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CONTENTS

CHAPTER 1

INTRODUCTION: DEPENDENCY AND PHONOLOGY

This monograph offers a theory of representation for the phonological consonant contrasts which are labelled place of articulation contrasts. The monograph will focus on place of articulation contrasts only and not consider other consonant contrasts. The monograph assumes the basic tenets of the phonological model known as dependency phonology. An important tenet of this model is that the segment should be viewed as a unit which is sub-structured in distinct gestures or sub-segments. One of these subsegments is the locational or articulatory gesture which, as the name suggests, exclusively contains information on the place of articulation of a segment. Viewing the segment as consisting of a set of subsegments, as do adherents of dependency phonology, enables us to deal with a limited part of the internal structure of segments. This explains why the present monograph is able to focus on a restricted area such as the place of articulation of consonants.

Dependency phonology is a theory of phonological representation, both segmental and supra-segmental, which was developed in the 1970s and early 1980s and which builds on the eponymous dependency relation (for a full presentation of dependency phonology see Anderson and Ewen 1987). From the time it was first applied in linguistics, dependency has been an alternative to constituency and the two types of notation have competed for representational superiority at different planes and levels.[1] At first dependency and constituency competed for representational superiority at the syntactic plane (cf. Hays 1964, Anderson 1977, Matthews 1981), but with the appearance of the so-called non-linear phonological models (for an overview see e.g. Durand 1990, Goldsmith 1990), the 'war' between dependency and constituency has been extended and also fought at the phonological plane (see Ewen 1986, Anderson and Ewen 1987: ch.3, Staun 1992). However, the two notations have not competed for representational superiority at all phonological levels. In phonology the competition between dependency and constituency has centred on how the supra-segmental phenomena should be represented, a contest that may be exemplified by the competing claims of dependency phonology and metrical phonology (for the latter see e.g.

1. The term plane refers to such disciplines as phonology and syntax, whereas level refers to the emic/etic layers within each plane. For discussion, see Anderson 1985, 1986.

Lieberman and Prince 1977, Hays 1980, Giegerich 1985), but as yet opinions are still divided as to which of the two notations has provided the best description of the phenomena belonging to this level.

But whilst the competition has been strong at the syntactic plane, and particularly at the supra-segmental level within phonology, dependency has 'reigned' relatively unchallenged at the segmental level (the appearance of feature geometry has somewhat altered this picture, however (see e.g. Clements 1985, McCarthy 1988). This is so because dependency phonology is the only so-called non-linear phonological model which is able to describe both the internal structure of segments and the supra-segmental structure in terms of the same relation. By comparison, other non-linear phonological models have only made claims (for example in terms of constituency) about the supra-segmental level and left it to a standard feature-based system such as that of, for example, The Sound Pattern of English (Chomsky and Halle 1968, abbreviated SPE hereafter) to handle the description of the internal structure of segments. Clearly, the absence of a competition at the segmental level makes dependency phonology potentially stronger than its fellow non-linear models, in particular when dependency phonology uses the same dependency relation to describe both the segmental and the supra-segmental levels.

The fact that it makes claims about segment-internal as well as supra-segmental structure entails that dependency phonology not only competes with non-linear (constituency-based) descriptions at the supra-segmental level, but it also that it constitutes a serious challenge to the standard feature-based frameworks such as SPE - and offshoots of this framework including feature geometry (see Lass and Anderson 1975, Lass 1984, Clements 1985, McCarthy 1988 *inter alii*) - as well as such standard frameworks as those proposed by Jakobson *et. al.* (1952) and Ladefoged (1971).

In fact, one of the motivations for applying dependency to phonological phenomena is the failure of standard frameworks to capture important aspects of the internal structure of segments (another motivation is the lack of a notation which can capture syllable structure adequately, see Anderson and Jones 1972, 1977). As a result, dependency phonologists first proposed an alternative description of the place of articulation of vowels and then a description of the major class properties of consonants. The remaining parts of the internal structure of segments followed later, and it is the contention of these descriptions that they can capture aspects of the segmental contrasts which usually are resistant to standard feature accounts. For example, the dependency description can capture the contrasts in the vowel space so that both scalar and classificatory properties receive a natural description, just as consonant lenition and sonority hierarchies are captured adequately within the consonant description.

The success of dependency phonology with respect to the description of such phenomena is due to two facts: i) that segment columns in dependency phonology are substructured in gestures (sub-segments), along which, for example, lenition/fortition takes place, and ii) that each gesture is composed of unary components which can allow for both scalar and classificatory properties.[2] Thus, schematically, the internal structure of a segment column in dependency phonology looks like the following (from Anderson and Ewen 1987:ch.3):[3]

(1.1)

locational sub-gesture	[place height rounding backness]
oro-nasal sub-gesture	[nasality]
phonatory sub-gesture	[consonantality voice continuancy sonorance]
initiatory sub-gesture	[glottal stricture glottalicness velar suction]

The only difference between a 'true' dependency feature column and (1.1) is that the former use unary dependency components which may interact in dependency relationships instead of binary features. For example, in a four

2. Within the standard frameworks such as SPE or Ladefoged (1971) the situation is typically this: if the framework is fully binary it can express classificatory but not scalar phenomena adequately, and if it is partly or wholly scalar it can express scalar but not classificatory phenomena adequately. For some discussion of this issue, see Anderson 1980, Anderson and Ewen 1987:ch 1.
3. For illustration the function of each gesture is specified in terms of standard feature-like labels. For a critique of this particular sub-division, see Davenport and Staun 1986.

vowel height system the vowel /e/ will be represented in the locational sub-gesture (articulatory gesture in the terminology used here) in terms of the unary components | i | and | a | with | i | as governor and | a | as dependent to reflect the relative close quality of this vowel (for a more detailed account, see § 2.2 below).

The applicability of dependency to phonological phenomena has made it possible to formulate a structural requirement which the descriptions of both the supra-segmental and the segmental levels should meet. This may be formulated as follows (cf. Anderson 1985, 1986):

> properties which are unique to a particular phonological level are illegitimate unless they follow from the relationship between that level and other phonological levels

It is Anderson's claim (op. cit.) that dependency phonology because of its recurrent use of the dependency relation fulfils this requirement, and that, by comparison, no other non-linear phonological model can live up to this requirement to the same extent. But this structural law can be carried even further. If dependency can be shown to be superior to constituency at the syntactic plane, then this law may be extended and apply to planes as well as levels. Anderson (1977, 1985, 1986) has shown how dependency constitutes a viable alternative to constituency in syntax when this syntax is relational and case-based and regards the verb as the kernel of the clause. Accordingly the above structural law can be reformulated as (cf. Anderson 1985, 1986):

> properties which are unique to a plane are illegitimate, unless they follow from the relationship between that plane and others

Clearly this assumption of structural analogy, as Anderson dubs it, is very strong and, in so far as it is borne out, makes dependency grammar superior to, for example, a constituency-based grammar. But, clearly, adopting such a strong view on linguistic structure also involves an extremely reductionist strategy. For example, it means that any non-dependency-based description is excluded in phonology unless this can be defended on the basis of the relationship one plane has with another plane. In other words, such a reductionist strategy, no matter how intriguing it may appear, involves the danger that phenomena which are not really readily described in dependency terms are forced into a dependency pattern irrespective of whether this is desirable or not.

