupier of the head phrase is [ʔ̲] and the natural occupier of the non-head phrase is [h]. The normal situation is for each element to occupy their natural phrases in Manner. However, as in other domains, [I̲] has special licensing powers: it is thus able to promote [h] to head position[19], or license its movement into the head of Manner. Non-head elements cannot do this. This gets why coronal fricatives can be strident or non-strident, while non-coronal fricatives can only be non-strident.

This structure and the licensing relations obtaining between its parts also lends itself very felicitously to modeling other segments with complex internal structures, as we anticipated at the end of 3.5.2. The workings of aspirated stops, non-coronal affricates and incomplete double articulations (i.e. /k^w, q^w, t^j, k^j, p^w, t^w/) can be subsumed under the same framework.

(17)(i)



(ii)

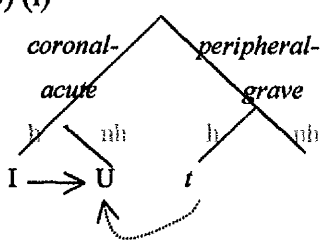


In (17i) we repeat the representation of an aspirated stop (with coronal or velar place, for the sake of example), given in (4). We can now add more detail about the manner part of the expression. In this structure, the resonance element licenses the manner element, as discussed. Here, though, [h] is not in head role. As such, it does not need to be licensed by a specially copied element in Resonance on a second round of interpretation; rather it is fully capable of being licensed by [ʔ̲]. This arises from the assumption that all heads

[19] And indeed forced to do so, so that strident coronal fricatives are generated before non-strident ones.

have some licensing powers; however, by the HDA a head in a nonhead phrase (i.e. [ʔ̲]) has weaker licensing powers than a full head like [I̲]. Thus, while [ʔ̲] licenses [h], the interpretation of [h] is deferred. In other words, [ʔ̲] only has the power to license its complements lazily. In (17ii), we see a structure with an element in the nonhead part of Resonance. We can assume that a Resonance head is fully capable of licensing [U] as lazy or lexical (being the head of the stronger phrase); so there is a choice between two interpretations of [U]. We can encapsulate this difference in interpretation by saying that [U] can be licensed lazily, that is *in situ*, or it can receive a license to move into the head phrase of Resonance. This becomes clear when we draw on the more articulated structure we posited for Resonance in Ch.2:

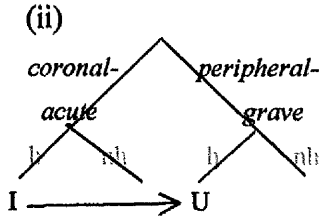
(18) (i)



(h = head, nh = nonhead)

movement/simultaneous-lexical interpretation of dependent element → /t̪/

(ii)



(h = head, nh = nonhead)

no move/in situ-lazy interpretation of dependent element → /t^w/

This assumes that one and the same language will not make contrasts between a dental and a labialized alveolar, which seems to be the case. We will draw on these representations later.

Thus there are four types of licensing within the element-geometric tree which model "contour segments", and indeed non-contour segments: Resonance-Resonance licensing

More on this later.

([I̲] licenses [U, A, I]), Manner-Manner licensing ([ʔ̲] lazy-licenses [h]), "Movement-Licensing" ([I̲] licenses [U] or [A] to move into the head phrase of Resonance) and "Lazy Licensing" (resonance or manner dependents are licensed *in situ*). The internal structure of segments will be important in modeling syntagmatic processes, such as phonotactic distributions within the phonological word in various languages, so that these principles and structures are not motivated merely by Kingston's statistics regarding inventory evolution. As indicated, the paradigmatic and syntagmatic facts support each other; but it is probably the latter which justify making such structure a part of the language user's phonological representations. Before we look at such phonotactic evidence for these internal structures, I will discuss some of Kingston's ideas about the functional underpinnings of inventory structure, and possible correlations they have with the structures being developed here.

3.7 The evolution of inventories: the formal and the functional modeling

As mentioned, Kingston follows the research tradition on feature enhancement or integration, using this (in conjunction with the notion of contrast block and adaptive dispersal, on which more shortly) to explain the distributions in Table 1 and 2. We have not commented on the particulars of this feature enhancement and how it is meant to derive some of the developments in the tables. Let us take two relevant to start the discussion on the adequacy of Kingston's explanations:

(19)

a. labialized dorsal double articulations, whether complete (/kp/) or incomplete (/k^w/) are more common than palatalized dorsals because lip-rounding and dorsum-raising both lower F2, thus enhancing the percept of low-F2.
b. Palatalized alveolars are twice as common as palatalized velars, as both palatality and the alveolar gesture contain mutually enhancing high-frequency energy.

(19a) refers to different parts of a complex segment; however the same explanation holds when features are found in the same part of a segment: backness and roundness tongue body gestures both lower F2, which is why vowels which agree for backness and roundness (as expressed in the [α-back] → [α-round] redundancy rule) are preferred to vowels which differ for values of these features (Maddieson 1984). I would argue that the preferred co-occurrence of sibilance and coronality has a similar explanation:

c. Coronal fricatives prefer to be strident (if /θ/ then /s/, /tʃ/ preferred to /c/) because the higher-frequency energy of strident noise enhances the high-frequency energy of the coronal place.

This brings me into conflict with Kingston's own explanation, and the conflict extends to other areas. For Kingston maintains that stridency on the posterior coronal stop (*aka* affricate) is chosen as it increases the contrastiveness between this stop and the anterior (alveolar) coronal stop. This is a notion he inherits from Ladefoged and Maddieson 1988, who talk of the "adaptive dispersal" of segments. Thus extra gestures (such as that for stridency) will be executed to form new segments if the gain of increasing perceptual distance between segments offsets the effort involved. I would argue that this notion is deeply flawed, though. Firstly, there is no way of judging how close or distant segments (construed as feature bundles) are. The posterior coronal stop has the feature specifications: [-anterior, -continuant, +strident]. The anterior coronal stop is: [+ anterior, - continuant, -strident]. The two segments are thus opposite-valued for stridency and anteriority. But then one would predict that the matrix [-anterior, +continuant, +strident] or /ʃ/ would be an even better opposition (as the values for continuancy are also opposite now). The result would be that 2-coronal inventories should optimally include only /t, ʃ/ -- which they don't. It all depends which feature one holds constant to effect a comparison. Secondly, maintaining that stridency is selected only because it makes affricates differ from anterior coronal stops ignores the fact that stridency is independently preferred for the anterior coronal fricative /s/, when that is the only sibilant added to an inventory. /s/ already differs from /t/ in manner, being [-continuant], so that in a comparison made along the above lines there would be no need for further differentiation in the type of friction. Why then is strident friction preferred here? Finally, the notion of adaptive dispersal clashes with Kingston's notion of a "contrast block". Kingston maintains that languages with large inventories differ from languages with smaller ones in that they add not just one or two isolated segments, but rather blocks of segments which use "all possible combinations of values for a set of distinctive features." Thus while voiced fricatives are marked, English has /z/ because the obstruent inventory is expanded wholesale along the [+/- voice] dimension. Regarding sibilants, a whole block is added (as we saw in table 2) because all combinations of [anterior, continuant] are exploited, while [+strident] is held constant. This must surely override the adaptive dispersal explanation: after all the latter predicts that there will be two maximally dispersed segments (in terms of opposition for the values of the features in question), while the former then predicts that all intermediate values between these poles will be filled in, so obscuring the optimal dispersion of these polar opposites. The same goes for an argument that says that addition of a palatalized labial increases distance between that segment and an existing dorsal (as maintained by Ladefoged and Maddieson 1988). True, but the acuteness of palatalization will make such a labial closer to an alveolar! Thus, the trajectories of segment addition (of the type /s/ >> /tʃ/ >> /ts/ >> /ʃ/ >> /f, x/ in Table 2) should not be explained by adaptive dispersal; rather each segment is added in this order because each segment is by itself an optimal combination of mutually enhancing features. This optimality of certain feature combinations is already given by the four licensing principles we have been developing in the previous sections. Thus the exclusive ability of the coronal Place to sustain both strident and non-strident fricatives is given in [I̲]'s greater licensing power (here ability to move-license [h]). The unmarked status of stridency is given if we say that there is a preference to use the maximal licensing powers of [I̲] (a point we will develop later). This would derive both the preference of /s/ over /θ/ and of /tʃ/ over /c/ (Table 2, A and C). E in Table 2 is a consequence of [I̲]'s natural headship. This leaves only B and D unaccounted for, which were:

(20) B.[coronal] specialization hierarchy:

/c/ >> /ʈ/ >> /t̯/

D. double articulation preference hierarchy:

(i){/tʃ/ >> /c/ >> /q/} >> (ii){ $/k^w, q^w/$ >> $/t^j/$ >> $/k^j/$ >> $/p^w,t^w/$ >> $/p^{\gamma},t^{\gamma},k^{\gamma}/$}

"complete secondary closure" — "incomplete secondary closure"

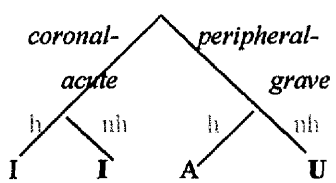
These distributions can be modelled very easily by positing two further principles which shape element combination in the tree:

(21) **Lazy Element Licensing Principle (LELP):**

1. Complements should be non-heads;
2. Complements should be in the same phrase as (tautophrasal to) their heads.

Applied to our tree, this will have the following effect on the generation of segments with incomplete secondary articulation (in our terms, lazy element licensing):

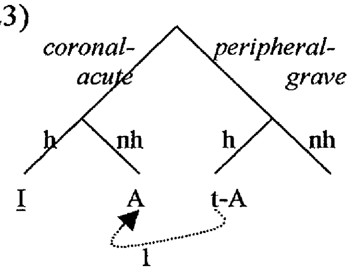
(22) Internal structure of (consonantal) resonance phrase



(h = head, nh = nonhead)

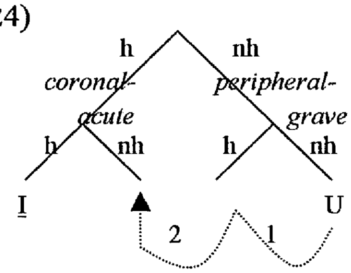
The elements which best serve as licensees are the bolded ones, those generated under a nonhead node (by LELP 1). Then if elements are to act as licensees of others, they should also preferably be in the same phrase as their licensers. Thus [U] will optimally be licensed by [A], as they are both generated in the "peripheral-grave" phrase of the tree. [I] will preferably be licensed by [I] for similar reasons. This means that $/k^w/$ and $/t^j/$ will be better segments than / k^j/. Segments which have [A] as a dependent element, i.e. those with secondary velarization or pharyngealization will, by contrast, be dispreferred and rare (this time by LELP 1, which prefers licensee elements to be non-heads). As regards segments with specialized articulations, which we modelled by saying that the dependent elements move into the head of Resonance Phrase, the situation is different. Here /ʈ/, which contains dependent [A] is preferred to /t̪/, which contains dependent [U]. We can assume that the LELP applies only to dependents which are licensed *in situ*; if the licensing head element licenses its dependent to move into RP-head, then the shorter the move from RP-nonhead the better.

(23)



→ Resonance structure of /ʈ/

(24)



→ Resonance structure of /t̪/

This can be governed by the following principle:

(25) **Shortest Move:**

Move elements the shortest distance possible

This derives (B) in Table 2: the palatal stop which contains [I] needs no movement at all ([I] is already in RP-head) and will be generated before the retroflex, which needs one move, and the retroflex will be generated before the dental, which needs two moves (as in (23) and (24)).

In short, the differential headship of elements, the four types of licensing and now two principles (the LELP and Shortest Move) are able to derive the distributions which emerge from Kingston's analysis of UPSID inventories. We can divide these principles into two sets: the initial division of the tree into a coronal-acute "phrase" and a peripheral-grave phrase, with the relevant headship of the different elements. This division was motivated in the last chapter to capture the close relationship between coronality and palatality in phonological processes, and will find similar motivation when we look at other processes in chapters 5 and 6. The second set consists of the set of licensing principles which operate on and make reference to this division of elements. In a way they are like redundancy rules, expressed as licensing constraints and without the drawbacks of underspecification. They are clearly functional in origin, capturing the preference that elements have for each other due to effects of mutual enhancement.

In sum, we are proposing a clear answer to the question: what is a segment? A segment is a bundle of *mutually compatible* acoustic-cognitive elements. Where the present account differs from previous versions of ET is in formulating licensing constraints for element combination which take compatibility into account. Such compatibility is complex: elements are acoustic, but they themselves are the result of mutually integrating articulatory gestures. However, articulation is not visible to the phonology. One level up, when these elements combine, enhancement effects (visible as the degrees of preference for the different elements' acoustic signatures for each other) clearly shape combinatorics according to clear principles. It is perhaps not immediately obvious whether such principles are inside or outside the grammar, and whether speakers consciously manipulate such principles. My contention, however, is that distributions of segments in words and between roots and suffixes is evidence that reference is made, and phonological processes are sensitive, to the internal structure of sounds, and to the degree of compatibility between elements in a segment. Again, certain element combinations are favored in the construction of an inventory, and certain element combinations display the properties we have seen in sound alternations. We looked at three processes in Chapter 2 which we held to be evidence of this. Let us review them briefly in the light of the above, and then look at one new process: labial palatalization in Zulu.

3.7 Palatalization and coronalization processes and internal segment structure

These three processes were: palatalization$_1$, palatalization$_2$ and coronalization (cf. 2.6)

(26) palatalization$_1$

/t/ → / tʃ/ [tj]u:n ~ [tʃ]u:n (English)

(27) palatalization$_2$

/s/ → /ɕ/ o[s]a ~ ó[ɕ]ie // wa[s] wa[ɕ]ik (Polish)

(dative) *(diminutive)*

(28) coronalization

/x/ → /ʃ/ mu[x]a ~ mu[ʃ]e (Polish)

(dative)

We noted that palatalization$_1$ in English was the simplest alternation, involving the least change of structure. In the light of further developments in this chapter, we can enhance this account by claiming that the /tj/~/tʃ/ alternation is one between allophones of a single phoneme: instead of considering /tj/ to be a branching onset, with the glide being complement to the head stop, we can model this an alveolar stop with secondary, i.e. "lazy", palatality: /t^j/ = ($\underline{\text{I}}$. (I). $\underline{\text{ʔ}}$ (h)). Then the internal reconstruction needed to capture the allophonic alternation between the different segments is:

(29) i. ($\underline{\text{I}}$ (I). $\underline{\text{ʔ}}$ (h)) → ii. ($\underline{\text{I}}$ (I). ʔ ($\underline{\text{h}}$))[20]

/t^j/ /tʃ/

Nothing more is involved than a change in the licensing of the noise element: in (29i) it is licensed lazily by [ʔ]; in (29ii) it is licensed by lazy [I], which promotes it to head, following a principle (which we will examine shortly) that ensures that elements fulfil their licensing potential. Briefly then, the two segments have the same elemental composition, but differ in licensing relations, which explains why these segments do not occur contrastively in English, or indeed other languages.

This situation contrasts with that found for palatalization$_2$ and coronalization:

[20] In this bracketed version of element trees, which are more economic to write, a "." represents the division between resonance and manner, and arrows relevant licensing relationships.

(30) i. (I . h) + [I]$_{aff}$ → ii. (I I. h)

/s/ + /i/ → /ɕ/

(31) i. (A. h) + [I(A)]$_{aff}$ → ii. (I I . h)

/x/ + /e/ → /ʃ/

In (30), the affixal vowel disrupts the optimal licensing situation: instead of fulfilling the power of a head element to move-license a manner-element, it merely licenses [h] *in situ*. In (31), the affixal vowel behaves, contrary to this, in a dynamic way: not content to dock at the nonhead node of RP-head, it also copies itself to the head node, delinking [A]; it also fulfills its manner licensing potential, promoting [h] to head position.

Both the processes in (30) and (31) constitute a deviation from normal licensing relations. In the former, non-optimal manner licensing is sanctioned by the morphophonological specifications of the affix; in (31) "over-optimal" licensing is likewise specified. Such specifications can be encoded in the following phono-morpho-syntactic matrix for the dative –ie suffix in Polish:

(32) a. osa "wasp-NOM-SG" o[ɕ]ie "wasp-DAT-SG"

b.

(I.A): spread [I] as a weak- licensing complement; fusion: non- analytic	case: dative

However the situation is more interesting than this, because as we can see in (27) and (28) the dative suffix –(i)e triggers both palatalization (if the root-final segment is coronal) and coronalization (if the root-final segment is velar). Thus a more flexible, underdetermined representation becomes necessary:

(33) *fragment of Polish lexicon: dative suffix*

M	**MP**	**P**

(**I**.A): [[dative], [synthetic], [spread-I]]

I-spread: [target: head; delink: non-head;
m-license: strong if head, weak otherwise;
copy: yes]

This fragment of the Polish lexicon posits that affixes are a conjunction of three bits of information: M(orpho-syntactic) information, M(orpho)P(honological) information and P(honological) information. The first matrix gives the case properties of the affix, the second gives the manner of its combination with a root (analytic or non-analytic, i.e. synthetic) and whether it is a suffix, infix or prefix (which I have ignored here), and the last gives information about any phonological interaction between root and suffix. The last matrix in turn refers to a battery of phonological constraints on "I-spread". These conditions specify what the target of I-spread is: here, it is the head of RP. However, the next condition constrains this: a license is given to delink a non-head (such as [A] or [U]) but not a head (i.e. [I]) if such occupies the head of the root-final segment. The next condition gives information about the m(anner)-licensing properties of spreading [I]; they differ according to whether [I] has managed to dock on target in the head of RP – in which case strong m-licensing occurs (movement of [h]); otherwise only weak m-licensing is sanctioned ([h] licensed *in situ*). (If [I] cannot enter the head of RP, it will dock by default onto the second node of RP). Finally, a matrix tells us whether [I], if it has succeeded in docking onto the head of RP, then copies itself into node 2 of RP. If it does so, the final segment, as here, is /ʃ/, if it doesn't the final segment is /s/. All these constraints apply as and when their conditions are met. Thus, if [I] is in the head of RP, spreading [I] will not dislodge it and it then only licenses [h] weakly, yielding /ɕ/. If [A] is in the head of RP, it will be dislodged, [I] will copy over and [h] will be licensed as [h].

(33) thus succeeds in capturing the coronalizing and palatalizing properties of the dative suffix with no need for rule-ordering or level-ordering.

This raft of additional constraints on spreading is part of the information given in the component of the lexicon where affixes are stored; this organization of the lexicon holds that such constraints are not available elsewhere, which automatically derives the "cyclicity" of such processes – that is, they apply only across morphological boundaries and only such morphophonolgical processes have the power to effect structure-changing operations.

In 2.7 we discussed Spenser's morpholexical modeling of such alternations. I held that his modelling was correct for the Czech case and it is probably the right approach for such fossilized alternations as k~s, t~ʃ in English of the following sort:

(34) a. reac[t] reac[ʃ]ion

b. electri[k] electri[s]ity

However, it is by no means clear that any phonologist in the literature has managed to come up with an infallible test for what should and should not be modelled in the phonological or morphological component of a language's grammar. More research is needed on this important issue. In the meantime, it can be noted that these alternations could be captured by a similar modelling, on the assumption that the structure of the lexicon is universal:

(35) *fragment of English lexicon; derivational affixes*

M **MP** **P**

(-ity): [[...], [synthetic], [spread-I]]

I-spread: [target: head; delink: head + licensee;
m-license: strong, [h];
copy: no]

Here the [I] in –ity spreads into the head of /k/, delinking not only [A] but its licensee [ʔ], and licensing [h] strongly in its place. No copy takes place, resulting in /s/ (as in 34b). The suffix –ion would have the following specifications:

(36) *fragment of English lexicon; derivational affixes*

M **MP** **P** (-ion): [[…], [synthetic], [spread-I]] I-spread: [target: head; delink: head + licensee; m-license: strong, [h]; copy: yes]

Here, the [I] and [ʔ] of /t/ are delinked under [I]-spreading, and [h] is strong-licensed. Furthermore, [I] copies, yielding not /s/ but /ʃ/.

However there are cases where orthography preserves a form of the root long since lost in pronunciation, such as "auction", pronounced not /auk ʃɚn/ or /auktion/ but /ɔːk ʃɚn/. To posit an initial /k/ and /t/ and then the –ion suffix is anachronistic, necessitating needless derivational chains and non-existent segments. Thus while similar processes might once have been operative in English, they are not any longer. But it seems that objects like (35) and (36) could exist in the grammars of some languages like this earlier stage of English and like contemporary Polish.

In the above modellings we see finally a convergence between the factors that conspire to form segment inventories and the factors which are operative in (morpho)-phonological sound change. The table in (37) gathers some of the facts we have seen – facts, that is, interpreted in the theory we have been developing. (37ib) refers to the fact that velars and labials[21] change into coronals, but not vice versa: /x/ → /ʃ/ under the influence of /i/ (which is seen to be coronal and thus to partake of the dynamism of this place), but there is no reverse process whereby /ʃ/ or /s/ become /x/ or /f/ under the influence of dorsal or labial vowels.

[21] See shortly for facts re. labials.

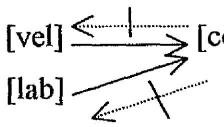
(37)

(i)

syntagmatic:

a. coronal vowels change consonants,
non-coronal ones don't

b.



c. [I] distributes freely,
[A,U] are phonotactically constrained[23].

(ii)

paradigmatic:

a. palatality is preferred on consonants[22]

b. stridency is licensed only by coronals

c. coronals have the richest subplace

This asymmetry is captured by the headship of [I]. The three points in 37ii have been examined in the preceding sections. It is thus our contention that segment inventories are built up according to certain principles, and that the internal structure of the resulting segments influences the distribution of these segments in roots and affixes.

In the next section we will look at another process which confirms and extends the application of this viewpoint: Zulu labial palatalization.

3.8 Labial palatalization (coronalization) in Zulu[24]

3.8.1 The basics

The English-Zulu/Zulu-English dictionary (Doke, Makom, Sikaki & Vilakazi (1990)) summarizes the palatalization processes in Zulu as follows:

[22] That is, palatality is the favored form of incomplete secondary articulation, over pharyngealization, velarization and labialization; the latter is only preferred if primary place is thereby enhanced.
[23] This refers to the Licensing Constraints for Australian in 2.10.1. We will see later the same is true for English (ch.5) and other languages (ch.6).
[24] In the following I draw mainly on Cooke 2000 for data.

(38)

/pʰ/ → /ʃ/

/tʰ/

/b/ → /dʒ/

/d/

/ɓ/

/p/ → /tʃ/

/t/

/m/ → /ɲ/

/n/

/mp/ → /ntʃ/

/nt/

/mb/ → /ndʒ/

/nd/

Palatalization occurs in three constructions: the passive, diminutive and locative. In the diminutive construction alveolar segments (bolded above) also palatalize, but only optionally. In all three constructions, it is bilabials which palatalize. Here we will examine only the passive, which is special in that there are two further facets to passive palatalization. Firstly, it occurs at a distance: that is, the palatal trigger does not have to be adjacent to the bilabial consonant (cf. 39bii below /pʰ/ and /(i)wa/ are separated by –ol-). Secondly, root-initial bilabials are exempt from palatalization, as the contrast between 39(a) and (b) shows:

(39) a. loba + (i)wa[25] → lotʃwa (/b/ + /i/ → /tʃ/)

"see" passive morpheme "be seen"

b. (i) eba + (i)wa → ebiwa (*etʃwa)

"steal" pass. "be stolen"

(ii) $p^h op^h ola$ + (i)wa → phoʃolwa (*ʃotʃola)

"examine" pass. "be examined"

As can be seen, in 39b(ii) the root-initial bilabial /p^h/ is immune to palatalization (we don't find the hypothetical bracketed form).

Next we come to the modeling or analysis of the palatalization process. Due to the complexity and details of the environments in which the process occurs, there have been a number of such analyses by different linguists. For example, Doke 1927 proposed that the process was one of dissimilation: the plausibility of this account comes from the fact that at a surface level, the passive suffix is –w-, and the vowel –i- only occurs when the suffix is added to monosyllabic roots:

(40) -p^ha -p^hiwa BUT -bona -bonwa

"give" "be given" "see" "be seen"

Thus the fact that a labial changes to an alveopalatal before a labial suffix looks like dissimilation.

Cooke 2000 (whose analysis is couched in a GP framework) argues that the process is one of *assimilation* (following Khumalo 1987 in this respect), positing that the /u, o/ suffix which triggers palatalization in fact consists phonologically of the round vowel/glide and a floating [I]) element. A recourse to the abstract positing of a floating element was not available to earlier more concrete phonemic/structuralist analyses, but it

[25] The form of the passive suffix will be commented on shortly.

is in keeping with generative, autosegmental phonology and descendants thereof, like GP. Moreover, as must needs be the case, it is well-motivated: Cooke shows that the –w- suffix in Tsonga a sister language of Zulu is –iw- . She also brings evidence of comparative surface i ~ ∅ alternation from the Venda locative suffix., which is –ni- compared to Zulu's –ini (Cooke:31). In old Zulu, furthermore, forms preserving the –i- of the diminutive suffix are found: thus modern Zulu –ana- appears as –yana in a form such as *indojeyana* "little man" (Cooke 2000: 25). Without much further ado, I will therefore accept Cooke's solution to the Zulu problem and make it my task here to see how the current framework can enhance her account.

Firstly, we can capture passive palatalization in the following "lexical box" format developed in the previous section:

(41) *fragment of Zulu lexicon; PASSIVE*

M **MP** **P**

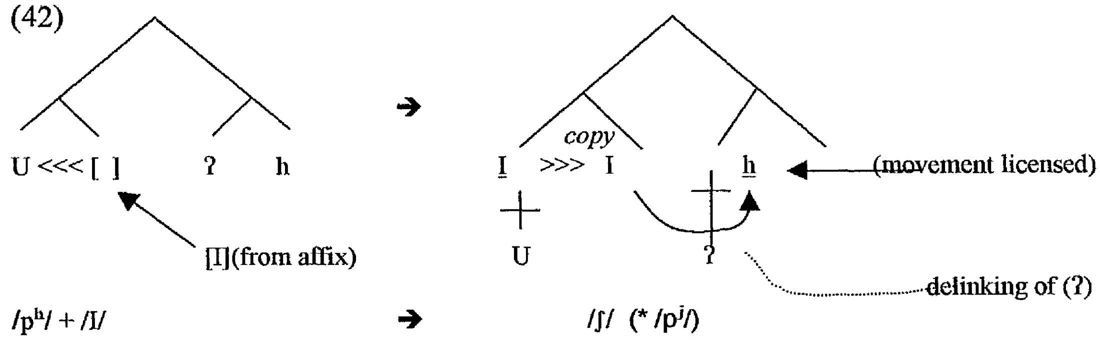
-(**i**)wa: [[…], [synthetic], [spread-I]]

I-spread: [target: head; delink: U + licensee;
m-license: strong, [h];
copy: yes]

Range: [all but root-initial]

This box resembles the others we have seen, except that it contains information defining the *range* of the element-geometric trees targeted by I-spread: informally stated, all segments in the root except the leftmost one (the root-initial one) are targets. It also specifies that [I] has the power to delink only [U] (and its licensees) and not [A] or [I]. This will be commented on shortly. Switching back to our tree formalism, the effect of these specifications will be as follows:

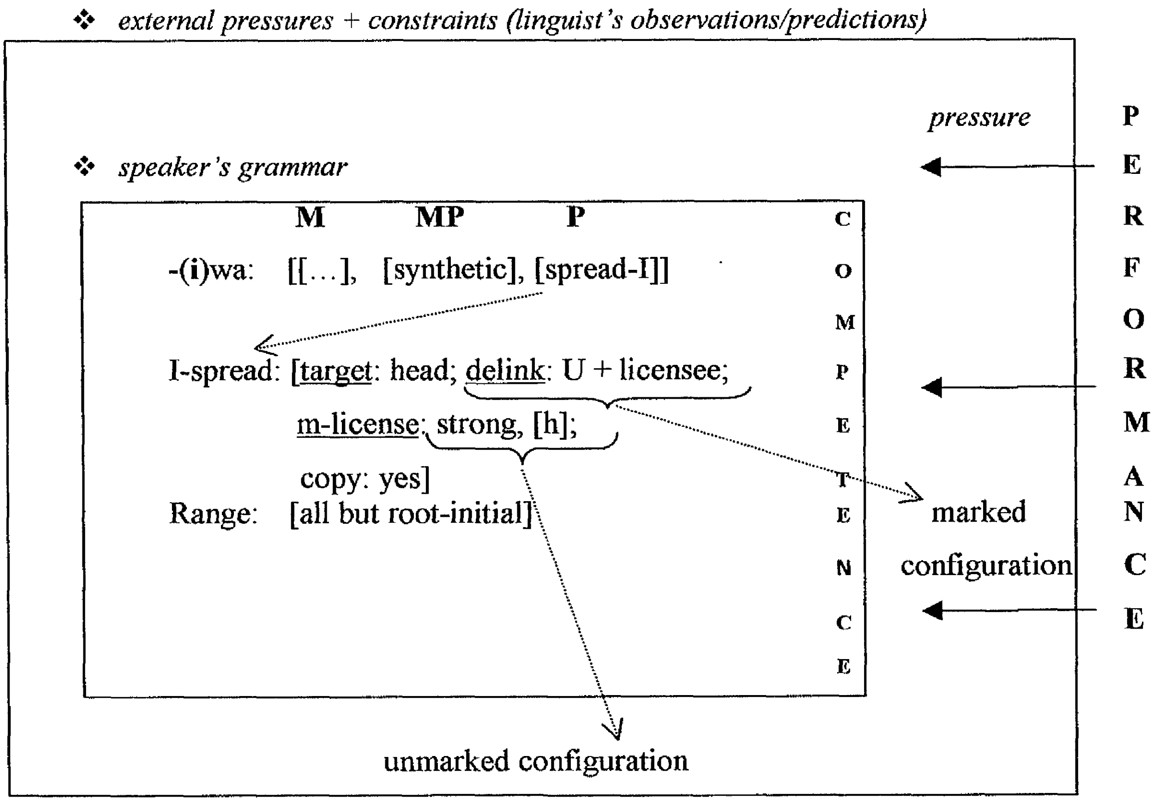
(42)



(41) and (42) represent the Zulu speaker's encoding of this process. However, we can add further information to the lexical box. It seems obvious that the speaker's grammar is entirely synchronic and has no "memory" of the pressures which led to labial palatalization. To encode such pressures in the synchronic grammar would be anachronistic. However, at some stage a labial did turn into a coronal probably via an intermediate palatalized labial /pʲ/. The resulting alternation turned into a discrete constraint for roots and affixes in (41). But from the point of view of the linguist who traces the diachronic history of the event, we can see that the synchronic constraints are held in place by a raft of functional constraints. These are performance- as opposed to competence-related factors which stabilize the synchronic structure. They ultimately explain why a change of this sort (rather than another one) comes into being and persists. This can be diagrammed as (43) below.

This diagram models the relationship between competence and performance, or form and function, along the lines suggested for syntax by Hawkings 1983, Kirby 2000 and Newmeyer 2001. In it, there are two dotted arrows highlighting a marked and an unmarked configuration. Taking [U + licensee] first: this is marked because (i) [U] is a non-head which has moved into the head of RP[26]. As such it is not as good a licenser of secondary elements as [I]. There is thus pressure to get rid of structures like (U →I/A/U). Secondly, the LELP2 (cf. (21)) is not optimally met: [I] is not tautophrasal to [U]. The LELP itself is really a functional constraint pressurising trees, ensuring that element combinations are mutually enhancing.

(43)



Meanwhile, the unmarked configuration in (43), [m-license: strong, [h]], is encouraged by a constraint we have stated only informally so far: maximise the licensing potential of elements. We can state it as follows:

(44) **Element Licensing Maximisation**:
Elements should discharge their full licensing potential.

Thus at the same time as an intermediate segment like /pʲ/ is discouraged, alternative more optimal coronal segments like /tʲ, tʃ, ʃ, s, ts/ are being encouraged. From a purely phonetic-functional viewpoint, choice among these options is a fairly close run. As Nettle 1999 shows (cf. also McWhorter 2002), factors affecting language change include the language-users' population size, geographic isolation and for individual lexical items

[26] It is not "base-generated" there – cf. 3.3.

frequency of use. Phonetic optimality is thus one of a number of "external" (non-competence-based) pressures: pace and diffusion (in the lexicon and the population) of change rely on extra factors. All the same, phonetic optimality highlights possible targets of change, and this is what we include in the performance box here.

3.8.2 Further manner-place interactions in Zulu palatalization

There are some further interesting details about Zulu palatalization, which can be modelled in the same way as above:

(45) i. aspirated stops turn into fricatives } under palatalization
ii. plain stops turn into affricates }
iii. laterals, though coronal, do not palatalize in the relevant environment

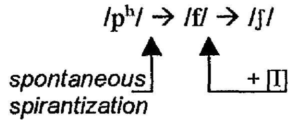
(45i) and (ii) can be confirmed by checking (38). Again there are functional underpinnings for the asymmetry between aspirated and non-aspirated stops. Basically, the combination of aspiration and occlusion seems to be antipathetic: one involves aperture, the other closure. This means that a combination of aspiration and occlusion will often be penalized, leading to spontaneous spirantization of an aspirated stop. This is pointed out in Scheer 1999, who categorizes spirantization into two types:

(46) 2 types of spirantization (Scheer 1999):
TypeI (spontaneous): /p^h/ → /f/ (bilabial stop → labiodental fricative) [e.g.:Indo-European → Common Germanic]
Type II (context-dependent): /b/ → /β/ (bilabial stop → bilabial fricative) [e.g. intervocalic in Spanish, /banca~ la βanca/]

The two differ as follows: Type I spirantization is "spontaneous", that is, it affects all segments in all environments in a diachronic sound change; secondly it changes not just the *manner* of articulation, but also the *place* of articulation, here from bilabial to labiodental. Type II spirantization is conditioned by a specific trigger, here the intervocalic environment, which provides a natural phonetic context for the change.

Secondly, type II spirantization changes *only* the manner, while the Place remains identical. Type I spirantization seems to be an intermediate stage in the diachronic evolution of the alternations we have seen, giving a history as follows:

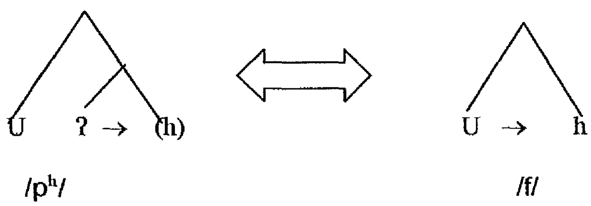
(47) i. aspirate palatalization (diachronic):



ii. plene palatalization (diachronic): /p/ → /pʲ/ → /tʃ/

In our terms, the incompatibility of aspiration and occlusion translates as the lesser capacity of the manner element to license a dependent:

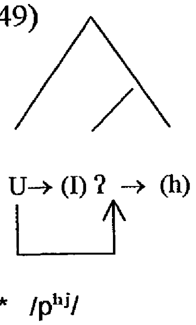
(48)



The spirantizing effect occurs when [h], instead of being licensed lazily, is licensed lexically in place of the delinked [ʔ][27]. In addition, in our case there is further pressure on [ʔ] to delink, given that [ʔ]'s licenser, [U], now also has to license the incoming palatal element, yielding the overburdened segment (violations in brackets) in (49). Here, [U] has two licensing functions to perform, and the pressure to deaspirate is increased by the presence of secondary palatality.

[27] When this happens, there is a slight change in articulation from bilabial to labio-dental: I take this to be a matter of optimal phonetic interpretation – the noise necessary to reach the target for (h) is perhaps better achieved with the labio-dental than the bilabial gesture, and thus do not encode it in the phonological representation

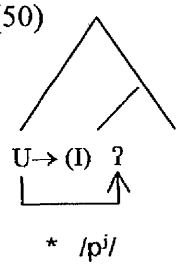
(49)



LELP₁: x
LELP₂: x
Manner-License: -1

Compared to this, /pʲ/ is less cumbersome:

(50)



LELP ₁: x
LELP ₂: x
Manner-License: 0

The violations of the LELP are the same for (49) and (50), but an additional violation of manner-licensing occurs for (49): it is normal for a Place element to license manner, but for that licensed manner element to further license its own dependent element constitutes a further stretching of licensing potential, which we mark with a "-1" in the bracketed representation of these constraints.

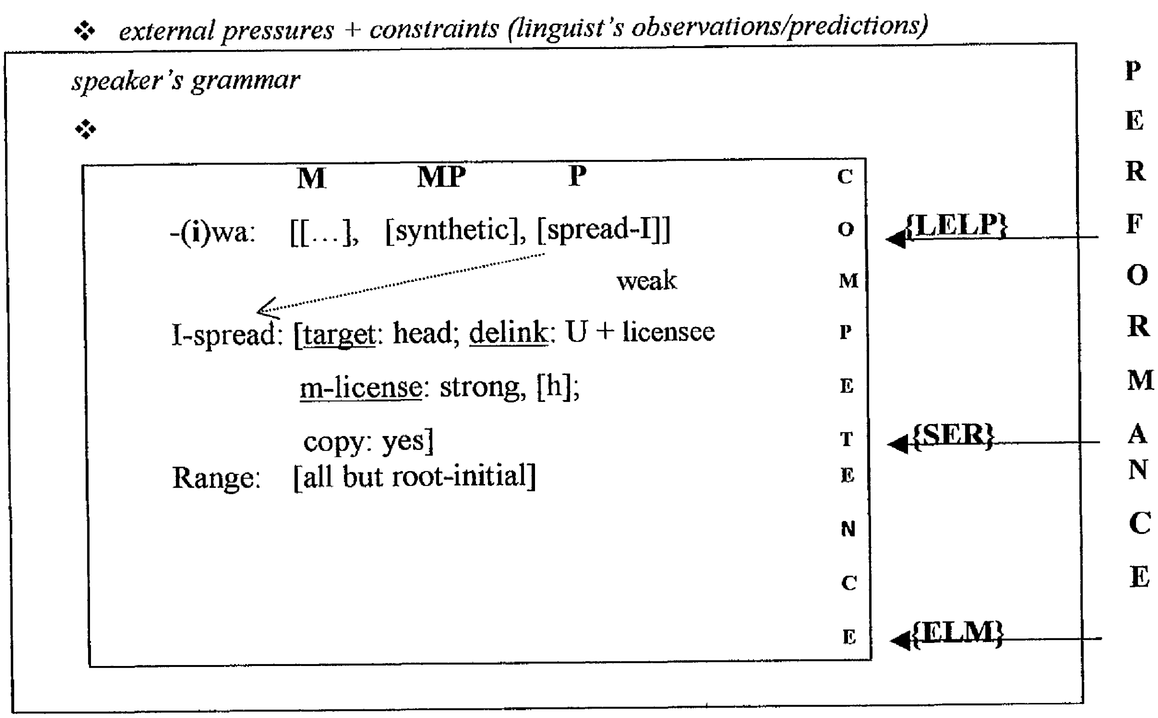
The question is how do we get from (49) and (50) to the representations for /ʃ/ and /tʃ/? There are several ways of restructuring these representations, indeed several orderings in which constraints could be applied. As yet, there is nothing to stop */pʰʲ/ being restructured as /tʃ/ and * /pʲ/ as /ʃ/, contrary to the attested outcome. The prioritising of constraints comes not from within the grammar, but from the performance/functionality component outside which shapes the grammar. One such constraint is:

(51) **Segment enhancing repairs (extragrammatical) (SER):**
Strengthen Place >> Strengthen Manner

The SER operates on the basis that place is the carrier or anchor for all other features, and it thus strengthens non-optimal place feature combinations, before attending to manner.

Thus a Place element that is overstretched will be delinked ([U] in (49) and (50)) and replaced by the stronger incoming element ([I]). Next Manner will be repaired. As part of "Strengthen Place", any weak manner licensee of the Place element will also be delinked. Weakness here is judged by whether [ʔ] is licensed by a Place element which already licenses a Place dependent, and whether [ʔ] also licenses its own manner dependent, as we saw. In (49) but not (50), [ʔ] does license a manner dependent, so that [ʔ] will be delinked in that case, but not in (50). Next Strengthen Manner assesses the outcome of this, promoting [h] or even activating[28] [h] where it is not present in the representation. Again, this means that the lexical box for the passive ending in (41) has to be altered slightly. [Delink: U + licensee] will read [Delink: U + weak licensee]. This will single out a dependent-licensing [ʔ], but leave in tact a [ʔ] without dependents. Thus /p/ + /(i)wa/ will yield / tʃiwa/ and /pʰ/ + /iwa/ will yield /ʃiwa/.

(52)



[28] More on the activation of [h] shortly.

Again, the synchronic grammar merely states the facts; the SER along with the LELP (Lazy Element Licensing Principle) and the ELM (Element Licensing Maximization) shape these facts from the outside, as represented in (52).

I should comment briefly about the notion of [h]-activation, referred to above. /p/, in which no [h] element is present, turns into a segment, /tʃ/, in which [h] is not only present but in head position. Introducing a segment *ex nihilo* threatens to undermine the restrictiveness of a theory, in that any element or elements could be so introduced, and has thus been resisted by GP theorists (though cf. Backley and Takahashi 1996). However, in the present theory element activation can be tightly controlled by stating that a licensing relationship must obtain between an activated element and its "activator". We can do this by adding more detail to the ELM, first stated in (44):

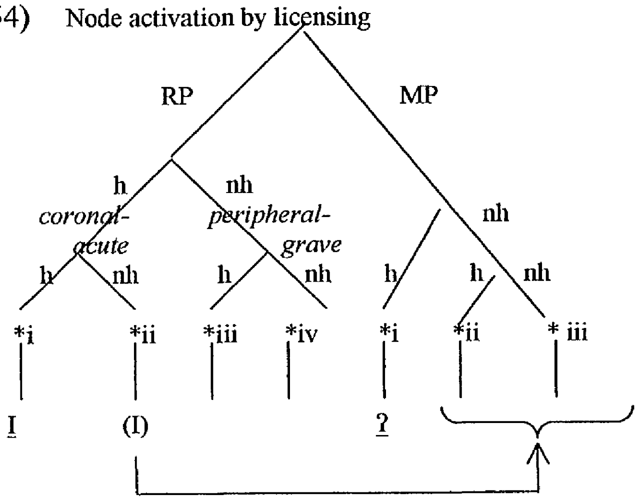
(53) **Element Licensing Maximisation**:

Elements should discharge their full licensing potential, as follows:

Let an element E_1 license its own or another element E_2's movement or activation if a potential licensing relationship exists between E_1 and E_2.

That is, activation only occurs if the node in the tree where the licensed element would be generated is in the scope of the potential licenser. This licensing scope can be illustrated graphically as follows, using labelled nodes for greater clarity:

(54) Node activation by licensing



The licensing relationships between elements and nodes[29] is as then follows:

RPi licenses MPi and below

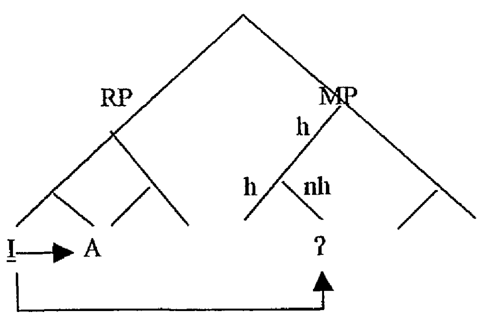
RPii licenses MPii and iii

The basic principle is that any node of cardinality n in RP can license any node m in MP if m is equal to or less than n. The constraint [m-license: strong, h] in (52) then occurs within the bounds of the ELM: node iii, where [h] originates, is in the scope of [I]. The ELM thus allows [h] to be activated there. To discharge the licensing potential of [I] further, [h] then is then licensed by [I] to move to node ii, which is the head node for [h]. Such licensing powers would not be available to Place elements that have themselves undergone movement into RP head. Thus element activation, like element licensing, is strictly controlled by the headship of the relevant elements.

3.8.3 Brief comments on the Zulu lateral

The third curiosity that we listed in 45iii was that only obstruents (of a certain Place) palatalized, while laterals resisted palatalization, even though they are coronal. We will look at liquids in detail in Ch.4. To preempt, we assume the following structure for laterals:

(55) Structure of a lateral:

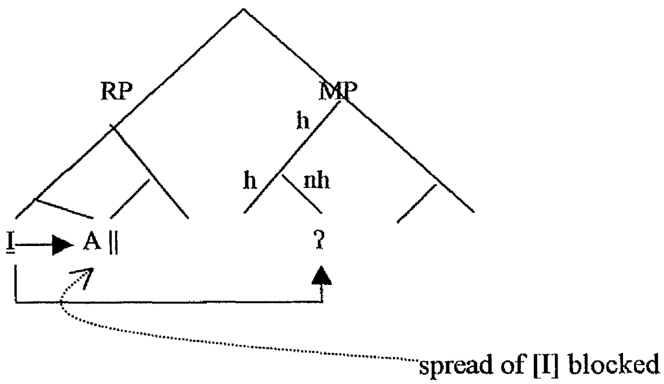


The exact motivations for this structure will become clear in the coming pages, but what this basically shows is that laterals have complex resonance, and weak (nonheaded) occlusion. (The Manner Phrase splits into a head and nonhead component. The former, in turn, splits into head and nonhead again: this captures that, just as we saw for [h], [?] too

[29] I will sometimes refer to the different parts of the element tree by these node numbers, for convenience, in the rest of this thesis.

can manifest itself in head or nonhead role, and is licensed to do so by [I]. All this is discussed in 4.4). The only important point as far as lateral resistance to palatalization is concerned is that [I] already licenses secondary Place in a lateral: thus the spread of the palatal element [I] into the lateral structure is blocked, as the nonhead site is already filled:

(56) lateral resistance to palatalization:



With this, we have succeeded in providing an answer to the third "curiosity" of Zulu labial coronalization.

All these phonological processes and constraints make reference to the headship of the different elements, and the licensing relations as they are affected by this headship.

3.9 Conclusion

In this chapter we have looked at how and why certain element combinations are preferred, or optimal, in inventories. We saw that (morpho)phonological processes like coronal, velar and labial palatalization (in English, Polish and Zulu) also show a preference to turn less optimal segments into more optimal ones, where optimality is construed as degree of enhancement between elements that make up a segment. The actual change from one segment to another is represented by simple constraints in a lexical box entry containing affixes' phonological and morphological information. This is the sum total of information that a speaker needs to execute such alternations in their language. Surrounding this box, however, is a box which represents all the functional constraints which conspire to initiate and then stabilize and preserve this alternation. These represent the linguist's knowledge of the origins of the alternation, but they may also represent certain factors in the user's performance which conspire to initiate, sustain or reject certain alternations.

In the next chapter we turn our attention to another important subset of coronals, liquids, seeing how these can be modeled using the framework developed in the last two chapters.

Chapter 4 Liquids and their incorporation into inventories

In this chapter we will look at liquids, the class of segments which comprises laterals and rhotics (roughly "l-sounds" and "r-sounds"). Liquids come within the remit of this thesis as they have generally been asserted to be and so modeled as coronal in generative phonology from SPE on. But this assumption is not straightforward. For a start, the term "lateral" refers to the manner of articulation in which the sides of the tongue are not constricted, so that closure is incomplete in the production of a segment. While labials do not use the tongue, velars do, and yet though there is a rare "sighting" of a velar lateral (cf. Dickey 1997), laterals are nearly always coronal (cf. also Paradis & Prunet 1991). The interesting fact, therefore, is that laterals do not – physiologically – have to be coronal, but are. We will thus be investigating this relationship. With respect to rhotics, their nature and the fact of their coronality is even more problematic. Phonetically, as we will see, rhotics (which is, literally, merely a fancy name for r-sounds from the Greek name for the letter "r", rho, an educated nominalization which has sometimes hidden a lot of ignorance, but which correctly captures the natural classhood of r-sounds) are a disparate group of sounds which it is difficult to pin down a common property for: often they are not executed with the tip or blade (i.e. the corona) of the tongue at all, and yet they still pattern with other (coronal) sounds which are so made. Finally, these odd laterals and odder rhotics often pattern together, which is why they have been assigned the feature [liquid] in recent work.

In what follows we will be drawing on Dickey 1997 quite extensively for insights into the phonetics and phonology of liquids. Before starting the investigation, let us outline the conclusions we will reach and aim to prove (as framed in the theory we have been developing). They are as follows:

(1)

a. liquids:

- have complex resonance, consisting of [I] and another element [U] or [A];
- have weak manner, i.e. either no manner element or [ʔ] in non-head role;

- these properties, which are precise element-theoretic characterizations of the informal notion of "sonority," make them governable by obstruents, and explain why they appear in "weak" parts of the phonological word, and are sometimes banned from strong positions in the word; they are also sufficient to make recourse to a unifying [liquid] feature unnecessary (let alone [lateral], [approximant], [rhotic] as in e.g Sagey 1986, Clements 1990, 1991a, Hume 1992).

b. rhotics:

- there are only two phonological rhotics, both of which contain [I] in non-head role, and another Place element [A] or [U];
- rhotics are thus phonologically differentiated according to Place, and not Manner or Laryngeality (pace Hall 1997 for example);
- any other variation in rhotic form is phonetic.

c. laterals:

- contain [ʔ] in non-head role (weak, or incomplete, occlusion);
- contain [I] in head role, and [A] as a secondary element;
- these two properties are related.

The picture we will establish of liquids being Place-complex will necessitate a revision of the standard GP view whereby they consist of a single Place element (be this element [A] (e.g. Ploch 1999), [R] (e.g. Harris 1994) or [I] (e.g. Brockhaus 1999)). This in turn demands a revision of standard GP definitions of the governing strength of segments, whereby a segment governs another simply if it has more elements. This revision of government is now overdue anyway, considering the novel representations of segments developed in the last two chapters. This question will be addressed, however, in chapter 5.

The immediate task is to tackle the points in 1.

We will start with 1c, laterals and move on to rhotics, discussion of which will take considerably longer, due to the greater complexity of the subject.

4.1 Walsh Dickey 1997 on laterals

Dickey 1997 proposes that both laterals and rhotics are Place-complex, and that the different resonance involved in their representation is coronality and dorsality. This is on the basis that laterals take part in phonological alternation processes with both coronals and dorsals (see below). Thus they must share Place properties of both these natural classes.

Dickey backs this up by showing that in articulatory terms, all laterals are coronal or velar, and sometimes a mixture of both. Acoustically, laterals display coronal and dorsal properties as well. In 2.4.2, for example she says: "The second formant in laterals is quite a bit lower than in plain alveolars, suggesting the presence of a dorsal gesture...In fact the first two formants of an alveolar lateral have values extremely similar to the glide [w]. The only consistent difference between [w] and [l] is that the high frequency components of the spectrum are lower in energy around F3 in [w] than in [l] (p.50)." This lowering of F1 and F2 suggests the presence of the element [U], and the high F3 suggests [I] (cf. the acoustic correlates of [U] and [A] as "secondary" elements in Chapter 2:8). In addition, as we will see, the alternation of laterals with velar fricatives and stops (see the table in (2) below) suggests the presence of [A]. We will model these acoustic properties, in conjunction with the facts of phonological distribution, shortly.

The phonological evidence that Dickey brings for why laterals are "corono-dorsals" (a term we will see the meaning of soon) is considerable, and I do not have space to review all the evidence here. Thus I will reproduce only a fraction of the evidence in the form of her Table 2.1 (see table (2) below).

For Dickey these alternations in coda-position are evidence of lateral alternation with velar and labial and coronal place, and of lateral simplification. Whether the change of the dorsal lateral affricate [lʒ] to [g] in Jibba:li is simplification (a stop generally being modeled as a strong/complex segment across diverse theories, cf. GP, Dependency Phonology, Natural Phonology etc.) or not need not concern us: what I do take from this table and the other data Dickey examines is a clear indication that laterals are composed of Dorsal and Coronal phonologically. In fact I would argue that only the alternation of /l/ with the labial and palatal glides can be seen as simplification. The change /l/ → /ɣ/ is perhaps best seen as a recomposition of existing features into a new configuration rather than a loss of any of them.

(2) Dickey: the corono-dorsal nature of laterals: coda simplification

Coronal loss: Simplification	Jibba:li (Johnstone 1975)	[lʒ] → [g]/ __]σ
	British English(RP&Cockney: Gimson&Cruttenden 1994)	[l] → [ɣ]/__]σ
Coronal loss: Structure Preservation	Belear Catalan (Alcover&Moll 1968)	[l] → [u]/ __] σ
	Mehri(Johnstone 1975), Brazilian Portuguese (Azvedo 1981)	[l] → [w]/__]σ
<u>Dorsal loss</u>	Florentine Italian(Holton 1994),Modern Greek (Newton 1972), Andalusian Spanish (Holton 1994) Caipira Portuguese	[l] → [ɾ]/__]σ
	(Azvedo 1991) Linngithigh and Alngith (Australian: Smith 1996)	[l] → [j] / __]σ

Be this as it may, the above changes motivate the following Feature Geometric representation for Dickey:

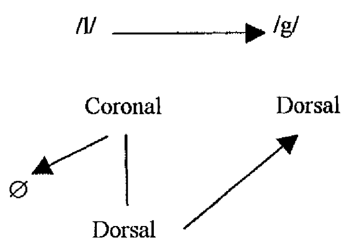
(3) Lateral Structure (Dickey 1997):

Root
|
Place
|
Coronal
|
Dorsal

Phonologically, laterals are primarily coronal. This comes out in the above table by the alternation of /l/ with alveolar tap /ɾ/ and palatal glide /j/ (she adopts a Hume/Clements-style characterization of palatals as coronal) – the unity of these two alternation being captured if both contain the feature [coronal]. Dickey gives many other examples of laterals patterning with coronals: a small and familiar example from English is the OCP constraint against *Place Place in an onset: this rules out [pw] as

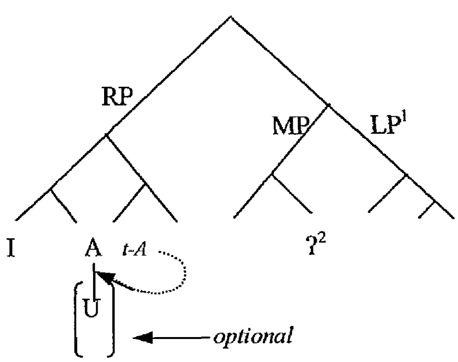
[Labial][Labial] and [tl] as [Coronal][Coronal]. (We will see why [tr] is permitted when looking at the structure of rhotics). Another example is the Finnish constraint that only coronals can appear word-finally: laterals appear finally and thus must be phonologically coronal (Yip 1991). The /l/ to /g/ alternation is then captured by the loss of [Coronal] and what Dickey calls the "promotion" of Dorsal, which is modeled as (Dickey '97, Fig. 2.20, p.65):

(4) Promotion of Dorsal node from secondary to primary; /l/ → /g/



What does all this mean in terms of Element Theory? It means that laterals contain at least I and A and sometimes U. Of course in standard ET, we might be afraid that this would boost the complexity of liquid p.e.s. In our element geometry, however, this need not be the case (as will have occasion to show later). Dickey's contention that liquids are coronal and dorsal with a phonological preponderance of coronality, putting them in a natural class with coronals, is easily implemented: we say [I] is head which licenses secondary Dorsal resonance. That will look as follows:

(5) Tree structure for a general lateral



– either U or A or both present

[1] LP = laryngeal phrase. Discussion of this will follow in Ch.5.

[2] The interpretation of [ʔ] will be taken up in 4.3. Briefly it represents weak, thus incomplete, occlusion, which is appropriate as the lateral is not closed at the sides, unlike stops.

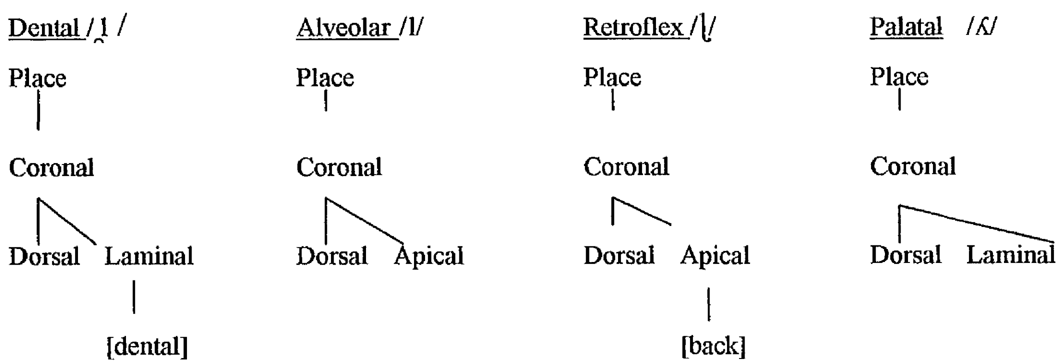
The exact nature of the Manner and Laryngeal Phrases in this lateral structure will be examined later. What this structure shows is an [I]-headed, i.e. coronal, segment where the [I]-head licenses a lazy complement, [A], which has moved from its original position into the head-phrase of RP – with the result that it is interpreted simultaneously with [I]. This element can optionally license another element, [U], which we might say is adjoined to it.

Of course, modeling /l/ as (I̲.A.?) raises the question of what the retroflex lateral will look like, and more generally of the representation of specialized laterals. We will examine this in the following section.

4.2 Subplace distinctions among laterals

Laterals are capable of supporting all the sub-place distinctions found with coronal stops: dental, alveolar, retroflex and palatal. The structures for these laterals will thus look like the corresponding stops – with the exception that the base, unmarked lateral is inherently place-complex. Dickey's representations of these laterals is, followed by my translations into Element-Geometry are (Figure 2.21, ibid: 67):

(6) Dickey 1997: Distinctions among laterals



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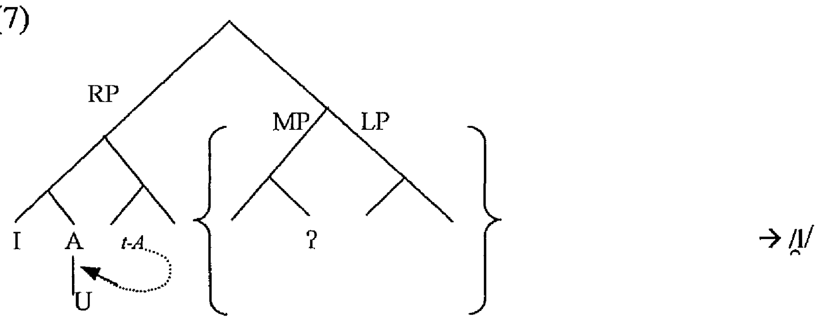
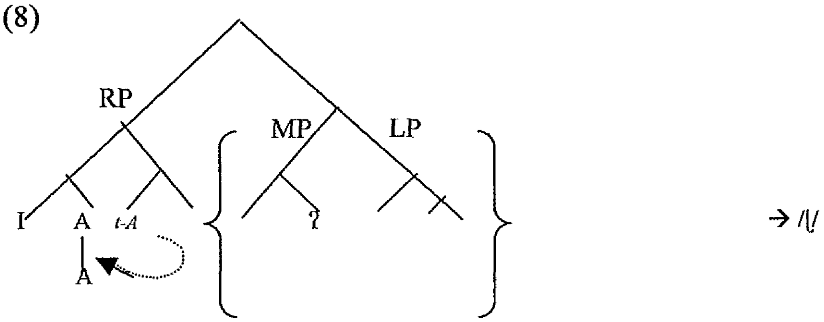
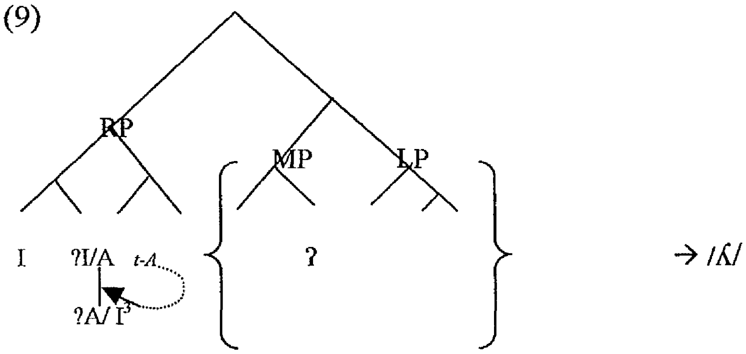


(8)



(9)



These representations can be considered a generalization over the known types of laterals in the literature. Obviously we have not captured the nuances of lateral phonological behavior. However, our aim here is to continue investigating and modeling the structure and growth of inventories, and for this general purpose these preliminary modelings will suffice.

We will return to these structures later. Our next task is to consider the nature of rhotics.

4.3 Rhotics: peculiar segments

4.3.1 the phonetic diversity of rhotics

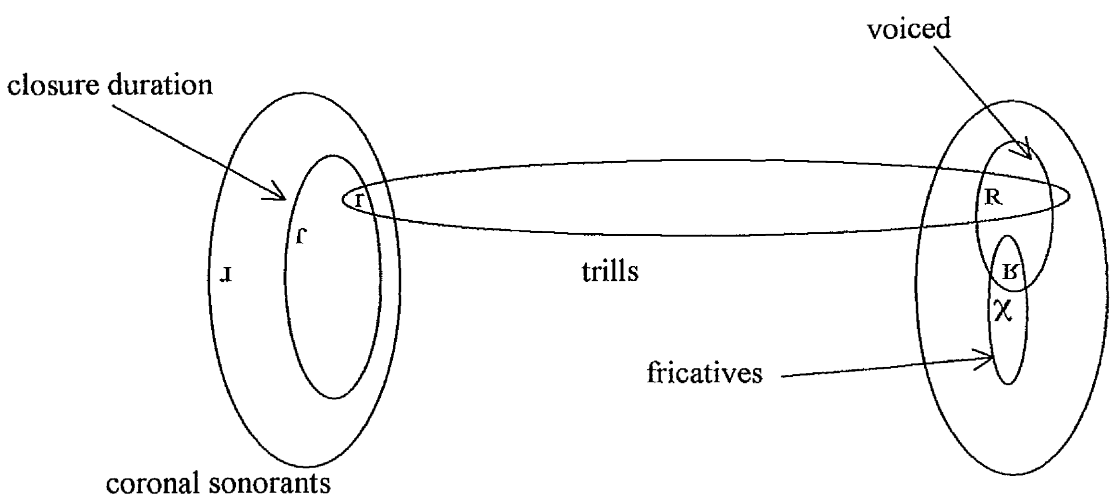
The striking characteristic of rhotics, according to Dickey, echoing Lindau '85 and Maddieson & Ladefoged '96 for example, is their lack of a unified phonetic

[3] [I] could dominate [A] or [A] could dominate [I]: one might favor the former as [I] is base-generated in a higher phrase, and might thus be expected to have precedence over [A]. I leave the issue unresolved for the moment.

characterization. This may seem paradoxical, and raises the question of why rhotics have been treated as a natural class at all.

Dickey's solution to this, following Lindau '85 (who herself abandons her own earlier theory of a possible unifying "lowered F3" phonetic property for rhotics) is to treat rhotics as a "polymorphous category". That is, instead of insisting that a rhotic is a rhotic only if it fulfils the classical "necessary and sufficient" conditions for membership in a class, Dickey adopts the Wittgensteinian notion of "family ressemblance" to deal with the phonetic disparity of rhotics: this insists only that "one or more of a set of properties must be present" to determine membership in a given class. There are therefore phonetic correlates of rhotics but the phonetics-phonology mapping is not one-to-one. The many different phonetic guises that rhotics come in (taps, flaps, trills, fricatives, sonorants, obstruents, retroflex and alveolar coronals, uvulars, and even bilabials as we will see) thus does not obscure their phonological unity. I myself will adopt this point of view and give an element-geometric structure for rhotics which reflects the phonetic freedom of their implementation. The polymorphous nature of rhotics can be seen in the following Venn diagram (Dickey 1997:89):

(10) Venn diagram of phonetic connections among rhotics:



The following properties are intended to show that rhotics do, however, form a natural class phonologically:

(11) 5 phonological properties of rhotics (abbreviated from Dickey 1997):

A. Positional restriction on rhotics as a class.

B. Cluster restrictions.

C. Alternation with other rhotics, (free variation, diachronic and synchronic phonological).

D. A restriction on coronal rhotics to an apical articulation (almost universal).

E. Resistance to palatalization – regardless of manner of articulation.

I will select some of Dickey's comments and illustrations from these five properties, briefly summarizing what she says.

A. Positional restrictions:

For example, in Australian, both the apical alveolar trill and the apical retroflex approximant cannot appear word-initially, even though other apicals can: this includes even other apical sonorants, such as /l/ and /n/. Interestingly, in some languages, there is a ban on laterals in word-initial position, so that an implicational hierarchy emerges here:

(12) *initial onset preference*:
obstruents >> laterals >> rhotics

We can intuit at present that this positional restriction will have something to do with the *weaker* internal structure of rhotics compared to laterals, and of laterals compared to obstruents, which makes them less likely to be licensed in this phonologically strong site – which is what we assume the intial onset to be, based on notions we will make more explicit shortly.

B. Cluster restrictions:

Dickey lists two types of cluster restrictions:

a) a prohibition on rhotics and non-rhotics clustering together:

*[rd] vs [ld nd] in Maung (Australia: Capell & Hinch 1970)

Dickey concludes of this phenomenon: "This kind of singling out of rhotics is evidence that rhotics all have some property that can be referred to by the phonology."

b) a prohibition on rhotic-rhotic clustering, i.e. [....r.r....], where /r/ is shorthand for any rhotic in the language in question (again these prohibitions come from Australian Aboriginal languages), e.g. apical or retroflex.

C. Alternation with other rhotics:

This can be seen most clearly by reproducing Dickey's table 3.3:

(13)

Alternation type	Language	Alternation
Free Variation	Estako (Dunstan 1969) Isoko (Dunstan 1969) Aranda (Strehlow 1944) Bello Horizonte & Sao Paolo Portuguese (Azevedo 1981)	ɹ ~ ɾ r ~ ɾ r ~ ɹ(in the absence of minimal pairs) ɾ ~ r ~ r̥ ~ ʂ ~ ʐ ~ ʐʀ ~ x
Diachronic	Madhi-Mahdi (Dixon 1980) Yidin (Dixon 1980) Banjalang (Dixon 1980) French (Haden 1955) Capira Portuguese (Azevedo 1981)	ɹ > r / V __ V r > ɾ r > ɾ r > R ɾ > r
Allophonic	Palauan (Josephs 1975) Gunwinggu (Dixon 1980) Alyawarra (Yallop 1977) Pennsylvania German (Reed 1974)	ɾ → r /#__ ɾ → r / __]σ r → ɹ/ V̌ __ V̌ r → ʁ / __]σ

Dickey focuses especially on the Brazilian Portuguese alternations, as here phonetic disparity of rhotics is joined with phonologically identical treatment, thus confirming the earlier classification of rhotics as a polymorphous category. Phonetically, free variants of the uvular trill include the following: retroflex coronal fricatives (voiced and voiceless), velar fricative and coronal trill (voiced and voiceless). Dickey remarks: "My claim is that all of these allophones of rhotics actually are specified for [liquid]. In situations of free variation, the allophone retains phonological, although clearly not phonetic specifications." It is here that her characterization of rhotics as a polymorphous category finds its strongest motivation. Their phonological unity, Dickey is claiming, come from their common specification for the overriding *phonological* feature [liquid]. The evidence compels us to accept this notion of polymorphous category; however, the phonological modeling of this can be achieved by a different means, as I show below.

D. Restriction to apical articulation of coronal rhotics:

Once again this is a property of *coronal* rhotics only. It manifests itself as follows: Even languages which contrast laminality and apicality for other manners, do not do so for rhotics. Strikingly "even rhotics at a dental place of articulation, which is normally laminal, are apical (ibid:98)." Again, it looks like this could be a candidate for a classical "necessary and sufficient" condition for rhoticity. Dickey resists this and states: "It would be odd if despite their phonetic diversity, all [rhotics] shared a phonetic restriction to an apical articulation...I maintain that the restriction of apicals to apicality is a phonological one (ibid:98)." Part of this unease at a universal phonetic apicality for rhotics is that uvular trills, which display free variation with rhotics are not phonetically apical. Rather than accepting a one-to-one phonology-phonetics correspondence for coronal rhotics at the risk of excluding the uvulars, therefore, Dickey adopts the idea that [apical] is a polymorphous phonological category, which includes uvulars. In other words uvular rhotics contain the *phonological* feature [apical]. This then forces her to say that the apicality of coronal rhotics is somehow not the result of a straightforward phonetic mapping of the phonological feature but also an indirect interpretation of the abstract feature [apical]. It seems misleading then to call the feature [apical] and not, say, [rhotic]. The latter feature would then be short hand for any segment in Dickey's Venn diagram. As it happens phonetic apicals are a subset of phonological apicals. This leads Dickey somewhat contradictorily to then profess an interest in whether uvulars may not turn out to be phonetically apical as well – when this should not matter, if the notion of polymorphous category is taken seriously.

E. Rhotic resistance to palatalization:

This is perhaps the most interesting of the properties that Dickey examines as it gives a clues as to the phonetic-phonological make-up of (coronal) rhotics:

There are three manifestations of this:

i) rhotics fail to change at all in a palatalizing environment, contra non-rhotic segments

ii) the rhotic will change (diachronically/cross-dialectally) to a palatal glide

iii) the rhotic will change to another type of segment altogether: {ʒ, lʒ, dʒ, s}

(Note how (iii) again shows the alternation of rhotics with coronal fricatives or affricates: this will be significant below).

Various other typological facts confirm the special relationship between palatality and rhotics. As they are important in the modeling I adopt below, I will list them in full:

(14) the connection between palatality and rhoticity:

(i) there are next to no rhotics with palatal Place (more precisely 1 out of 451 UPSID languages has a palatal rhotic).

(ii) Only 7 out 451 UPSID languages have palatalized rhotics (Bulgarian, Lithuanian, Nenets, Saami, Igbo, Russian, Irish) and these languages also have the non-palatalized variant (the latter is thus less marked).

(iii) Rhotics block the spread of palatalization

(iv) [i] and [j] are allophones of rhotics (e.g. Linnigithigh and Alngith where r~j alternate; cf. also Samothraki Greek example in 4.2.5).

This special relationship of rhotics to [i/j] and palatalization can be explained if one assumes that rhotics already contain palatality: thus any further palatalization is vacuous. Dickey adopts the Hume-Clements representation of front high vocoids and palatalized consonants as containing the feature Coronal, with one modification. For her "palatalization is secondary laminality," on the grounds that it is the "tongue blade specifically [which] is implicated in palatality." The primary coronal property is apicality. Thus Dickey arrives at the following representation for a coronal rhotic (ibid.106):

(15) Coronal rhotic structure

[liquid]
|
Coronal
|
Apical
|
Laminal

We thus have a significant lead on what rhotics, of the phonetically coronal variety at least, look like: in elemental terms they will contain [I] – whether in head or nonhead role, is a matter we will take up later. The problem with extending this view to uvular rhotics is that it is difficult to ascertain whether they palatalize or not, as uvulars in general do not palatalize; we are thus deprived of an argument for a palatal make-up for uvular rhotics; however, in the modeling ultimately adopted here this should not matter.

Our next step in this investigation of rhotics, after considering the great phonetic diversity of rhotics and the problems it raises, will be to consider the actual *lack* of diversity of rhotics in single languages: a language only supports a maximum of 2 *contrastive* rhotics, as we will see from the investigations of Hall 1997. This will give us the final clue as to rhotic representation.

4.3.2 rhotics: their phonological paucity

Hall 1997, chapter 4, examines rhotics from the point of view of inventory size. The most striking fact he highlights is this: there are 9 (main) phonetic incarnations of rhotics (4 alveolars, 4 retroflexes and one uvular, see below) but languages have at most 3 rhotics[4] in their inventory (they are thus less diverse than laterals which can number up to 4). Hall lists the 9 as follows:

(16)

	alveolar	retroflex	uvular
Nonlateral Approximants	ɹ	ɻ	
Taps/flaps	ɾ	_	
Trills	r	r̠	R
Fricative Trills	0	ř	

In fact we have seen from Dickey's discussion of BP that we must include velar fricatives and retroflex coronal fricatives in this inventory. And we must go even

[4] Maximum 3 *phonetic* rhotics that is. It will turn out that free variation between 2 of these rhotics in the languages in question means the number is maximum *2 phonological* rhotics.

further still and include the bilabial trill found in Kele, represented by the IPA symbol as [B] (Hall '97: 111). Three things emerge again:

(17)

a. Place is mysteriously unimportant in defining a rhotic. (Though this won't remain a mystery for long). Uvular, velar and even (in a highly marked case) labial sounds can acts as rhotics.
b. Despite the broad range of phonetic options in implementing rhoticity, only a small subset is chosen (1/3 of the options on Hall's conservative estimate) for any one language.
c. Of this small subset, the options are further decreased as some of the 2 or 3 rhotics in a given language are often in free variation (see below).

In other words, we would be missing an important phonological generalization if we tried to implement all 9 phonetic differences, such as trill vs. tap vs. fricative trill as special phonological categories accessible to Universal Phonology. One reason is that possible features such as [fricative trill] or [tap] or [flap] do not combine productively with other established features like [labial], [velar], [continuant] to create a broad range of segments, a good number of which are found in languages. For example [-continuant], or [?], combines with all major places to produce at least 3 phonemic stops in nearly every language. But [flap] or [trill] would be able to combine only with idiosyncratic place specfications (alveolar, retroflex, uvular – the last two being marked elaborated sub-places of coronal and dorsal respectively), and would then generate a lot of segments which surface in only a small number of languages. The marked nature of the Place these features combine with and the excessive generation of segments they would allow leads us to reject Hall's arguments for the features [tap] and [flap][5].

Rather, what the above data tells us is that these 9 phonetic objects, which pattern the same way across languages, and which no language selects more than 2 or 3 of, are surface manifestations of some deeper phonological property.

[5] He eventually opts for one feature [flap] which combines with [continuant] to produce taps and trills. See below.

4.4 A preliminary structure for rhotics

At this point, having seen several properties of and data about rhotics, we should put our cards on the table and advance an analysis of our own.

From the above discussion, we take the following points:

(18)

a. all rhotics contain palatality, or the element [I][6] in nonhead role.

b. Manner in rhotics can vary between approximant, tap, fricative, i.e. manner implementation is optional.

c. rhotics are the last segments to be chosen for initial onset position.

d. rhotics can appear in the complement of branching onsets, i.e. are governable.

e. only 2 *phonological* rhotics can appear in any one inventory.

We can see points (c) and (d) as connected: if initial onset position is a strong position (perhaps regardless of its tonic properties which may vary) then the rhotic ban there is the flip-side of rhotic suitability for branching onsets. Why this is, should be reflected in our modeling.

To the above five points we can add another two:

e) rhotics alternate with the glides /w, j/[7]

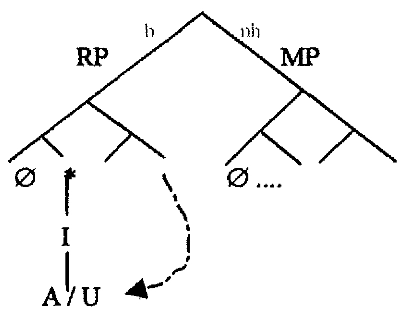
f) beyond palatality, secondary Place properties are optional (cf. free dental, uvular, velar, alveolar manifestations).

Again we can see these properties as linked: (f) proves that like laterals, rhotics are Place complex: they are palatal and something else – that something else can vary. Indeed this Place-complexity will be the key to why rhotics and laterals form a natural class.

Given these points, we will want our rhotic structure to look like this:

[6] This could not be proved for uvular rhotics, but has to be assumed by analogy with those rhotics which do resist and block palatalization.

(22) structure for a rhotic



Aspects of rhoticity captured by this structure are:

a) The structure has [I]-nonhead in its usual position under the non-head node of the RP-head phrase. A rhotic with this structure will, as Dickey points out for rhotics, resist palatalization because the landing site for the palatal element is already occupied.[8]

b) In addition, [I]-nonhead dominates either [A] or [U]: a rhotic can thus be (IA) or (IU) – this captures the possibility of alternating with the palatal (I) or labial glide (U).

c) An [A]-ful rhotic will have dorsal properties; this will be able to capture phenomena like the rhotic "colouring" of vowels (cf. Dickey 1997: 5.4).

d) As we will see in Ch.5, the fact that RP-head is not filled (marked by ∅) and the fact that Manner head is not filled (" " ∅) will mean this rhotic structure is governable.

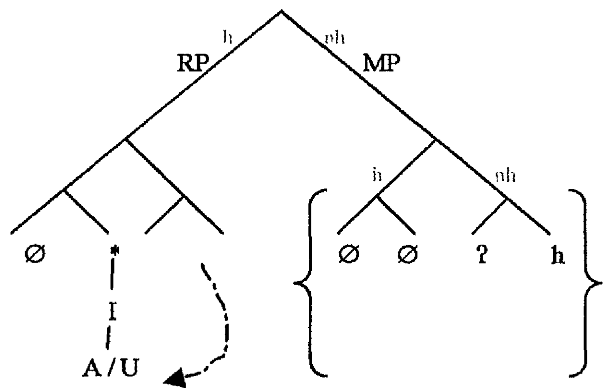
4.4.1 Variable phonetic interpretation of rhotic structure

I will now look briefly at the structure of Manner Phrase, which has been ignored so far, and say something about the variant manner in which rhotics appear (as we have seen: tap, trill, flap, fricative, approximant).

---

[7] I give an example of a /r/~/w/ alternation below; an example of a /r/~/j/ sound change is from Standard Greek (SG) ~ Samothraki Greek (SthG): xarti (SG) "paper" → xaiti (SthG); kardhia (SG) "heart" → kaidhia (SthG). (cf. Newton 1972, who Dickey draws on for this data).