The present monograph is triggered by exactly the danger of a reductionist strategy. I'm not convinced that the consonantal place description prospers from being subjected to dependency. In fact, it is my contention here that the description of consonantal place proposed by Anderson and Ewen in dependency phonology is an example of how a reductionist strategy has given rise to problems rather than solved problems. Consequently, my object here will be to propose an alternative description of consonantal place which is less homogeneous but more eclectic, and which recognises the fact that a place description of consonants is more adequate if it is not fully dependency-based. But the alternative description will be indebted to the standard dependency-based account. My personal bias and devotion to this notational framework ensures that those feature which are worth keeping will be reused.

The alternative description that I shall propose will assume that the articulatory gesture should be sub-divided into three descriptive layers. The motivation for this subdivision is primarily phonetic rather than phonological (unlike the motivation which led to the subdivision into gestures, which was phonological (see § 4.1 below). In particular, it reflects an interpretation of what I think plays a primary and what plays a secondary role in the articulation of primary consonantal place. I shall assume that the stationary places of articulation which stretch from the lips to the pharynx are primary. I realise that - for some - this interpretation is controversial, but it is the one which I have found least problematical given the many requirements that a place description must meet. And in fact it is an interpretation which is supported by phonological facts, as I shall return to in ch. 3.

It is a prerequisite for proposing an alternative representational system that the 'mother-system' is in want of a revision. In chapter 2 I shall deal with this issue and show how Anderson and Ewen's use of dependency in their standard description suffers from the weaknesses alluded to above and which follows from a reductionist strategy. This naturally leads up to the alternative proposal *proper*. Two of the three layers in this new proposal act closely together: they constitute what I shall refer to as the articulatory network. Chapter 3 will deal with these two layers and not only describe each layer in detail, but also establish relative complexity for the various places of articulation and provide a way of representing this relative complexity. Chapter 4 will be devoted to the third descriptive layer and again I shall discuss how relative complexity affects this layer and how it should be represented. And finally in chapter 5 I shall consider how the three types of co-articulation should be accounted for in this new representational system. They include nasality, double articulation and secondary articulation.

CHAPTER 2

ON THE PROBLEMS OF THE STANDARD DEPENDENCY ACCOUNT OF CONSONANTAL PLACE.

2.1 Introduction

As observed in the previous chapter, one reason why dependency phonology marks a break-through in the theory of phonological representation is that it enables the phonologist to describe the internal structure of segments in a way which is resistant to standard feature-based notations. For example, with respect to the vowel space (the articulatory gesture of vowels), dependency phonology can express both the scalar relation between vowel heights and natural classes such as front vowels and back vowels in terms of the same primitives and without using disjunctive rule formulations. Another advantage of the dependency account is that it allows for up to five vowel heights, a number which can be extended to seven with a little refinement, as I shall return to below.

Because of its applicability to vowels, Anderson and Ewen (cf. 1987:ch.6) have also used dependency to describe the articulatory gesture of consonants. But as I anticipated above, dependency is less apt to describe consonantal place than it is to describe the locational properties of vowels. My concern in this chapter is to examine Anderson and Ewen's description of consonantal place, and show why dependency is not as easily applied to this part of the consonant description as it is to other parts of the description of internal structure. My criticism will not completely denounce the principles on which the dependency description is based. Like Anderson and Ewen I shall assume that the phonological primitives can - and often should - be unary and that some gestures, vocalic or consonantal, are most adequately described if the primitives are of this nature.

I begin the chapter by showing how the use of such unary components when they interact in dependency relations lead to an adequate description of the articulatory gesture of vowels. A consideration of the vowel space is illustrative for two reasons: firstly it shows the applicability of dependency and thus provides an argument for reusing the vowel components in the consonantal description if possible; and secondly it explains why my loyalty to dependency is greater than the consonantal phenomena subsequently discussed in this chapter perhaps justify.

2.2 Dependency and the vowel space: an illustration

As illustration of how vowels are described in dependency phonology, let us consider the following five Danish vowels: /i/ *mit* 'mine', /e/ *midt* 'middle', /ɛ/ *mæt* 'satisfied', /a/ *mat* 'dull', /ɑ/ *Marht* name (for a description of the Danish vowel system, see Basbøll and Wagner 1985). Firstly, the difference between such (and other) vowels is accounted for in the articulatory gesture, i.e. that sub-segmental hierarchy which describes locational activity. Secondly, as observed already, components, in particular unary or single-valued components, and not features, describe such gestures, including the articulatory gesture of vowels.[1] In the description of vowels the following three components play a crucial role: |i| 'palatality', |a| 'lowness' and |u| 'roundness.'[2] The components are modelled on the three peripheral and widely attested vowels, /i/, /ɑ/ and /u/ (see Maddieson 1984: ch.8). The assumption of dependency phonology is then that the vowel space is triangular rather than quadrangular (for discussion see Anderson and Ewen 1987: ch. 6)

The unary status of the vowel components entails that they may either individually constitute the articulatory gesture of a vowel or enter into (structured) relations with one another which then constitute the articulatory gesture of the vowel in question. Thus the three common vowels /i/, /ɑ/ and /u/ are individually described by the three corresponding components respectively. Thus in the Danish set given above, the highest, /i/, and the lowest, /ɑ/, will individually be described by |i| and |a| respectively. Non-peripheral values, by contrast, involve combinations of the components: in the case of front vowels combinations of |i| and |a| and, in the case of back vowels, combinations of |u| and |a|.