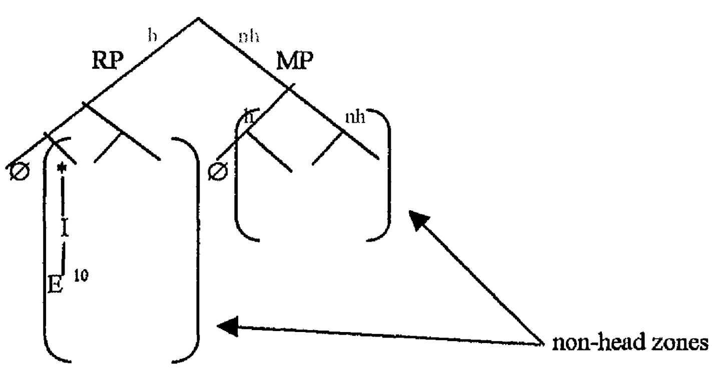
(23) <u>The Manner Phrase of the rhotic:</u>



In this structure I have reworked Manner Phrase so as to include a distinction in the headship not just of [h] but of [ʔ] too. This will mean that there can be a strong (headed) and weak (non-headed) interpretation of the occlusion element, as we have had so far for the noise element. The latter interpretation will represent the incomplete occlusion of lateral closure[9] and the rapid, fleeting closure of the tap or flap gesture. (The idea is that both [ʔ] and [h] are generated in the nonhead of Manner and are then moved into head or nonhead position of the lefthand phrase of Manner).

How does this relate to rhotics? We assume the following structure for rhotics generally, along with the following principle of interpretation:

(24) Structure of a rhotic again:



[8] This is true of laterals as well: at the end of Ch.3 we saw that the Zulu lateral did not palatalize; this is because the secondary Place node is filled by [A]; [I] could "adjoin" to [A], but this would be a marked operation.

[9] If we look at (5) again, we see that nonhead [ʔ] represents the incomplete closure of the lateral too – in conjunction with [I] in head role, though.

[10] E = any of {A,U}.

(25) *rhotic structure and interpretation (RSI)*:

(i) a rhotic R consists phonologically of headless {I,E} in RP where I,E are not ordered into head/nonhead roles; at least one of {I,E} must receive phonetic interpretation.

(ii) any non-head element from MP or RP may be overlaid onto this core during phonetic interpretation. The number of phonetic variations of R is shaped by non-linguistic considerations of simplicity/economy and the choice of variant by sociolinguistic pressures.

There are 2 zones in the rhotic structure which are unheaded, as indicated by arrows in (24). The RSI says that any element from this zone can be added to the core phonological structure of a rhotic. In manner terms, this includes: [h], [h̲] or [ʔ]. For resonance this includes [U] or [A]. Combinations of these mean that velar or uvular fricatives, strident coronal fricatives or coronal taps can be produced, and still be rhotics. (These are indeed attested alternants, cf. Table 15).

As far as the core properties are concerned, these consist of [I] (palatality, as shown by Dickey) and one other place element.

We further say that while {I,E} are present phonologically, the relationship that they are in – represented by a vertical line between the 2 – is not an asymmetric one of domination. This is appropriate for the unusual situation whereby an element moves into nonhead of RP-head when the latter is already occupied by an element. Then we add that only one of {I,E} need be interpreted: if [I] is not interpreted this gets us the possibility of uvular rhotics which are not proven – yet – to be palatal. Such a configuration would be (A.A.h): here

(i) the first [A] is the phonological one, the instantiation of E. (and I is not interpreted).

(ii) the second [A], giving uvularity (remember /q/ was (A.A.ʔ), is freely picked from the nonhead zone of RP – in phonetic interpretation.

(iii) the friction [h] is freely picked from the non-head part of MP – in phonetic interpretation.

The specification "non-head Manner" also permits {ʔ, h}, i.e. a tap (as we have just seen) or fricative manner, so that we can also get velar fricatives (Ah), retroflex coronal fricatives (IAh), a dental approximant (I.U), a retroflex approximant (I.A) and so on.[11]

The second clause of RSI(ii) says that non-linguistic economy limits the number of realizations of a rhotic in any one language. That is, while there are 11 or more possible realizations of rhotics, arising in our model from the possibility of superimposing nonhead elements in phonetic interpretation, a language will usually settle for one or two manifestations of the underlying phonological object, on the basis that it is simpler to interpret one object in one way without multiplying labour. This of course need not be the case, as the extreme amount of variation in Brazilian Portuguese with respect to the one rhotic, testifies.

Thus we have shifted the phonetic diversity of rhotics into the phonetics – albeit that the phonetics has to work within structural phonological constraints – , so that we get the manifestations of rhoticity that we want. But what about the generative possibilities of underlying phonological rhotics? Phonologically, our structure for rhotics has very small combinatorial possibilities: we allow {I.E}, where E can be A or U. Thus we predict that only 2 phonological rhotics can be generated (with the possibility that one or both rhotics might have variable surface manifestations). These are, of course: (I.U), (I.A).[12] ([I] alone will be the palatal glide). Given that we have found that there are indeed a maximum of 2 phonological rhotics in one language, this is the ideal result (it is more parsimonious than Hall's model: among other objects he predicts the non-existent [-tap, - continuant], as we will soon see – a deficiency arising in this case from his use of binary features; he also has to make implicational stipulations, as we will see in 4.9).

There is another important point concerning the underlying nature we have posited for rhotics: and that is, that if a language has 2 rhotics, they will differ according to their resonance structure (between A and U) and not according to Manner, which will be a phonetic difference in the interpretation of one underlying rhotic. This is an important prediction, which we should investigate.

4.4.3 Phonemic distinctions among rhotics

[11] We said in Chapter 2 that the approximant manner was the default – because phonetically optimal – interpretation for nonhead-[I] without [?] or [h].

[12] Not (A.U), as E has to move into RP-head to be interpreted: A.U would mean 2 moves, one for [A] and one for [U] – this is not allowed. I will take up the constraints on movement after the discussion on rhotics and laterals is complete.

A completely contrary principle is stated by Hall 1997:

If a language has more than one rhotic then these sounds will be distinguished in terms of manner or laryngeal features rather than place features. (Hall '97:110 (5)).

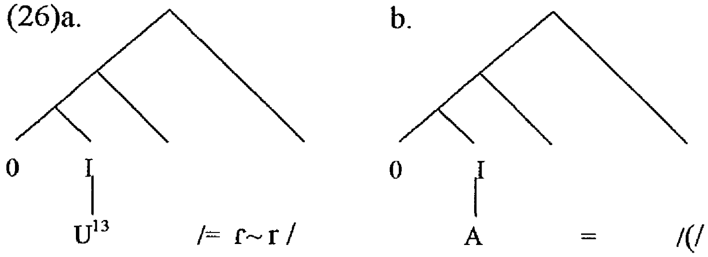
Pitta-Pitta has the three rhotics {r, ɾ, (}, according to Dixon 1980. Looking at Hall's chart we see that these IPA symbols denote respectively an *alveolar* trill, an *alveolar* tap and an *alveolar* non-lateral approximant (cf. (16)). Therefore they all share the same Place, and are distinguished by Manner, as per Hall's principle. If this is indeed the case for Pitta-Pitta, then we have been wrong in making Manner distinctions non-phonological in the way outlined above. Furthermore, we would have to get the difference between a tap and trill into the phonology: the alterations to Manner Phrase above only introduced a stop/tap distinction, and we said the tap was a question of phonetic implementation for rhotics. Luckily, Pitta-Pitta in fact seems not to have three phonemic rhotics which are distinguished by the manners tap vs. trill vs. approximant.

Hamilton 1996 draws on different sources (Blake 1979b, Blake & Breen 1971) for Pitta-Pitta, and he adds the following to a characterization of this language which overturn Hall's claim:

1. Hamilton comments: "the alveolar trill and tap are in free variation in C_1."
2. He categorizes the approximant quite clearly as apico-postalveolar and retroflex: "the members of the apico-postalveolar series are distinguished mainly by the retroflection they impart to the preceding vowel..." (ibid.: 296)

Phonologically we thus have an alveolar tap~trill and a retroflex approximant for Pitta-Pitta. There is thus no reason why the following contrastive representations won't suffice:

(26)a.



[13] We are not working here according to precise phonetics. I assume that an [U]-ful rhotic will have maybe lip-rounding and/or the tongue extended towards the front-peripheral region; in conjunction

If the trill and tap do not ever contrast in a language, then we will not need to distinguish them phonologically. We can thus see nonhead-[?] as being variably manifested as a tap or trill. (Interestingly, Spanish appears to contrast a tap and trill: however, this contrast is operative in only one position, and according to Lipski 1990 both are underlyingly identical, differing at surface level due to a rule which links them to one or two timing slots (ibid. for more detail); thus there is no need for features to encode this difference as argued by Hall (1997: 117-124)).

We can therefore bypass Hall's discussions on the motivation of a feature [flap] (which he combines with + or – [continuant] to get a trill versus a tap). The incorporation of such a feature, even though it is an improvement on a feature geometry which includes [tap], [flap] and [trill] only leads to overgeneration and is not phonologically well-motivated.

Another example of a maximal rhotic inventory, which once again proves we have adequate resources to model rhotics, is that of another Australian language, Arabana-Wanganura. Hall, quoting Hercus 1973 says this language has "two trills and a retroflex approximant (p.110)". Hamilton 1996, using the same source but also the later Hercus 1994 and 1979, reports that "the two vibrants are in free variation in C_1 with a preference for a trill articulation." Thus Arbana-Wanganura in fact only has 2 contrastive rhotics.

Thus, our rhotic structure along with the RSI, provides an adequate and accurate modeling of rhotics.

4.5 Coronal uniqueness again

Before looking at instances where laterals and rhotics pattern together, we should recap what has been discovered about liquids above, highlighting what is unique about them in their capacity as *coronals*. To model laterals, we had to introduce a new manner distinction, whereby [?] appears in nonhead capacity. We also had to assume that the default resonance status of liquids was complex, a combination of [I] (as head or nonhead) and some other Place element. This sounds familiar. In chapter 3, we

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with [I] this will give the so-called alveolarity of rhotics. Future work should make these claims more precise. Phonological evidence for this is the r~u alternations found in e.g. English dialects, and in discovered that coronals have a special relationship with (i) manner: only coronals can be strident and only coronals can be affricated, and (ii) place: coronals have the greatest capacity for subplace specialization. To this we can now add, only coronals can be tapped, (flapped or trilled – though in our analysis these latter are phonetic variations on the first, we decided), and the only segments which are part of the basic (Set 1, in Kingston 1993's terms) segment inventory that are place-complex are coronal. Again, all this is best modeled as being a result of the natural head [$\underline{\text{I}}$]'s capacity to license other elements.

Of the four types of manner which we have discovered to be phonologically fundamental, [$\underline{\text{I}}$] can license all four while {A,U} can license only two, i.e.:

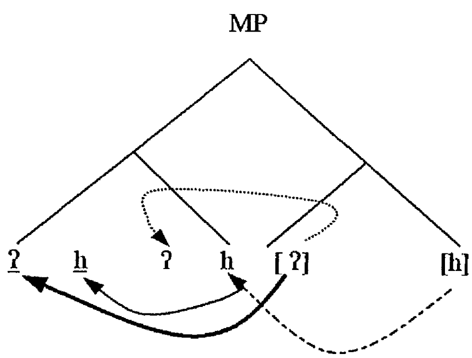
(27) [$\underline{\text{I}}$] → { $\underline{?}$ $\underline{\text{h}}$? h }

{A, U} → { $\underline{?}$ h }

As we noted in chapter 3, [$\underline{\text{I}}$] prefers to license occlusion and stridency, while the peripheral elements prefer to license occlusion and mellow friction. We put this down to the ELM, the principle which stated that an element maximally fulfils its licensing potential where possible. We should note that maximal licensing does not translate straightforwardly as licensing a head in MP: in (27) we see that {A, U} license a head and a nonhead; also, as laterals are Set 1, i.e. unmarked, segments [$\underline{\text{I}}$] must have no problem licensing [?]-nonhead in the case of the lateral. The difference in the capacity of [$\underline{\text{I}}$] vs. {A, U} in licensing manner turns not on the headship of the manner element, but on the amount of movement needed to get a manner element interpreted in the correct capacity. If we look at movement within MP, we see the following:

English-speaking childrens' pronunciation of /r/ as /w/ ("vewi" for "veri" – only part of the rhotic

(28) The interpretation of {?, h} through different types of movement in MP:



——————▶ head-to-head movement (occlusion: (?)) [idem]

——————▶ complement-to-head movement (licensed by [I]-head only: strident (h))

- - - - - - - - ▶ complement-to-complement movement (nonstrident (h)) [idem]

{ ....▶ head-to-complement movement}

What this shows is the following: [?] is a natural head, [h] a natural nonhead. We assume that these elements originate in the righthand phrase and are moved into the lefthand phrase when licensed by a Place element. We say that it is easier for movement to go from a node of type X to X: head to head or nonhead to nonhead, and we call this idem-movement (identical, X-to-X) movement. The opposite movement we can call non-idem movement. Then the different licensing capacities of [I] versus {A, U} are clear: the former licenses both types of movement, the latter only the easier idem-movement.

Moreover, resonance elements license movement firstly of manner elements, and only then of resonance elements in their own phrase; we can thus call all movement of "secondary elements" within RP non-idem movement as well. A head RP element will thus firstly start moving manner elements and then resonance elements. (The rationale is that licensing movement in a complement phrase is easier than in the head phrase).

One final requirement will make the status of laterals and rhotics fully clear: we can say that an element tree prefers optimally to have a head in RP and a head in MP – this is the configuration for a stop, which is the optimal obstruent.

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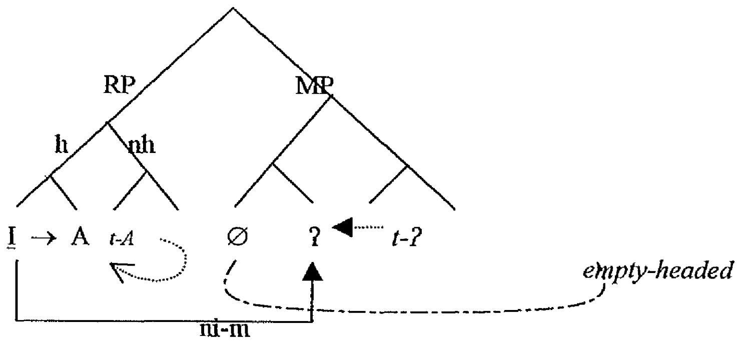
would have been mastered).

However, if we look at the structure of a lateral again, we find that MP is *not* headed:

(29) lateral structure



We can thus see movement of [A] into the head phrase of RP as compensatory movement for the lack of a head in MP. That is, if a head is not created in MP then at least all of the headphrase of RP is filled. This goes beyond the minimal requirement to have a head in RP. Of course, this option is only available if [I] is in RP, as only this element has the power to move resonance elements in this way. We will call this need for a state of minimal headedness the Head Condition. We will return to this in 4.7.

Rhotics and laterals are therefore structures which emerge due to the special licensing powers of the coronal element, which we have seen manifested in other ways. Their peculiar structure and interpretation will also, as we will now see, explain the distributional constraints to which they are subject in some languages. The same properties will also be used to explain why liquids are governable by obstruents, but we will only tackle this question in Chapter 5.

4.6 Dispensing with a [liquid] feature

In the preceding sections we motivated the element-geometric structures for laterals and rhotics. In this section we will consider cases where laterals and rhotics pattern together phonologically, which has led phonologists to posit a feature [liquid]. Here I will only look at two of the cases of liquid patterning, word-initial prohibition and liquid dissimilation in Latin. We will try to show that an independent feature [liquid] is not necessary, but that these cases can be analyzed in terms of the common internal structure of laterals and rhotics as just modeled.

4.6.1 Word-initial prohibition.

We mentioned this property above for rhotics, and related it to the strength of the initial onset position and the weakness of rhotics. The converse of this is the preference for rhotics in coda and onset-complement. The same applies to laterals, and thus to the putative class of liquids. We can thus say, along with traditional element theory, that there is no feature [liquid] but rather what unites rhotics and laterals here is their *weakness*. For traditional element theory, this means their lack of elemental complexity – however we have seen that liquids contain more than one (rhotics) and more than two (laterals) elements, so this will not hold straightforwardly. What's more traditional element theory holds that the lateral has a fairly strong characterization (if by strong we mean "complex" and calculate complexity from number of elements without recourse to type of element). Harris 1994 makes it:

/l/ = (R. $\underline{ʔ}$)

and dark /l/ is

(R. $\underline{ʔ}$ .U)

Elsewhere in Harris 1994, we find (for what Harris calls the "clear approximant /r/"):

/r/ = (R.I).

This becomes problematic when we consider that glides are not prohibited from appearing in onset, and their representations in the traditional theory are simply (I) and (U).

Thus in Kuman for example we find (Dickey: 144):

(34) jalo "plant, verb. sg."
wije "husband"
*lado } hypothetical liquid-initial words
*rado

Here glides but not liquids appear initially; though as the first word shows, liquids can appear in weaker (i.e. non-initial, or intervocalic) onsets.

The obvious property of liquids to point to, which will distinguish them from obstruents and glides, — and Dickey herself makes the suggestion – , is their place-complexity: it must be this which causes them to be shunned in the strong onset-initial position. However, it cannot be this alone, as doubly articulated stops like palatals or labiovelars are not shunned in these positions. Along with their place-complexity, then, it is also their manner which makes liquids vulnerable here. The link between these two factors can be expressed by referring to the type of movement of elements which is licensed in their internal structure.

The movement of secondary elements within RP and the movement of [?] to nonhead position were both classified above as nonidem (ni) movement. It is this kind of movement which is shunned by onsets, especially initial onsets, while conversely codas prefer this movement. The following hierarchy expresses this:

(35) *Movement preference hierarchy (MPH)*:

[1] MP-movement → i-movement (i)
[1] MP-movement → ni-movement (ii)[14]
[2]RP-movement → ni-movement (iii)[15]

ni = non-idem; i = idem

(36) Onset licensing preference:

Across languages if an onset licenses a segment at point *n* on the MPH it will license segments at all points above *n*.[16]

Segments with MP-i-movement include fricatives and stops; segments with MP-ni-movment include laterals; segments with RP-movement include laterals (as well) and rhotics, with the difference that rhotics do not have any MP-movement. Again the hierarchy applies vacuously to glides, which have neither movement. The advantage to this taxonomy is: laterals are preferred before rhotics for onset position (as is empirically the case) as they have *some* MP-movement. Glides are as preferred as

[14] This predicts that /s/ is not as good as /p, t, k, f/ in onsets. Evidence for this comes from Ancient Greek lenition whereby /s/ → /h/ in all word-initial contexts (cf. Beekes 1995).

[15] Here, we view all movement of elements across nodes in RP as ni-movement. But see later.

[16] This is stated merely as a descriptive generalization for the moment. In 5. 9 → we will derive this from the licensing powers of the onset's adjacent licensing nucleus.

obstruents for onset position as they escape evaluation. Finally rhotics, which have no MP-movement at all (because they have no MP elements), but do have movement in RP, come last in onsets. The opposite principle will presumably apply for "codas" (which for GP will be post-rhymal complements):

(37) Coda licensing preference:

Across languages if a coda licenses a segment at point *n* on the MPH it will license segments at all points below *n*.

This will be subject to modifications when we turn our attention more fully to prosodic activity.

We have seen that onset avoidance of "liquids" can be explained by looking at the internal structure of rhotics and laterals, without positing a feature [liquid]. This approach can be extended to other instances where Dickey argues such a feature is needed.

4.6.2 Liquid dissimilation: the case of Latin

Liquid dissimilation, according to Dickey, is a language's solution to an MSC against multiple occurrences of identical liquids in a morpheme. Again, Dickey claims it motivates a feature [liquid]. However, positing of such a feature only allows her to state a constraint *[liquid][liquid] for a morpheme. The question then arises: why is there not a similar constraint for one or more of the features [-continuant],[coronal] etc. If we look at an example of liquid dissimilation in Latin, which Dickey models through this constraint, we see that words can contain two instances of /r/: [rerum] "things gen. plural" – so that in fact the MSC *[liquid][liquid] cannot be correct for this language.

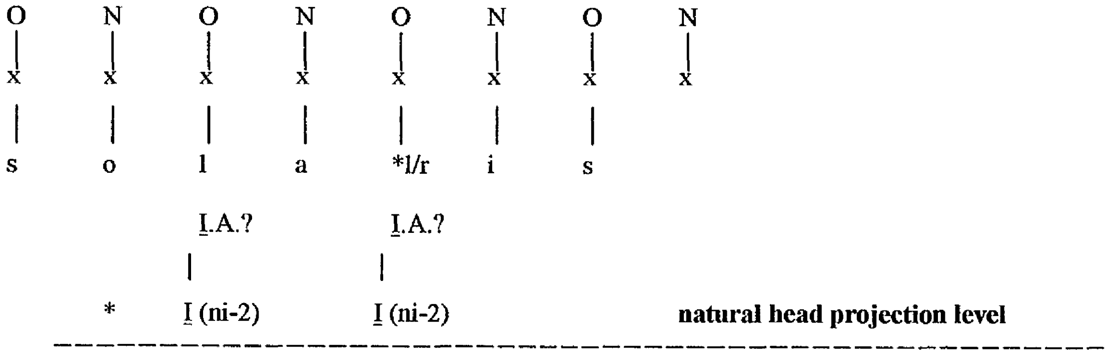
The dissimilation in Latin in fact only refers to the conversion of a lateral into a rhotic to avoid adjacent occurrences of laterals:

(38) a. nav-alis "naval" – but:

b. sol- aris "solar" (*sol-alis)

We can model this by assuming that the natural head element [I] can see other occurrences of [I] across intervening syllabic structure as follows:

(39)



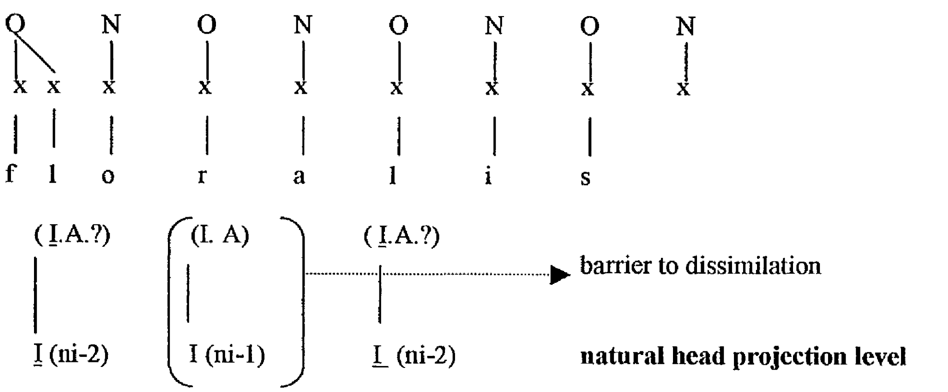
The ban is then on adjacent[17] occurrences of [I]-head which license two instances of ni-movement: ni-movement of [A] into node ii[18], and ni-movement of [ʔ] into nonhead of MP. The solution is dissimilation into structurally similar segment /r/, in which ni-move =1 (cf. 43 and 44 below).

Evidently there is no ban on adjacent [I] where one of these [I]'s does not license ni-movement: /n...l/, /t...l/ sequences are allowed (e.g.[fatalis] "relating to fate").

This picture is somewhat complicated by the fact that the intervention of a rhotic can block lateral dissimilation; other coronals, such as /n/ in [lun-aris] fail to prevent the process occurring. But forms like [flor-alis] "floral" and [litor-alis] "of the shore" are well-formed.

To get this, we must assume that [I] projects even in nonhead role, thus separating the two instances of [I]-head which license two unnnatural moves:

(40)



[17] Adjacency here would be calculated with reference to what might be called a level of Natural Head Projection.

[18] Later, when discussing the generation of liquids in inventories, we will have to assume that such [A] movement is i-movement. This would undo the present analysis. A reconciliation between this syntagmatic and paradigmatic modeling will have to await future research.

Here the two offending [I]'s are not adjacent.

However this still does not predict the fact that non-rhotic coronals do *not* block lateral dissimilation:

(41)

```
O     N     O     N     O     N     O     N
|     |     |     |     |     |     |     |
x     x     x     x     x     x     x     x
|     |     |     |     |     |     |
l     u     n     a    *l/r   i     s

 (I.A.?)    (I)        (I.A.?)
 |          |           |
 |          |           |
 I (ni-2)___I (ni-0)____I (ni-2)_______natural head projection level___
```

Non-liquid coronals are evidently transparent to this constraint (cf. /fatalis/ above). We can thus say that the constraint only inspects elements which license ni-movement (bolded above):

(42) ni-movement constraint at the Natural Head Projection:

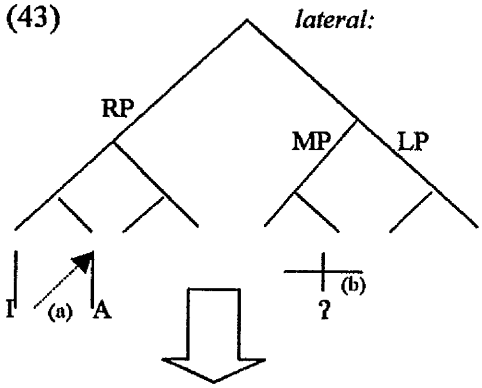
For all [I] where [I] licenses ni-movement, *(adjacent I, I) if ni-movement is greater than 1.

This means that /t, n/ are not inspected, and thus do not block dissimilation. The constraint is a limit only on *unnatural* movement-licensing at the Natural Head Projection.

Thus Latin lateral dissimilation can, indeed must, be captured without recourse to the feature [liquid]. (Steriade 1987b attempts to capture the process using [-lateral] and [+lateral]. The assignment of [-lateral] to rhotics must precede its assignment to non-liquid /t, n/; I eschew such an analysis as it relies on rule-ordering and the dubious idea that absence of a property (lack of laterality) can be active in a phonological process).

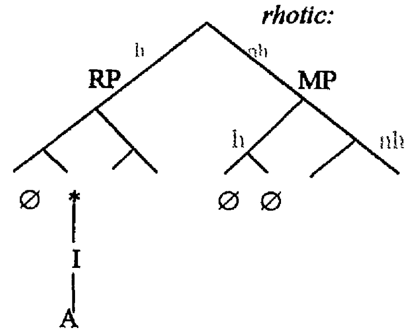
The subsequent conversion of the lateral into a rhotic in Latin is captured straightforwardly with the current representations, as follows:

(43)



(a) demote [I]
(b) delink now unlicensed [ʔ]

(44)



In addition, the concept of a Natural Head Projection level, intended to capture coronal visibility across intervening noncoronal segments or segments with different coronal subplace, receives irrefutable motivation from coronal harmony processes. Shaw 1991:128-9 lists 9 languages in which harmony of a phonological (rather than morphological) nature takes place between coronal consonants across intervening non-coronal consonants. She points out that such harmony is not attested for labial, dorsal or pharyngeal places of articulation. Once again this asymmetry attests to the special status of coronals. Indeed some of these harmony processes make reference to coronal subplace features like stridency (e.g. Chumash sibilant harmony). In one process, therefore, we see both (i) coronal subplace richness, (ii) inter-coronal visibility, two properties which distinguish coronals from noncoronals. Both follow transparently from a modeling of the coronal element as head.

Unfortunately, I do not have space here to model these processes, and will have to leave this to future research. However, the above modeling of lateral dissimilation has already put into place the fundamental mechanism which would be needed to model these processes, that of a Natural Head Projection level, which renders coronals visible to each other over intervening noncoronals. Again, this derives – as do all the other properties of coronals I have examined and have yet to examine – from a simple concept: that of the coronal element as a natural head element.

4.7 The place of liquids in inventories

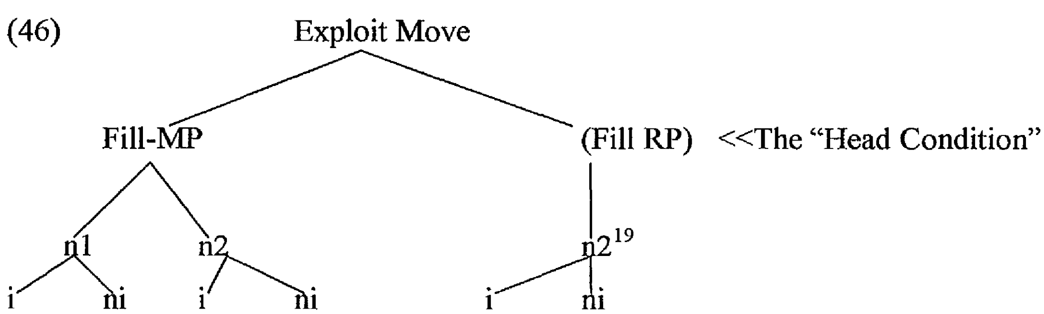
Finally, in this chapter we will see how the principles on element combination generate an inventory of Set 1 segments , which consists of (Ladefoged & Maddieson 1988):

(45)

obstruents:				sonorants:		
p	t	k	ʔ	m	n	ŋ
b	d	g			l	
f	s		h		r	
	tʃ			w	j	

In 4.3 we introduced the different types of movement, idem (i-) and nonidem (ni-) movement. We also introduced the Head Condition, which basically demands heads where possible in the head of each phrase. Finally, there is the idea that movement is licensed first in Manner Phrase and then Resonance – though of course the first head to be created is a Resonance Head, as it licenses subsequent movement. The last two conditions mean that heads (to accompany the RP-head) will be created first in MP, then RP.

(46)



[19] Node 1 is, of course, already filled by the head of the whole tree.

Segments will start being created by running through all the Movement options of each (Place) head element, a process we can call "Exploit Move", according to the schema in (46) (where "n" means node in a egt).

That is, all the movement-licensing potential of an element is exploited, following these priorities: use i-movement before ni-movement (and only [I̲] has the power to ni-move), filling the head phrase (node 1, then node 2) first of MP and only where licensed (conditions will be discussed later) of RP. In addition, we say that in the creation of a structure, ni-movement can only be used if i-movement is used too (the former being more marked than the latter).

This has the following outcome: Filling n1 of MP by i-move will promote [ʔ̲] to this position; using ni-move will fill this position with [h̲] in head role. As mentioned, only [I̲] can use ni-move, so this option is vacuous when the head Place element is [A] or [U], or when there is no head Place element. When [h] is moved into n1-$_{MP}$, it first of all undergoes i-movement to its natural landing site (cf. (28)); under the influence of Fill-n1-$_{MP}$, however it is ni-moved one step further. Here ni-movement only takes place as i-movement has already been performed. The resulting segment is [I̲.h̲] or /s/.

The generation of other segments following this schema is as follows, with the move-licensing Place element leftmost:

(47)

	i-move	ni-move
[I̲] +	[ʔ̲] (=/t/)	[h] (=/θ/)
		[ʔ.A] (=/l/)[20]
	[ʔ̲],[h̲](=/tʃ/)	[h̲] (=/s/)
[A] +	[ʔ̲] (=/k/)	--
	[h] (= /x/)	--
[U] +	[ʔ̲] (= /p/)	--
	[h] (=/f/)	--

[20] Cf. discussion later on.

The generation of [I] + [ʔ.A] deserves comment. [ʔ] is move-licensed by Fill-MP, node 2, with ni-movement. However, we said that there can be no ni-movement without i-movement; in this case then the least marked option of Fill-RP is availed of: Fill-RP, node 1, with the (required) i-movement. Thus, a Place-complex resonance phrase always accompanies headless [ʔ].

As can be seen, with [A] and [U], ni-movement cannot be availed of, so that only stops and non-strident fricatives are generated.

This covers the situation when there is a head in RP. When there is no head, elements in MP and RP are granted a single, natural move by what we dubbed a "Bootstrap" option. In MP this will license the following:

∅ +	[ʔ] (= /ʔ/)	[h] (=/h/)	[by Bootstrap]

In RP, we will get:

∅ +	[U] = (/w/)	[by Bootstrap]

The generation of /r/, which is (I.A), depends on whether [I] (nonhead) can license the adjunction of [A] or [U], to give the structure in (22):

(48) [I] licensing power:
[I] move-licenses: Y (unmarked)/N.

Selecting No for this parameter will give a language which has no rhotic. Such a language will have a lateral however, or more probably a sound intermediate between the two (exhibiting the Mittelding phenomenon), as in Japanese or Swahili.

In all then, Exploit Move, the Head Condition, Bootstrap and the [I] licensing parameter have generated the following segments: {p, t, k, tʃ, f, x, ʔ, h, r, l, w, j, θ}. If we assume that nasality and voicing are added unproblematically to stops (we will look at this assumption in more detail in ch.5) then we also get: {b, d, g, m, n, ŋ}. Thus we have generated exactly the Set 1 segments with one important exception: marked /θ/ is included in the set, counterfactually. /x/ is also generated with /f/, but according to Kingston 1993 this too is statistically as unmarked as /f/. We thus overgenerate by one segment, which is not too serious.

The generation of complex segments is then a matter of parametric exploitation of the last option in (46): Fill-RP. That is, the resonance of the basic segments is enhanced by this additional parametrically governed option. This works as follows.

The movement of [A] into the head phrase of RP is deemed idem movement (a head into head phrase). That of [U] is nonidem movement (a nonhead into head phrase).

Then Fill RP, n2, using i-movement will yield [I.A.ʔ] or [I.A.h] (retroflex stop or fricative). Fill RP, n2, using ni-movement will yield [I.U.ʔ] or [I.U.h] (dental stop or fricative). The retroflex precedes the dental, as we saw in Ch.3 (Table 2, B). Both these will be preceded by the palatal stop [I.I.ʔ], as [I] does not have to be moved to get into node 2 of RP, as it is "base-generated" there.

Another option, recall, was for secondary Place elements to be licensed lazily in situ; presumably a choice between this and moving them is mutually exclusive for a language.

Other complex segments are generated, as we saw in Ch.3, using the Copy parameter, which is availed of again according to the headship of the element. (COPY is automatically granted to [I], so that that /ts, tʃ/ are unmarked, and then – by parameter – to [A], so that (A.A.ʔ)[21] or /q/ is generated. This too follows the markedness trajectory in Ch.3).

This then captures what element combinations are preferred, and so how inventories are generated.

The three main principles which shape the ultimate structure of segments are Exploit Move, the Head Condition, and the difference in Movement-Licensing potential. These have ultimately functional underpinnings: *Exploit Move* varies according to the headship status of the Place elements, which in turn reflects the articulatory-acoustic capacity of each element to create robust element combinations; the different *types of movement* rest on a difference in the headship of [ʔ] and [h] (the former a natural head, the latter a nonhead), and ultimately encodes what form of a manner element, the head or nonhead congener, optimally combines with its Place licenser (or, in Kingston's terms, optimally integrates with/enhances it); finally, the *Head Condition*, which favors segments where Manner and Place are "filled" ultimately has a syntagmatic function: segments with a headed internal structure are, as we will see in the next chapter, good governors, while empty-headed segments (the glides and liquids) are good governees, and the distribution of strong and weak segments in a string probably serves to help listeners parse strings of phonological words into discrete items (pace Kaye 1989).

It is the headedness of segments that we will take up in the next chapter, as we move from looking at the structure of inventories back to looking at phonological processes in the word which exploit internal segment structure.

Before moving onto this, it will be instructive to compare the present modeling of coronality and inventory structure with Hall 1997, which is one of the few works in the literature to look at feature combinations from the point of view of inventory structure.

4.9 Comparing the present generation of inventories with other approaches

Hall claims there are 4 major generalizations concerning coronal inventories (Hall's numbering in square brackets):

(80) [4] A 4-way contrast among [-continuant] coronals (of the same series) is the maximum.

(81) [6] The upper limit of [+cor., -cont., α-anterior] segments is 2.

(82) [13a.] No language has more than 5 PoA's among coronal fricatives of the same series.

b. No language can have more than 4 PoA's among sibilants of any given series.

(83) [15a.] No greater than 2 PoA's for [+cor., -ant.] fricatives.

b. No greater than 3 PoA's for [+cor. +ant.] fricatives.

c. If 3 [+cor.,+ant.], then no more than one = nonsibilant (fricatives).

---

[21] Cf. van der Weijer 1994 for motivations for this representation of /q/.

(series = voicing or secondary articulation)

Eschewing functional explanations (Hall gives as an example Martinet 1955's maximalisation of available space explanation for the tricorn vowel series), Hall wishes to derive 80-83 through limiting feature combinatorics. Thus (4) and (6), resulting in the maximal inventory found in Australian Aboriginal languages' coronal series, {t̪ , t, ʈ, c}, falls out if coronal noncontinuants are described by two binary features ($2^2 = 4$):

(84)

	t̪	t	ʈ	c
[coronal]	+	+	+	+
[anterior]	+	+	-	-
[distributed]	+	-	-	+

However, there are not just 2 coronal sub-place features; [back] is required to describe the alveopalatal stop (Hall retains features which phonologists such as Gnanadesikan 1993 and Lahiri & Evers 1991 reject):

(85)

	t̪	t	ʈ	c
[coronal]	+	+	+	+
[anterior]	+	+	-	-
[distributed]	+	-	-	+
[back]				-

To prevent the generation of 8 (2^3) segments, an implicational universal is required:

(86) (23) If [-anterior, +distributed], then [-back].[22]

The [-back] feature is used to capture the palatality of /c/; but phonetically there is more to /c/ than just backness – according to Keating 1988 for example, /c/ must be specified for two Tongue Body features, [-back] *and* [+high]. A four feature combination would lead to a prediction of 16 (2^4) possible segments. And while Hall

[22] Cf. Stevens, Keyser & Kawasaki 1986 for the functional notion that [back] enhances [anterior].

states that none of the other coronal non-continuants "are inherently plus or minus [back] (ibid:98)", it is in the nature of binary feature systems for the absence of a feature to be specified. So it seems arbitrary intervention is required to prevent overgeneration to 8 possible feature bundles. In our system, using {A,I,U} to capture additional sub-place among coronals actually gets the 4-Place maximum generalization of (4) with no such problems. As we've seen, (IA) is retroflex, (II) alveopalatal, (IU) dental, and (I) alveolar. Only two of these (with I and A) are so-called [-anterior] segments; thus (6) is captured. The same holds for the maximum 4-sibilant observation of 13b.

15c is interesting: it describes the limitation of non-strident coronals which we claimed had a functional basis in optimal feature enhancement. 13a observes that there can be a maximum of 5 coronal fricatives, as opposed to the maximum 4 for stops: the addition of the non-strident coronal fricative to 4 strident ones would get us this: and indeed this is the case – Toda, the only language known according to Hall (ibid:92) with 5 coronal fricatives has: s̺, ʂ, s, ʃ and and θ. Respectively these are (I̱ Uẖ), (I̱ Aẖ), (I̱ ẖ), (I̱ Iẖ), and (I̱ h). The first 2 have exploited Fill-MP, so that licensing of a second Place element is given by the parameterized movement of elements into RP; thus while possible, the addition of a dental and retroflex sibilant is clearly marked in our system; in Hall's system they are a natural outcome of feature combination.

Looking at 15a,b next: No greater than 2 [-anterior] fricatives are attested for one inventory. We can assume that the default situation is for licensing of a secondary Place element to take place only in segments whose MP-n1 is filled with a head (i.e. the most optimal segments by (46)). This means that secondary [A] or [U] can only be added by parameter to (I̱.ʔ̱) and (I̱.ẖ), creating exactly the 2 "posterior" sibilants /ʂ, ɕ/.

There seems to be one language, however, which has 3 posterior coronal fricatives, namely Bzhedukh (ibid:93) which has, /ʂ, ɕ, ç/ [23] – Hall treats the latter two as non-coronal fricatives; if we treat them as coronal, though, (given that they appear to be the fricative equivalents of the alveopalatal stop /c/), we can allow for less than

[23] θhis contradicts van der ʌeijerƒʝs statement about the non-cooccurrence of / ç,ɕ/ -- which we took on faith earlier (in 2.13); however Bzhedukh is an extremely rare case.

optimal segments[24] to license secondary Place, by a marked parametric setting, so that [A] and [U] can be added to (I̲.h) as well, giving (I̲.h.U) and (I̲.h.A). The latter would be /ç/, and the former a variant of the non-strident coronal fricative, /θ̟/. Presumably, the non-appearance of *both* these marked segments in an inventory is due to the fact that building up RP, while neglecting MP, is a highly marked option anyway.

This also captures the distribution of 15b: No greater than 3 [+coronal, +anterior] (with suitable caveats about the phonological reality of "anteriority") segments is given by (I̲.h̲), (I̲.U.h̲), being alveolar and dental strident fricatives, and (I̲.h) being non-strident /θ/. A limit on the use of Move-α rules out the creation of (I̲.h.U) or /θ̟/.

If we compare the present element-geometric account for coronal fricatives with Hall's we see it fares better: adding the binary feature [strident] to [anterior] and [distributed] gives 2^3 or 8 possible segments (table taken from Hall 1997:98):

(87)

	θ̟	θ	s̺	s	ʃ	ʂ	?	?
[coronal]	+	+	+	+	+	+	+	+
[anterior]	+	+	+	+	-	-	-	-
[distributed]	+	-	+	-	+	-	+	-
[strident]	-	-	+	+	+	+	-	-

The first two segments cannot co-occur in one inventory: so a statement must be included saying that interdentals are unmarked for the feature [distributed]. Again, the last two feature combinations do not occur: Hall rules them out with another implicational universal (ibid:99):

(88) [25] If [-sonorant, +continuant, +coronal, +anterior] then [+strident]

, on the basis that "non-anterior fricatives are always sibilants." However, we have seen that there is good reason to analyse /ç/ and /ç/ as coronal fricatives: as they are non-sibilant and posterior, we would have to say that this feature combination is a possibility; certainly, we saw that posterior coronal affricates and stops are not of

[24] Segments in which MP-node-1 is filled by i-movement (first option in tree (46)) are best placed to exploit parametrically optional RP movement. These are stops and the strident fricative. All other segments are non-optimal. This includes peripheral fricatives /f, x/. This captures why coronals are the first to exploit specializations in inventory expansion.

physiological necessity strident (Kingston 1993 on /tʃ/ vs. /c/), but on our analysis prefer for integration reasons to be strident. If this is true then (88)/[25] is as arbitrary as (86)/[23]. Again, for not wholly satisfactory reasons [back] is excluded again from combining freely with the three other features. Otherwise, 16 or 2^4, coronal fricative segments would be predicted – way in excess of the 5-maximum observed in 13a. With [high] included, that total would be brought to 32, a more than sixfold overgeneration.

Thus, while there is the odd lacuna in the predictive power of the current theory, we converge almost exactly on the descriptive observations made by Hall 1997, without recourse to arbitrary implicational statements – the constraining mechanisms are those of the related notions of movement and headedness. These mechanisms have been proven to have a functional basis (articulatory-auditory flexibility/productivity of the coronal zone and percept) in certain cases (stridency of coronal fricatives, richness of coronal obstruent subplace distinction), while in other cases the case is assumed by analogy and awaits proof (as in the case of the exclusive suitability of the coronal zone for the production/perception of laterals).

The good points of element geometry then, which are partly inherited from standard Element Theory, are the small number of primes, their monovalence and the formal-functional restrictions on their combinability.

Chapter 5 Coronal anomalies across the word

In the last three chapters, we looked at the phonetic interpretation of segments and the mechanisms driving the combination of elements and the generation of inventories. In GP terms, that is, we have been focussing nearly exclusively on the melodic level. In this chapter, we will take the segmental representations we have built up and look at how they are incorporated into prosodic structure. The focus at this level, as at the melodic level, is on the asymmetric behaviour of coronals, for which there is ample evidence in the phonological literature. We will start with English coronal anomalies: this is because English is a familiar case, and well-analyzed in the GP framework (the main source is Harris 1994). The aim here is to preserve the advantages of the GP analysis of English but to use our element-geometric representations to give a transparent account of English coronal anomalies which has hitherto been lacking.

Next, having established a system to capture the interlocking of prosodic and melodic structure we will look at a range of coronal anomalies in other languages, which involve melody-prosody interaction. We will also look briefly at the theory put forward by Rice 1996, building on other contributions in the literature, that the Velar place is also in some sense default. (This is adopted by GP which represents velarity either by absence of a Place element (e.g. Toft 1999) or through the neutral element @/v (e.g. Harris 1994)). We will show that velar does display default behaviour in one very limited context, but that in all other contexts coronal is exclusively default.

5.1 English and coronal anomalies

At the beginning of this chapter, we will assume the GP principles outlined in Chapter 1. They will be modified as and when necessary. One of the first mechanisms that we will have to revise are the related notions of segment-complexity and government, as we are now operating with the significantly different segmental representations developed in Chapters 3 and 4. However, though the main motivation for the last two chapters' element trees was paradigmatic (the development of segments in relation to one another in whole inventories), we pointed out intances where standard segmental representations were unsuitable even from a syntagmatic point of view, so that changes to the concepts of complexity and government are necessary indepedently. For example, clear approximant /r/ is (R.I), while light /l/ is (R. ?). Forms in rhotic dialects like "pearl" are represented as:

(1) pea r. l

t.g. t.g. = transcontituent government

(R.I) ← (R. ?)

Here /l/ is "no more complex than" /r/; but /r/ is also no more complex than /l/, so that we expect the following sequence (cf. the definition of Complexity and Interconstituent-Government in ch1.(28)):

(2) pea l. r

t.g

(R.?) ← (R.I)

to be well-formed – counterfactually.

One could argue that [?] in /l/ is headed. In Chapter 3, I objected that it is rather the occlusion in isomorphic /t/ that should be modelled as headed, as lateral closure is incomplete at the sides of the mouth. The only reason to make /l/ headed would be so that it could govern /r/ and not vice versa, a circular motivation. Besides, the Complexity Condition as stated contains no reference to the headedness of p.e.s. Thus the complexity and governability of liquids is not entirely resolved even assuming the standard representations.

However there is an area of systematic segment distribution which makes the standard account even more problematic, throwing into doubt the notion that crude element counting which disregards the *types* of element from which a segment is composed is sufficient. These are right edge obstruent-obstruent cluster place asymmetries.

Consider the following list of English words (data taken from Harris 1994, Rubin 2000, Yip 1991, Davis 1991):

(3). *Place asymmetry in English (Southern British)*

a) (i) apt, act (ii) *atp, *atk

b) (i) raft, *{rafk, rafp}. (ii) past, ask, rasp.

c) (i){mount, roast, hoist, scrounge, post, pint, hold, field, bolt...} (ii) *{roump, rounk, raimp,failk, rousp...}

d) (i) went, wind (ii) wink,*wing (iii) ramp, *ramb

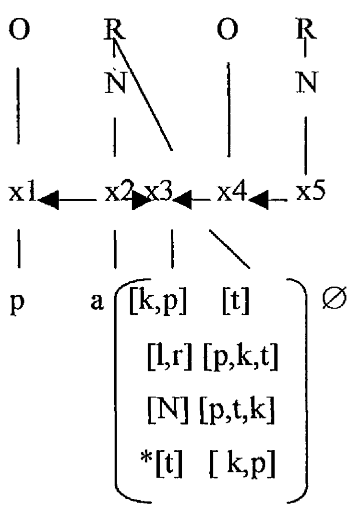
e) (i) state (ii) *spep, skek (iii) tot, pop, cake

[(f) (i) better → be'er (ii) flicker → *fli'er (iii) rapid → *ra'id)]

The problems for the standard elemental representations of segments and their interaction with government can be seen in the following representations:

(4)*GP representations of the English words*

a)



N = homorganic nasal

This structure shows the first anomaly: in GP stops can govern fricatives, liquids and nasals either because they are more complex than them, or as complex as them but headed as well – depending on the version of the Complexity Condition one adopts. This explains the middle two sequences of square-bracketed segments dominated respectively by the coda and onset. The top and bottom segment sequences are where the problem for GP lies: the first sequences shows us that any peripheral stop can be governed by a coronal stop, while the bottom sequence shows us that the reverse is not the case. However, the representations for {p,t,k} in standard element theory (by "standard element theory" I mean Harris 1994, Harris & Lindsey 1995, Brockhaus 1994 – the problem exists for other versions of element theory so the selection of sources is not significant) are:

(5) /p/ = (U. ʔ. H. h)
/t/ = (R. ʔ. H. h)
/k/ = (@. ʔ. H. h)

That is, all stops are equally complex regardless of place. This predicts that all 3 stops should be able to govern each other if attached to the appropriate constituent. We should find words in English like:

(6) {apk, akp, atk, atp}

but we don't. For those GP theorists who subscribe to the view that headedness as well as complexity is a precondition to governing power, the temptation is surely to posit the following representations to capture the asymmetry between the coronal and non-coronal stops:

(7) /p/ = (U. ʔ. H. h)
/t/ = (R̲. ʔ. H. h) >> coronal element is headed
/k/ = (@. ʔ. H. h)

Then the Complexity Condition plus headedness would derive the correct distributions:

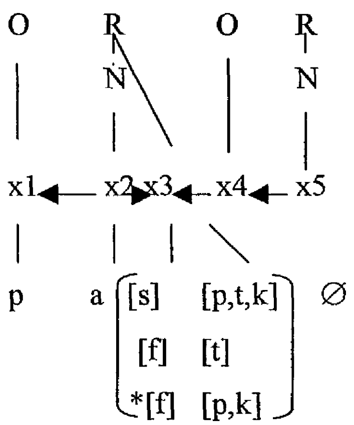
(8) Complexity plus Headedness Condition (possible formulation)

Let a and b be melodic expressions occupying the positions A and B respectively. Then, if A governs B, b is no more complex than a, and if b is as complex as a then a must be headed.[1]

An approach which takes this as starting point is developed in Rubin 2001. Otherwise, there are only three references to my knowledge in the GP literature to this problem, Harris 1994 and Brockhaus 1995, 1999 – and no viable solution is offered.

However, making [R] headed – an interesting notion, in that the coronal element is held to possess a property in addition to non-coronal elements, while the Underspecification Theory approach (e.g. Yip 1991) sees coronal distribution as being the absence of a feature which is filled in by redundancy rule (we will look at this approach later) – and reformulating the Complexity Condition will not be sufficient to model another coronal/noncoronal asymmetry:

(9)



Here, we see that while /sC/ right edge clusters are permitted, where C can be any stop, in right edge clusters consisting of /fC/, C can only be a *coronal* stop. But the coda-onset sequence /f.p/ now looks as follows:

(10)	/f/	/p/
	(U.h.H)	(U.?.H.h)

[1] The condition cannot simply read "and a is headed", as then unheaded /p/ would not be able to govern /r/.

Here /p/ is more complex than /f/ so that no recourse to headedness should be necessary. For if we held that governors must be "more complex than their governees and headed", the elements [U] and [A] would never be able to govern anything: we would rule out branching onsets /pr, fr, pl, fl, kl, kr/ and coda onset pairs like /lk, rk, lp, rp/.

Interestingly, the only obstruent segment which the peripheral stops can govern is a coronal obstruent, /s/. Likewise, those other governable segments /r, l/ are also coronal. In other words, the traditional notion of complexity and government are leading us into contradictions:

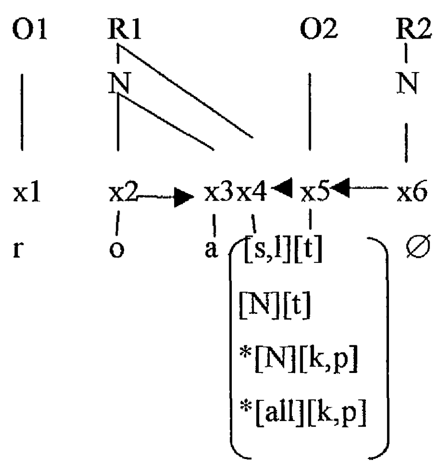
(11) <u>Coronal government paradox</u>

The coronal place makes for a good governor, non-coronal place for a bad governor between stops,.

The coronal place makes for a good governee with /s/ (but not /t/) and /r, l/; non-coronal /f/ is a bad governee.

That is, coronality is both easy and difficult to govern, a sure paradox. We must take this as indication that notions of government and complexity need to be revised. Let's look at another asymmetry.

(12)



The above diagram shows the structure assigned to right edge consonant clusters which appear after long vowels (VVCC). Such strings have been referred to as hypercharcterized syllables (cf. Sherer 1994), or super-heavy rhymes (Harris 1994). It is the latter structure which is shown for these VVCC strings. The rhyme is said to be superheavy, because both the nuclear and rhymal portions branch. (A heavy rhyme is one in which only the nucleus branches). Again, the content of C_1C_2 here revolves round a coronal asymmetry: the second consonant must be a coronal stop (represented here by /t/, -- this includes voiced and voiceless coronal affricates (cf. /launch, strange/) which have basic stop structure, cf. Ch.3), while the first consonant must be /s/ or a homorganic nasal[2].

There are additional asymmetries involving voicing and lenition, which I will not deal with in this section. If we look at (13) d and f above, repeated here for convenience, we can see what they are:

(13) (d) (i) went, wind (ii) wink,*wing (iii) ramp, *ramb

(f) (i) better → be'er (ii) flicker ↛*fli'er (iii) rapid ↛ *ra'id)

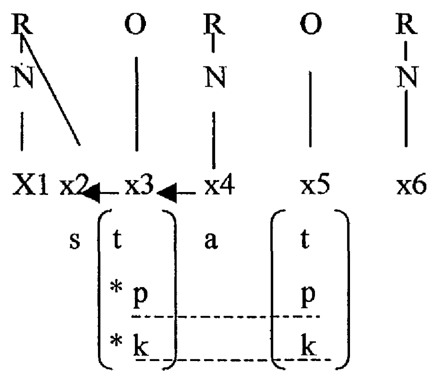
In (d) we see that right-edge NC clusters, where C = a stop, if C is coronal then it can be voiced or voiceless, whereas if C = non-coronal it must be voiceless[3]. In (f), we see that one dialect of English, London English or Cockney, the coronal but not the non-coronal stops lenite. We will postpone a discussion of this data until 5.17.2. and set about addressing (a) – (c).

The final asymmetry in (e) is discussed by Fudge 1969 and Davis 1991 among others. It refers to a curious condition whereby after after sC + vowel sequences the only C which can appear is one with coronal place. In GP terms (using a Magic-Licensing model of the sC cluster) this will look as follows:

[2] The only exception I can think of is the word /chamber/ which has a superheavy rhyme containing labial place. The right-edge context is more stringent though and there are no words like */chambe/.

[3] This is in RP; there are dialectal differences.

(14)



We will see that this can be explained in the same terms we use to resolve the above paradoxes.

5.2 Modeling the coda-onset coronal anomalies using element geometry

Here we will suggest how the above anomalies can be modeled using the representations developed in the last two chapters. Let us repeat for convenience which strings are licit, and what the element-geometric representations of the segments will be.

(15)(i)

V {
[k,p] [t]
[l,r,s] [p,k,t]
[N] [p,t,k] (N = homorganic nasal) — licit
[f] [t]
}

V {
*[f] [p,k] — illicit
*[t] [k,p]
}

(ii)

VV {
[s,l][t] — licit
[N][t]
*[N][k,p] (N = homorganic nasal)
*[all][k,p] — illicit
}

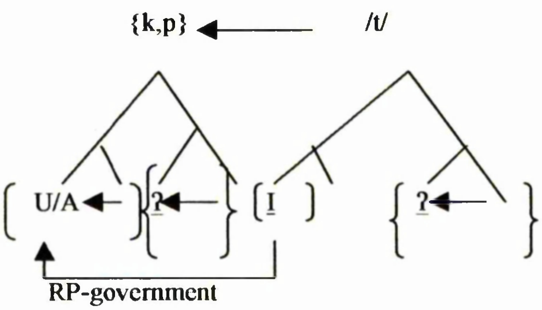
Let's start with the data in (15i).

We can given the following representations to these segment strings:

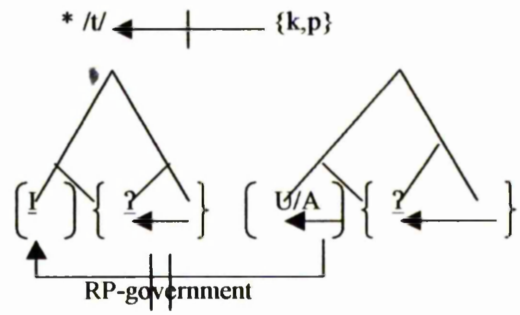
({   }: MP; (   ): RP; heads are underlined; movement in RP or MP marked by an arrow; only relevant structure shown; explanations follow in the text).

(16)

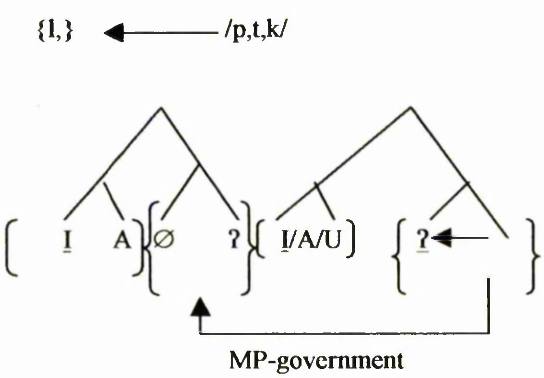
a.i.



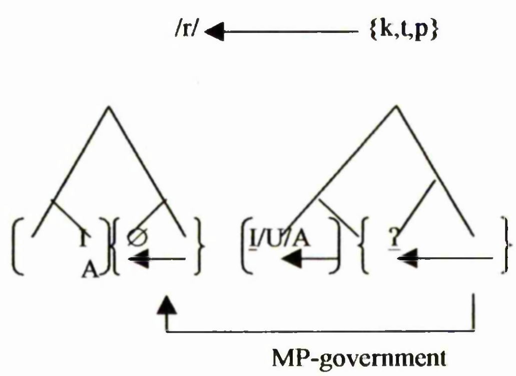
ii.



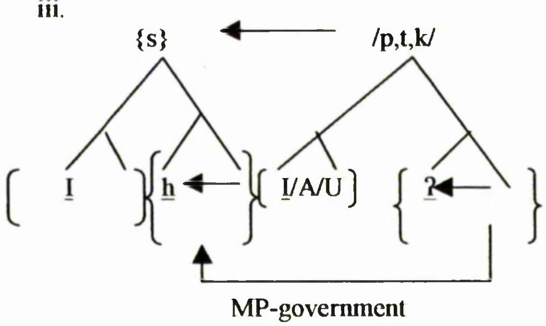
b.i.



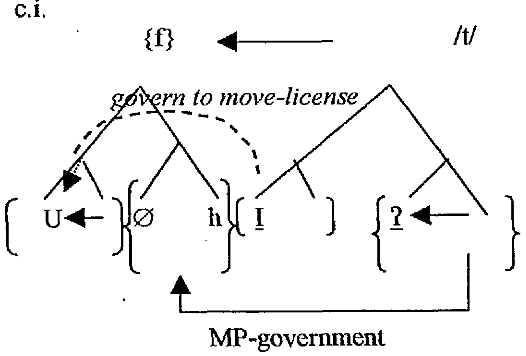
ii.



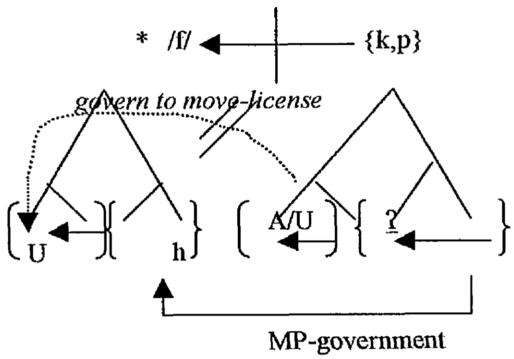
iii.



c.i.



ii.



The paradoxical distributions stop being paradoxical when element-geometric trees are used in combination with the following two principles. The second principle is phrased in a somewhat arbitrary way at present, but the motivation for it will be made clear soon.

(17) *Element-Tree Government, or S(ubsegmental)-Government*

Let a and b be element-geometric trees (e.g.t) occupying the positions A and B respectively. Then if A governs B,

(i) MP-a < MP-b, or (<:stronger than; to be defined)

(ii) RP-a < RP-b.

and RP-b must have a movement-license.

(18) *Coda Manner Restriction:*

Manner elements need a special license to appear in coda. This license is given when RP-b, the move-licensing resonance element in RP-b of e.g.t. b , is governed by RP-a, the head resonance element in RP-a of e.g.t. a.

Let's go through the trees above seeing how the principles work. In each of the trees the coda will be referred to as position B dominating e.g.t. b, and the onset as positon A dominating e.g.t. a.

In 16a(i), the Manner Phrase of e.g.t b is headed by [?], and so is that of a. Both Manner Phrases are therefore equal, and the first condition for element-tree government is not met. We turn to the disjunction of (ii) in "Element Tree Government", and find that Resonance Phrase a is filled by natural head [I], while Resonance Phrase b is filled by moved head [A] or [U]. We say that a (bootstrap-)moved element is weaker than a non-moved element base-generated in head-position, or in other words that a natural head governs a moved head. So (ii) of Element-Tree Goverment is met. The sequences /...k~p. t / is licit by Element-Tree Government.

In 16a.(ii), MP-a does not govern MP-b; we turn to (ii) of Element-Tree Government: does RP-a govern RP-b? No: a moved head is weaker than a natural head and cannot govern it. The sequences /...t. k~p/ are illicit.

In 16b.(i) MP-a is headed by [ʔ], while MP-b is headless. MP-b thus governs into a headless node, than which it is obviously stronger. The Element-Tree Government Condition is phrased as a disjunction: if any of (i) or (ii) are met, government goes through. We thus do not have to look at (ii). (When we do, we find that RP-b does not govern RP-a, except in the case of /t/). The sequence /...l.t/ is thus licit.

In 16b.(ii) MP-b governs MP-a, for the same reasons as above. The sequences /...r.t *or* k *or* p/ are licit.

In 16b.(iii) MP-b is headed by [ʔ] and MP-a is headed by (h). Adopting the same principle we did with [I] versus {U, A}, namely that moved heads are weaker than non-moved heads, we say that because [ʔ] has moved into MP-head by one idem-move, while (h) has moved into MP-head by 2 moves, one idem- and the other nonidem-move (cf. Ch.4), [ʔ] is stronger than or governs (h). We might phrase this as:

(19) *Element governing strength:*

The more moves an element has undergone, the less its governing power.

Thus (i) of the Element Tree Government condition is met, and element tree a governs element tree b, so that the sequences /....s. t *or* k *or* p/ are licit. (For neither of /t, k, p/ does RP-b govern RP-b: for /k,p/ = {U, A} are weaker than [I] of /s/, while for /t/ [I] is equal to [I]. We have made government an asymmetric condition, elements having to be in a stronger position not just equal to their governees).

At this point we should consider the legitimate sequence /...l.f.../: here onset /f/ governs coda /l/. The resonance of /f/ (= [U]) cannot govern the resonance of /l/ (= [I]); thus it must be the Manner of /f/ (= [h]) which governs the Manner of /l/ (= [ʔ]). That is, nonhead fricative element [h] governs nonhead glottal element [ʔ]. We need to add something to the definition of government: where 2 elements E1, E2 (in adjacent[4] element-geometric trees) are in nonhead position E1 governs E2 if E1 is natural there (that is, idem-moved there) and E2 is non-natural there (that is, non-idem moved there). We will return to this when we consider branching onsets. Again, this exploits the notion of *type* of movement, developed in Ch.4.

Finally, we turn to 16c.(i) and (ii). In ci, MP-a is occupied by [ʔ] and MP-b head position is unoccupied: MP-a > MP-b, so the string /f.t/ is licit. In Cii, MP-a is stronger than MP-b for the same reason, but /....f.k *or* p/ is illicit: this is because of the Coda Manner Restriction, stating that (movement of) a manner element in a coda needs to be licensed, and that this license is granted if the element move-licensing the manner element in question is itself governed by RP-a. We can think of RP-b needing a special, additional license to move-license a manner element in a non-onset constituent. Now {A or U} in RP-a are not stronger than {A or U} in RP-b, so this condition is not met and e.g.t. a does not govern e.g.t. b. Thus /...f.k *or* p/ are illicit.

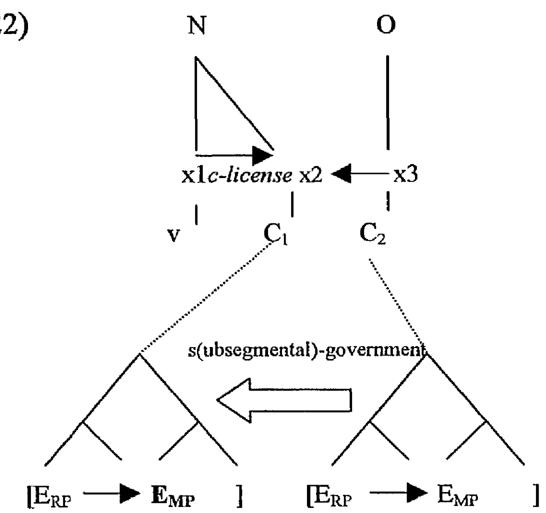
Having said that RP-elements in a coda need a special license to move-license their manner elements, we should check that this condition is met for the previous trees we have looked at. For all of 16(b) this is the case as RP-b is headed by [I], of which we can say that as a natural head it has the power to license manner movement without external help; it is only bootstrap-moved non-natural heads that need this license. (Bootstrap-move applies automatically in onset, but not in coda, in an expansion of concepts developed in the last chapter, as we in the coming section). Turning to 16(a) we find that the only licit sequence is where RP-b is filled by {A or U} and RP-a by [I]: the latter governs the former and in so doing licenses them to move [ʔ]. Thus this condition has been met in all the other trees we have looked at.

5.3 The nature of the coda

[4] In all of this we assume that adjaceny is a basic requirement for government between egt's, as it is for government at the prosodic level. Also, we assume that the various phrases of egt's are able to "see each other" in order for government to take place. Adjaceny is achieved if the skeletal points to which the egt's are attached are adjacent. (Any other visibility will need a special projection, as we assumed for liquid dissimilation in Chapter 4).

I propose that the Coda Manner restriction follows because the coda position is really a *nuclear* position. GP's abolition of the coda and "coda"-licensing principle were introduced in Chapter 1, where it was pointed out that the licensing of the rhymal complement was arbitrary. In addition, the status of a branching rhyme was unclear. This can be resolved now if we see the rhymal adjunct as a nuclear complement containing non-nuclear material which the nucleus itself is powerless to license, and which must thus be licensed by the following onset. Kaye's coda-licensing principle thus receives a straightforward motivation. The following tree illustrates this:

(22)



A nuclear head can license a resonance element in C_1, but not a manner element. This follows if we assume that certain elements are restricted to appearing in consonantal or vocalic egts[5], unless certain extra licensing conditions are met. This means that E_{MP} of C_1 is the anomalous element in the nuclear complement, which needs a special license to appear there. But that license depends ultimately on its own Place licenser. If this is [A] or [U], then these elements in turn need a movement-license to move manner elements. We can thus pinpoint the anomaly of the "nuclear consonant" by saying that it is this movement-license which a nuclear head does not grant. Rather such a license must be

[5] This is already implicit in element theory: [ʔ] and [h] for example cannot appear in onets, and [H] and [L] only have a tonal interpretation if they appear in onsets.

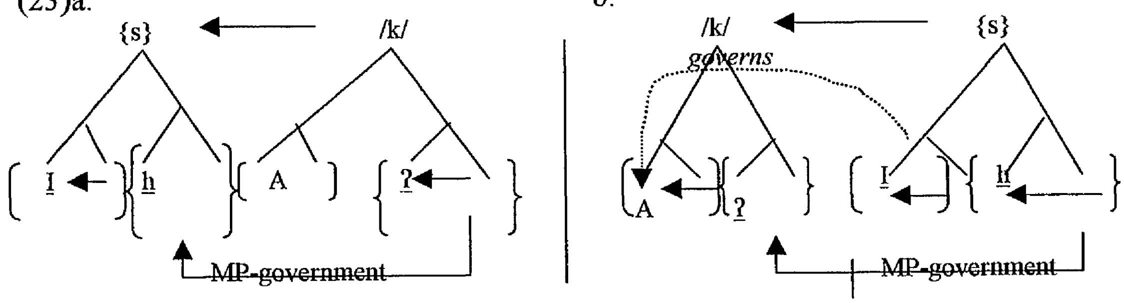
granted by a following onset consonant: hence the necessity for E_{RP} to be governed, *unless it is coronal*. If E_{RP} is coronal, such a license is not required[6].

A further motivation, relevant to the internal structure of segments developed here and confirming this view of MP-neutralization under government, is that there is strong evidence that in English word-final rhotics are syllabified as codas and not as onsets (cf. Harris 1994: 258-61 for these arguments). Under the above theory, the reason why rhotics, but no other consonants, would be allowed in a coda which is not followed by a governing onset is that they have no manner elements which need to be neutralized under government. This is the converse of the bar on rhotics in initial onsets that we discussed in chapter 4. We will explore more repercussions of this in the coming sections and in the next chapter.

5.4 Modeling more coda-onset coronal asymmetries

The principles we have outlined so far resolve a paradox which that we have not mentioned yet, and that is the reversibility of /sC/, /Cs/ sequences in coda-onset strings. That is, the word /aks/ ("axe") is possible in English, but so is /ask/. This reversibility is true of no other right edge sequence in English. In our system the /sk/ and /ks/ sequences are:

(23)a. b.



[6] One should ask at this point why (I.?), or /t/, in nuclear complement needs to be followed by an onset at all. By the above account [I] does not need a movement-license, as it is a natural head: it thus does not need to be granted one by a following stronger resonance element. This important point will be taken up as the theory expands and develops.

Both these strings are valid, but for different reasons:

In (23a), /k/ governs /s/ because its MP phrase has a "stronger" head than that of /s/. The state of RP is irrelevant due to the disjunctive formulation of the Element-Tree Government Condition.

In (23b), the MP of /s/ is weaker than the MP of /k/. Government fails on this count, but goes through on the second count: the RP of /s/ is stronger than the RP of /k/. Government thus succeeds by (ii) of the Element-Government Condition. This of course goes for pairs with a labial stop like /apse, lapse, synapse, rasp, clasp etc.../. It is hard to see how a traditional GP approach could account for this dual distribution of /s/, as /s/ is (R.h) and /k/ is (U.ʔ.H.h), so that the less complex and equally headed former segment should never govern the latter.

Finally, the only sC/Cs string which is asymmetric is /ts/: /test/ is good, but there is no reverse sequence /tets/ (unless there is morphological complexity: tet-s). In the current analysis, this is because RP of /s/ is equal to and not stronger than /t/ ([I] and [I]), and the MP of /s/ is weaker than that of /t/ ([h] vs. [ʔ]).

The next set of strings to account for are those licensed in superheavy rhymes and following onsets.

5.5 Subsegmental government in superheavy rhymes

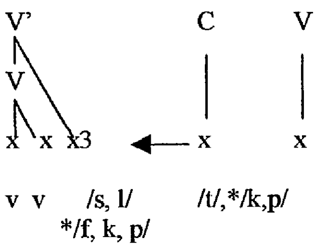
These strings, repeated for convenience, were:

(24)

VV	[s,l][t]		licit
	[N][t]		
	*[N][k,p]	(N = homorganic nasal)	
	*[all][k,p]		illicit

We will not take issue with Harris 1994's basic syllabification, but will merely adjust it to turn the rhymal adjunct into a nuclear adjunct as follows (V/C can stand for N/O now that these are the only constituents countenanced):

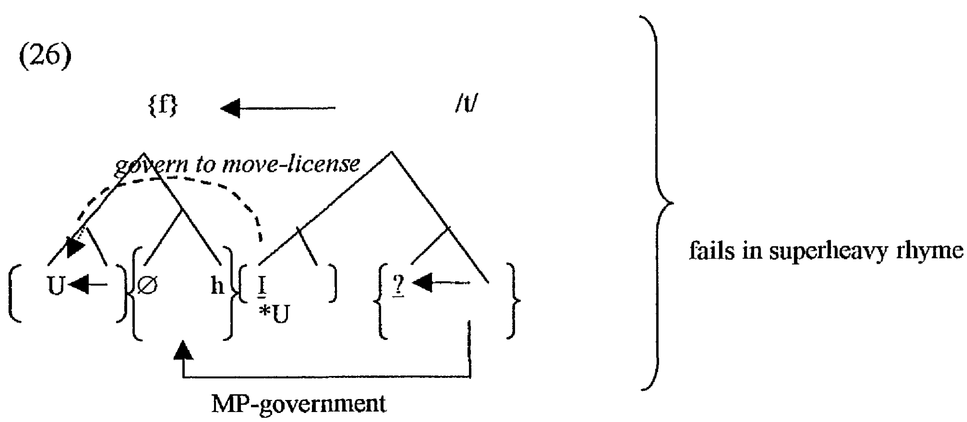
(25)



The key here (as pointed out by Harris 1994) is that x3, the "rhymal" adjunct, fails to be licensed by the head of its constituent, as licensing is binary and adjacent – here x3 is not adjacent to x1. This means that a "coda" whose Place head is [A] or [U] also needs to be c(onstituent)-licensed – as well as being governed by a following onset. This is necessary, we can say to bootstrap-move these elements into the head of RP.

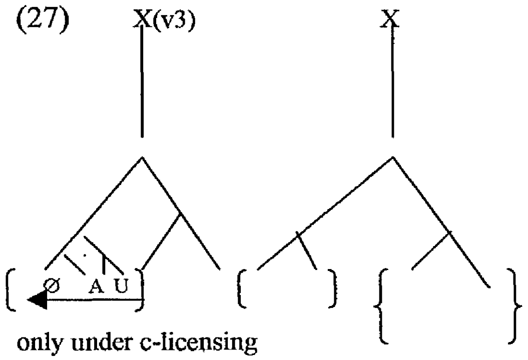
Where this extra condition is not met, even most CC pairs which would normally be licensed are ill-formed. Consider /ft/ sequences for instance, which we modeled earlier for regular rhymes:

(26)



The fact that licensing fails in the structures in (16), means that [U] or [A] need one more form of licensing, which we have ignored.

(27)



This additional also requirement rules out /roaft, rouft...../ as well as nonexistent sequences such as /roikt, roupt..../, i.e. VVKT (where K = /p or k/), as the would-be RP-head, {U or A}, does not have its "bootstrap move" c-licensed.

However, it still lets in illicit sequences like /hoisk, housp..../, i.e. VVCK where C = /s, l/ and K = /k, p/. This is because /s,l/ are self-licensing in RP-head and are less strong in MP than /k,p/. (Remember that a governor so far only needs to be stronger than a governee in its MP phrase *or* in its RP phrase, cf. Element-Tree Government).

What we need to say is that where the nuclear complement's skeletal point is *not* c-licensed, as in a superheavy rhyme, a stronger condition for the licensing of consonantal trees under V-points holds. This can be incorporated into Element Tree Government, or better, "Subsegmental Government Condition", giving:

(28) *Subsegmental Government Condition(SGC):*

Let a and b be element-geometric trees (e.g.t) occupying the positions A and B respectively. Then if a s-governs b (where B is c-licensed),

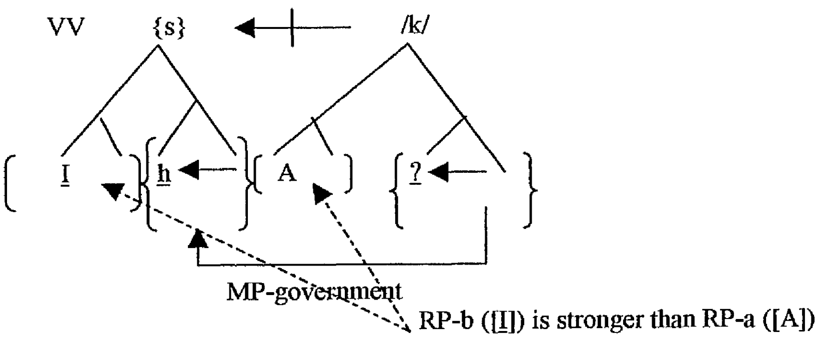
(i) MP-a < MP-b, or

(ii) RP-a < RP-b; and RP-b must have a movement license.

If B is not c-licensed then the above holds, but in addition RP-b must be no stronger than RP-a.

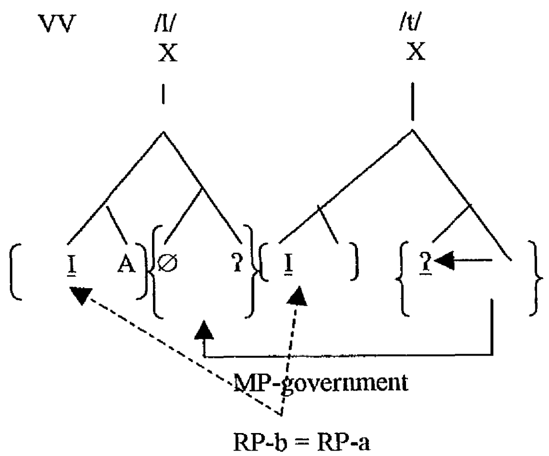
The last phrase rules out /VVsk/:

(29)



Sequences like /VVlt/ and /VVst/ are still allowed as RP-b equals (but is not stronger than) RP-a:

(30)

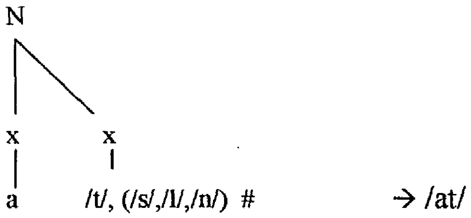


The SGC thus gets all the facts we have examined.

5.6 Coda licensing: final matters

There is one odd phenomenon which slips emerges from the above analysis, and this is that the following structure is still permissible:

(31)

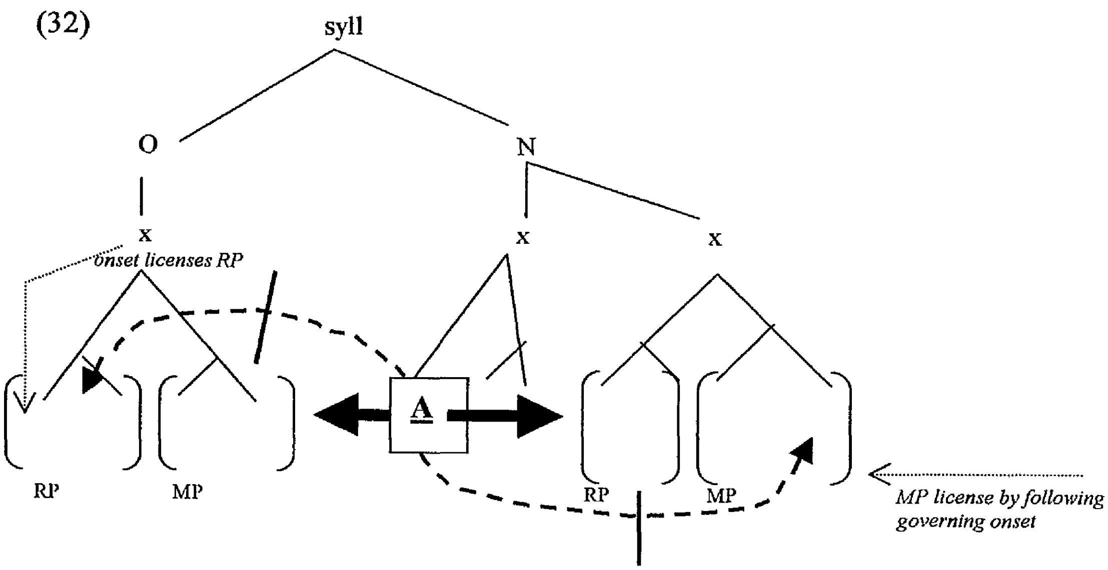


This is a structure where a word-final coronal is syllabified as a nuclear complement. Here /t/ is (I.?): in this p.e., [I] is base-generated and so needs no bootstrap move; it also "grants itself" a license to move [?], being a natural head. And yet, final coronals do not behave differently in English from final velar or labial obstruents (unlike final /r/ which does). This will be discussed at greater length in Ch.6, but the mechanism which I propose rules (38) out for English is the HDA: English will not tolerate a structure where a nuclear complement's egt is headed by a natural head, as this makes the complement structurally as strong as the head of the nucleus. In other words, the HDA applies *strongly* across the nucleus: a head must be stronger than its complement. A weak version would run: a complement can be as strong as its head. In that case, a nuclear complement could indeed be filled with a natural head. As it happens, there is good evidence that languages systematically exploit this latter option. We will look at them in the next chapter. Now, however, we will turn to the question of differences in licensing of onset and coda material by the nucleus, and how the structure of different segment-types is more or less suited to appearing in different constituents.