Depending on the overall structure of the vowel system under consideration, the intermediate values will be described in terms of simple combinations or structured combinations involving dependency relations. For example, in the representations of the three remaining Danish vowels, /e/, /ɛ/ and /a/, the components |i| and |a| will enter into dependency relations in which either |i| governs |a| or |a| governs |i| or a relation in which the components are equally preponderant. Thus /e/ since it is closer to /i/, i. e. more |i|-like than any of the other vowels, will be described in terms

1. Henceforth I shall refer to the phonological primitives as components when they are single-valued; otherwise the term feature will be used
2. For the description of central and back unrounded vowels a fourth component |ə| centrality is required; since I am only dealing with front vowels here, it is not relevant here.

of a dependency relation in which |i| governs |a|. This asymmetric dependency relation is denoted by a semicolon. Conversely, since /a/ is closer to /ɑ/, i.e. more |a|-like than any of the other vowels, /a/ will be described in terms of an asymmetric dependency relation in which |a| is governor and |i| is dependent. Finally /ɛ/ will be described in terms of the symmetric dependency relation. In the symmetric relation the two components are mutually dependent or equally strong. The symmetric relation naturally captures /ɛ/'s intermediate position between /e/ and /a/. Thus in dependency phonology the five Danish vowels will appear as follows where the symmetric dependency relation is denoted by a colon (curly brackets indicate that the sound in question is represented by just the enclosed components):

(2.1)	/i/	/e/	/ɛ/	/a/	/ɑ/
	{|i|}	{|i;a|}	{|a:i|}	{|a;i|}	{|a|}

From (2.1) it is apparent that the relative placement of a vowel in the system is reflected by the relative strength of the components. Thus |a|-ness becomes gradually more dominant (strong) as the vowels become more open, and similarly the more close the Danish vowels are the more dominant (strong) |i|-ness is.

Clearly the use of such unary components in dependency combinations or alone results in a very attractive description of a vowel system which has more than three vowel heights by bringing out the scalar nature of vowel height in a phonetically natural way. But it is not within the capacity of the dependency model as formulated by Anderson and Ewen to describe more than five heights. It is then Anderson and Ewen's hypothesis that vowel systems universally will not have more than five height contrasts, a hypothesis which seems to hold for nearly all languages.

Consequently, the existence of a vowel system with more than five heights leaves dependency phonology with a serious problem, and unless it can be accounted for, such a system may well result in the dependency notation becoming replaced by such a component-based model as that of van der Hulst (1988) which can allow for up to eight vowel heights. But how many languages with more than five height contrasts are there in fact? In the UCLA Phonological Segment Inventory Data Base, henceforth acronymised UPSID (cf. Maddieson 1984), there are thirteen languages which have five or more than five vowel height contrasts. Of these probably only one has more than five genuine height contrasts. This is (Afro-Asiatic (Cushitic)) Somali which is reported to contrast six unrounded front vowels (cf. Armstrong 1934, Andrzejewsky 1955).[3] Another potentially 6-contrast language is (Niger-Kordofanian (Plateau)) Amo, but Amo has a low vowel /ɐ/ which might be described in terms of the fourth vowel component |ə|, centrality, which is used for central and back unrounded vowels. If |ə| is used, only five contrasts remain for the |i| - |a|-dimension and Amo can be left out of consideration.

But how can the dependency notation then account for the Somali vowel system given the limitations mentioned above? If the vowel components are allowed to occur more than once per vowel representation, then this is a fairly straightforward case. The six front unrounded vowels of Somali can be distinguished as shown in (2.2):

(2.2)

<table>
<tr><td>|i|</td><td>|i;a|</td><td>|i;a|</td><td>|a;i|</td><td>|a;i|</td><td>|a|</td></tr>
<tr><td></td><td>│</td><td></td><td></td><td>│</td><td></td></tr>
<tr><td></td><td>|i|</td><td></td><td></td><td>|a|</td><td></td></tr>
<tr><td>/i/</td><td>/ɪ/</td><td>/e/</td><td>/ɛ/</td><td>/æ/</td><td>/ɑ/</td></tr>
</table>

which does not utilise the symmetric dependency relation such as is customary in vowel height systems with an even number. The six vowel heights are distinguished by two extra dependent |i| and |a|. The extra dependent |i| enables us to express a value in between /i/ and /e/ which is not as |i|-like as {|i|}, as it has some |a|-ness in it, but more |i|-like than /e/ which lacks the extra subjoined |i|. The extra dependent |a|, by contrast, enables us to express a value between /ɛ/ and /ɑ/. This value differs from /ɛ/ in being more |a|-like, having an extra dependent |a|; at the same time, /æ/ is still different from /ɑ/ as it has some |i|-ness in it which /ɑ/ completely lacks.

Thus a slight refinement of the notation enables us to describe more than five vowel heights. Note that the occurrence of more than one component per representation is also used in the categorial representation of consonants. The description proposed here is then not weakened by the fact that it is an innovation introduced to deal with the particular problem posed by Somali. It is also important to observe that the use of more than one occurrence of the same component per representation does not prevent us from expressing the

3. Throughout this study, any non-Indo-European language will be genetically classified and sub-classified when first mentioned. Thus Somali belongs to the Afro-Asiatic subfamily of Cushitic languages.

hierarchical nature of vowel height which has been the trademark of the vowel description in dependency phonology. The relative openness of a vowel is still directly expressed in terms of the relative preponderance of |a| and the relative closeness of a front vowel in terms of the relative preponderance of |i|. The alleged adequacy of the notation consequently remains unchallenged by the existence of inventories which contrast more than five vowel heights.

Nor does the existence of languages with six vowel heights such as Somali complicate the expression of classes of vowels. Another trademark of the dependency description of the vowel space is that it can express classes of vowels in terms of the same components that represent vowel height. Recall that the dependency representation of a vowel such as Danish /e/ is {|i;a|}. The presence of verticals indicate that /e/ is characterised exactly by the components enclosed by the verticals. But the notation also allows for representations in which the verticals are absent. One or more components enclosed by just curly brackets represent a sound whose representation is not necessarily constituted by the specified component (components) alone. Thus, {i} is a vowel which has |i|-ness in it, but not necessarily as the only component; the specification {i} covers all vowels with |i| in them, i.e. all front vowels. Similarly, the class of back vowels is represented as {u}, i.e. as vowels which have |u| in them, but not necessarily as the only component present. Whether there are five or six vowel heights (or fewer) in a language, does not matter then. The ability to express classes of vowels remains a trademark of the component-based dependency notation.

After this illustration it should be clear that a phonological model of representation which is based on unary components and which allows them to interact in dependent-governor relations, leads to a powerful and uniform description of the vowel space. Not only does it permit that vowel height and vowel class be expressed in terms of the same components, but it also makes the claim that the number of vowel height contrasts typically does not exceed five cross-linguistically. And if, as in such exceptional cases as Somali, more than five contrasts occur, dependency phonology is still able to cope with such systems both as regards height and class. With respect to the vowel space, the dependency notation is thus very powerful.