5.7 The integration of paradigmatic and syntagmatic requirements

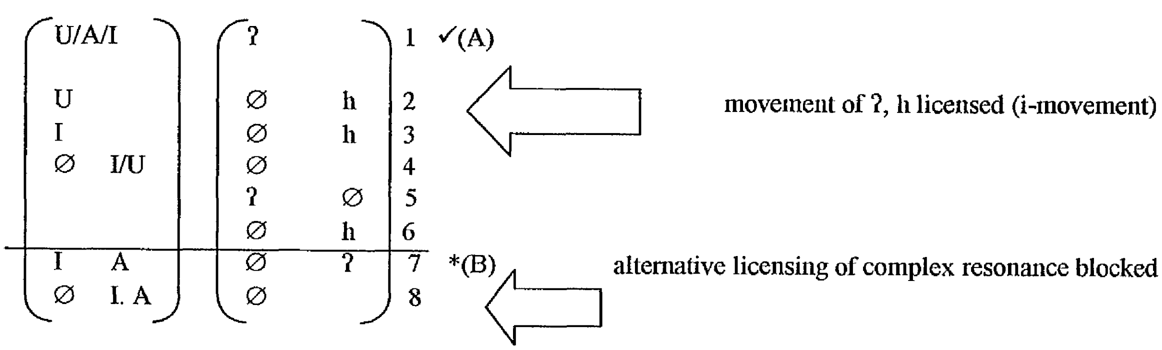
Having reduced our constituent inventory down to onset and nucleus, we can model the two as entering into the following relationship:

(32)



We symbolize the head of the nucleus with [A], which is the head element in vocalic expressions (cf. Chs.2, 3). We can get the equivalent of Clements' (1988) Sonority Dispersion Principle by assuming that [A] enters into subsegmental licensing relationships with the adjacent geometric parts of the adjacent segments. On the right, we have already posited that the nuclear head only licenses the Resonance Phrase of the nuclear complement, so that only vowels and s-governed consonants can appear in "coda" position. On the left, we now posit that [A] enters into a licensing relationship with the Manner Phrase of the onset consonant. In this way [A] moves the manner elements {ʔ, h} into the head/interpretation phrase of MP, so generating obstruents. The following will take place:

(33)



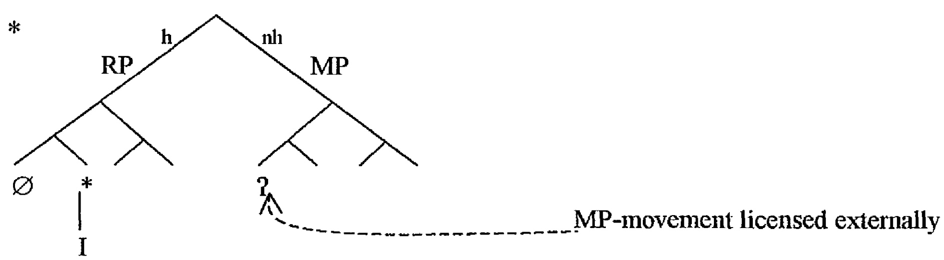
The (A) segments are respectively {p, t, k, f, θ, j, w, ʔ, h[7]}.

The (B) segments are respectively {l, r}.

We posit that the nuclear head forces i-movement of {ʔ, h} in MP. Meanwhile the onset node, we can say, licenses the movement of Resonance elements in RP – but this onset licensing is limited: the only type of licensing an onset grants is bootstrap-licensing (to bootstrap {A, U} into RP-head). Beyond this, elements enter the egt from the "element-lexicon" and are left to their own devices thereafter: in the case of the natural head [I], this element can appear as head or nonhead. In the case of {A, U}, these elements are bootstrapped into RP, or if the optional bootstrap move is not availed of, they remain *in situ*.

Now in the case of nonhead [I] and *in situ* {A, U}, these elements will not be able to license the nuclear-moved manner elements, and these manner elements will be uninterpreted: in this case we will get the glides {j, w} (33.A, line 4). In the case where no elements are entered from the lexicon we will get the glottal stop and fricative (33.A, lines 5 and 6). That is, even though the nuclear head licenses the MP movement externally, there is a requirement that segments be independently well-formed, so that the following structure is prohibited:

(34) *



This can be enforced by the following principle:

(35) Prosodic- and subsegmental- licensing harmony:

[7] The absence of /s/ from this set will be commented on shortly.

Any move licensed prosodically must also be independently licensable according to the principles that govern well-formedness within egts.

The principles governing internal well-formedness are those we looked at in the last chapter, concerning what types of movement different Place elements can license, and the notion that all MP movement is licensed by a Place element in node 1 of RP. Thus the structure in (34) will be ill-formed.

What is not automatically granted by the onset's prosodic licensing powers is a license for an element to license another resonance element to move in RP – as happens in the generation of /l, r/. Such licensing in RP is granted by parameter:

(36) Onset Licenses secondary movement in RP: YES (unmarked)/NO.

As most languages in fact do allow liquids in onset, we can say that the YES option is the less marked of the two – but the parameter still captures the asymmetry between liquid and non-liquid distribution that we looked at in the last chapter. Thus the segments in (33.B) which involve [I̲] or [I] licensing the movement of [A] need a setting of the Onset RP-movement parameter.

Finally, we said that the nuclear head licenses i-movement[8] of Manner elements. The generation of /s/ involves i-movement of [h] to nonhead and then ni-movement of [h] one step further to head-position; this last move will be licensed by [I] in RP, rather than directly by the nuclear head (which only minimally requires [h] in the consonantal segment's MP)[9]

The situation, therefore, is that /r/ needs the switching on of a parameter to license it on onset position. However, as it has no heads to neutralize and is headless in RP, it needs no extra licensing whatsoever to appear in coda position. The default option will thus be to syllabify /r/ into coda where there is a choice between 2 syllabifications as there is at right edge. This, as we saw earlier, is the situation in English.

[8] A reminder that: i(dem)-movement is when a head element moves to head position and a nonhead element moves to nonhead position.

[9] We might say that this extra licensing of Manner by the RP-head element in an onset is somehow marked: cf. the tendency of initial /s/ to lenite in Ancient Greek: * setpa → hepta.

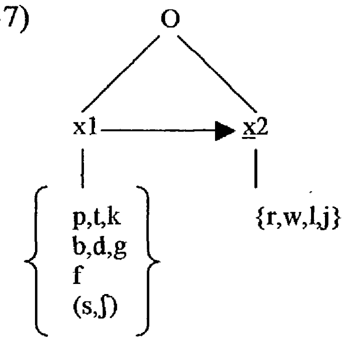
At this point, we would do well to comment on our definition of a segment: it emerges that the conjunction of properties that is a segment is a result of (i) general phonetic integration requirements between element-signatures, and (ii) licensing of these properties differentially in different positions in the syllable. Our earlier picture of segments being generated paradigmatically in isolation from syntagmatic needs and requirements is thus modified here, in the interaction of principles regulating movement with the movement-licensing properties of syllabic constituents.

This view has a strong precedent in Firthean prosodic phonology: the Firthean school (cf. Firth 1957b, Robins 1961, 1969, Anderson 1985: 169-189) of prosodic analysis did not view the phoneme, which was the central ontological object of the contemporary American structuralist tradition, as primary. The segment instead was construed as a blend of structure (syntagmatic constructs) and system (paradigm). The former comprised prosodies, which included not only suprasegmentals such as stress and tone whose domain was larger than the segment (as traditionally recognized), but also more traditionally segmental elements like aspiration, palatalization and labiovelarization. The latter consisted of segmental substance bleached of these prosodies which were predictable by position. As such bundles of segmental substance were not called phonemes (which are defined according to their contrastive function), but "phonematic units". Since the phoneme has proved so definitionally difficult (cf. Chomsky 1964's original critique), it is better to see the "segments/phonemes" analyzed in the last two chapters (culled direct from Kingston 1993) more accurately as phonematic units. Here, we are simply looking at the remaining features they acquire once slotted into the syntagmatic structure of the word, their prosodies.

5.8 Branching onsets: defining s-government within the onset

Our next task is to consider the phonotactics of segments within the onset constituent. The English branching onset looks as follows in GP terms:

(37)



Segments on the left are obstruents and segments on the right are liquids or glides. The former can govern the latter with a few OCP place constraints. Thus, missing are:

(38) /fw, pw, bw/ due to *Labial Labial.
/tl/ due to *Coronal Coronal[10]
/sr/ due to the palatalization of /s/ before /r/, which yields /ʃr/.[11]

Obviously onset clusters are a subset of coda-onset clusters, so conditions on intraconstituent onset government are going to have to be more stringent than transconstituent government, which we modeled above.

The difference is quite simple: all stops have a natural head in MP-head, while the MP-head of the governees is empty for all of {l,r,w,j}. This is true for /s, ʃ/ too, whose MP-head is filled by (h̲). The only case which might cause any doubt is /fl/, which we dealt with above: both /f/ and /l/ are headless in MP, but their nonhead position is filled by [h] and [ʔ] respetively. We said that in this case [h] governs [ʔ] as [h] is natural to nonhead position (moving there by idem-movement) and [ʔ] is non-natural to it (moving there by nonidem-movement). Thus for all intraonset governor-governee pairs, MP-x1 must govern MP-x2.

The point is that subsegmental government as defined above depends on Manner government, and not a choice between Manner and Resonance Government and other

[10] One might very well ask why /tr/ in which 2 coronals are adjacent is not banned. This will be taken up later (cf. 5.16).

[11] /s/ + /w,l,j,r/ are analyed as branching onsets here. The motivation is that in languages which parse /s/ + C clusters with a pre-s epenthetic vowel only do so if C is an obstruent (Armenian –cf. Vaux 1996, and Avestan Persian cf. Beekes 1988). Also /s + sonorant/ pattern differently from /s + obstruent/ in reduplication processes in Sanskrit (MacDonnell 1966).

conditions. Incorporating this into the definition of subsegmental government requires a phrase that makes reference to the constituent affiliation of the skeletal positions A and B. We can add it quite simply in a second clause (B) as follows (with additional clause (B) italicized):

(39) *S(ubsegmental) Government Condition(SGC)[revised for intraonset government]:*

Let a and b be element-geometric trees (e.g.t) occupying the positions A and B respectively. Then

(A) if for two different constituents X and Y, A is dominated by X and B by Y, then if a s-governs b, B must be c-licensed and

(i) MPa-head < MPb-head, or RPa-head < RPb-head, and

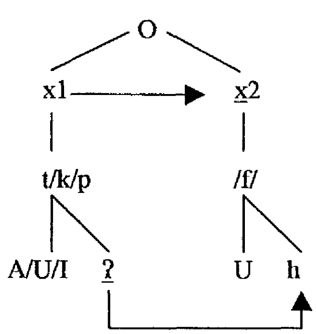
(ii) RPb-head is governed by RPa-head, or RPb-head is self-licensing.

If B is not c-licensed then the above holds, but in addition RPb-head must be no stronger than RPa-head.

(B) If A and B are dominated by one constituent X, then if a s-governs b MPa-head < MPb-head.

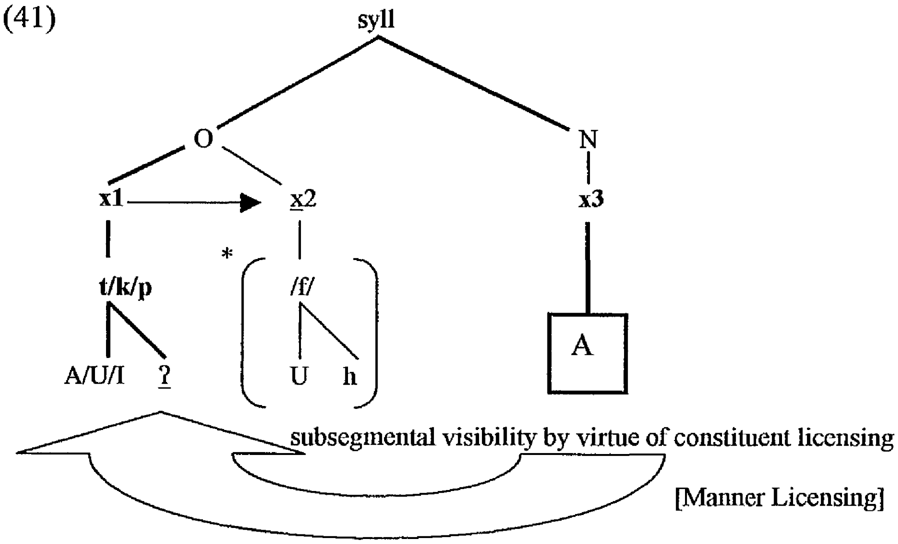
However while this formulation gets all the licit sequences, it also spreads its net a little too wide and drags in the following:

(40)



If MP-government is a sufficient condition for segment pairs within the onset, we will allow /tf, pf, kf/, which are illicit. But conditions on what movement an onset licenses, and its licensing relations with the nuclear head will resolve this:

(41)



We said earlier that the nuclear head licensed MP-movement in the onset, and that the Onset constituent licensed Bootstrap-move in its element-geometric tree. We referred at that point simply to the onset, making no distinction between the head and complement points that the onset can dominate. We can now think of the nucleus-onset licensing relationship as being contracted between onset-head and nuclear head. That is, egt's can see each other not by virtue of simple subsegmental adjaceny but by virtue of licensing relations contracted at the syllabic (or N') level.[12] As such, only the onset *head* will have its manner elements move-licensed by the nuclear head. Furthermore, we earlier said that the Onset constituent licenses the bootstrap move of its Resonance elements; we can adjust this to saying that the Onset constituent can grant one bootstrap move to its egt's – and that move will be used by the more prominent egt, i.e. that dominated by the head onset point. This will leave x2 in (69) (i) with no manner move, and (ii) with no bootstrap move. Thus [U] will not get bootstrapped into RP-head, and will thus not be able to move-license [h] in its MP. The configuration /tf/ is thus ruled out.

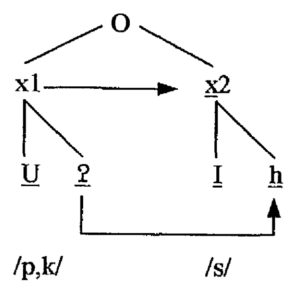
Note that /r, w, j/ have no head in RP, and thus need no bootstrap move. The lateral /l/ does have a head in RP, but it is [I]-head which is base-generated there and needs no bootstrap. [I]-head can also license its own movement in MP: it moves [ʔ] into nonhead

[12] Again, it cannot be the skeletal level as x1 and x3 are not adjacent there. We state the relationship between constituent heads.

position; were [ʔ] to be moved into true head position then the segment would not be governed by the preceding segment's MP.

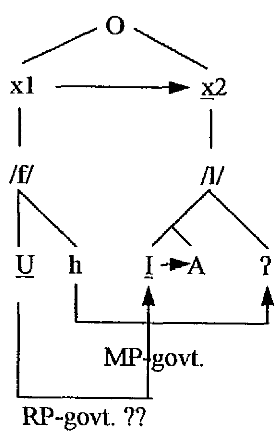
We thus seem to have generated all and only the licit onset clusters of English. As is the way of these matters, however, we find that one more unwanted illicit string is allowed in, which will necessitate one more final revision:

(42)



If [I] is self-licensing in the onset complement and can license its own MP-movement then /s/ will be able to appear in onset complement when there is a stop in onset head. It turns out then that the conditions for onset sequences are more stringent than we previously thought: they too must involve Place phonotactics. We will have to say that RP-x1 has to govern RP-x2 for s-government between egt's to go through. Given that neither of {U, I, A} is stronger than [I] in the above configuration, the sequence /ps, ks/ would fail. Actually, RP-x1 is clearly stronger than RP-x2 for all of the obstruent sonorant pairs allowed in English onsets, the only ambiguity being in the cases where non-coronal stops or fricatives precede /l/ (exemplified by /fl/ below):

(43)



For this to go through, [U] has to RP-govern [I]; but the former is bootstrap-moved and the latter is a natural head. We said the more moves an element has undergone, the weaker it is. However, we also said that the bootstrap-moves of [A] and [U] were licensed by the Onset constituent, thus in this prosodic configuration U/A are as strong as [I]. But still, the condition for government is that A be stronger than B, not as strong as. Thus we can say that U/A are stronger than I-head, when U/A are independently bootstrap-licensed and when the strength of [I] is compromised due to having to move-license an element in RP (using the more difficult ni-movement).

With this in place we can give the conditions for onset government as:

(44) *S(ubsegmental) Government Condition(SGC)[revised for intraonset government]:*
Let a and b be element-geometric trees (e.g.t) occupying the positions A and B respectively. Then if A and B are dominated by one constituent X, RPa-head > RPb-head and MPa-head > MPb-head.

This really will generate all and only the onset strings of English.

In the above two sections we have thus combined element-geometry with GP principles to derive the coda and onset distribution of English segments. The analysis takes into account the sometimes subtle interaction of Place and Manner in an explicit way.

The analysis is founded on the same coronal-noncoronal asymmetry which we argued for in the paradigmatic generation of coronal segments in inventories. What is novel about this approach, when compared to the only mainstream theory to have tackled coronal asymmetries in detail, namely Underspecification Theory (Paradis & Prunet 1991, and specifically with regard to English, Yip 1991), is that is does not rely on underspecification of features, and consequent feature fill-in according to ordered rules. This approach had the undesirable effect of separating surface and underlying forms by a long derivational chain which was often poorly motivated and created ordering paradoxes (cf. McCarthy & Taub 1992 for a critique; also 5.9 below for a critique of this aspect of Rice 1996).

In the next part of this chapter, I address the claim that velar place is in some sense default in the same way that coronality is.

5.9 Rice 1996's Default Variability – The Coronal-Velar Relationship.

Rice 1996 points out that both velars and coronals have been modeled as the default Place of Articulation in the literature. The reason is that in different languages, one (and sometimes both) of them do the following:

(45) (i) appear in coda position, where other places aren't licensed

(ii) act as the epenthetic place in "inserted" stops (velar is epenthetic in e.g. Murut, Aradhi[13], coronal in e.g. Amharic, Gokana).

(iii) assimilate when preceding other PoA's, while not triggering assimilation on preceding PoA's.

Labial never exhibits this behavior. Velars and coronals are thus both special.
Rice proposes the following representations to capture this:

(46)

a. Underlying Coronal/velar	b. surface coronal	c. surface velar	d. underlying/ surface labial	e. underlying/ surface dorsal
Place	Place	Place	Place	Place
	|		|	|
	Coronal		Peripheral	Peripheral
				|
				Dorsal

What she calls the "Default Variability Hypothesis" proposes that default coronals result from "default fill-in of the unmarked feature" which is [coronal]. Default velars result

[13] The Aradhi epenthetic velar segment is nasal, a point which will become relevant below.

from "failure of fill-in of the unmarked feature, with interpretation of the node (i.e. creating a velar)". Both underspecified coronal and velar assimilate by acquiring a (specified) feature from a following node.

She differentiates between "velars" and "dorsals": the latter are fully specified, and are made "with the back of the tongue raised against the velum". The former are made "the tongue in a position of rest, or raised in the region of the back of the mouth."

Now languages which select velar as the default place are languages which lack the default fill-in rule which causes velars to surface as coronals.

There are 3 major flaws with Rice's approach:

(47)

a. velar segments which appear in weak positions, like coda, are automatically assigned the underspecified stucture 46c and not 46e; but there is no proof for any of the cases that these segments are phonetically velar and not dorsal; for one case (Selayarese), the relevant segment fits Rice's own description of *dorsal* articulation ("pressing the tongue against the back of the velum"). Thus a given segment is assigned the structureless representation merely because it appears in coda, which is circular.
b. Rice's claim that coronals change to velars where a language lacks the coronal fill-in rule is vacuous, because such changes take place in word-medial onsets, i.e. sites which by no definition can be seen as weak. Also, she ignores the fact that labials (with highly specified structure) continue to be licensed in these "weak" sites. We will look at the cases of Cologne German, Vietnamese and Polish below.
c. There is one striking fact that Rice ignores about default velars: epenthetic velars and genuine cases where weak sites prefer velars involve only the velar *nasal* (e.g. Midi-French, Genovese Italian, Selayarese, Japanese, Andalusian Spanish); in the same language, coronal serves as epenthetic in the oral series (e.g. Midi-French has epenthetic /t/[14], but word-finally /n/ has become /ŋ/).

[14] Cf. epenthetic /t/ to separate vowels in "Y-a-t-il" (Is there?), co-occurring with /paŋ/ (Standard French "pain" = "bread").

There is thus no serious challenge to the default status of the coronal Place. All that can be said is that for the nasal series, in some cases, the velar place competes with the coronal. I suggest this context is confined to coda (now, nuclear complement), and that the reason for it is that the nasal element [L] (*pace* Ploch 1998a and Nasukawa 2000) is interpreted with [A] (and perhaps [ʔ][15]) if it appears in isolation in coda. We can state this descriptively as:

(48) Nasal interpretation condition:
Coda [L] is phonetically interpreted with [A] and [ʔ].

This remains descriptive and unintegrated into the present framework; but work on nasality would take us too far afield from the topic of coronality[16]. However, in the final section of this chapter, we will propose a tentative modeling of this state of affairs.

In the next few sections, we will look at three languages which Rice proposes need to be modeled by default velarity. In each case, a more perspicacious analysis can be achieved by continuing to assume that coronal is headed.

5.10 Velarity and Coronality in Polish, Cologne German, Vietnamese

The first case we will look at is Polish.

5.10.1 Polish

Polish words can end in any nasal, which in Polish are the following:

(49)

labial	front labial	dento-alveolar	prepalatal	default (labiovelar nasal glide)
m	m’	n	n’	N

[15] There is some dispute as to whether nasal stops contain [ʔ] or not. Cf. Rennison & Neubarth (1996) for a [ʔ]-less modelling.

The following words illustrate word-final coronal nasals and the default nasal.

(50) a. se[n]"dream"

b. se[n'] "vestibule" [w̃] = nasal glide

c. s'e[w̃] "reflexive"

d. to[w̃] "this, instrumental singular"

The default nasal, which Rice symbolizes as [N], has different surface manifestations, depending on context. It is realized as a homorganic nasal stop before stops, and as a labiovelar continuant before continuants and prepausally. These examples (from Rice 1996 who takes them ultimately from Czaykowska-Higgins 1993) illustrate from a-c respectively the pre-stop, pre-continuant and pre-pausal environment in which [N] varies:

(51)

	underlying:	surface:	
a.	raNbac	rambac	"hew"
	peNc	pen'c	"five"
	wsteNga	fsteŋga "ribbon"	
b.	wstaNzka	fstaw̃ska	"ribbon (diminutive)"
	waNski	vow̃ski "narrow"	
	weNx	vew̃x	"smell"
c.	taN	tow̃	"this one (fem)."

This data is problematic for Rice's default variability hypothesis which posits that coronals and velars have the same underlying representation with languages choosing whether to implement a coronal default rule (so that coronals are default) or not (in which

[16] There are fairly well-established phonetic reasons why [L] and [A] would combine, cf. Kingston 1993:73.

case velars are default). Velars should not surface as default if coronals do, and vice versa coronals should not surface as default if velars do. As Rice puts it: "...this representation is problematic: a word can end in a plain coronal and a velar. Again if both have the same representation, what determines when Coronal is filled in and when it is not? As in Uradhi context does not provide an explanation." I maintain that context does indeed provide the explanation. But first let's consider Rice's solution. She proposes that because Coronal is a contrastive feature for nasals, "the Coronal default rule cannot operate, making the velar nasal the only possible surface realization of N." So coronal nasals in Polish are underlyingly coronal. There are two things to say against this: (1) we have seen other languages where coronal and velar are default in one and the same language (cf. Midi-French whose epenthetic stop is coronal but whose word-final velar is nasal) so that this solution will not work for other languages; and (2) Rice's construal of underspecification theory holds that if coronals contrast, i.e. if they dominate subplace features (like [distributed] or [laminal] or whatever features are being used), then the subplace-rich coronals as well as the non-subplace-rich coronals must be specified for [coronal], i.e.

(52)

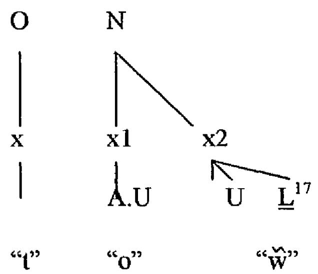
	Place		Place
	|		|
if /c/ =	Coronal	then unmarked /t/ =	Coronal
	|		
	[distributed]		

Now this will mean that if a language has coronal contrasts, coronal is specified for [coronal], and so the default [coronal] insertion rule is blocked and coronals cannot be unmarked in such languages. But this is patently false, as critics of Constrative Underspecification have pointed out: English has /ʃ/ which is a complex coronal (i.e. one which needs subplace feature specification to distinguish it from /s/), but in English the coronal stop acts as default in Rice's sense of being able to be licensed in places where non-coronals cannot appear (as the previous sections amply illustrate). For these two reasons, Rice's "default variability" analysis of Polish is unsatisfactory.

In contrast, I propose that syllabic environment can solve the issue of what determines whether a coronal or velar surfaces.

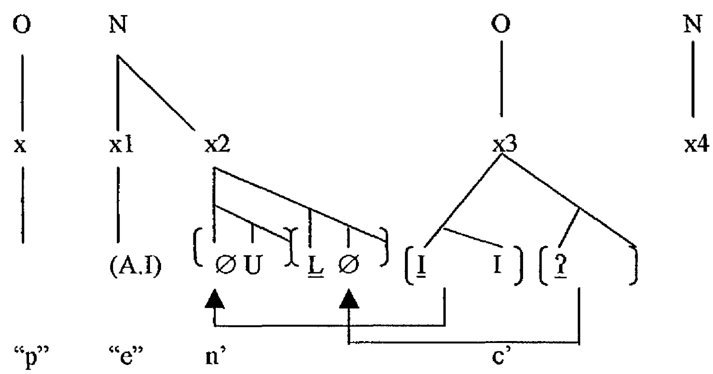
[N] surfaces as a nasal glide prepausally. Glides are segments which are indistinguishable from the offglide of diphthongs postvocalically. We can speculate that our nasal glide appears in a coda then (or more accurately nuclear complement). Furthermore we know that codas like nasality. And to cap this intuition we see from the data in (51) that this glide hardens into a homorganic stop when followed by a stop. Nasal stop-oral stop sequences are syllabified as coda-onset pairs across widely differing theories. We thus posit the following representation for word final [N]:

(53)



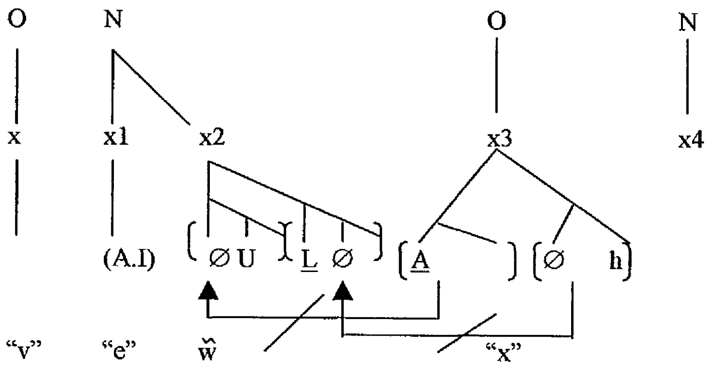
We represent the nasal glide as the labial glide [U] plus nasality. As such, this is the lexical specification of the labiovelar nasal glide (rather than being a fill-in feature). When followed by a stop, the following occurs:

(54)



That is, because RP and MP of the following onset s-govern (are stronger than) the empty RP and MP of [N], the governing elements spread into the coda's vacant sites, whilst leaving L-head in tact: the result is a prepalatal nasal stop. ([I̲]-head drags along its licensee element [I], which dislodges [U], we must say). If the following onset segment is a fricative however this does not happen:

(55)



Why should this be? There is a typological markedness implicational that fricatives will cause assimilation only if stops do. Again this is not something that GP has attempted to capture: however the preferential spreading of [ʔ̲] over [h] is read off the current model easily: [ʔ̲] is the natural head of MP and thus has greater freedom of movement than non-head [h] – one could imagine a special parameter to license the spreading of Manner nonheads, while a "spread-license" is granted automatically to [ʔ̲]. The reason why [A] above does not spread seems to be a constraint on the spreading of elements under government: Manner head and nonhead must spread together: if the spread of nonhead [h] is not licensed, this blocks or holds back the spread of RP head. The same analysis will hold for /s/ (here though [h] is in head position (=stridency), it is a non-natural head). Once RP and MP are filled by new elements, U is delinked, as the new RP element (A, U or I) cannot license it. This is either because (A̲.U.ʔ̲), (I̲.U.ʔ̲) are not licensed paradigmatically in Polish, or else because the new RP element now intervenes between the nuclear head element which licensed U, and U: this destroys the adjacency necessary for licensing. Unlicensed elements are delinked and not interpreted.

---

[17] In this structure I assume that [L], the nasal element, appears under a laryngeal phrase. Details are not

All the other word-final nasals, by contrast, are syllabified into onsets – like the corresponding oral obstruents that end Polish words.

No recourse is needed to default velarity, or indeed default coronality to model Polish.

5.10.2 German

A further interesting case that Rice 1996 presents is that of Cologne German (ibid. 513), in which the following velar to coronal shift has occurred:

(56)	New High German	Cologne (shifted)	
	brau[n]	bru[ŋ]	"brown"
	Wei[n]	Wi[ŋ]	"wine"
	mei[n]e	mi[ŋ]	"mine"
	schei[n]en	schi[ŋ]e	"shine"
	schnei[d]en	schni[g]e	"to cut"
	Zei[t]	Zi[k]	"time"
	Leu[t]e	Lü [k]	"people"

The data show that the coronal nasal shifts to a velar nasal, and also that the coronal oral stop shifts to a velar oral stop.

Rice models this shift as a change from a dialect which has the coronal default rule to one which has lost it (so that default segments have velar Place). It is unclear on Rice's analysis what is default about the syllabic position in which the change to velarity occurs: in /bruŋ/, /ŋ/ might be in coda position – but in /schnige/ it is by any account in onset position. Why should a default rule apply in onset position?

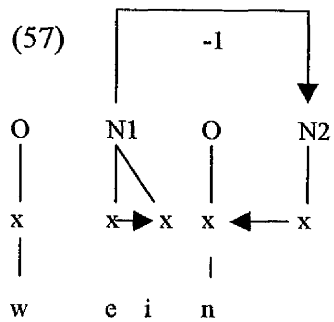
I propose a different analysis of this data, as follows:

The interesting facet to the above shift (which Rice does not comment on) is that all the diphthongs after which the new velars appear have turned into short vowels. It is my contention that the two facts are connected. To back this up, we can consider the English data we have looked at in detail: in English only coronals can appear after superheavy rhymes, i.e. in the VVCC configuration, while labials and velars are banned from there

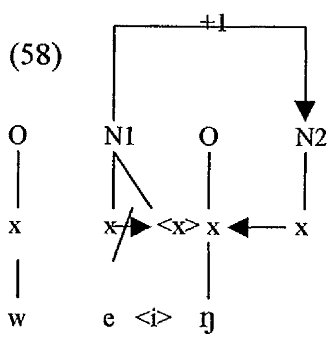
important for these analyses, and will be discussed more when the need arises.

(cf. (3c)). The licensing of coronals after VV is merely the converse of the non-licensing of noncoronals after VV. Why would the two be connected? The obvious explanation that we used before would be to say that the syllabic structure of the shifted words is different: the /ŋ/ is now in coda. However, (i) we get /shnige/ a supposed coda followed by a vowel, which means that /ŋ/ cannot be in coda, and (ii) not only the velar nasal but the oral velar stop shift as well: we argued that codas only prefer nasals if they are velar. We will have to try the Licensing Inheritance explanation:

(57)



(58)



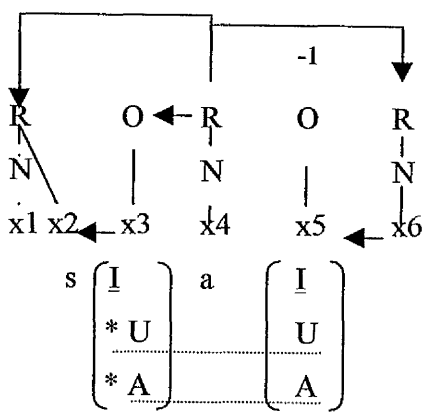
We assume that there was an independent trigger for the change of coronal to velar (McCawley 1967 reports that the shift occurs only after a high vowel – why this would trigger a shift of Place I leave unexamined here). Once the change happened, Cologne German found itself with final velars which were licensed by a nucleus whose inherited licensing stock was depleted. The depletion is due to the fact that the nuclear head of the domain had its own immediate nuclear complement to license. We mark this in (57) by "-1" to signify licensing potential at its thinnest. The solution, seen in (58), is to delink the nuclear complement, so increasing the potential that flows to N2 (+1: licensing potential boosted).

Licensing Inheritance was applied initially to Manner depletion (debuccalization, spirantization, deletion of melody in weakly licensed sites, cf. Harris 1997, Chapter 1 here): now that we have systematically incorporated Place into GP, it finds a timely application in modeling Place alternations too[18].

The word-final site in Cologne German is not weak (at least as regards Place): after all like standard German, it presumably licenses a full range of (devoiced) obstruents. Thus, Rice's arguments that velarization here show the default nature of the velar Place must fail (unless she extends this to the Labial stops which also appear word finally[19]). The present explanation in fact shows that diphthong simplification means that velarity needs more licensing in this site. This ties in perfectly with our analyses of English, Selayarese, Polish, Japanese and Midi-French.

Moreover, at this point we can resolve the *spep phenomenon of English (2f above):

(59)



This too can be seen as a function of the depletion of licensing potential at the edge of a domain. The head x4 has to perform several licensing functions: (1) it licenses x1 and 6, the first and last nuclear points and (2) it licenses the onset x3 to govern the coda x2. Note that when this second licensing function is not performed Place-occurrence is unrestricted (as 3.e.(iii) shows: "tot, pop, cake"). It seems that the nuclear head can perform at most two out of these three functions; when x4 has to government-license x3,

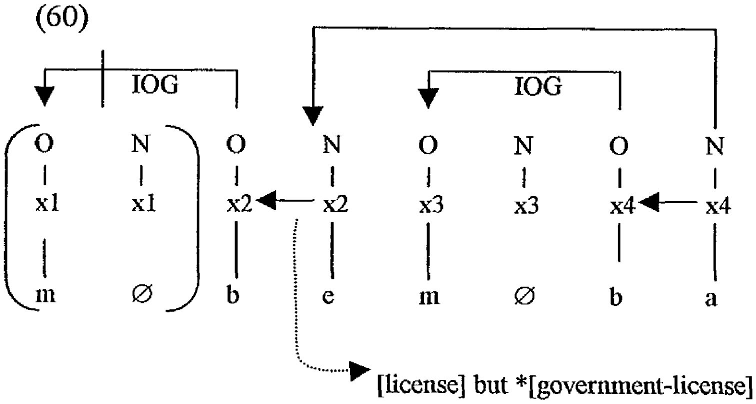
[18] Cf. a similar explanation for degemination gradation in Finnish, Ch.6.

[19] And of course to maintain that /k/ is made "with the tongue in a position of rest, or raised in the region of the back of the mouth" is wrong. It is made "with the back of the tongue raised against the velum", and is thus a fully specified dorsal (46e); Rice's analysis founders on this inconsistency alone.

the licensing potential suffers and the only Place that can appear there is the self-licensing coronal element.

We will see in the next chapter how Licensing Inheritance can model Place variation in Australian languages. A similar sort of decomplexification in the word is found in Bantu languages that disallow two nasal stop clusters in one word. These clusters have been modeled as ONON clusters by Marten & Kula 1998 (see the reasons given there). This would look as follows:

(60)



Here the first nasal-stop cluster simplifies to a stop as nuclear x2 only has the power to license onset x2, and not to government-license it – such a license already having been issued to the right of it in the domain. Again, this illustrates simplification of the same type as seen in German and English above, but taking effect not with respect to Place but to clustering. Similar modelings can be assumed for laryngeal decomplexification such as that found in Grassman's Law, which bans two occurrences of aspirated stops in a word.

5.10.3 Vietnamese

Finally, let us consider Rice's analysis of Vietnamese. Vietnamese (I take data from Rice 1996 again) has the following consonants:

(61)

p	t	t̲	c	k	?
f	s	s̲	j	x	
w	t'	t r	l	g	h
m	n		ɲ	ŋ	

Only the following appear finally:

(62) p t k m n ŋ ʔ h

In the northern Hanoi dialect of Vietnamese all of these consonants appear word-finally with no special conditions attached. In the Southern dialects of Vietnamese, however, the consonant depends on the preceding vowel:

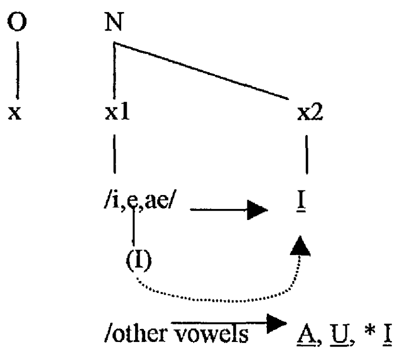
(63)	/i/, /e/	{p,m,t,n}
	/ae/	{p,m,t,n,k, ŋ}
	all other vowels	{p,m,k, ŋ}

Exact vowel quality is not important for the present critique of Rice. Suffice it to say that the vowels I have symbolized by {i,e} are high or upper-mid and front, while /ae/ is lower-mid, front. In elemental terms, both these vowels will thus contain [I]. According to Hume 1992's theory of coronal-front vowel interaction, which Rice (and I myself) adopt, these vowels are thus coronal and can be seen as triggering the appearance of coronal /t, n/ in South Vietnamese. Rice 1996's interpretation of this data is that South Vietnamese lacks the default coronal rule (like Cologne German). Therefore in weak positions, velar surfaces by default (again – crucial to this and all Rice's analyses – there is no confirmation of whether Vietnamese /k/ is velar or dorsal phonetically). Coronal only surfaces in weak positions if licensed do so by a coronal vowel.