2.3 The locational description of consonants.

Up till now the strategy adopted to describe consonantal place in dependency phonology has been similar to the strategy used to describe other parts of the segment-internal structure: invocation of unary components which may interact in dependency relations. Thus Anderson and Ewen (1987:ch.6), following Ewen (1980:ch.8) whose work Anderson and Ewen's account is indebted to, introduce the following six unary components (cf. 1987:ch. 6):

(2.3)	|l|:	linguality	|r|:	retracted tongue root
	|t|:	apicality	|α|:	advanced tongue root
	|d|:	dentality	|λ|:	laterality

which - according to Anderson and Ewen - together with the vowel components, |i|, |a| and |u|, suffice to describe consonantal place universally.

The assumption is that to describe the various place contrasts these components may interact in dependency relations, very much as the vowel components either alone or in combined dependency relations may describe different vowel qualities. However, in the following I shall question this tacit assumption. By examining the individual accounts of place contrasts suggested by Anderson and Ewen, I shall show that although the application of dependency to, for example, vowels results in a very promising description as shown above, the use of dependency to the describe the locational properties of consonants does not always lead to an equally successful result.

Anderson and Ewen first invoke dependency relations to distinguish between apical, laminal and retroflex articulations. Two components, they contend, are needed to account for this distinction, viz. |l| and |t|. Thus a language showing this three-way contrast phonologically should be represented in the articulatory gesture as shown below (cf. 1987:239):[4]

(2.4)	{|l|;|t|}	{|l|:|t|}	{|t|;|l|}
	laminal	apical	retroflex

A sound which is characterised by the presence of the linguality component |l| is 'produced with the blade or body of the tongue as an active articulator' (op.cit.:237). The presence of the component |t|, on the other hand, indicates apicality, |t| being defined merely as 'apicality' with the qualification that its 'characterisation will be similar to that of Williamson's [cf. Williamson 1977 J.S.] multi-valued feature [apicality]' (op. cit.:239).

Clearly, it is a problem that the contrasts displayed in (2.4) are not found phonologically. (2.4) in itself then provides no justification for the introduction of dependency relations to describe consonantal place except at the

4. So far no language has been reported to make this contrast phonologically. The representations displayed in (2.4) are then only relevant phonetically and not phonologically.

phonetic level. But what if they were found phonologically? Would (2.4) then be an appropriate representation? Anderson and Ewen base the representations in (2.4) on the following observations. With laminals |l| is in governing position because with this sound type 'the blade is more 'important' than the tip' (op. cit.: 239). With apicals, on the other hand, 'the tip is more important and the blade less important' (ibid.); |l| and |t| are therefore mutually dependent. Finally, while 'only the tip can make actual contact with the passive articulator because of the nature of the configuration of the tongue' (ibid.), retroflexes show a predominant |t| in their representation.

I am not convinced by this description. Firstly, I find it difficult to accept that the relationship between laminals, apicals and retroflexes is a gradual one, as this description clearly suggests. As has been pointed out by Ladefoged (1971), for example, apicals and laminals are active articulations whose function can best be described as those of intensifiers (see also § 3.2.4 and 4.2.9 below). 'They intensify the small differences in place', to use Ladefoged's expression (op. cit.:39). Either the tongue tip is or is not involved. Thus if two consonants at the same place differ in one being apical and the other laminal, this difference should be described by the presence *vs.* the absence of whatever feature characterises apicals and laminals. To employ dependency relations which imply that the tongue tip is more or less preponderant with, for example, laminals and apicals is to obscure the phonetic facts. Secondly, the dependency representations also loose force because, as far as I know, no phonological processes involve stepwise moves along a |t| - |l| 'hierarchy'. Typically dependency relations are appropriate where scalar phonological processes occur regularly. Therefore vowel height, as we saw above, is naturally described in terms of dependency relations, and consequently an important vowel process in the history of English, The Middle English Great Vowel Shift, which is a scalar process, receives a natural interpretation within dependency phonology (for discussion see Anderson and Jones 1977:ch.3). Similarly, the general description of sound types contained in the categorial gesture is naturally represented in terms of dependency. For example, this is confirmed by the readiness with which dependency can account for the many scalar lenition/fortition processes which occur along this hierarchy (for discussion, see Lass and Anderson 1975: Ch.V, Anderson and Ewen 1987: ch.4).[5] But as far as I know, apical, laminal and retroflex consonants do not participate in such scalar processes.

5. One example of the latter from the history of English is the lenition of an intervocalic obstruent which becomes a sonorant and then is lost probably via a vowel. Compare Old English *agan* and Modern English *own*.

Thirdly, it is not at all clear to me that the use of the |l| component actually is justifiable as a component to characterise apicals. Recall that |l| is used for sounds produced with the blade or body of the tongue. How can it then be appropriate for a sound produced with the tip of the tongue? It is also debatable that retroflexes should require |l| for their characterisation. The active articulator with retroflex sounds is either the tongue tip or a part of the underside of the tongue tip. It is difficult to see how even a subordinate |l| could contribute to the characterisation of this kind of articulation. In fact, of the three articulations discussed, only laminals appear to have |l| uncontroversially in their articulatory representations.

Nor is the adequacy of the representations in (2.4) supported by Anderson and Ewen's subsequent discussion of the nasals in (Dravidian) Malayalam (op. cit.:241). Here the representations {|l;t|} and {|t;l|} are employed again. But whereas the employment of these in (2.4), as far as I understand them, illustrates how different active articulations could be reflected when occurring at the same place, in the discussion of the Malayalam data they seem to be used in a different way, such that {|l;t|} and {|t;l|} represent alveolars and retroflexes with an *apical* articulation respectively. Clearly, this involves a different interpretation of retroflex. It is now used as a term referring to a passive articulation. How this accords with the use illustrated by (2.4) I do not understand. Or if it does, (2.4) is even more problematical as it then confuses what appears to be two separate parameters, viz. a passive and an active one.[6]

Finally Anderson and Ewen directly invoke dependency relations in the section dealing with pharyngeals (and uvulars). They propose, tentatively, that to allow for the property 'width of the pharynx', a component |r| which they define as 'retracted tongue root' is required. Apart from being used to represent pharyngeals, this component is also required to represent some vowel harmonies involving the size of the pharynx. For example, in the vowel systems of some African languages (cf. Lindau 1978) the vowels divide into two harmony sets, each of which differs in the size of the pharynx. This difference is due to a variation controlled by the root of the tongue. An-

6. Probably the reason why Anderson and Ewen describe all alveolars and retroflexes as apical is that Ladefoged, who is the source of the Malayalam data, explicitly recognises dental, alveolar and retroflex as places of articulation. This he does because 'at each of these places of articulation it is possible to produce stops, nasals, fricatives and sounds made with other manners of articulation' (Ladefoged 1975:139). For further discussion of the need for a clear distinction between a passive retroflex place of articulation and an active specification referring to retroflexion, see § 4.2.1 below.

derson and Ewen propose that this difference can be captured by means of |r| such that the set which has a relatively advanced tongue root has a dependent |r|, while the set with a non-advanced tongue root shows a dominant |r|, as demonstrated in (2.5) (cf. cit.:244):

(2.5)

$$\begin{array}{cc} i & r \\ | & | \\ r & i \\ \text{advanced} & \text{non-advanced} \\ \text{tongue root} & \text{tongue root} \end{array}$$

It is not clear what the motivation is for representing this difference in terms of dependency relations. As the descriptional labels underneath the representations suggest, the difference is really a binary one: presence *vs.* absence of advanced tongue root. Presence of |r| for non-advanced tongue root and absence of |r| for advanced tongue root would then seem a more appropriate solution for this contrast.