A problem which Rice seemingly ignores is that /p, m/ are licensed in weak position too. These of course (along with so-called dorsals) are the most complex segments in Rice's representation and disprove her contention that the weak syllabic site in Vietnamese cannot license specified Place. This alone should lead us to look for an account which does not assume default velarity.

One could try to model this data by assuming that final consonants are syllabified into coda. (When we look at more languages in the next chapter and refine our notion of what can and cannot appear in a coda, we will see that this approach is undesirable). This might capture why there appears to be interaction between the vowel and the following consonant. Then the Vietnamese word would look as follows:

(64) South Vietnamese word (possibility 1):



Whereas before (we can assume like Rice that Hanoi preserves the older state of affairs), Southern Vietnamese could license all the final consonants, in a new development it licenses only stops whose Place the nuclear head has itself (move-)licensed, i.e. only [A]- and [U]-ful stops (velars and labials). This would derive from the HDA: base-generated [I] is the strongest Place and so will be licensed only in special circumstances. This is when [I] spreads from a coronal vowel into the egt in the nuclear complement, thus creating a coronal stop. In short, Southern Vietnamese would only tolerate Place in nuclear complement position if this Place is directly licensed by the nuclear head. This analysis would resemble Rice's own, translated across frameworks.

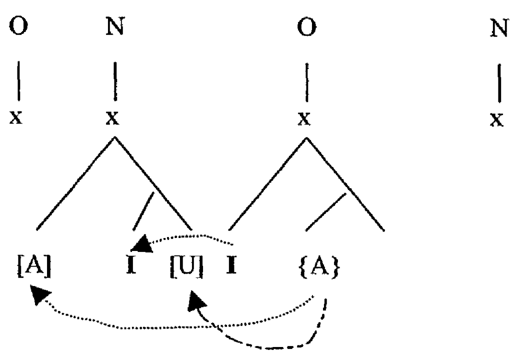
There are two problems with this: firstly, that we now allow codas to license coronal and velar place in any manner – we have thus completely eroded the difference between coda- and onset-profile consonants, so that determining the status of final consonants in a language is practically impossible. This would also destroy what we worked out above concerning the licensing of RP and MP elements in coda/nuclear complement by the nuclear head: in /k/ = (A.ʔ), we maintained that [ʔ] could only be licensed if material in a following onset s-governs [A] or [ʔ].

But secondly, – and for less theory-internal reasons – final consonants in Southern Vietnamese are stops, and moreover the labial (oral and nasal) stop can appear both after /i,e/ (where the above model predicts only /t,n/), as well as after all other vowels. Free occurrence of the labial stop (for which no other default behavior is attested or contended for other languages) seems to indicate that we are still dealing with a final onset here. And of course, Hanoi dialects from which South Vietnamese derives, license all stops freely domain-finally regardless of preceding vowel content.

It thus seems most reasonable to posit that South Vietnamese has onset-profile final consonants. But we can say that the place of these consonants must agree in element content with the preceding nucleus.

We can ignore the occurrence of /p,m/ which appear regardless of the content of the preceding vowel. Element agreement thus takes place only between velar and coronal consonants and the preceding vowel. It will look as follows:

(65) South Vietnamese word (possibility 2):



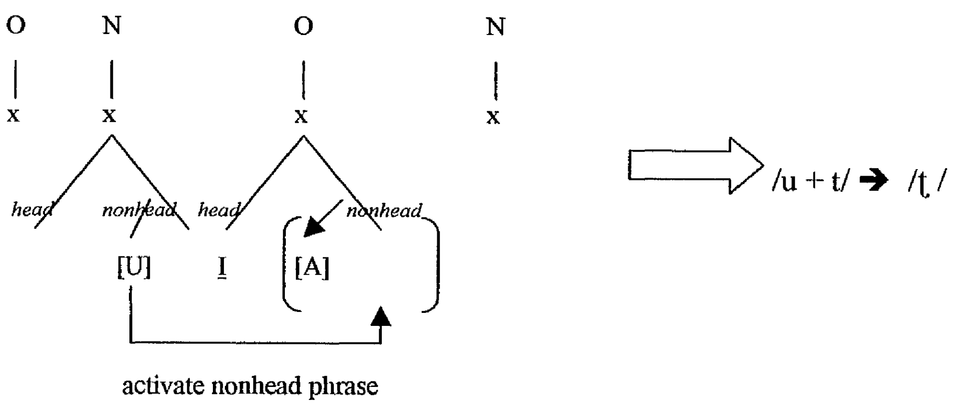
vowel	consonant	nucleus	onset
(1) /i/, /e/	{t,n}	(I)	(I)
(2) ·/ae/	{t,n,k, ŋ}	(IA)	(I), (A)
(3) all other vowels	{k, ŋ}	(A)	(U), (A)
		(U)	(U), (A)

[A]-ful velar consonants must be preceded by [A] or [U], and [I]-ful coronal consonants must be preceded by [I]. The vowel /ae/ which is composed of [A] and [I] thus allows velar or coronal consonants to follow it.

It is interesting that velars can be preceded by [A] or [U]. This suggests that [A] needs to be preceded by an element that is not identical to it but merely tautophrasal to it: the phonetic correlate of this tautophrasality is of course graveness (low frequency spectral energy). In actual fact, according to our modeling (cf. Ch.2) [A] and [U] are not tautophrasal in the *vocalic* element tree – but it seems that consonantal [A] is blind to that. This means it cannot see the structure of the adjacent tree. We can say that element tree structure is only visible if both trees are within the same constituent: this means nucleus + coda (both in nucleus) or onset + nucleus (both in syll. or N'), but not nucleus + following onset (heterosyllabic). This "element agreement" refers to phonetic substance alone.

Whether the exemption of labials from this agreement is significant or not, I cannot say. However this nucleus-following onset interaction involving gravity has an exact parellel in the process of retroflexion which we mentioned in passing in Chapter 2, whereby the "apico-alveolars" of proto-Australian became retroflexes after /u/ (Dixon 1980). This will look as follows:

(66) Development of retroflexes (after Dixon 1980)



Why does the p.e. (I.A.?) – the representation of the retroflex – surface after the vowel /u/? The reason we give is that [U] activates the whole nonhead phrase of the consonantal egt; subsequently the head element of this phrase is activated, namely [A]. Thus we still need to make limited reference to the properties of gravity which unites [A] and [U]. (We might also expect processes which refer to [U] and [I], which would involve the manipulation of diffuseness).

To sum up, we have posited that South Vietnamese final consonants are onsets, and that their Place is determined through agreement with the preceding vowel.(For consonant vowel agreement in an element-theoretic framework, cf. Cyran 1997 on Irish). This involved referring to the phrasality of elements, and not just to the elements themselves.

We cannot pursue the repercussions of this here — though the case of Australian retroflexion indicates that it has appliances elsewhere.

In Chapter 6, we will see evidence from other languages which make it desirable not to prefer peripheral Place in coda before Coronal Place. Indeed, a restriction to coronality or Placelessness is always indicative of possible coda status – bar the example of the velar nasal which we have already discussed.

In the above sections then we have argued that reports of velar defaultness are true only for the nasal series, and only in the specific context where languages have word-final codas filled with such velar nasals.

We have tried to illustrate how this alternative approach can cover some of the more interesting cases analyzed by Rice 1996, and that rather than default variability of Place defaultness, a more parsimonious and successful assumption is one of exclusive coronal defaultness.

In the last part of this chapter, I return to two last problems thrown up by the data set which triggered the investigations of this chapter: coronal lenition and the licensing of voiced coronal stops where voiced peripheral stops are banned (3.d, f).

5.11 Coronal lenition and a Place-Voicing relationship

The relevant asymmetries were exemplified by the following words:

d) (i) went, wind (ii) wink,*wing (iii) ramp, *ramb

(f) (i) better → be'er/bere (ii) flicker ↛*fli'er (iii) rapid ↛ *ra'id)

We will start with (d), which involves the licensing of voicing.

5.11.1 Coronality and the licensing of voicing

If a voiced stop appears after a homorganic nasal at right edge in English it must be coronal. After liquids, labial Place is licensed, cf. /bulb/, while velar Place is not: *{alg, melg...}. We will not deal with this asymmetry between Labial and Velar. Furthermore, /nd/ clusters can appear after superheavy rhymes: /sound, grind, bind..../, whereas even a voiceless peripheral stop is banned in this context (*/ounk, oump.../).

That these facts are significant, and involve the licensing of voicing, can be seen from the process of German Final Obstruent Devoicing (FOD). In German, all underlying voiced stops devoice at right edge (cf. Brockhaus 1994/7 for a GP modeling and references therein):

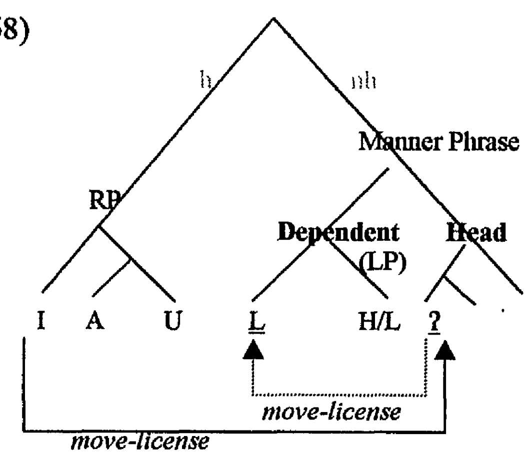
(67) Tag (= /tak/) "day. nominative." vs. Tage (= /tage/) "day. dative"

In this example voicing only surfaces if "supported" by a following suffixal vowel. Brockhaus 1992/5 models this loss of voicing as the failure of the element L to be licensed in a weak site, which in the above example would be an onset licensed by a domain-final empty nucleus. (Filled nuclei then have the power to license L).

English thus seems to exhibit a limited case of FOD. (In all other contexts voicing is contrastive word-finally). And, as we can see, English FOD interacts with Place-Licensing in interesting ways.

We can capture the place of voicing ([L]) and voicelessness ([H]) in the following tree:

(68)



Here LP is the Laryngeal Phrase, which hosts elements [H] and [L]. [L] in turn is interpreted as voicing or nasality, depending on headedness (*pace* Ploch 1999a). The decision to make nasality [L] and voicing [L̲] is arbitrary, and based on the following larger assumptions.

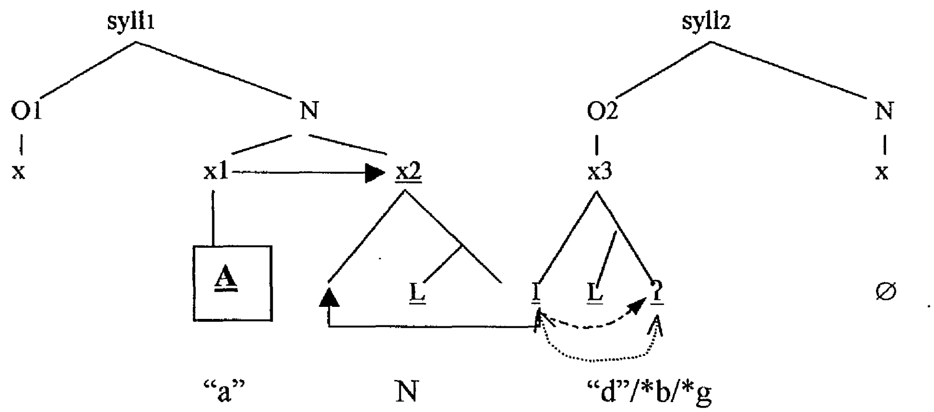
This is that LP is a dependent phrase of MP, and that all elements in it are licensed to move into head position by the head of RP (in this case [ʔ̲]). We thus assume that the mechanisms which operated in the generation and combination of manner and place elements also holds for laryngeal elements. The difference here, though, is that we assume that the HDA holds between MP and LP: that is, it is better for LP to less headed than MP. In this case then, a tree where [L] has not moved into the head of LP is preferable, so that {L, H} are generated in combination with [ʔ̲] before [L̲]. This gets us the well-known markedness implicational that if a language has voiced stops it will also have nasal and voiceless ones. The latter is the preferred laryngeal[20] configuration for occlusion. It will also, as we will now see, derive the syntagmatic facts of English voicing distribution.

We now say that L̲ – voicing – needs a license to move into the head of LP, and that once there it will be less preferred, as now MP is merely *as strong as* LP, i.e. the HDA only weakly holds. This license is given, as mentioned, by [ʔ]. And of course [ʔ] is itself licensed to move by a Place element. This system thus captures for us a chain of causation between Place element to Manner element to Laryngeal element.

The Place element has to move-license [ʔ], and it has to grant [ʔ] a license to move [L] into head position, as follows:

[20] Our taxonomy of what counts as laryngeal is different from S.P.E or say, Halle & Stevens 1971, which groups together aspiration, glottalization and voicing under this rubric. Aspiration and friction are seen as related (Harris 1994, Harris & Lindsey 1995); glottalization has been passed over here, but would be modeled as occurrence of lazy [ʔ], in head role. Nasality is included with voicing elements and so is classed as laryngeal, rather than coming under a Soft Palate (Sagey 1986) or Spontaneous Voicing node (Avery & Rice 1989a,b). Given these wholescale differences, and given that we adopt an non-articulatory approach to features (so that the "larynx" location is meaningless), our use of the term "laryngeal" is best seen as a convenient, abstract label for the natural class of nasality and voicing.

(69)



[(i) ....> move-license [ʔ] (ii)- - - - -▶ grant [ʔ] a license to move L to head position (= L̲)]

(In addition, [I̲] spreads into the RP of the preceding Placeless nasal).

The ungrammaticality of */b, g/ in this position now receives a ready explanation: [U] and [A] can move-license [ʔ], but they do not have the power of the Natural Head [I̲] to grant [ʔ̲] a license to move [L̲].

When, /b, g/ are followed by a filled nucleus, this nucleus moves [ʔ̲] (cf. diagrams (32, 33) above), so relieving {U, A} of some of the strain of licensing. Hence the licitness of words like /ambient, angry/.

The above thus constitutes a particularly interesting case: there are clear indications of asymmetry in all three phrases, between:

(70)
(i) coronal and noncoronal place
(ii) stop and fricative manner (the latter cannot license nasality)[21]
(iii) voicing and nasality/voicelessness (the former cannot appear at right edge NC#).

This provides motivation for the tripartite tree we have assumed.

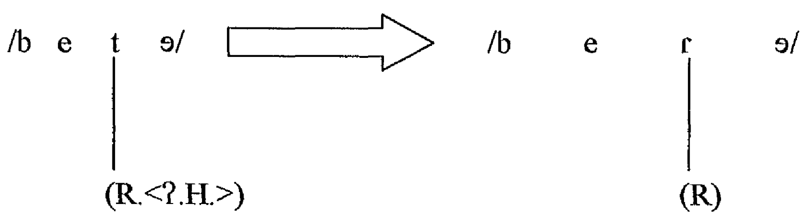
5.11.2 Coronal lenition

The last problem concerns lenition. The facts of lenition for London English are these (taken from (3)):

(f) (i) better → be'er/bere (ii) flicker ↛ *fli'er (iii) rapid ↛ *ra'id)

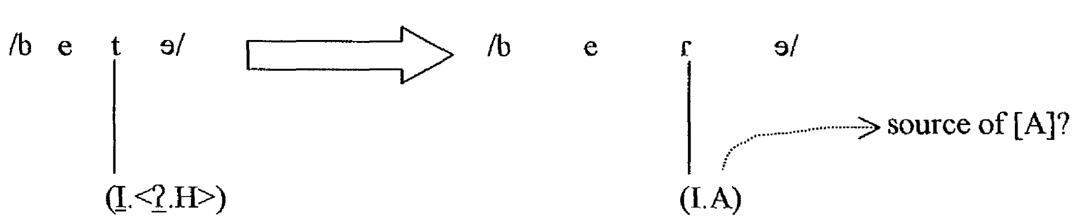
Here I will not have much to say about why coronal lenites preferentially to peripheral stops. This may not be a universal tendency, as there are languages in which velars have lenited rather than coronals. What I wish to model for the sake of completeness is the /t/ ~ /r, ɾ/ alternation[22]. An attractive aspect of Harris 1994's modeling of lenition in English is that intervocalic tapping is captured by simple loss of elemental content (cf. Chapter 1 here).The intevocalic /t/ is a stop in a weak foot, with the weakness of the foot being the reason for depletion. Schematically this is:

(71)



Simple though this is, the data concerning the coronality of /t/ and /r/ which we adduced in the last three chapters means that we can no longer use [R] to model the alveolar stop and rhotic. There are several possibilities open to us. We could model tapping as the conversion of /t/ to an r-sound:

(72)



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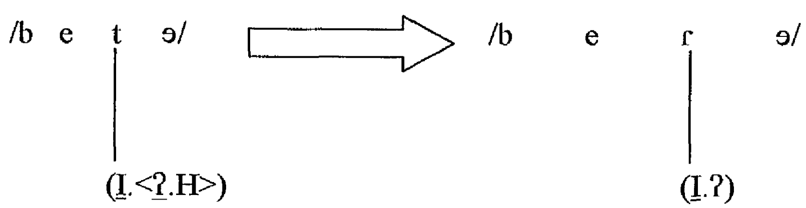
[21] Unfortunately on this construal of LP structure, we do not get why nasal fricatives are marked. Voiceless fricatives and nasal fricatives should now be equally desirable. This is a point we leave unresolved for now.
[22] In Scouse dialects, the lenition is to /r/ and not to a tap. More on this shortly.

This preserves the economy of Harris's modeling, except for these points: we have to explain where [A] comes from, and also explain why [I̲] becomes [I]. The latter is easy to account for: [I̲] is demoted in a weakly licensed syllabic site. However, this alone would lead us to predict a /t ~ j/ alternation. Which brings us to the overlaying of rhoticity onto demoted [I]. We could say that demoted I in this position simply activates [A]: given that (I.A) is possible paradigmatically in English because [I] is granted the power of ni-movement, we say that [I] licenses [A] simply because it has the license to do so.
Alternatively we could model the tap, not as a conventional rhotic but as (I̲.?):

(73)



Here only [?] is demoted, from head (stop) to nonhead (tap) role, and distinctive laryngeality [H] is lost. This would mean we would not have the problem of introducing [A].
The latter solution would give a different representation to /r/ and /ɾ/. Given that the two segments have different distribution in English, (/r/ can appear initially, but the tap can't), this is perhaps justified. The representation (I̲.?) is strange from the point of view of our segment licensing trajectory in Chapter 4 and the HAMI principle: this is because if [?] is demoted we would expect compensatory licensing in RP to move A and yield: (I̲.A.?). This is a good prediction, as we find /d ~ l/ alternations in a number of Bantu languages. The [A]-less congener in English may be licensed only as an allophone of /t/, hence its limited distribution. (This would presuppose different well-formedness principles for underlying and derived segmental representations).
Indeed, perhaps both solutions are correct for different dialects: in Liverpool English the realization of intervocalic /t/ is a rhotic approximant, indistinguishable from phonemic /r/. For this dialect solution 1 would be viable. In RP, the congener is a tap – which as we

have seen differs in distribution from the phonemic rhotic. (Cf. /Betty/ tapped to /beɾi/, where the tap will be contrastive with the rhotic in "berry").

The discussion could lead into fairly hoary arguments concerning what level of phonetic detail and allophonic variation a phonological theory should capture, so I will terminate it here. Suffice it to say that there are a range of possibilities to capture tap~lateral~rhotic~coronal stop alternation within the limits of the theory developed here, though a systematic answer still awaits development.

In this chapter, then, we made a start towards integrating the paradigmatic representations of segments with their syntagmatic distribution, using a number of coronal anomalies in English as a starting point, and taking in some other languages along the way. In the next chapter, we will apply the mechanisms developed here to other language groups.

Chapter 6 Coronal anomalies across the word: extending the approach to other language groups

In this chapter, I will look at special coronal behavior in representative languages of the following language-families: Chadic (Margi), Khoisan (!Xoo), Bantu (Shona), Finno-Ugric (Finnish), Kartvelian (Georgian), Indo-European (Tocharian, Greek, Sanskrit), Algonquian (Menomini), Malayo-Polynesian (Selayarese) and Australian (a range of languages). This investigation has two aims.

The first is to develop further the concept of the coda as a nuclear complement, an analysis which we proposed in our modelling of English. Here we will see that the segment licensing properties of the coda differ parametrically across languages. Such underlying variations in syllable structure will be used to explain striking differences in the phonological shape of words cross-linguistically (for these purposes we will be looking at Selayarese, Finnish, Menomini and Australian).

The second aim is to examine more evidence of how coronal has unique properties in the creation of exotic segments or segment sequences (the issue of unit or sequence status is one of the problems we will investigate) such as clicks (in Bantu and Khoisan languages) and complex segments like corono-labials (in Margi), as well as in exotically complex clusters involving coronals (in Georgian and Indo-European). This will follow on from investigations as to the nature of a possible segment started in Ch.3. We will conclude that the objects just mentioned should be modeled as C(V)C sequences, rather than as unit segments.

Let us start with the first topic.

6.1 Finnish

In Finnish there are intervocalic consonant clusters, which follow a short or a long vowel. If we represent a short vowel as V and a long vowel as VV, we see the following patterns (data from Sherer 1993):

(1) V + :

ɱp **nt** **nk** **ns** nj **nd** 1

lp	**lt**	**lk**	lj	**lv**			2
rt	**rk**	**rs**	rj	**rv**			3
ht	**hk**	hj	**hv**	**hd**			4
lm	**rm**	**hm**	lh	rh	hr	nh	5
ps	<u>tk</u>	<u>ts</u>	<u>ks</u>	**st**	**sk**		6
(pp	tt	kk	ss	mm	ll	rr)	7
VV +							
<u>ts</u>	**st**	<u>sk</u>					8
(pp	tt	kk	nn	ll)			9
nt	**lt**	<u>rt</u>	<u>ht</u>				10

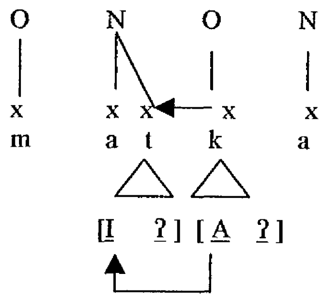
The clusters I have bolded are sequences which would be perfectly licit in English and many Indo-European languages. Thus after V we get homorganic nasal-stop pairs, lateral-obstruent pairs and rhotic-obstruent pairs. I have also bolded pairs in which /h/ is followd by an obstruent: these do not occur in English, but this might be merely due to a restriction of /h/ to onset. Thus they are not particularly alien from an English point of view. Likewise Finnish has /ps, st, sk/ after V, as does English ("collapse, past, ask": note that /ps/ in "collapse" seems to attract stress onto the /a/). Finnish has geminates, which English doesn't, but English has pseudo-geminates as homorganic nasal-stop clusters are sometimes referred to, and cognate[1] Romance languages like Italian have real geminates: the two have been modeled as coda-onset pairs where the Place and Manner of the onset is doubly linked to the coda. Looking at the VV context, we get /st, lt, nt/ as in English "roast, field, point", so these too are unexotic.

6.1.1. The nature of Finnish syllable structure

Is Finnish just like English then? Sherer 1993 adopts the same syllable structure for both. But we have found, in the last chapter, that differential surface segment distribution can often be a consequence of different underlying syllable structure. If we look at line 6 above, we find three pairs /tk, ts, ks/. On a naive assumption that Finnish and English syllable structure are identical, we would syllabify a word like /matka/ "trip" as follows:

[1] "cognate" in the sense of being close cousins in a related family (Germanic and Romance in Indo-European), compared to Finnish which is in a completely unrelated family, Finno-Ugric.

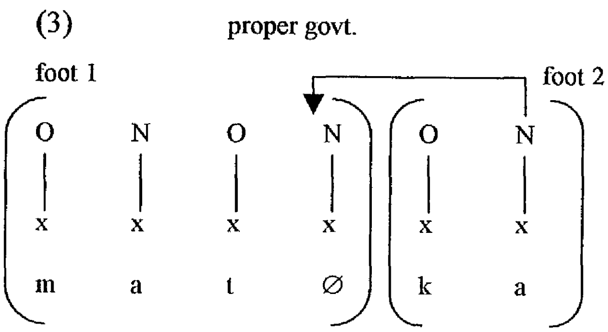
(2) *Finnish syllable structure ??*



And if this really were the correct representation of syllabic and intrasegmental relations in Finnish, we would have disproved the theory of coronal exclusiveness in the sense developed in this thesis, for here we would have a language where [I]-head can be s-governed by [A]. The logical conclusion would be that, in our terms, velarity was stronger than coronality in Finnish.[2]

In Rubin 2001 I proposed an analysis of words with /tk/ type sequences which made appeal to the following structure:

(3)



(matka = "trip")

I proposed that Finnish has a basic CVCV structure and that words divided into weak and strong feet. Segments appearing at the end of the first foot were licensed by an empty nucleus and as such were licensed only weakly. As a consequence only naturally headed Place could appear there, such Place being self-licensing. The onset of the weak foot, which was licensed by a full vowel had the power to license non-natural heads like /p, k/. This avoided the unpleasant consequence that /t/ might be said to appear in coda governed by following /k/.

However, there is another better-motivated account of Finnish, which takes account of a range of facts.

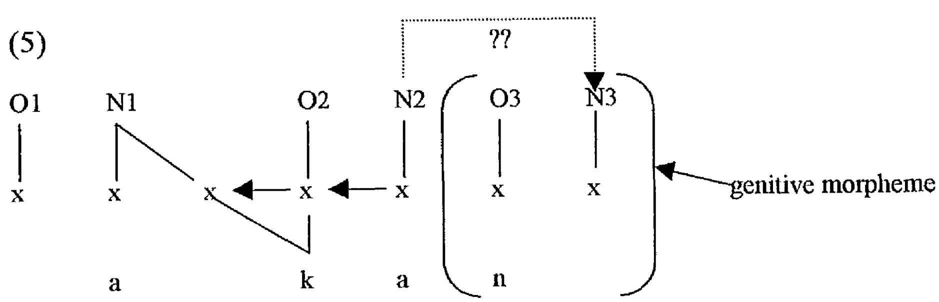
[2] Foley 1976's α-scales make such claims that place and manner strength differ arbitrarily between languages, as phonology is abstract and the mapping onto phonetics arbitrary. For reasons set out in Ch.2 we disagree with (extreme) phonological abstractness.

Firstly let us consider the lenition of consonants in Finnish, which is called "gradation". The environment in which this happens is according Keyser and Kiparsky 1984 "in the onset of a non-initial closed syllable within the word, if that syllable contains a single vowel or a vowel-i sequence." Elsewhere Keyser & Kiparsky show that diphthongs can count as single nuclear slots, as proved by the occurrence of other phonological processes which are triggered only after short vowels continuing to occur after such diphthongs. I will thus take the context "single vowel or a vowel-i sequence" to be phonologically a single nuclear point, perhaps dominating two melodic expressions (a short diphthong in other words). Examples of gradation are (from Yip 1991:72)

(4)	akka	akan	"old woman (nom/gen)"
	takki	takikisi	"coat (nom/transl)"
	sukka	sukaksi	"sock (nom/transl)"

What happens, with /akka/ is that the geminate /k/ reduces to a single /k/ when the case-morpheme /n/ is added to the word. The "second" (orthographic)[3] /k/, finding itself in the onset of the syllable which was /ka/ but is now closed by the /n/, becoming /kan/, disappears, and we get /akan/. Now according to Kaye 1990, this would not really be a closed syllable, as the /n/ would syllabify into a domain-final onset. Government Phonologists are rightly cautious about the term "closed syllable". However in this case, when one comes to analyze why it is that /k/ should degeminate, one has two representations to hand (now that Piggott 1999 has reopened the possibility of final /n/ really being a coda here), and it turns out that a coda analysis of /n/ is better theory-internally for transparently representing causes of degemination.

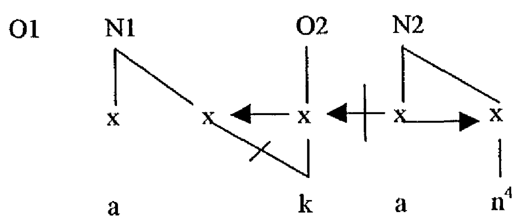
(5)



[3] Which /k/ disappears is a moot point, and autosegmentally we would say there is only one doubly linked /k/. More of this later.

Let's assume that geminate /k/ is a coda-onset linked /k/ segment. We can imagine N2 government-licensing O2 (in the sense of Charette of 1990, 1991, 1992), so that /k/ has the licensing power to link up to two skeletal positions. Now the genitive morpheme is added: there is no necessary licensing relationship between incoming N3 and N2, though one might imagine an internuclear licensing relationship symbolized by the dotted arrow. However, it might be more plausible to assume that N3 is p-licensed parametrically, or that it is licensed at another projection by the head nucleus of the domain N1 (N1 always bears primary stress in Finnish, and stress is a way to identify the most prominent/head vowel of a word). The reason one would look for another licensing relationship being contracted by N2 is that it would detract from the licensing potential it expends on O3 in giving it a license to govern the "coda". But such a licensing relationship is far more transparent if the morpheme /n/ enters into the coda of N3:

(6)



In that case N2 has to license an immediate complement and the repercussions for O2 are transparently clear: retraction of a government license, and only a license left for a single /k/ segment.

So far we have two theory-internal representations. But there are facts from word-final consonant phonotactics and secondary stress placement to back this coda analysis of /n/ up.

Let's consider secondary stress. Yip 1991, relying on Harms 1964, gives the facts of Finnish stress as follows: primary stress always falls on the first vowel. Secondary stress depends on syllable weight: counting from the beginning of the word, it goes on the leftmost nonfinal heavy syllable (but never on the second syllable). For example (Yip 1991:72):

[4] We can imagine the morpheme having the phonological shape of a nuclear complement and being fused onto the vowel-final (nuclear head final) root. In GP vocalic affixes are lexically attached to independent nuclei; the root-final empty nucleus of a consonant-final word has to be deleted to make

(7) pé. rus. te. le. mát. to. mal. ta "unfounded"
hár. ras. túk. sel. li. nen "relating to a hobby"

What this shows is that /ks/ and /tt/ (and other geminate clusters) count as heavy for the purposes of stress. Rubin 2001 was therefore wrong in trying to analyze all clusters as CVCV pairs: Finnish transparently has coda consonants which add to syllable weight. I have not been able to find out if /tk/ sequences add to syllable weight, and close the syllable for the purposes of gradation: if they did not, that would constitute very interesting behavior and one would be justified in seeing them as /t/ as a post-nuclear onset rather than coda segment. Then a CVCV analysis of /tk/ on the lines above would be motivated. However, in the absence of such evidence I am assuming[5] that /tk/ does add to weight and suffice for gradation.

We can now bring in the final piece of evidence about Finnish: and that is that only coronals are allowed word-finally {s, l, t, n}. Some say that /r/ cannot appear word-finally (Yip 1991), others that it can (cf. Collinder 1960). How can one enforce a ban on peripheral place at right edge? Again, if one was loathe to see coronal stops in coda – on the basis that English bans them – one might posit that /t/ in /talat/ was in a weakly licensed final onset where self-licensing [I]-head was favored (*pace* Rubin 2001). But in light of the fact that /tk/ counts for stress, and /t/ closes a syllable for gradation purposes, we can assume the following syllabification:

(8)

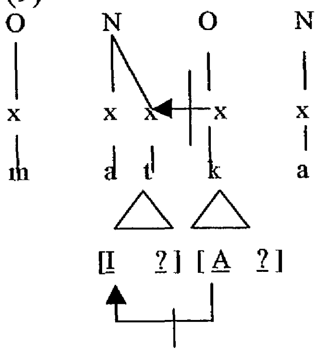
O1	N1	O2	N2		
x	x	x	x	x	
t	a	l	o	t	"house (nom. pl.)"
s	a	m	a	l	"moss"
vi	e	r	a	s	"guest"

way for the affix. Thus I do not see that this proposed form of morphophonological affixation is any better or worse than that currently countenanced in GP.

[5] This is not an initially favorable assumption from my point of view – evidence of coronal uniqueness in being non-coda worthy would make Finnish just like English and make proof of coronal specialness immediately sustainable. As it is another plausible account is possible, though.

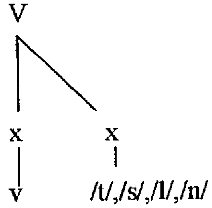
The pleasant consequence of this analysis is that we do maintain the syllabic structure posited above, but we no longer need to say that mysteriously, [A] must s-govern [I]-head in Finnish for /tk/ sequences to be licit:

(9)



Just as in English, and all other languages we maintain, the hierarchy of Place elements is maintained: I → A → U. So /k/ does fail to s-govern /t/ in Finnish but /t/ is independently licensed in the coda in Finnish anyway: and the proof of this is that /t/ does not *need* to be followed by /k/ to be well-formed in coda. Words like /akan/ in which /n/ is in a coda, thus closing the syllable and leading to degemination of /k/ prove that coronals can appear in codas unlicensed by a following consonant. In other words, the structure that we posited on merely theoretical grounds in 5.6, (31), has found an application in the real world:

(10)



We ruled this structure out for English on the grounds that nuclear complements had to be less headed than their heads by the HDA. The structure had to be ruled out for Polish, too, where final coronal nasals were syllabified into onsets and only the default nasal glide was allowed in coda.

6.1.2: Parameterizing the content of the nuclear complement

We can frame this as a parameter:

(11) Nuclear licensing parameter (NLP):

HDA holds weakly/strongly between a nuclear head and its complement.

Strong languages are: Polish, English, Japanese, Midi-French, Italian, German.
Weak languages are: Finnish (and, as we will see later, certain Australian Aboriginal languages).
How does this structure fare when applied to the rest of the clusters in (1)?
Looking at line 6, repeated here, we have:

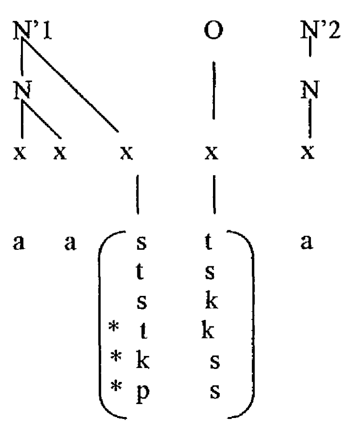
(12) **ps** tk ts ks **st** **sk** 6

Now in /tk, ts/, /t/ appears in coda, /s/ in onset. In /ks/, /k/ appears in coda, but has to be followed by a coronal which s-governs it. In /st/, /s/ a coda appears in coda without having to be s-governed and can be followed equally well by /k/ as by /t/, giving /st, sk/. Finally in /ps/, /p/ is licensed in coda through s-government by /s/ (again the proof is that /p/ does not occur finally). The interesting question now is why some of these sequences fail after a long vowel. The obstruent-obstruent sequences allowed after a long vowel are:

(13) ts **st** sk 8

The assumption that Finnish licenses only coronals in coda is vindicated again.

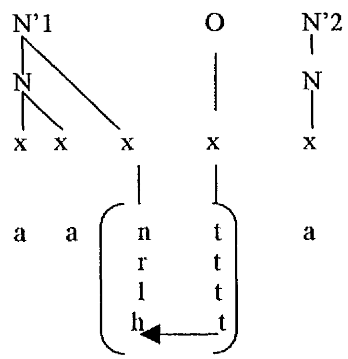
(14)



All (but one) of these distributions fall out of the syllabification given, which makes recourse to a superheavy rhyme, as we did for English. The only difference between English and Finnish is that a word like /aatsa/ is well-formed in Finnish but not English, due to Finnish being an "NLP-weak" language. The absence of /tk/ after VV is not directly predicted by what we have assumed so far. We know that /t/ is fine in the isolated coda of the supeheavy rhyme (due to /aatsa/); it must be /k/ that is difficult to license, and we can perhaps say that N'2 receives a weaker licensing potential due to coming after a superheavy rhyme (which will naturally due to its weight be capable of stress-attraction; post-tonic consonants are in weaker licensing sites)[6].

Looking at line 10 we find that all "supercodas" are either coronal or placeless (/h/) – and if placeless they are followed by a coronal stop: we can say that self-licensing [I]-head move-licenses [h] to be interpreted:

(15) **nt** **lt** rt ht 10



The glottal fricative /h/ is in our representation the single element [h] which has moved from nonhead to head phrase of resonance (nonhead node): to do this it needs a license: [I]-head of /t/ provides it. Again the absence of /VVhk/ suggests that such a move-licensing post-superheavy- rhyme onset must be a self-licensing coronal.

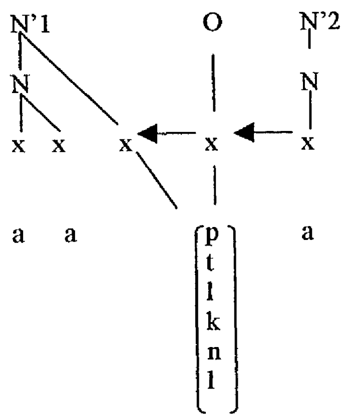
Finally, geminates are allowed after VV:

(16) (pp tt kk nn ll) 9

They will be represented as:

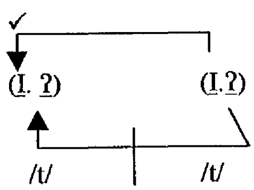
[6] This mirrors the explanation for *spep and vowel shortening before velars in Cologne German, in 5.14.2.

(17)



Again, delinking between N1 and O takes place if N2 licenses a nuclear complement. N2, as we said above licenses the double-linking of a segment to two skeletal points via Charette-style government licensing (cf. Ch.1). Gemination, incidentally, will be allowed if a language allows government to include instance where resonance is equal between segments:

(18)



language with gemination:
RP-a s-governs RP-b if a = /< b

That is, /t/ (or /k/ etc....) can only appear as /tt/ if the equal relationship between identical elements counts (parametrically) as government – because for identical segments, government, defined asymmetrically, fails for MP: [ʔ] cannot govern [ʔ], and s-government goes through if either RP-a or MP-a governs the corresponding phrase in egt b.

As a final point, it is interesting to comment on the absence of /kt/ clusters (which have a strange and interesting history in Indo-European, as I shall discuss below), which would be predicted under the present analysis. Collinder 1960's Comparative Grammar of the Uralic Languages shows that they do exist in cognate languages. Here are some correspondences:

(19)

Finnish	laehte	
FinnisKola Lappish	-likte	"go, start, depart"
Kola ICheremis	lakta	"go out, depart"
Cheremis	lakta	

Finnish	maetaes ~maettaeae	"tussock"
Lappish	miekta	"tussock"
Southern Lappish	makta	"tussock"
Finnish	yksi ykte	"one"
Lappish	okta	"one"
Cheremis	ik, ikte	"one"

Abondolo 1998 comments that "outside of poetic vocabulary, the abstract sequence KT is read as /ht/...only in the numeral 1 and 2." The change, therefore, from proto-Uralic to Finnish was evidently: /kt/ → /ht/, with the /t/ sometimes leniting under gradation to /d/ or by palatalization to /s/. The same process can be seen with the /kt/ clusters that Italian inherited from Latin:

(20)	Latin	noctis	"night"
	Italian	notte	"night"

Both cases can be seen of instances of lenition of a stop under government, and followed sometimes by eventual invasion of the coda by the governing onset's melodic material. The governor in both cases is the unique coronal stop. We will say more about /kt/ (and /pt/) clusters later in this chapter.