For this reason, probably, Anderson and Ewen subsequently adopt such a 'binary' solution, only the component used is now $|\alpha|$ and not |r|, and a 'binary' solution is then contemplated for representations involving |r| too.[7] Their representations involving $|\alpha|$ thus look as follows (cf. op. cit.:245):

(2.6) $\{|i,\alpha|\}$ $\{|i|\}$

After a closer inspection, Anderson and Ewen thus admit that a representation in which the tongue root component, $|\alpha|$, either is present or absent is more appropriate than the equipollent representations in (2.5) to reflect tongue root harmony. This seems a sensible enough conclusion. However, it gives rise to another problem, the problem of expressing relative complexity. If in languages with tongue root harmony, the advanced set is dominant and the recessive set less common, should the dominant set not be less complex in the representation? In (2.6) it is more complex. I shall not

7. The motivation for replacing |r| by $|\alpha|$ is that in the majority of tongue root harmony languages, advanced tongue root versus non-advanced tongue root, rather than retracted tongue root versus non-retracted tongue root, seems to be the predominant system.

pursue this problem here, but it certainly is spurious; instead I shall consider whether Anderson and Ewen's treatment of other primary articulations provides support for the use of dependency relations. Such an examination will reveal whether the pursuit of such issues of complexity is worthwhile or not.

Clearly only those primary articulations which require more than one dependency component for their characterisation constitute potential candidates for the employment of dependency. Consider then labio-dentals, dentals, palatals and velars which at least in some languages, depending on the nature of the consonant system in the language in question, should be described by the following two-component representations (cf. Anderson and Ewen op.cit.:237-41):

(2.7)	{|u,d|}	{|l,d|}	{|l,i|}	{|l,u|}
	labio-dentals	dentals	palatals	velars

However, no dependency relation proper is invoked in these representations, i.e. no component invoked in (2.7) either governs or is dependent on another component. Rather, as is indicated by the use of the comma, the mutual relation between the components is merely that of simple combination. Typically, the relation of simple combination is used to describe the non-peripheral value of a three-way contrast. For example, /ε/ in the /i, ε, a/ vowel system of (Amerindian (Athapaskan)) Chipewyan (cf. Maddieson 1984:369) would be described as {|i,a|}, a combination of the two components which describe the two peripheral vowels individually. But such a description is only plausible provided |a| and |i| individually can represent a vowel. The vowel components are endowed with this capacity. But not all consonantal components employed in (2.7) may individually represent the articulatory gesture of some consonant, although this is otherwise the nature of the unary dependency components. In the case of, for example, |d| this is never the case. '|t| and |d| are 'secondary' components in that.... they cannot occur alone in the articulatory gesture' according to Anderson and Ewen (op.cit.:242).

Neither is the dependency relation motivated by the way Anderson and Ewen describe the difference between such place types as those listed in (2.7) (op.cit.:241-45):

(2.7)	{|u|} labials	{|u,d|} labio-dentals
	{|l,l|} alveolars	{|l,d|} dentals
	{|l|} non-lateral alveolar liquid	{|l,λ|} lateral alveolar liquid

In non-dependency-based frameworks the members of such pairs would typically be distinguished by a difference in value for a binary feature (e.g. [+lateral]/[-lateral]). This is an intuitively natural way to conceptualise the two-choice situation that the speaker/hearer is confronted with on producing/hearing one of these sound types. In Anderson and Ewen's description this situation is conceptualised by the presence *vs.* absence of a component, for example, presence *vs.* absence of |λ| in the case of laterals/non-laterals. This also brings out naturally the choice between two alternatives. But again dependency need not be invoked. The naturalness of the expression rests solely upon the presence or the absence of a component, but it is not dependent on the use of dependency.

There is nothing in the material considered thus far which suggests that dependency leads to new insights when used to describe consonantal place. The main problem is that the full parameter of place of articulation is not scalar, at least not in its full length (but see Nolan 1992), and dependency is tailored for the description of this kind of opposition. Therefore it works well for the description of vowel height, just as the general categorial description of speech sounds receives a natural interpretation within the framework, but it is not obviously applicable to the consonantal place oppositions. Interestingly, Anderson and Ewen themselves in connection with the treatment of the tongue root harmony phenomena discussed earlier, point to the inappropriateness of dependency. And I quote (op.cit.:244): 'there is a great deal of evidence....that the equipollent nature of the representations in [(2.4)] is inappropriate' and they propose that such representations be replaced by representations in which 'the dominant set will show |α| [or |r|, J.S.] in combination with the normal vowel representations, while the recessive set will simply lack the component'. Although they are only used about isolated articulations, these remarks might as well be a description of the application of dependency to consonantal place in general. At best what remains of the original description is the components and the relation of simple combination, and no more than that. But if only this and no dependency relation proper has to be invoked - and recall simple combination is not unproblematic given the fact that some of the components are not genuinely unary - then one might well ask whether there is any justification at all for applying dependency to this area of consonants. In my view there is very little justification and at least not enough to leave out the possibility that some other approach which is less homogeneous - and consequently less devoted to the dependency view - is tried out. The formulation of such an approach is the object of the following chapters.

CHAPTER 3

LAYER 1 AND LAYER 2: TOWARDS AN ALTERNATIVE DESCRIPTION OF PRIMARY CONSONANTAL PLACE.

3.1 Preliminary.

I concluded the previous chapter with the hypothesis that a full-scale use of dependency is inappropriate to describe the place of articulation of consonants. However, this hypothesis does not entail that dependency should be left out of the description of consonantal place all together. As has been pointed out so often before (cf. Ladefoged 1971, Davidsen-Nielsen and Ørum 1978, Lass 1984) the 'best' representational system is not necessarily a homogeneous one, i.e. one in which the primitives on which it is based are all either binary, scalar or whatever type of primitive is chosen; rather the highest level of descriptive adequacy is most likely achieved by an eclectic approach - this is the lesson taught by the afore-mentioned specialists - in which the phonological description builds on a heterogeneity assumption so that the phonological primitive inventory consists of a set of heterogeneous phonological features. Thus in so far as there are aspects of the dependency approach which help us describe and understand the locational articulation of consonants, dependency - that is, dependency relations or dependency components - should definitely be invoked. Otherwise dependency will not be used in the description. And it is my contention that there are aspects of the locational description of consonants which will benefit from the invokation of dependency or dependency-like descriptions. Consequently, the following account will be much indebted to the proposals of dependency phonology.

Before I propose an alternative primary place description for consonants which follows this eclectic path, there is a question which I must answer first. This question is independent of the representational issue of whether, for example, dependency or not should be invoked. It is more general. In particular, it is the general question of what a model of (primary) consonantal articulation exactly should be able to account for (apart from, of course, in principle all underlying place contrasts). We should expect that standard works such as SPE or that proposed by Ladefoged (1971) or other similar frameworks with universal claims about the internal structure of segments have provided answers to this question. But none of these frameworks have supplied any direct answers; only indirectly do we learn that a place description should be able to:

(3.1a) refer to positional classes such as bilabial, dental, alveolar etc.

(3.1b) allow for the possibility of referring to both active and passive articulators

(3.1c) describe vowels and consonants in terms of the same primitives

But although they are essential, (3.1a), (3.1b) and (3.1c) will not suffice. Much recent work, including that of Anderson and Ewen (1987) and work within underspecification theory (Archangeli 1984, 1988) and feature geometry (Clements 1985, McCarthy 1988, Paradis and Prunet 1991b *inter alii.*), emphasises that requirements (3.1d) and (3.1e) also should be met. Thus a description of primary place of articulation should also be able to:

(3.1d) allow for the cross-classificatory phenomena such as e.g. 'gravity'

(3.1e) allow for and express the relative complexity of the contrastive articulations and as part of this allow for and express the special status of coronals

As observed, neither SPE nor Ladefoged lives up to all of these requirements. None of them observes (3.1e); SPE does not meet (3.1d) and although he fully recognises its importance, Ladefoged does not comply with (3.1c). As for (3.1a), this is allowed for in both frameworks, but in different ways: in SPE through features which - with the exception of [anterior] - refer to the active articulator, and by Ladefoged in terms of the multivalued feature [articulatory place] which refers to the passive articulator. Both frameworks also meet (3.1b), either in terms of the features which also allow for (3.1a) or through independent features. Anderson and Ewen are more successful. Their account fulfils all requirements except for (3.1e) which is partially but not fully complied with. But all requirements must be met irrespective of the nature of the phonological primitives employed (binary, multivalent or componential). And work within underspecification theory and feature geometry has specifically emphasised the necessity of also fulfilling (3.1e).

The discussion below will consequently refer to the requirements in (3.1a - 3.1d) time and again. A basic claim of the proposal to be adduced below is that the primary articulatory event for consonants should be described in terms of three layers. This reflects the subdivision represented by (3.1a) and (3.1b). The three layers in question will be termed layer 1, layer 2 and layer 3; layer 1 and layer 2 will form a unit - although they individually refer to separate events - and will have as their primary function that of allowing for passive articulation, i.e. (3.1a), whereas the function of layer 3 will be that of specifier of active articulations and hence largely allow for (3.1b). This chapter will deal with layer 1 and layer 2. Chapter 4 will deal with layer 3. But whilst (3.1a, c, d,) will be dealt with in chapter 3 and (3.1b) in chapter 4, (3.1e) will be discussed and allowed for in either chapter. Relative complexity and its representation is as much a feature of passive as it is of active articulation.

3.2 Layer 1: Towards a description of passive articulation

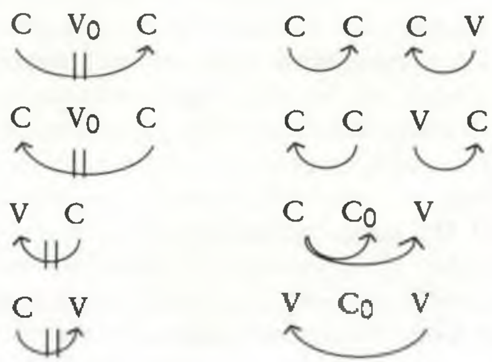
3.2.1 Preliminary. The basic hypothesis of this chapter is that the locational articulation of consonants consists of two parts: a passive and an active part. As I anticipated above, it is my contention that three descriptive layers are needed to account for these two aspects of consonantal place. It is my contention that two of these layers form a unit, a unit which I shall refer to as the articulatory network. This is layer 1 and layer 2. Layer 3, on the other hand, acts independently of the other two and specifies active articulation only. The function of layer 1 is to specify passive articulation; it enables us to specify a consonant as bilabial, dentoalveolar etc., that is, it refers to the stationary places of articulation associated with the non-movable part of the articulatory tube. On the other hand, layer 2 can be regarded as a mediator. Its function overlaps with that of layer 3 by specifying active articulation; at the same time it interacts closely with layer 1 with which it forms the articulatory network. The defining property of this network is the individual values, the so-called articulatory zones, of layer 1. Layer 1 thus plays a basic role in the description of consonantal place.

The defining role assigned to layer 1 is the result of a choice, a choice which involves a preference to describe positional classes such as dental, alveolar, velar etc. in terms of an exclusively passive parameter, i.e. the stationary part of the articulatory tube, rather than in terms of the active articulator or a combination of the two. This choice is somewhat controversial in that the passive parameter is not always chosen as basic. SPE and SPE-like frameworks describe such positional classes in terms of features which primarily refer to the tongue (with the exception of [anterior]), i.e. the active articulator. Ladefoged, on the other hand, accounts for the same classes by means of the feature [articulatory place], i.e. a feature which, like the description to be proposed here, exclusively refers to the upper part of the articulatory tube. However, neither framework motivates its choice of basic articulator in detail. SPE states that basing the description primarily on the active articulator enables the phonologist to describe consonants and vowels articulatorily in the same terms. Ladefoged does not motivate his choice which is all the more incomprehensible as he too recognises the importance of using primitives which can account for both vowels and consonants. The fact that he favours a description of the locational classes in terms of the upper part of the articulatory tube, partly reflects his own personal bias and partly his desire to propose an alternative to SPE.