In the next section I will look at Menomini, an Algonquian language of North America (which includes Cree, Fox and Ojibwa), which partly resembles Finnish, though with interesting differences.

6.2 Menomini

Menomini (Bloomfield 1962, Yip 1991) has the following inventory:

(21)	p	t	c	k
			s	
	m	n		

w j h ?

Words can end in any of these consonants, e.g. napo:p "broth", me?tek "tree", apec "to that degree."

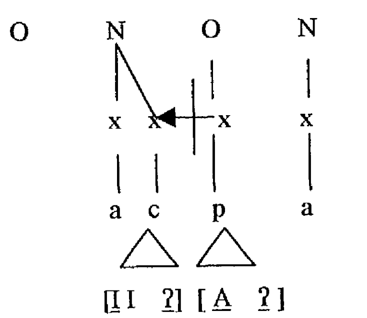
The following are the only intervocalic clusters allowed:

(22)

cp			ck		
hp	ht	hc	hk	hn	hs
	?t	?c	?k	?n	?s
sp			sk		

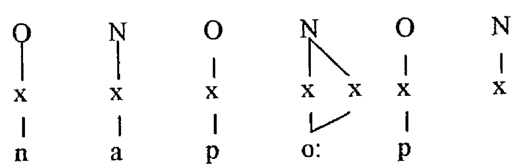
As can be seen only coronals and glottal obstruents are allowed in C_1 of these C_1C_2 clusters: {c, s, h, ?}[7]. On the above analysis we can start by saying that Menomini, like Finnish is NLP-weak, and thus allows [I]-head into the coda; thus /acpa/ would be:

(23) *The Menomini word:*



One essential difference, though, is that Menomini allows non-coronals finally. This means that word-final consonants have an onset-profile, so /napo:p/ would be syllabified as:

(24)



[7] The absence of {t, n} seems to be an accidental gap, given the presence of 2 coronal obstruents.

What syllabification is then appropriate for final coronals? Are they restricted to a coda syllabification, an onset syllabification, or can they appear in both contexts? Later, we will bring evidence from Australian for the latter syllabification. In addition, our present assumption that C_1 coronals are syllabified as codas is more of a theory-internal hunch at present. Again, examination of variation across the Australian family will make this contention more convincing.

However, over and above this, there is another interesting difference between Menomini and Finnish: Menomini does not allow *any* non-coronals into coda, so that intervocalic /pt/-type clusters (cf. /ks, ps/ in Finnish) are not found – with the exception of the glottal stop. What are the reasons for this?

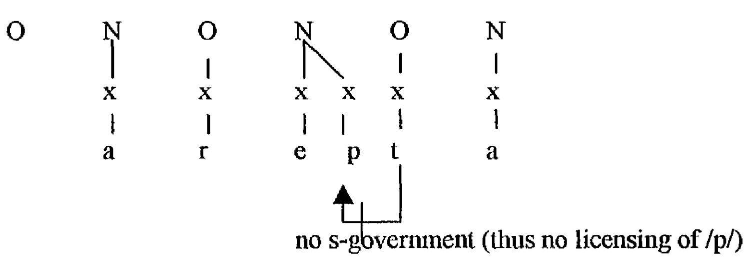
When looking at English, we said that consonants were allowed in coda only if they were governed by a following onset consonant. In Finnish, this was also true, but coronals did not need to be governed as they were self-licensing. (Government, after all, is a type of licensing). In Menomini, coda consonants are also self-licensing; but the difference, we can say, is that government between an onset and coda does not take place, so that there is no way for non-coronals to be licensing in coda.

That is, there is parameter regulating whether transconstituent (TC) government is licensed in a language, for which Menomini adopts the negative setting:

(25) TC Government (TCG): Y/N.

Thus Menomini words will rule out /pt/ as follows:

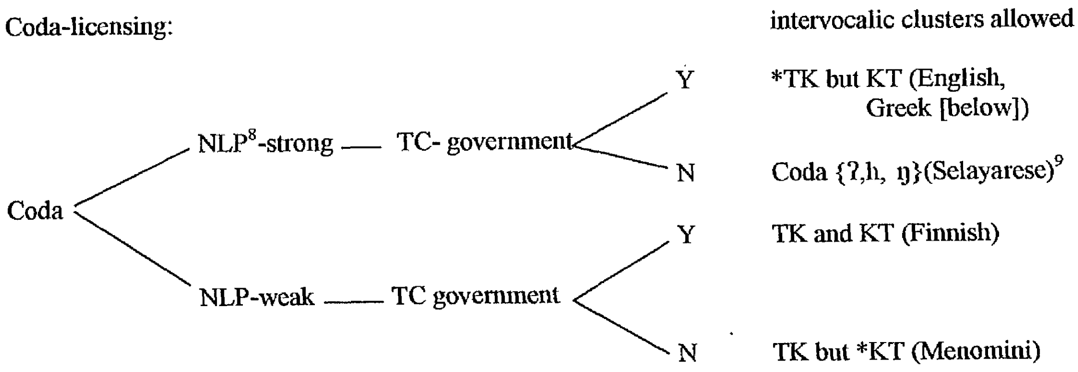
(26)



This allows us to expand our typology:

(27)

Coda-licensing:



T = coronal, K = peripheral

In Finnish /tk/, we say /k/ attempts to s-govern /t/ but fails – as /t/ is self-licensing this does not matter; in /ps/, /s/ also s-governs /p/, and succeeds – failure would mean that /p/ could not be licensed in coda. The option of s-government is not open to Menomini.

The next point to remark on is the appearance of /ʔ/ in coda along with coronals.

6.3 Deriving subsegmental government

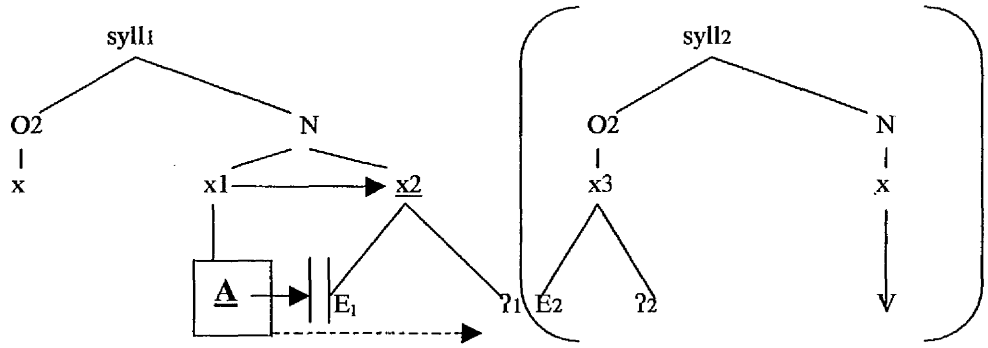
The exclusive licensing of /ʔ/ in coda is also found in Selayarese[10] (Piggott 1999). Thus it seems there is something special about this, and coronal segments which allows them to appear in a coda[11]. In ch.5, we argued that consonants were only licensed in coda if either their manner or place were governed by a following onset, or were self-licensing like [I̲]. We also speculated that this condition followed from an inability of the nuclear head to license manner elements, which had to be neutralized (cf.5.3).

However, if [ʔ̲] (which is the representation of /ʔ/) can be licensed in a coda, this does not follow.

[8] For the definition of NLP, cf. 6.1.3, (11).
[9] This will be discussed shortly.
[10] In this language, /ŋ/ is the only other segment licensed in coda. The somewhat mysterious – at present – status of the velar nasal was discussed in Ch.5. For more details, cf. Piggott 1999.
[11] Underspecification Theorists (cf. Yip 1991) hold that both are Placeless, the Place of the coronal being underspecified and inserted by redundancy rule in a serial derivation. We reject this theory, and so must look for an explanation which takes into account fully-specified representations.

We can solve this by saying simply that for an element to be licensed in coda, it simply has to be *adjacent to the nuclear head.* Where a resonance element intervenes licensing will be blocked:

(28)



If E_1 (any Place element) is absent, that is, [A] can see through to and so license [ʔ]; however if E_1 is present, this licensing is blocked. It is under these circumstances that [ʔ] must be governed by a manner element in a following onset, and that E_1, if it is not coronal, must receive a license to move [ʔ] from the following Place element. In other words, the disjunctive phrasing of the Subsegmental Government Condition (either Resonance or Manner must be governed) derives straightforwardly from regular conditions of adjacency and constituent and interconstituent government already present in GP theory.

This then explains why Menomini licenses coronals *and* /ʔ/. But why does Selayarese not permit coronals in coda as well? The answer to this must be that it is NLP-strong: RP of nuclear complements cannot be as headed as RP of the nuclear head. Note that this condition is still observed when only MP is headed (with [ʔ]).

This, therefore, constitutes a reworking of the deeper motivations for coda licensing and subsegmental government.

This analysis can be compared with Piggott's (1999) reworking of coda licensing, which invokes the D(irect)- and R(emote)-Licensing of word-final consonants. Abstracting away from details, R-licensed consonants have onset-profile, whereas D-licensed ones have coda-profile. A flaw of the system is that D-licensing is the unmarked form of prosodic licensing, present in all grammars. However, to derive the fact that final consonants normally have onset-profile, Piggott has to stipulate that at right edge R-licensing is the norm. (Our own handling of right-edge consonant profile will emerge in the next section). From the point of view of what has been proposed in the previous section and more generally in the previous chapter, there are more pertinent flaws to Piggott's approach: even when a word ends in a coda, so ensuring word-final coda-profile consonants, there is still no proposal of what consonants a coda can and should support (there are representations in which stops appear in codas with no following onset), and no explanation of why codas in some languages can support only limited segmental material, while onsets have phonotactic freedom. Finally, some languages are able to end in coda and onset constituents, so that the previous question becomes very germane: given both possibilities, how is an unambiguous syllabification of a particular consonant to take place? Some of these questions have already received answers in the present framework; the others will be answered below.

In the next section, we will see how the behaviour of Finnish and Menomini is found with variation across the Australian language family.

6.4 Coronals in Australian Aboriginal languages

We looked at the phonotactics of coronal subplace (laminal and apical) in Australian in Ch.2, mainly as it related to internal clusters. Here we will look at coronal versus non-coronal distribution in this and other sites. We saw that there were gross phonotactic preferences according to consonantal site as follows:

coronal

(29) (i) C_{init} and C_2: labial > velar > laminal > apical

(ii) C_1 and C_{fin}: apical > laminal > velar > labial

coronal

To this we can add the following Manner phonotactics for the same sites (from the same source, Hamilton 1996):

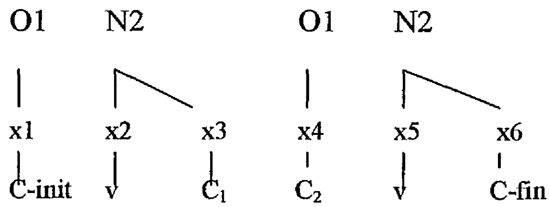
(30) (i) C_{init} and C_2: obstruent > nasal, glide > liquid

(ii) C_1 and C_{fin}: liquid > nasal > obstruent, glide

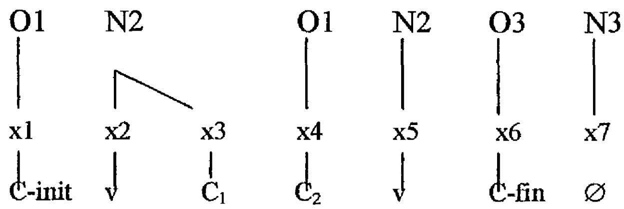
In Ch.2 we were not overly concerned with syllable structure. In this section, we will see that these phonotactics can be explained by the parameters we explored in the previous section.

We will need three different configurations to explain the variation across Australian:

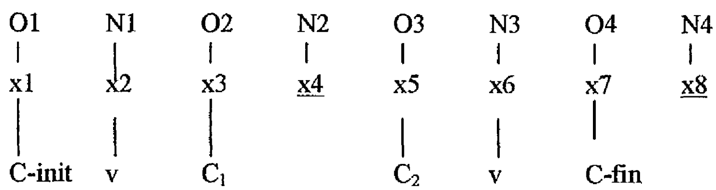
(31) Australian syllable structure (1):



(32) Australian syllable structure (2):



(33) Australian syllable structure (3):



Looking at (29ii) first: The similar (though not identical, as we will see) phonotactics of C_1 and C_{fin} is given by syllabifying them similarly; in (31) and (33) they are dominated by the same constituent. In (32), however, C_1 is syllabified into a coda and C_{fin} into an onset. This is because for some languages C_{fin} has freer phonotactics than C_1: in Agghu-Tharrnghala, for instance, C_1 is limited to {n , l, r}, while C_{fin} can be any of {l, r, n, ṋ, m, ŋ, w, j}. In other words, closer investigation reveals that (29ii) applies in varying degrees to the 2 sites grouped undiscriminatingly together: C_{fin} allows a velar and labial, in addition to the coronals permitted in C_1. This greater phonotactic freedom is captured by syllabifying C_{fin} into an onset. We saw for Finnish, Menomini and English that codas[12] license coronals preferentially. In English, we saw that noncoronals can appear in coda too. But the important point that we developed above was that noncoronals in coda had to be s-governed by a following onset's segmental material. Without such government, noncoronals are

[12] Meaning, of course, nuclear complement.

banned from coda. If s-government between points x3 and x4 in (96) and (97) does not occur, not being licensed, then we will get a coda which licenses only coronals. A striking indication that this is the case in Agghu-Tharrnghalla-type languages is that /n/ in C_1 does not assimilate to a peripheral stop in C_2: this means there is no phonological interaction between the two sites[13]. The fact that C_2 prefers obstruent segments is given by its onsethood: onsets preferentially license strong manner (cf. Ch.5) and any Place. The reason why coronal Place is specifically less preferred in C_2, we can ascribe to an OCP effect: this bans two adjacent occurrences of [I̲]. The onset status of C_2 also explains why liquid is the least preferred manner here: its place-complexity makes it marked in onsets, as we argued in Chapter 4[14].

To sum up: an ungoverned coda syllabification derives languages where C_1 is confined to coronal place. An onset syllabification plus the OCP gets the preference of C_2 for labials and velars, and the dispreference for liquids and preference for obstruents. Furthermore, the opposite manner of C_1 (given in 30ii) derives from its coda behavior, though we need to add an extra point. The coda/ nuclear complement must be judged not just by the headedness of RP, but by the headedness of MP as well. 30ii tells us that rhotics, which are headless in RP are optimal, followed by laterals, in which the head of MP is empty (in node i; node ii is filled by nonhead [ʔ]). Finally, a special dispensation seems to be needed to let a coronal *stop* into the coda (obviously granted by Finnish – internally and finally – and Menomini – only internally). This developing order of preference for coronals according to manner, giving r > l > t, was not evident in Finnish, which allows all three. But across Australian, some languages have laterals and rhotics but lack coronal stops. We can ascribe this to the fact that /t/, which is (I̲. ʔ̲), is headed in RP *and* MP. We can frame a parameter charting this development as follows:

(34) Nuclear complement: (i) RP-headed, or MP-headed (unmarked);
(ii) RP-headed and MP-headed (marked).

[13] This language does have homorganic NC pairs. For these we can say that N is placeless "archiphonemic" feature bundle, and that Australian requires a place element in coda segments: then a place element will spread from the following onset. This is not English-style government, but an independent constraint.

[14] In ch.4 we looked only at evidence that liquid bans operated word-initially; we now see that in Australian they operate word-internally.

This parameter, of course, can only be set if the language in question firstly allows the NLP (cf. (11) to be set at weak. Some Australian languages do not have (34ii) set to YES: in other words they don't allow a 2-headed consonant in coda, ruling out coronal stops but permitting rhotics and laterals.

Selayarese, which we discussed in 6.3, allows a glottal obstruent (/ʔ/) into the coda, while disallowing liquids. It thus selects the second phrase of (34i). Menomini, selects this *and* (34ii): it has /ʕ/ and coronal obstruents in coda. The parameter in 34 thus breaks down the different types of headedness allowed by the NLP parameter.

As the markedness implicationals in (29) and (30) show, however, there are languages where C_1, in addition to hosting coronals also hosts non-coronals, and has obstruents as well as liquids. Our theory of the coda means that all non-coronal segments must be syllabified into onset. Thus these types of languages will have the syllabification in (33). If there is no interaction between O_2 and O_3 here, then manner and place distinctions will be completely eroded. This is indeed the case: a language like Jingili (Hamilton 1996: 264) has the following C_1 C_2 clusters: {pc, pk, kʈ, mk, tk, tp}. So coronal-noncoronal and the reverse noncoronal-coronal sequences are permitted.

In other words, moving from structure (31) to (33) represents a decline of markedness, with phonotactic distributions getting looser and looser. Most Australian languages have "mid-way" structures like (97), i.e. strict C_1 phonotactics, but less strict C_{fin} phonotactics. (Only 12 languages in fact obey the complete restriction to coronal consonants in C_{fin}, and only 10 have unrestrained C_1C_2 phonotactics).

This mixed markedness status for the Australian language family as a whole can be understood by considering the following parameters and their settings (in addition to the more detailed parameters considered above).

6.5 The typology of coda-licensing

The choice of structures in (30) to (33) depends on the setting of six basic parameters, some related and some separate. These parameters make reference to whether a nucleus is dominant or recessive, that is, whether it is close to (or indeed, *is*) the head of the word, or whether it is distant. For present purposes, the recessive nucleus is the word-final one. Using the theory of Licensing Inheritance, we can say that recessive nuclei can license as much as, but never more, than head nuclei – or in terms of parametric settings, recessive nuclei can never choose a more marked setting of a parameter than head nuclei.

The parameters governing syllable structure are given on the left, and the result they will have on surface phonotactics is given on the right:

(35)

(i) Dominant Nucleus branch: y (unmarked) /n	V: internally
(ii) Recessive Nucleus branch: y(marked)/n	V: finally
(iii)Dominant Nucleus NLP: weak(marked) /strong	only coda coronals in C_1
(iv)Recessive Nucleus NLP: weak(marked) / strong	only coda coronals finally
(v) Recessive Nucleus empty: y(unmarked)/n	C_{fin} in onset
(vi)Dominant Nucleus empty: y(marked)/n	C_1C_2 free phonotactics

None of these parameters are conceptually new. (i) and (ii) refer to the branching status of nuclei, and do not concern us here (except inasmuch as (iii) and (iv) are not options unless these have a prior positive setting; this makes the prediction: "no coda consonants unless long vowels", which as far as I can gauge is correct).

(iii) and (iv) make reference to the parameter outlined in (11).Assuming that Australian, unlike Finnish or English but like Menomini, allows no government of coda material by a following onset (so that non-coronal place and dependent manner cannot be licensed – the TCG parameter, (25)), (iii)'s licensing of [I] in a nuclear complement results in nuclear complements being allowed to contain consonantal material, with that material restricted to coronals.

Now the same question arises that we considered when looking at Menomini: A further marked setting for Parameter (iv) permits only coda coronals finally. If we look ahead to parameter (v), we see that an unmarked setting here will permit free consonant phonotactics word-finally. (Once final nuclei are allowed to be empty – and this is their default status due to the depletion of their licensing power which distance from the nuclear head ensures – this means words can end in onsets, which have no place restrictions). These two settings of parameters (iv) and (v) seems to give rise to clash between word-final specifications. We will resolve this by appeal to the Elsewhere Principle (Kiparsky 1973): the more specific (here, more difficult to generate) structure overrules the more general one. Thus only coronals are allowed word-finally. For some Australian languages, then, the normal setting for final consonants *is* active, but unable to surface. In Menomini, by contrast, (iv) will be set at unmarked, as will (v), so that while this language's internal codas host only coronals and the glottal stop, at right edge consonants have onset-profile.

In the relevant Australian languages, C_1's restriction to coronals is the result of a marked setting for (iii) as well. Comparing parameters (iii) and (iv), we see that there is a clear implicational relationship between them: it is impossible for the more restricted, (word-final, or recessive) context to select a marked parameter setting if the stronger, freer context has not done so as well. This makes clear and testable predictions about Australian (and general) word-structure: C_{fin} should always be freer or as free as C_1, but never vice versa. A quick survey of the languages in Hamilton's appendix indeed shows that only a handful of Australian languages enforce this strict restriction of C_{fin} to coronals, while for many more languages C_1 is so limited. Finally, there are no languages where C_{fin} is restricted to coronals while C_1 supports noncoronals. This vindicates the structure of the parameters proposed here.

Let us turn next to the phonotactics C_{init} and C_2: as mentioned, the ban on C_2 coronals arises from the OCP; the ban on coronals in C_{init} actually boils down to a ban on *liquids* in this environment (for which we have already seen the motivation): none of the 87 languages whose phonotactics are given in detail in Hamilton prohibit a coronal stop initially, so that the implication given in (29ii) is, again, misleading.

Finally, the last parameter, (vi), regulates internal clusters. It states that the normal condition is for all but recessive nuclei to be filled. (Again, the converse of the situation in (v)). Thus an internal empty nucleus, separating two onsets and so giving rise to a surface string where both C_1 and C_2 have completely free phonotactics (due to both having onset status), is marked. In conjunction with our previous parameter settings, this means most Australian languages will have C_1 restricted to coronals and C_2 to (OCP-obedient) noncoronals, as they have structure (30) or (31), but that once such a setting is switched on, all these restrictions are overriden. Again, looking through the appendix, less than 10 languages display free C_1 C_2 phonotactics, while most have the restrictions discussed.

These parameters nicely supplement the findings of Goad & Brannen 2000, who develop a typology of syllable structure using notions of coda-profile and onset-profile segments proposed by Piggott 1999. They list the following language types:

(36)

Goad & Brannan 2000:7

Word-internal codas	Word-final consonants	Example languages
(1) Yes	Onset	Diola-Fogny, French
(2) Yes	Coda	Selayarese, Japanese
(3) No	Onset	Yapese, Kamaiura
(4) No	Coda	--

What stands out from their investigations is the lack of type 4 languages: these are languages which would lack internal codas (i.e. C_1's followed by C_2's, where C_1 was restricted to a particular subset of consonants from the inventory), but actually have *final* codas: that is, such a language would have no internal clusters, and unrestrained phonotactics for all consonants other than those ending a word. I critiqued Piggott's attempt to model this outcome above in 6.3. (which relied on the notions of R- and D-licensing). This, of course, is the situation we have just ruled out by our own parameters, which make recourse to Licensing Inheritance and empty nuclei.

As for the other types in Goad & Brannen's table: Type 2 is (31) and Type 1 is (32). Type 3 arises when the NLP is set to strong, so banning any consonantal material in the nuclear complement, and ruling out internal coda-profile consonants. As we saw, though, final onsets are still generated by the unmarked setting for parameter (v). Thus, as Goad & Brannen point out, Type-3 Yapese has words like "danoop" ("the world') and "faraf" ("floor"), but not words like "da[nd]oop" or "fa[rd]af." Due to the independence of parameters (iii) and (v) from each other, the present system also predicts a reverse scenario, whereby the NLP is set to weak, allowing internal codas, and (v) is set to "marked", banning onset-profile final consonants: such a language is Italian ("ca[ld]o" but *"caldo[n]").

To conclude, the present analysis captures the same facts as the Piggott-Brannen-Goad analysis, but also highlights and successfully models a range of new ones. Australian has provided a good testing ground for the concepts initially proposed for English, and then expanded to Finnish and Menomini.

In the next sections, we will turn to the question of clusters and complex segments involving coronality.

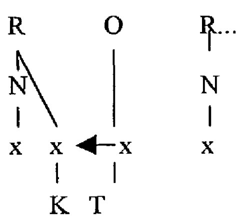
6.6 Clusters and complex segments involving coronality: Greek

In all the languages we have looked at in detail so far (English, Finnish, Menomini, Australian), we have found that there is a major asymmetry in phonotactic distribution in the phonological word involving coronality. In the next two sections, I want to look at a well-known case of coronal asymmetry from a novel perspective: this concerns KT-clusters in Ancient Greek (AG). After that, I will apply the modelling established for AG to less well-known (within GP at least) cases: that of 3-term clusters in Georgian, the nature of corono-labials in Margi and of clicks in Khoisan and Bantu.

6.6.1 Ancient Greek

Kaye et al (1991) modeled KT[15] clusters in AG in the same way as sC clusters:

(37)



This was on the basis of reduplicative morphophonology involving KT. For the most part, such clusters pattern with sC clusters in not repeating the first member:

(38) Ancient Greek reduplication

<u>*a.*C-intial roots</u>

luo	"I loose"	leluka	"I loosed"
drao	"I act"	dedraka	"I acted"

b.*sC-intial roots*

[15] K = any of {p, k}, T = {t, s, n}.

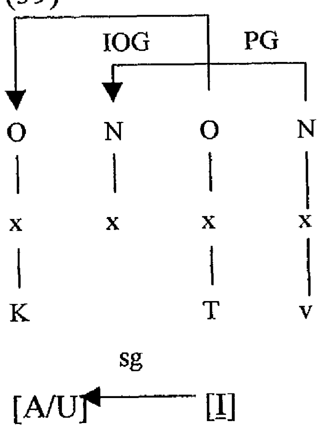
strateuo "I serve in the army" estrateka "I served in the army"
(*sestrateka)

c.KT-initial roots

ktizo "I build" ekktika "I built"
(*kektika)

If the first reduplicable member of the cluster is in fact an "empty" vowel, then this explains why K does not reduplicate. The rhyme-onset structure of (37) was established for sC clusters on the additional basis that word-initial occurrences of such clusters add weight to a preceding syllable, indicating the presence of an empty nuclear slot before the /s/. However, certain facts tell against an identical structure for KT (cf. Pagoni 1993): (i) KT is subject to further restrictions on clustering not found with sC: so /spr, skl/ are possible (sC + governable sonorant), but we do not find */ktr/; (ii) some roots do in fact repeat K in reduplication, e.g. [ktaomai]~[kektemai]; (iii) KT doesn not make preceding vowels heavy, as would be expected if there were an empty vocalic slot before K. For these reasons, it is better to posit an ONO "sandwich" to model KT, in which T interonset governs K (cf. Cyran & Gussman 1999 for this concept)[16]:

(39)



[16] This structure would in the default case disallow K to be reduplicated, due to its status as a governee. In much the same way, the complements of branching onsets are not reduplicated: prempo → [p]epepsa/ *[pr]epepsa. But as a marked alternative, permission could be granted to governees to reduplicate. (This difference in reduplication is vindicated by variable reduplication patterns cross-linguistically: Gothic repeats all consonants, Avestan repeats the first consonant regardless of sonority, so /sta/ → /sista/ (or /hista/ after lenition), while Sanskrit only reduplicates "governors": /sta/→ /tasta/, /sru/ → /susru/). In the latter case /s/ and /r/ are evidently in a branching onset.

This structure is posited by Pagoni 1993 for Modern Greek KT; what is novel about the present structure is that finally we have a mechanism to make KT non-reversible: the headedness of [I̲]. For IOG to go through, T must govern K. Our definition of government in the last chapter includes the condition that the RP of a governing segment must be stronger than that of a governee. Thus T must follow K and not vice versa.

Still, this is only what we have already seen for English clusters of the same type. What I wish to add to this analysis is some diachronic background to this structure.

6.7 Cluster optimization by metathesis: Proto-Indoeuropean to Ancient Greek

Brockhaus 1996, commenting on the absence of /tk/ coda-onset clusters in German, remarks that such clusters are absent universally, and she suggests, as a way of modeling this fact, that perhaps /t/ must always contain the voicelessness element H, and can never be (laryngeally) neutralized like the weakened /p,k/ that appear in coda governed by /t/.[17] She admits this is a stipulation, and adds furthermore: "Of course the question remains why it should be (neutral) *t that is non-existent in English," which translates into the question of why mirror-image {tk,tp} clusters are ungrammatical, "has remained unanswered quite generally in phonological theory." (Since then there have been phonetic OT attempts to derive the absence of /tk/ which I will examine briefly in Chapter 7). However, saying that TK is absent is a simplification.

We have seen that TK is in fact licit in Finnish, Menomini and Australian, while the opposite KT, which we find in AG, is ruled out (at least for the last two). We found that this was not due to a change in the head status of the coronal element (much less to its ability or not to license [H]), but rather to different parameters involving syllable structure in these languages. Thus, it is highly interesting to learn that Greek KT clusters in fact originated as TK in Proto-Indoeuropean (PIE) clusters, and that they metathesized to this familiar form in daughter languages. Details can be found in

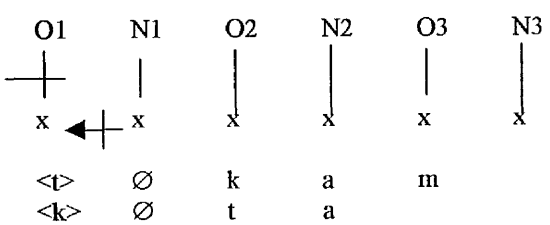
[17] Additional H on her Complexity Condition assumptions would make /t/ a better governor than H-less /p,k/. But "voiced" (or at least not voiceless) /d/ behaves as strangely as /t/ in some English dialects, as the data and analysis at the end of Chapter 5 reveal.

Beekes 1996 and Schindler 1977 (on PIE in general), and in Van Windekens 1982 and Adams 1988 (for the data concerning Tocharian). The picture is as follows. Taking one word as an illustration of the general sound change that occurred in Indo-European languages, we find that "earth" is /te:kan/ in Hittite, /tkam/ in Tocharian A, and /kton/ in Ancient Greek. Hittite and Tocharian have been proved to be more archaic than AG on independent grounds. Thus what we are faced with is a change of the following order:

(40)	Hittite/PIE: tekan		TvK	(i)v-deletion →
	Toch.	: tkam	TK	(ii)metathesis →
	AG	: kton	KT	

The first process that leads from PIE to Tocharian is v-deletion. This, we can speculate was aided by a stress-shift, so that initial v, being thrown into a pretonic position, was eventually lost. This left a TK cluster. Why did this then metathesize[18]? Some facts about Tocharian will help us judge. Firstly, there are two dialects of Tocharian, A and B, which we can call TA and TB. In TA the form for "earth" is, as we said for Tocharian generally, /tkam/. In TB, however, it is /kam/. This means that within Tocharian itself, not metathesis but deletion of the initial segment took place. This deletion seems to take place because an empty vocalic slot is unable to license the presence of a consonant. One might think that the nature of the initial consonant or the second consonant in the cluster were somehow involved. However, that this is not the case is proved by looking at the TB word for "where": in PIE this word is /kuta/; in TB it is /ta/. So, not only initial /t/ but initial /k/ is dropped before an internal empty nucleus:

(41) Tocharian



→ /kam/ "earth" (TB)
→ /ta/ "where" (TB)

Throughout TB in fact there are numerous such simplifications, both initially and medially (cf. van Windekens 1982). From this, we may surmise that K and T had an identical status in clusters in TB. This, we can theorize, is because there was no government between consonants in the language.

If there were a notion of government, then we would expect KT sequences to survive, while TK ones perished, or – metathesized; which is just what we find in AG (cf. 39). Just as goverment of a non-coronal in a coda was a way to license the material there, government of a weakly licensed onset performs a similar function. A full nucleus performs manner movement on egt of the onset to its left (ch.5), and the onset itself licenses Place movement. An empty nucleus, which has no Place head, cannot perform this first role; in such a situation government by the Place and Manner (which is in turn licensed by a Place element) of a following onset can replace these functions of the nucleus. However, interconsonantal interaction (IOG) has to be sanctioned in the first place, for this to go through[19].

Thus Greek KT clusters are in a sense unique and special, in that the language "went out of its way" to create them, while shunning opposite orderings. However, the present approach to phonology is abstract and cognitive. We are not, it should be noted, saying that KT sequences are somehow phonetically superior to TK ones[20]. Indeed, if the direction of government was different, we might expect a language to license only TK and not KT. Such an asymmetry has been seen for Australian, but the reasons there were not reverse government, but in fact lack of coda-onset government all together (and coda licensing only of naturally headed coronal place).

In the next section, we will consider some facts about Georgian which suggests that a hypothetical language where TK is privileged over KT due a reverse direction of IOG can and does exist.

6.8 Georgian

[18] This is misleading: the form did not metathesize in Tocharian itself, as we will see; rather there must have been some language intermediate between AG and Tocharian which had TK. In this language, which fed into AG, the form metathesized, while another solution was adopted in Tocharian.

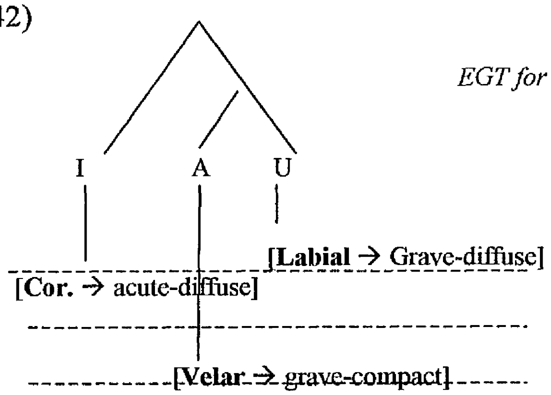
[19] The presence, and retention, of an empty internal nucleus is incidentally marked according to parameter (35vi). This, in turn means, that initial clusters should be marked, which seems to be a good prediction. The retention of the empty nucleus could in turn be aided by the presence of a surrounding IOG relationship.

[20] Cf. Ch.7 for discussion of such an approach in phonetic OT.

It is beyond the scope of this thesis to give a full characterization of Georgian clusters. A brief sketch will suffice: Georgian can contain up to 6-term clusters. Clusters are decessive and harmonic (Vogt 1958). The first term means that each member of a cluster must be articulated further back in the mouth than the previous term. So /pk, tk/ are well-formed but /kt, kp/ are not. The second term means that cluster terms must agree in laryngeality, of which there are three types: glottalized, voiceless and voiced. For more detail cf. Vogt 1958, Aronson 1989.

There are exceptions to this rule about decessiveness and harmony of clusters; there do seem to exist accessive clusters, and the harmony between terms seems to be lacking sometimes (cf. Vogt 1958's examination of accessive clusters). But on a broad scale this standard characterization seems to be largely true. What is interesting from the present point of view is that articulatory criteria seem to play a large role in ordering cluster terms. We have modeled elements as integrated articulation-to-acoustics mappings. So far we have pictured the articulatory mechanisms as being inaccesible and thus irrelevant to phonology. A language like Georgian might necessitate a (limited) revision of this. The following representation might suffice:

(42)



EGT for "accessive" and "decessive" languages

In the case of accessive or decessive languages, the phonology seems to let the executive articulations as well as the acoustic targets enter the phonological representation.

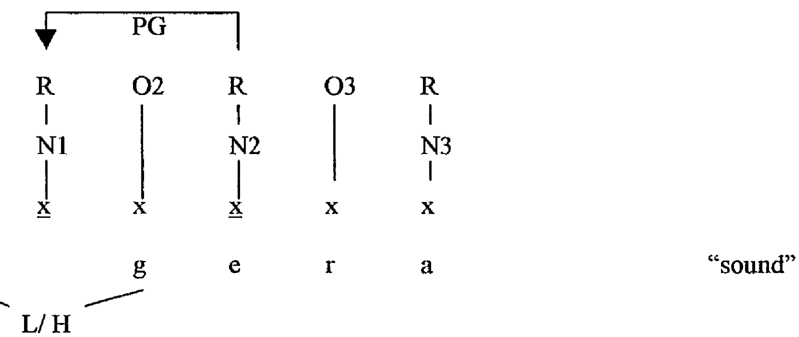
This is the first rather novel point to consider about Georgian. The second point of course is that any coronal-peripheral asymmetry seems to conspire against the coronal exclusiveness that we have been looking at. This is because articulatorily /k/ is furthest back in the mouth, so that both /p/ and /k/ can combine with it. As we saw

/pk, tk/ are well formed, but /kt/ isn't. The fact that /pt/ is well-formed is due to entirely different (articulatory) reasons than its well-formedness in AG and English.

If there is no evidence of coronal-peripheral asymmetry in Georgian, why would one continue to posit the element geometric tree in which {I,A,U} are ordered as they are? The reason is that there is an interesting restriction on the shape of three-term clusters which points to the existence of the type of coronal-noncoronal asymmetry which has become familiar to us from other languages – and which an appeal to the articulatory taxonomy of clusters cannot explain. In what follows, I will assume an ONON structure for Georgian with various forms of IOG and PG (cf. Toft 1999 for a similar approach to Georgian syllable structure).

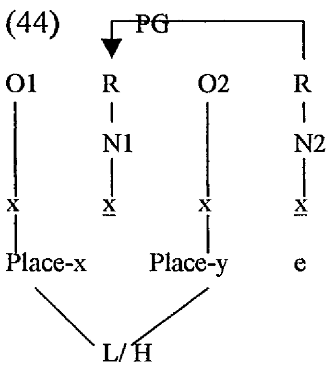
Let us start by considering harmonic clusters, which will look as follows:

(43)



Here we represent the word /bgera/ "sound", which starts with a harmonic decessive cluster /bg/. All we have to do to get contiguous /b/ and /g/ is assume that the nucleus separating the consonants is properly governed by the following filled nucleus. In addition to this to get the shared laryngeality of the consonants, we represent one laryngeal element linked to both expressions, insuring that laryngeality is not specified independently for each consonant.

(44)



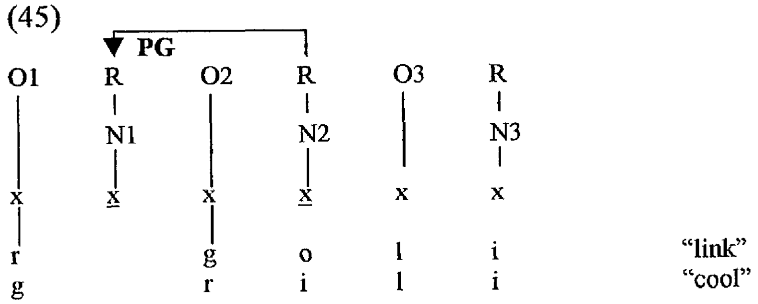
x > y (> : "is decessive to")

As for the decessive Place requirement, that each member of the cluster be further back in the mouth than the preceding one, we can assume the template for O1, O2 clusters in (44) (assuming Georgian phonology has access to articulatory Place as mentioned).

This will then license only /dg, bg, bd, tk, p'k'…/ and so on.

Linking of laryngeal elements and Place visibility only takes place over a p-licensed nucleus. As these restrictions hold only between obstruents, this also predicts that Georgian will start words with either sonorant-obstruent or obstruent-sonorant clusters, which is just what we find:

(45)



This suggests that we do not even need to posit that onsets branch in Georgian (I follow Toft 1999's analysis on this). Stop-liquid clusters have the same structure as harmonic clusters, minus the Place and voice agreement.

So far, then, we have made recourse only to proper-government and a special laryngeality agreement condition which applies only between obstruents (only obstruents, after all, can license glottality and voicing: I leave an element-geometric modeling of this proposal aside, as it is not central to the issue at hand). In this way we have captured initial harmonic clusters and the "gr"/ "rg" –type reversible clusters, which are again found in Polish, which has IOG, but not English, which lacks it[21].