But is it possible to motivate that location or place be described in terms of the passive parameter exclusively? The physiological facts do not help much here, as a subdivision of the roof of the mouth, i.e. the passive side of the articulatory tube, is as arbitrary as the subdivision of the tongue, the corresponding active side. Then phonology perhaps provides the clues. SPE's point about the importance of a set of primitives which can be used both for vowels and consonants favours the tongue-based solution. But only if a passive solution excludes this possibility. My contention is that the articulatory network which will play an important part in the present description makes up for this deficiency. On the other hand, it could be said to count against the active solution that it does not - at least not in its present form - represent a genuinely active solution: to allow for all positional classes it has to resort to the passive feature [anterior]. Thus it speaks in favour of the passive solution that in this no such mixture of descriptive primitives is necessary. But in view of the limited significance of the homogeneity assumption this is not a very compelling argument.

Probably only an examination of a wide range of phonological evidence would settle the question. One such piece of evidence is assimilation. In the environment of one or more intermediate consonants - usually described with the variable C_0 - vowel to vowel assimilations are quite common. But we do not find consonants assimilating to consonants across one or more vowels (V_0). A further asymmetry involves the sequence plain consonant followed by a vowel or a vowel followed by a plain consonant (plain = without secondary articulation). In these sequences we often see the consonant assimilating to the vowel but not the vowel assimilating to the consonant. Schematically these facts can be represented as in (5.2):

(3.2)



in which the double crossed arrows indicate the environment in which assimilation is usually not found.

Such asymmetries can be explained in terms of a system in which the passive parameter is assigned basic status. The absence of assimilations from a C either across a V to another C or to an adjoining V is due to the basic features of layer 1 not being able to spread across or to a segment which is not obligatorily specified for layer 1. The basic status of the passive parameter means that a consonant always is specified for layer 1: this is obligatory, but a specification in terms of one or more vowel components, i.e. layer 2 components, is optional. A vowel, on the other hand, is never obligatorily specified for layer 1 only for layer 2. Observe that this explanation is not possible if the active parameter is taken to be basic, as both vowels and consonants will be obligatorily specified for this parameter. Thus the 'ranking' inherent in the articulatory network - that layer 1 is more basic - helps explain what seems to be a general tendency in the way assimilation works in many languages.

As more evidence is examined I am inclined to think that the option with the passive parameter as basic will prove the best. Not only will it allow for such evidence as that summarised in (3.1). It will also readily allow for up to nine positional classes phonologically which is necessary to allow for the data discussed below, and it entails that it is possible to establish the relation between relative complexity and the positional classes of consonant in a straightforward way. But the fact remains that basing the choice of primary parameter on the physiological facts exclusively will not clearly favour the passive parameter. The subdivision of both the active and the passive parameter will always be equally arbitrary. For this reason I have deliberately chosen the term zone to refer to the values into which the roof of the mouth - and hence layer 1 - is divided.

3.2.2 The articulatory zones. As established above, the function of layer 1 is to refer to the phonetic parameter which includes those positional stationary classes the non-movable part of the articulatory tube is divided into. For the moment I shall assume that seven such positional classes are needed for the description of passive articulation (see § 4.2.1 for an extension of layer 1). As observed above, I shall refer to them as articulatory zones. Thus layer 1 may be represented as in (3.3) which gives the seven zones and the abbreviations associated with each zone to be used hereafter (I return to the motivation for conflating dental and alveolar into the dental/alveolar zone; glottal is not a value of layer 1, as glottal sounds are allowed for in the initiatory gesture, see Anderson and Ewen 1987 and Davenport and Staun 1986 for discussion):

(3.3)
Layer 1:

P	F	T	C	K	U	Ph
bi-labial	labio-dental	dento-alveolar	palatal	velar	uvular	pharyngeal

Roughly speaking, the zones of layer 1 correspond to the values of, for example, Ladefoged's multivalued feature [articulatory place] (cf. Ladefoged 1971:42 ff.). They constitute independent and not scalar values. I realise that not all evidence supports such an interpretation, as, for example, Ladefoged's discussion of some of Greenberg's observations (1971:43) has made clear. Also the frequent occurrence of one place of articulation assimilating to an adjacent place of articulation points in the direction of some values of articulatory place being ordered (see e.g. Nolan 1992). Nevertheless, shall consider the values as independent, because moving from one value to the next does not represent a change along some easily definable phonetic scale, but a change from one discreet value to another. I shall refer to this parameter as the oro-pharyngeal parameter. Pharyngeal is the innermost value on this parameter, the outermost value is bilabial. When we disregard the movability of the upper lips and the velum (for discussion see § 5.4.6 below), the parameter covered by layer 1 thus includes the entire nonmovable part of the articulatory tube.

I refer to each value on the oro-pharyngeal parameter as a zone rather than a place. I prefer the term zone to the term place, because this is the best way to reflect the physiological facts. As observed earlier (cf. also Catford 1977), a subdivision of the passive parameter will always be arbitrary. Using the term zone reflects this fact and expresses the fact that I do not commit myself to specifying exactly where one place type ends and the next one begins. But from the point of view of a phonological description, the term zone will also suffice. It is not necessary to be more specific than is implied by this term. Observe also that although two entities quite clearly represent distinct objects, it is not always easy to define exactly how they differ from one another nor describe in absolute terms where the borderline between the two should be drawn. Still this fact does not prevent us from considering them as distinct entities.

3.2.3 Frequency and relative zonal complexity. It is my hypothesis, then, that the locational articulatory property of a consonant should be described in terms of one of the zones specified by the labels, bilabial, labiodental etc. However, clearly such a specification will not represent a descriptive improvement unless the proposed zone types can be shown to differ among themselves with respect to relative complexity, and unless this difference can be expressed directly in the representations. Consequently, this and the following sections will consider how it is possible to subclassify the zone types into two groups with distinct complexity values and propose a way in which this difference can be expressed (for a similar hypothesis, see e.g. Paradis and Prunet 1991a and § 3.3.3 below).

I establish first the relative complexity of the articulatory zones on the basis of the relative frequency of occurrence of phonological segments. I shall assume that, typically, relative high frequency equates with simplex (unmarked) status. I stress that this is how high frequency typically should be interpreted. But it is important to note that this is by no means always an accurate interpretation. For example, it is necessary to allow for exceptions caused by genetic factors, as well as for exceptions determined by idiosyncrasies of specific phonological classes (see this section, § 3.2.6 and § 4.2.9 below). Secondly, once complexity has been established, I shall show how this complexity is also supported by relative saliency, and finally in § 3.3.2 I shall propose a way of representing relative complexity underlyingly.