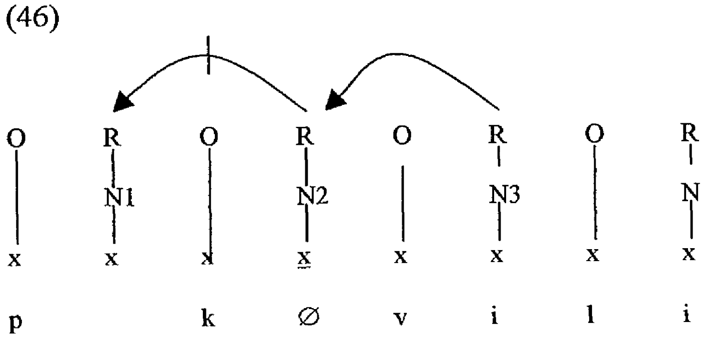
Having accomplished this, we have come to that aspect of Georgian clustering which is most interesting for the theory of coronal exclusiveness being argued for here. This concerns the asymmetric behavior of three-term clusters in Georgian. It is most aptly summarized with a quote from Chitoran 1998:

[21] One might posit that language with IOG are more marked. This is a condition, after all, which allows governing relations to take place between the nonhead constituent, i.e. the onset. Coda-onset licensing, under the revisions to coda-licensing put forward in Ch.5, is a question regarding the licensing of material by the nuclear complement, which is still a species of head-constituent, and so should be expected to have more expansive licensing powers.

"Although the clusters listed in 4(a)-(d) [all standard decessive clusters (DR)] are referred to as harmonic, there exists an asymmetry between coronal-dorsal and labial-dorsal clusters...Coronal-dorsals may be members of 3-stop clusters, but labial-dorsals may not. Coronal-dorsals allow the combination [stop][coronal-dorsal], as in [bdɣvili] "cloud of dust", [coronal-dorsal][stop], as in [t'k'bili] "sweet". Similar clusters containing labial-dorsal harmonic groups, such as *[pkdili] or *[dpkili] for example, are not attested.."

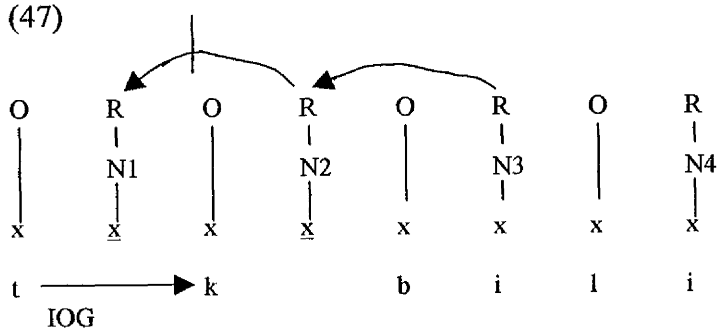
This asymmetry in three-term clusters involving coronal-dorsal harmonic clusters receives a perspicacious analysis, if we combine the universal mechanisms of PG, IOG and coronal headedness with the language-specific Georgian facts of decessive Place ordering. Given the condition so far, we would expect a word like [pkvili] to be ill-formed:

(46)



This is because, if N2 is properly-governed by N3, it cannot in turn properly govern N1: we would expect a vowel to surface between /p/ and /k/: [pekvili] would be the result. This then is in keeping with what we have assumed so far. However the form [tkbili] is well-formed. The following shows why:

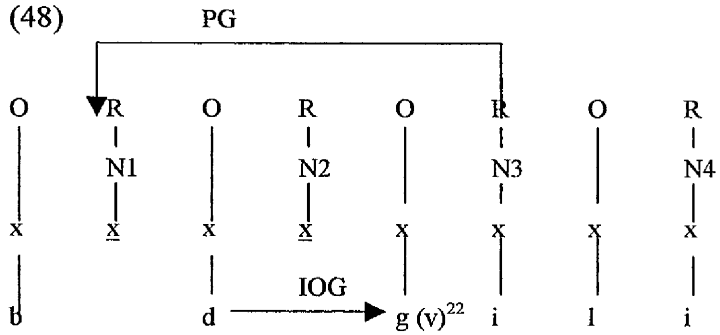
(47)



Here, we assume that proper government between N2 and N1 fails as well. However N1 is still p-licensed: we can thus assume that there is an alternative mechanism silencing N1, and that is, a process of interonset government that takes place between O1 and O2 (the notion of IOG as means to p-license sandwiched nuclei is developed by Heo 1994 and Cyran and Gussman 1998).

Thus the word [bdgvili] will also be well-formed, following the same assumption in Cyran & Gussman 1998 and Kaye and Gussman 1993, that nuclei can proper govern over licensed nuclei:

(48)



Why do we assume that IOG goes from left to right with /t/ governing /k/ and not vice versa? If we assume this we get *p∅t∅vili: /p/ fails to govern /t/ and */p∅k∅vili/ where /p/ fails to govern /k/. If IOG went from right-to-left then /ptvili/ and /pkvili/ would both be well-formed.

But this assumes that the Place strength hierarchy is the same for Georgian as for all the other languages we have considered. And after all, as we are trying to prove that Georgian still makes recourse to the element-geometric tree we posit is universal, our assumptions are circular. As a thought-experiment, let's imagine that the ranking is completely opposite. So:

(49) /p/ > /k/ > /t/ (> is stronger than)

Then, if in addition government goes from right-to-left, we get:

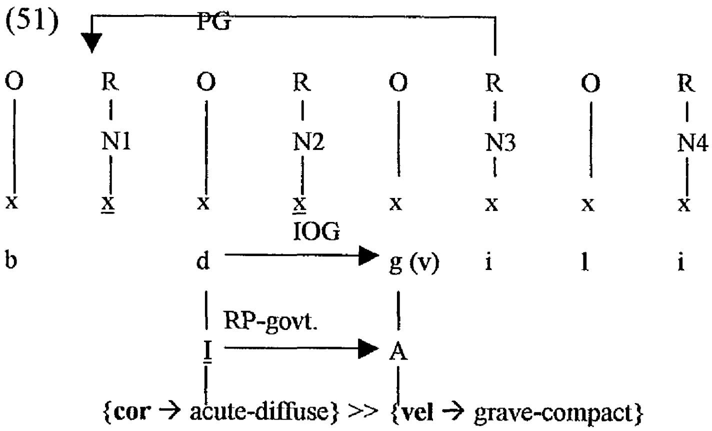
(50) /p k/ fails in 3-term clusters, as /k/ cannot govern /p/
/p t/ fails as /t/ cannot govern /p/
/t k/ succeeds as /k/ can govern /t/.

[22] I ignore /v/ here, which can take the form of an offglide and whose placement in the word depends on OCP considerations and other factors, cf. Butskhrikidze & van der Weijer 2000.

These are exactly the distributions that our view of (t > k > p) and left-to-right government gets. So what is to stop us assuming that Georgian does not have the ranking (U> A > I)? Firstly, we should note that on such an analysis we still have to assume a ranking of Place-elements which is different from the articulatory one appealed to in harmonic cluster ordering which was: /p/ > /t/ > /k/. This still has to be appealed to rule out /tp/, where /p/ would govern /t/. It would be different if the facts could be derived only by appeal to the articulatory ordering, as this would make for a simpler description of Georgian as an "articulatory" language. As it is, within the articulatory taxonomy /tk/ is different from /pk/. The necessity then is to appeal to non-articulatory reasons for this distribution, and the most theoretically parsimonious way of doing this is by assuming a structure vindicated (admittedly in an inductive fashion) in many other languages. In other words, what has the alternative /p > k > t/ to recommend it? The answer is, apart from being a possible ordering for one language – nothing. With two equal choices, we take the one that has proven itself in uncontroversial cases.

Thus the full representation of a word like /bdgvili/ will be:

(51)



IOG takes place if the RP of the left segment s-governs the RP of the right hand segment. The conditions on articulatory decessiveness given in (63) apply as well (ruling out /tp/: IOG would take place, but **cor** is not decessive to **vel**).

To conclude: Georgian clusters have been described as decessive. This predicts clusters like /TPK/ which do not occur, while clusters like /PTK/ or /TKP/ do. Decession alone cannot fully account for Georgian clusters. One solution, that of Deprez (1988) proposes that all coronal-dorsal harmonic clusters can be either true clusters or complex segments, based on lexical distinction. But this is merely to consign the exception to the lexicon, i.e. to treat it as "irregular". There is a basis for treating identical sequences of segments as phonologically different: an example is /ts/ which can be an affricate, i.e. a unit segment, or a /t/, /s/ string. The difference can be determined by seeing whether /ts/ appears in place prohibited to clusters: thus German, which has /tsehn/, does not allow /ksehn/ or /ktehn/ at left-edge. The trouble is that one posits:

(52) a. /dg. bili/ versus b. /d. g ili/

Here in both words /d/ and /g/ are in the same position in the word; they agree in voicing; and they are decessive – all properties of two-term clusters, as Deprez admits. It seems that the decision to assign a unit structure to /dg/ in a) and a sequence structure to /dg/ in b) is made only on the assumption that Georgian does not allow three-term clusters. But this is what we are trying to ascertain. Moreover the question arises as to why a unit /dg/ would obey the decessiveness constraint, which in all other cases holds only between separate segments. In other words, /dg/ behaves suspiciously similarly to all other two-term clusters. The present analysis treats it as such, and looks to universal phonological patterns to explain its exceptional behavior with regard to other Georgian clusters. Again, unit /dg/ would be odd: it would be a corono-velar double stop, an extremely marked and according to some (cf. Kingston 1993 and discussion in Ch.3) non-existent entity. It seems preferable to model Georgian /dg/ using general unmarked structures which have succeeded in analyzing all its other clusters.

This analysis of Georgian is by no means final, and more investigation is needed. However, at least for some aspects of Georgian's phonological structure, we have found a type of language which is "Greek in reverse".

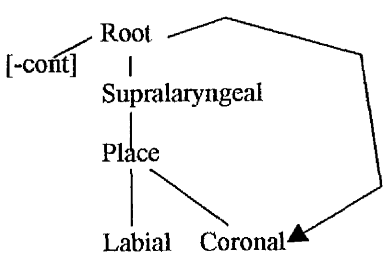
In the next section I will take up again the possibility of the existence of a complex corono-velar segment in African languages. The standard analysis of TK in these languages is as unit segments. This analysis has, as we have seen , been considered for Georgian. In what follows, I will try to show that the unit analysis fails for African as it did for Georgian.

6.9 Corono-velars/-labials in African languages: clusters or units?

In Margi and Bura (Chadic), and !Xu, Hottentot, Nupe, Shona (Bantu) there are said to exist "complex" corono-velar and labio-coronal segments (which include clicks for the latter group). The analysis of these entities differs between linguists. Maddieson 1983 argues that the labio-coronals of Bura are consonant clusters rather than complex segments on the basis that they have a longer duration than single consonants. Likewise, Ladefoged and Maddieson '96 argue that Shona /tk/ is phonetically heteregenous on the grounds that each segment has a discrete release burst. Of course this does not constitute an argument that /t/ and /k/ are not in fact underlyingly a single complex segment. (sC as a result of syncope from svC and sC as a genuine cluster have non-discriminable phonetic properties, cf. Fokes & Bond 1993 who show syncopated and real clusters in English are not significantly distinguished by phonetic cues). Sagey 1986a argues that the labial-coronals of Margi are not clusters but single complex segments on the basis of their behavior under reduplication (both the labial and the coronal reduplicate, in a process which looks like the reduplication of single onsets only). Van der Weijer 1994 argues for "a compromise representation...with a single timing slot and two root nodes (ibid.189)", a representation which is forced on him for /bz/. The latter "cannot be represented in any other way in the framework developed so far, and hence must be represented as two-root complex segments." In addition to these two representations, we will consider the possibility that /bz, pt/ are two onsets linked by an interonset government relationship – in other words that they have the representation we assigned to AG KT, and Georgian TK. This would give us the choice of the following:

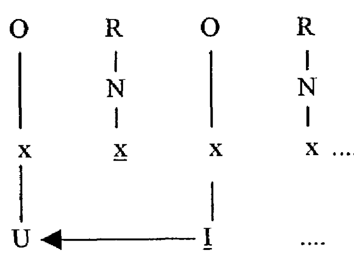
(53)

a. Sagey 1986a



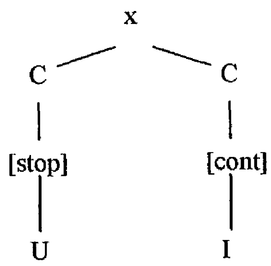
/pt/

b. (as above)



/pt/

c. Van der Weijer 1994



(U =labiality, I = coronality)

/bz, ps/

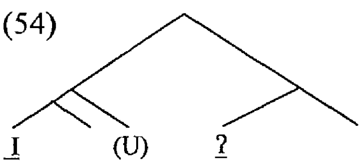
We ourselves seem to have made a unit analysis of these objects a marked option. Recall that the LELP (ch.3) read as follows:

Lazy elements licensing principle (LELP):

1. Complements should be non-heads.
2. Complements should be in the same phrase as (tautophrasal to) their heads at deep structure.

This applies to secondary elements which are licensed *in situ*. This meant, as a non-marked option, that only [I̲] could combine with {I, U} and only [A] could combine with {U, I}. This generated /k^j, t^j, t^w, p^j/. In the marked instance where the complement was a head, i.e. [A], we could generate marked /t^γ, k^γ, p^γ/. Interestingly, in Abkhaz, /t^w/ alternates with /tp/ (Ladefoged & Maddieson 1996), so that we could posit the following structure for both these alternants:

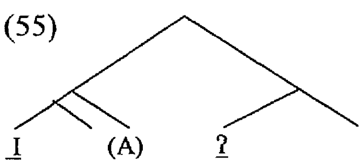
(54)



/t^w ~ t^p/

This does then raise the possibility that a structure, where [A] is licensed lazily by [I̲] could not only be /t^γ/, but might also be interpreted as /tk/ (which would be suitably marked):

(55)



= /tk/

However, there are certain configurations which we rule out: we cannot represent /pt, kt, bz/ as complex segments as {U, A} being "unnatural" heads could never move into a position to license natural [I]-head.

Which analysis we choose depends in part on the modelings available to us, but in part on the data itself. We will see that in most instances, the marked option of the LELP need not be availed of, as an ONO analysis is better motivated. This again justifies the severe restrictions we placed on element licensing and segment well-formedness in ch.3 when examining inventories.

Let us look at examine the evidence in different languages.

6.9.1 Margi

The consonant inventory (relevant segments only) of Margi is, in part, as follows (cf. Sagey 1986a: 176):

(56)

Single PoA:						Labiocoronals		
Lab.	Alv.		Lat.	Pal.	Vel.	Alv.	Lat.	Pal.
p	t			c	k	**pt**		
b	d			j	g	**bd**		
.								
.								
.								
f	s	s	l	c	x	**ps/fs**	pl	**pc/fc**
.								
.								
m	n			n	n	**mn**		**mn**

The above table recapitulates the assumptions of descriptive linguists who assume without much argument that there are complex unit segments called labiocoronals.

The question of unit or cluster status hinges round reduplicative morphophonology (again, cf. AG and comparative analysis of reduplication below). The data are as follows (Sagey 1986: 170 ff.):

(57)

a. Simple Form — Reduplicated Form

(i) s(u)kuda, skuda "to push" — seskuda "to push bit by bit"

(ii) ckwari "to touch" — ceckwari "to touch many things"

b. bde "to chew" bdebde "chewed"

pse "to dye" psepse "dyed"

pte "to be insufficient" ptepte "insufficient"

c. Total Reduplication (Sample from Sagey's (22) p.181)

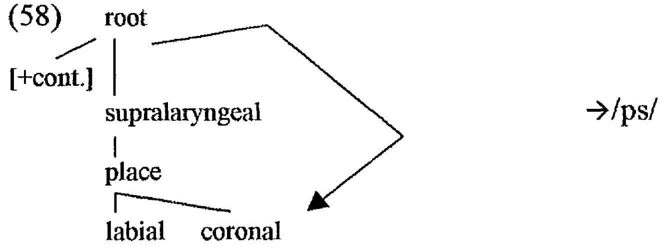
bel	belbel
duwa	duwaduwa
kungura	kungurakungura

d. First consonant and vowel reduplication (Sample from Sagey's (23))

(i) ndal	ndandal
(ii) sel	sesel
(iii)yalna	yayalna

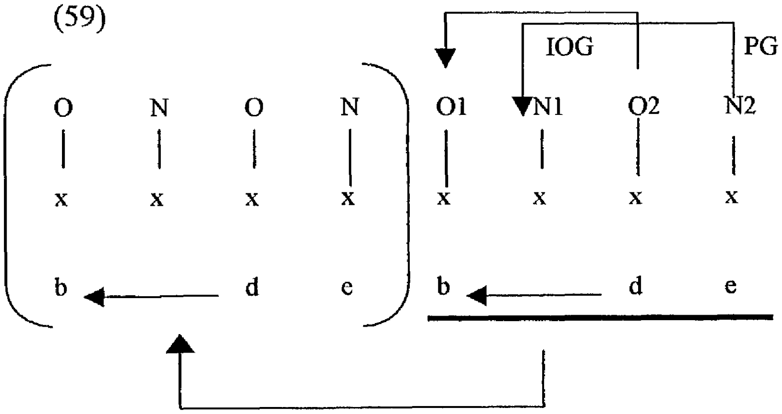
The simplest instance of reduplication is where a root starting with a single consonant and vowel repeats that consonant and vowel, as in (57d) ii and iii. A clearly different type of reduplication is seen in (57c), where the whole root is repeated. The problem starts with the reduplication of consonant clusters in (57) a and b. In (57ai) there is a vowel which is optionally interpreted. Even when the vowel is not interpreted as in (57aii), only the first of the two consonants repeats, indicating clearly that these words are analysed as C_1vC_2 structures, with C_1 and [v] repeating as in (57d). But what then is one to make of the forms in (57b), where C_1 is a labial and C_2 a coronal and there is no intervening [v] ? Sagey (1986) argues that if C_1 and C_2 were analysed separately as in (57a), we would expect only C_1 to reduplicate, yielding /bebde/, for example. She thus proposes that /ps/, /bd/ and other "labio-coronals" have the structure in (54a). As mentioned, we cannot model /ps/ as a unit segment. This, however, can be considered an advantage for several reasons: firstly, corono-labials where the coronal part is a fricative, like /ps, bz/ are immune to prenasalization – just like fricatives. In (54a), repeated in (58) for a fricative equivalent, Sagey intends the stopness of the coronal part to be added later by default rule. But there is no way of telling which part of the representation is more phonologically significant than any other. In fact, the [+cont] part must determine the manner status of the whole object, due to this resistance. If we adopt an ONO representation, as in (54b), the reason why /ps/ functions as a fricative is clear: the governor /s/ is a fricative. Thus a two segment analysis, where the last segment is phonologically stronger than the first, is preferable.

(58)



However, a pressing question which arises if an ONO structure is adopted is why /bde/ does not reduplicate as /bebde/, but rather as /bdebde/. If the rule is for C_1 and first [v] to reduplicate, this might be the expected result. But we saw, when looking at Greek, that languages reduplicate consonants in different ways. Greek itself, faced with KT clusters, sometimes does not reduplicate K (ktizo~ektika "build~built"), but sometimes does (ktaomai~kektemai). The question can be framed as whether a governee consonant is permitted to reduplicate or not. A language which reduplicates both governor and governee is Gothic which as we saw has pairs like staut~sta-staut (Beekes 1996). Margi is just such a language: an initial governee consonant cannot reduplicate unless its governor comes along for the ride, as it were in order to license it in its new position:

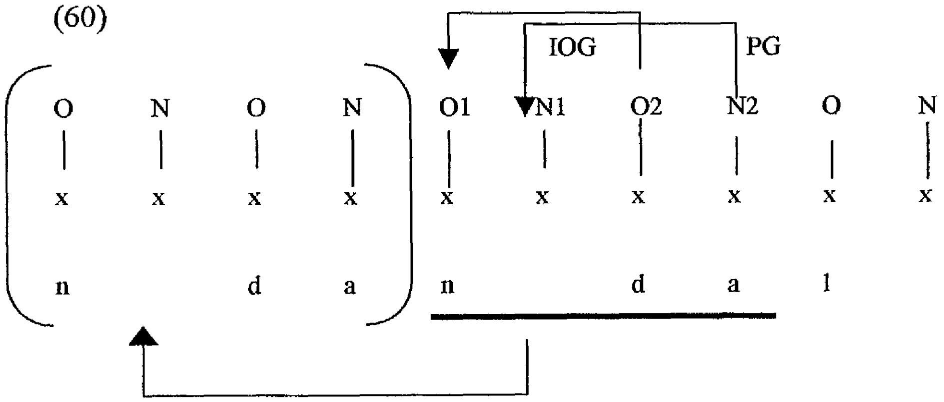
(59)



This cross-linguistically motivated approach answers Sagey's objection that a two segment analysis cannot explain the reduplication of both consonants.

Interestingly, a similar ONO structure has been proposed for prenasalized stops by Kula & Marten 1998 in Bemba, a Bantu language, on the basis that they are formed by addition of a nasal prefix /N/, which becomes homorganic with a following root-initial obstruent. Moreover, a fricative will harden when preceded by this nasal affix: this can be seen as addition of an element so that O2 can govern O1 as above. Thus, in Bemba, at least, prenasalized stops originate as two segment sequences. If this is the case, then reduplication of the prenasalized stop in (57di) will be no different from that of the "corono-labials":

(60)



Under the present analysis, then, Margi labial-coronal clusters exhibit the same phonological behavior that we have come to expect of coronals from AG; indeed they are identical to AG clusters. We are thus vindicated in our contention that /pt/ cannot be analyzed as a doubly-articulated stop with the element [U] as head: this was an option we had already ruled out by encoding that nonhead [U] can never license natural head [I].

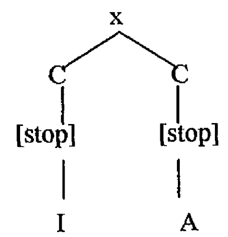
6.9.2 Clicks

The last segment type we will look at is clicks. Once again, it seems that coronality has a special status in the structure of these rare segments.

Clicks are found in the Southern African Khoisan languages and have entered into some neighbouring Bantu languages.

Van der Weijer 1994, following Chomsky and Halle 1968, divides the constrictions involved in the production of clicks into primary (the influx) and secondary (the efflux[23]). Van der Weijer represents the alveolar click as follows:

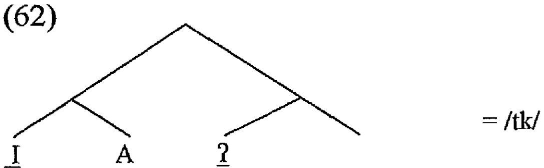
(61)



He comments that the influx part of this click must be primary "since here palatals are allowed, as well as finer distinctions in the coronal area," while "the efflux can only be located at the velum (and is therefore predictably specified as A)...." For us, this is again evidence of the greater flexibility of the coronal Place, manifesting itself in the ability to license subplace distinctions absent in the velar part of the segment.

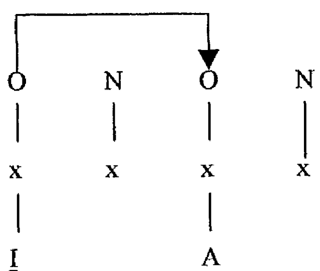
We can felicitously translate this into the present formalism as the marked structure (IAʔ) which we speculated about earlier:

(62)



Alternatively, we could represent it as:

(63)



Either way, coronal productivity is captured[24].

This representation of clicks as part coronal, part velar, with coronal the dominant part is supported by the data from !Xoo: there dental clicks behave both as coronal and dorsal with respect to phonological processes and restrictions. They front and

---

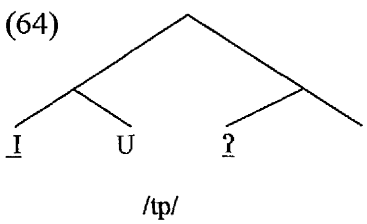
[23] The terms "influx" and "efflux" date back to Chomsky and Halle 1968's source, Beach 1938.

[24] Traill 1981 argues that clicks are segment sequences, on the basis that this eliminates their exotic structure. Van der Weijer 1994 contends that this merely pushes the exoticness into the syllable structure; however, we have seen that ONO structures are not particularly exotic.

raise the vowel /a/ in specific environments (cf. Sagey 1986a: 127 ff.). Another constraint allows only back vowels after dorsal consonants – and clicks fall into this category. However, and this can perhaps be taken as showing that the dental click is a typical [I̲]-headed coronal, the first person singular [N] and the verbal formative [N] assimilate to the clicks, becoming coronals – this would be assimilation to the head Place (as per the fricative character of z-headed /b∅z̲/ in Margi).

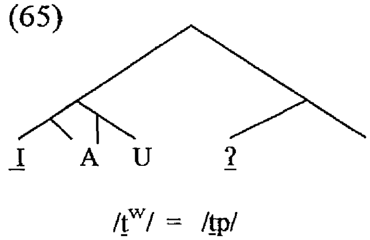
We can conclude this section by mentioning Ladefoged and Maddieson 1996's contention that there exists a doubly articulated corono-labial stop, /tp/, in Yeletnye, spoken on Rossel Island, Papua New Guinea (ibid.344). They contend that this entity is a unit segment. If this is phonologically (as well as phonetically, which is the scope of their assertion) a unit, then we can give it the following representation (where lazy [U] is idiosyncratically interpreted with [ʔ], as in the Abkhaz case cited above:

(64)



Again, an indication that it is [I̲]-headed comes from the fact that the coronal but not the labial portion can have different subplace features: there is an additional TP segment where /t/ is slightly post-alveolar, so that /tp/ contrasts with /t̲p/. The latter might look as follows:

(65)



This would push the possibilities of resonance licensing to the limit, and again it might be better to model these segments as ONO structures. However, I do not have enough information to decide the matter.

Conclusion

In this chapter we extended our revised theory of "coda-licensing", and examined in greater detail specific cases of segment structure which involved coronal asymmetries. In the next and final chapter, we will briefly consider and critique a recent approach to some of the phenomena examined here, which dispenses with formal phonological mechanisms, and attempts to derive everything from the phonetics: phonetic Optimality Theory.

Chapter 7 Conclusion

In the previous chapters I used (an adapted) GP syllable theory and element theory to model coronal anomalies in inventories and anomalous coronal distribution in the phonological word. There are some coronal anomalies that I did not have space to attend to in this thesis: a more precise account of the behavior of laterals (their assimilatory behavior, their patterning with other sonorants, cf. Rice & Avery 1991), and the behavior of coronal consonants in consonant harmony processes (cf. Shaw 1991). Nor was the phenomenon of coronal lenition entered into in much detail. Extending the framework to cover these topics will be the subject of future research. I would like to conclude this thesis by taking a very brief look at an important theoretical development that has taken place in the last half decade or so: phonetic Optimality Theory.

7.1 Hamilton 1996: perceptual and articulatory constraints in Australian phonotactics

We have drawn on Hamilton 1996's descriptive generalization concerning the phonotactics of Australian Aboriginal languages at several points in this thesis. Here I will look at the theoretical modelings of these facts he puts forward. I will not concentrate on the features he proposes for Australian segments, as this was examined in Chapter 2. Rather it is his notion that distributions are best modeled by violable constraints which make reference to only the phonetic substance of strings that I will critique. Hamilton 1996 is a good work to comment on, as the body of evidence he covers is large and his approach is seemingly sophisticated in that he considers both the acoustics and the articulatory properties of segments. Most phonetic-OT analyses look at only the articulatory (e.g. Sherer 1994, Hayes 1997) or the acoustic (e.g. Steriade 1997, Kirchener 1998, Seo & Hume 2000) though Boersma 1999 also looks at both domains. In addition of course, I have modeled some aspects of Australian, so the present analysis will serve as an example of another approach to the same data.

Hamilton contends that traditional syllabic/prosodic licensing approaches to segment distribution cannot account for Australian phonotactics. Instead, he proposes that clusters and word-edge distribution are best explained in terms of perceptual and articulatory ease. In Chapters 2 and 6, I presented explanations of these phonotactics using the notions of government, licensing and headedness. These accounts show that there is a way of modeling Australian using a GP approach. What I would like to show here is that for all their intuitive plausibility, phonetic accounts do not really capture the data. I will have space to analyze only a few examples.

Hamilton assumes the following featural composition of stops of Australian:

(1)

	Articulatory	Acoustic
Labial	[labial]	[+grave],[-compact]
Lamino-dental	[coronal],[laminal],[dental]	[-grave],[-sharp],[-flat]
Apico-alveolar	[coronal],[apical],[alveolar]	[-grave][-sharp][-flat] (diff.burst)
Apico-postalveolar	[coronal],[apical],[postalveolar]	[-grave],[-sharp],[+flat]
Lamino-alveopalatal	[coronal],[laminal],[alveopalatal],[high]	[-grave][+sharp][-flat]
Dorso-velar	[dorsal],[velar],[high]	[+grave][+compact]

We will examine first how these features in conjunction with constraint families is meant to derive the phonotactics of labials and dorsals in C1 and C2.

The markedness scales that we have seen in heterorganic clusters are explained in terms of the perceptual optimality (and sometimes the articulatory optimality) of sequences of these feature bundles. The markedness hierarchy for Place in this context, recall, was:

(2) C_1: coronal (apical > laminal) > velar > labial

C_2: labial > velar > coronal (laminal > apical)

Hamilton contends that different Places have differential perceptibility in a pre-consonantal context. In such a context, stops are deprived of CV transitions, and also of their release burst. The only cue they have is the VC transition. According to Hamilton, the perceptibility of labials is compromised most in this cue-impoverished context, followed by velars, followed by coronals. This is captured formally as follows (ibid.116):

(3) *[+grave, -compact]' >> *[+grave, +compact]' >> *[-grave, +sharp]' >> *[-grave, +flat]

(i.e. labials) (i.e. dorsals) (i.e. lamino-alveopalatals) (i.e. apico-postalveolars)

*[F]' (F = any combination of features) here means that the segment consisting of F is unreleased, and such an unreleased combination is banned. The >> symbol is a ranking: it is more important that feature matrices to the left be banned than those to the right. The top matrix is undominated and so comes into effect in C1 in all clusters in Australian. An important premise here is that such phonetic rankings are universal as they are based on universal anatomical or physiological facts about the human make-up.

The first two rankings will get:

(4) /k'p/ >> */p'k/

That is, /pk/ will be banned as /p/ is unreleased, while /kp/ is allowed as a dorsal without release is still perceptible.

There are two problems with this:

(5)

(i) the constraint rankings are universal: this predicts languages which have both orders of /p/ and /k/ -- as both constraints could be dominated by some other constraints which means all such sequences are allowed. However, a language with /pk/ but not /kp/ would be banned. Such languages exist, however: for example Georgian, which we looked at in ch.6, and Kui (Hume 1998: Kui allows only /pk/ clusters, turning morphophonologically created /kp/ clusters into /pk/ by metathesis).

(ii) These constraints do not really explain why the language does not simply choose to release the stop – for instance Georgian consonant clusters generally have release bursts (cf. Chitoran 1998), as do Shona clusters (Ladefoged & Maddieson 1996). But even with release bursts in clusters, Georgian and Shona still ban the opposite place configurations. Some other factor than release must be at play.

(iii) Finally, on an empirical point, Winters 2000 investigated the perceptibility of different places in VCCV context and found, contra Hamilton 1996 and Jun 1995 on whom Hamilton draws that the order of perceptibility for Place of unreleased coda consonants is Labial >> Coronal >> Dorsal. He concludes: "These results conflict with Jun's proposed hierarchies of salience for unreleased stop place. Labials are stronger than expected; dorsals are also surprisingly weak....Place salience for stops is generally (but not always) higher before coronals than before non-coronals...(ibid.238-241)." Translated into Hamilton's formalism this would give the ranking: *[dorsal]' >> *[coronal]' >> *[labial]', giving sequences such as /kt, pk, pt..../, the opposite of those found in Australian.

Point (i) is the most damning: the existence of systematically opposite orderings in other languages means phonetic cues cannot be the underlying reason for the Australian phonotactics. This justifies the decision to analyze these phonotactics as a function of systematically different underlying syllable structure and licensing conditions. Point (iii) concerning Winters' finding is interesting. Winters' experimental subjects were all native English-speakers; the peceptibility of the /pt, kt/ sequences recapitulates the sequences actually found in English. It looks as if ability to perceive clusters reliably is a function of the clusters one is accustomed to, which in turn is a function of the phonology of the native language. In other words, phonology may well drive perception rather than vice versa.

Let's look at one more example. As we have seen, Australian allows alveolar-noncoronal clusters like /tk/ and /np/. Unusually, the alveolar nasal does not assimilate to a following noncoronal oral stop. I captured this by assuming that Australian codas license only coronals in them due to the fact that no government is allowed between coda-onset pairs (which would neutralized [A], [U]). According to Hamilton "the place cues of alveolar consonants are perceptually opaque under co-articulation with another coronal (ibid.87)." This results from gestural overlap with a following noncoronal consonant which means that "succesful detection of a C1 alveolar is...severely hampered (ibid.124)".

The rankings given in (3) only refer to the salience of unreleased alveopalatals and retroflexes, not to apico-alveolars. The former segments are perceptually salient in the VC context due to the presence of [+sharp] and [+flat], Hamilton holds[1]. In contrast,

[1] On p.116, Hamilton admits: "There is no perceptual literature on the relative saliency of the features [+compact], [+sharp] and [+flat] in unreleased contexts...However impressionistic observations suggest that retroflexes and alveopalatals are more robust than dorsals." The r-colouring of retroflexes on preceding vowels, and the palatal offglide of vowels preceding retroflexes are cited as saliency-rescuing cues for the VC context. However, alveopalatals are more marked than alveolars in VC, and retroflexes are preferred to alveolars utterance-initially in Walmatjari (cf. Ch.2), a CV context where there are no VC cues.

coronals lacking these extra features will be perceptually bad. To capture the fact that apico-alveolars are bad in VC context, Hamilton adds to his scale as follows: (p.125):

(6)

*[+grave]' >> *[-grave]', *[+sharp]' >> *[+flat]'
(peripherals) (alveopalatals) (retroflex)
(dentals, alveolars)

I am not quite sure how to construe this hierarchy. Hamilton seems to want flat and sharp coronals (/ʈ/ and /c/) to be preferred in C1 before nonflat and nonsharp /t̪, t/. But it seems the interpretation of this hierarchy is that retroflexes are most salient followed by all other coronals, followed by peripherals. A still more confusing result is that coronals as a whole will still be preferred to dorsals and labials, this despite the fact that Hamilton quotes Jun 1995 with approval. The latter, however, holds that peripherals are preferred to coronals in this context. This will not effect the point that I am about to make.

Though it seems that his own formalism does not reflect it, Hamilton agrees with all the researchers he cites (Zsiga & Byrd 1990, Gimson 1962, Bailey 1969 among others) that coronals are perceptually bad in C1 as their cues are muddied by the C2 noncoronal. It is the step he takes to remedy this that damages the whole enterprise. For he claims that Australian makes reference to a different articulatory hierarchy of the following form (ibid.125):

(7) Articulatory constraints: *[place] >> *[alveolar]

This is intended to capture the fact that "alveolars are harmonic under the gestural theory of markedness, a constraint preferring configurations of least effort." The quick and flexible tongue-tip movements of alveolars are said to be easier than those of laminals and peripherals.

Invoking an articulatory hierarchy to license a segment that it vigorously ruled out by a perceptual hierarchy is undesirable for the following reasons.

Firstly, Hamilton's phonetic hierarchies are strictly implicational. His own definition runs:

(8) Implication: F' is ϕ only if F is ϕ, where F > F'.

This reads: a featural configuration F' is well-formed only if another configuration F is well formed where F is less marked than F'. This leads to strict predictions regarding possible configurations across languages. As Hamilton says: "Within the constraints theory of markedness the incremental elaboration of complexity means that there can be no language in which a feature F' is ϕ while F is $*\phi$ if F is less marked that F'."

Then he draws attention to what this means from the point of view of acquisition : "...the child initially assumes a maximally harmonic phonotactic grammar, and elaborates complexity only on the basis of positive evidence consistent with a cue-based learner strategy...(p.210)."

Now we see why it is unsatisfactory for [articulation] to outrank [perception] for certain sequences: a child will encounter the situation of a more marked feature F'-p (p = perceptual) being grammatical where the less marked feature F-p is ungrammatical. In our above example, we find some languages which allow coronals in C1 but disallow noncoronals. Now noncoronals are perceptually better than coronals. In terms of Acoustic Constraints, this means that a featural configuration F' is well-formed and F is not well-formed where F is less marked than F'.

All this arises due to interference from the articulatory scale: coronals are surfacing in C1 to the exclusion of noncoronals, because on that scale the coronal feature is less marked than the noncoronal feature.

In general: for a family of perceptual constraints, where we expected a markedness implication A > B > C we in fact get C > A > B (or B > A > C etc...). The opposite should also be expected to occur. That is, for a family of articulatory constraints, where we expected X > Y > Z we get Z > X > Y (or Y >X > Z etc...). This predicts that languages which observe the markedness hierarchies are merely one of many which at surface level flout them. And this leads to a severe loosening of the theory's predictive power, not to mention the licensing of strings which are phonetically ill-formed in either the articulatory or acoustic domain.

To sum up, Hamilton's phonetic OT account must be rejected because:

(9)

(1) a number of the constraints have no real experimental basis (cf. fn 130 above),

(2) systematically opposite orderings across languages undermine the idea of a universal phonetic scale,

(3) some of his assumptions regarding optimal perceptibility are wrong, but even where right point (2) casts doubt on the phonological relevance of such data, and

(4) the interaction of articulatory and perceptual constraint families ultimately predicts all and any phonetic patterns.

Similar points can be made regarding other phonetic OT accounts (cf. Harris 2000 for a critique of Flemming and Kirchner 1998).

7.2 Consequences

The conclusion that flows from this is that work still needs to be conducted within a framework that assumes systematic prosodic licensing and the existence of prosodic constituents (the nature of which is of course open to discussion). While there must be a phonetics-phonology mapping between elements and the signal, as argued for in Chapter 2, the manipulation of element-bundles (phonological expressions) often follows quite abstract routes. I argued that the coronal element was unmarked in consonants, probably for acoustic-auditory reasons (as Stevens & Keyser 1989 speculate, coronal sounds are "especially tied to the fundamental capabilities of the auditory system for processing temporal and spectral aspects of sound"). However, this serves merely to generate coronal-rich inventories. The distribution of the unmarked Place within the word can take quite different, even surface-contradictory, forms. What's more, in terms of perceptibility in a specific context, although the experimental literature as we have seen throws up contradictory results, coronals appear in very "difficult" – that is, cue-poor, -- positions, and in a systematic way. This is best captured by assuming asymmetric licensing routes between syllabic constituents, which determine the conjunction of syllabic position and melodic expression, as maintained by the theory of Licensing Inheritance. While there are still flaws and unresolved issues in the analyses presented here, hopefully future research along these general lines will iron them out.

References

Abbreviations:

IJAL: International Journal of American Linguistics.

JASA: Journal of the Acoustical Society of America.

JIPA: Journal of the International Phonetic Association.

SOASWPL: School of Oriental and African Studies Working Paper in Linguistics (and Phonetics), Volumes 1-10 (1990-2000).

UCLWPL: University College London Working Paper in Linguistics 1-12 (1988-2000).

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