In order to establish relative complexity of the articulatory zones on the basis of frequency, I shall draw on two indispensable works, namely that of Nartey (1979) and that of Maddieson (1984). Both works examine the relative frequency of various phonetic parameters with the major classes of sounds. Both studies are based on the 317 languages which occur in UPSID, the UCLA Phonological Segment Inventory Database. On the basis of these 317 languages Nartey and Maddieson posit a set of phonological universals which specify the recurrent phonological patterns of the major consonant classes. Nartey's and Maddieson's universality claims also concern the recurrent places of articulation. Place of articulation, it is true, is not always a parameter specifically dealt with. This varies from sound class to sound class. But when the place parameter is specifically discussed, I shall use the evidence adduced by these two scholars. Otherwise it is usually possible to infer from the evidence they adduce how place and complexity interact.

I begin with an examination of stops. On the basis of the distribution of this class in UPSID, Nartey posits the following assumptions (1979:17):

> Languages usually have at least three primary oral stops (assumption 12)
>
> If a language has only three oral stops their primary allophones are most likely to be /p t k/ (assumption 13)

Although they contain no direct mention of place of articulation, these assumptions clearly suggest that labial, dentoalveolar and velar are the basic place types among stops. In any case, the basic status of these three places is directly confirmed by Maddieson's investigation. Unlike Nartey, Maddieson specifically examines the distribution of stops with respect to place of articulation. The following generalisations sum up his interpretation of the stop data (cf. 1984:39):[1]

> A language is most likely to have stops at three places of articulation. 171/317 53.9%

> A language most typically includes stops at bilabial, dental or alveolar, and velar places of articulation. 312/317 98.4%

It should also be mentioned that the number of languages with stops at the three places, bilabial, dentoalveolar and velar in UPSID are 314, 316 and 315 respectively. In other words, a very good case can be made for the universality of the three articulatory zones, bilabial, dentoalveolar and velar with stops. By contrast the number of languages with stops occurring at other places is not in any way near these figures, the highest being 59 which is the number of languages with palatal or palato-alveolar stops. On the basis of relative frequency of stops, it is thus clear that these three zones should be considered simplex.

By including fricatives it becomes clear that one more zone should be added to the basic simplex set. About fricatives Nartey states the following (1979:10 & 4):

> The preferred number of fricatives is two (assumption 6)

> If a language has only one primary fricative its primary fricative is most likely to be /s/ (assumption 2)

> If a language has only two primary fricatives the second one is most likely to be /f/ (assumption 3)

---

1. The specifications of the kind 171/317 53.9% mean that the parameter in question includes 171 out of the 317 languages in UPSID, i.e. 53.9%.

And Maddieson makes the following observations about fricatives:

> the total number of fricatives in the languages surveyed ranges between 0 and 23, but the modal number is 2 (1984:43),
>
> of the languages with only one fricative...it is overwhelmingly probable that that single fricative will be a voiceless dental or alveolar sibilant (1984:52)
>
> the most frequently found pair of fricatives is /*s, f/ (1984:53)[2]

To this it may be added that the three most frequent places at which fricatives occur are dentoalveolar, palato-alveolar and labio-dental, whereas fricatives at the other places are in no way as common. Firstly, the fricative data then confirm the basicness and hence simplicity of the dentoalveolar zone, dentoalveolar fricatives being the most common of the three frequent types. Secondly, the data tell us that there are only two basic zone types for fricatives. The question is then: should this be the place at which /ʃ/ is articulated or labio-dental, the place of articulation of /f/? Relative frequency speaks in favour of the place of articulation of /ʃ/, whereas the fact that the most frequently found pair of fricatives is /*s/ and /f/ speaks in favour of labio-dental. Fortunately, this ambiguity is resolved by other evidence, namely that the behaviour of other consonant types does not point to palato-alveolar (or whatever articulatory zone /ʃ/ should be associated with, see §4.2.2 for discussion) as simplex and that perceptual salience does not support palato-alveolar but labio-dental, as I shall return to shortly.

Thirdly, the fricative data suggest that, unlike with stops, the velar zone is complex for fricatives. Although this conflicts with the status of velarity established above, I shall not take it as counter-evidence to its generally simplex status. The number of times a particular type of consonant occurs in a language varies, but there is a modal number for each type. For fricatives this number is 2, cf. above. There are then also 2 basic (simplex) places of articulation for fricatives. Consequently, velar cannot be simplex; it has, as it were, been relegated to complex status because the most frequently occurring pair of fricatives is /*s/ and /f/. A similar situation obtains with other consonant types. In general, different consonant types acquire maximal effect at different place of articulation and consequently prefer specific

2. /*s/ represents all types of *s*-sounds together, i.e. dental, alveolar or unspecified dental/alveolar *s*-sounds, cf. Maddieson 1984:44.

places of articulation. This is the reason that one articulatory zone will not recur as simplex in all consonant types, cf. again the work of Stevens and Keyser (1989). Thus, in sum - despite the distribution of fricatives -the set of simplex zones subsumes: bilabial, dentoalveolar, velar as well as labio-dental.

Incorporating the class of nasals does not add new simplex classes. Nartey's assumptions concerning nasals merely confirm the simplicity of two of the zones just mentioned (1979:30):

> There is a very highly significant tendency for languages to have at least one primary nasal consonant (assumption 24)
>
> If a language has only one primary nasal consonant, its primary allophone is most likely to be /n/ (assumption 25)
>
> If in a given language there are only two PNC's [primary nasal consonants, J.S.] the other one is /m/, that is its most characteristic allophone is labial (originally an assumption of Ferguson's (cf. Ferguson 1961) taken over by Nartey, assumption iii)

In other words, that the bilabial and dentoalveolar zones are considered simplex is also supported by the distribution of nasals. Maddieson's investigation points in the same direction as the following generalisations confirm (cf. 1984:69):

> Most languages have at least one nasal. 307/317 96.8 %
>
> A language with any nasals has /*n/. 304/307 99%
>
> The presence of /m/ in a language implies the presence of /*n/. 297/299 99.3 %

Interestingly, the ranking of place of articulations implicit in the last generalisation may be extended such that the third most frequent place of articulation for a nasal is velar and the fourth most common palatal. Apart from confirming the basicness of velarity, this fact would be completely uninteresting if not nasal palatal stops were comparatively more common than their nonnasal stop counterparts. In fact, palatal nasals and velar nasals are almost equally common. In other words, the nasal data might be interpreted as contravening the pattern found with stops so that palatal and not velar should be considered simplex. But such an assignment would not be justified. The complex status of palatal nasals still holds true because out of the 95 languages with three voiced nasal continuants, 65, or 68.4% of these, have /m, *n, ŋ/. Note also that out of the total of 934 found in UPSID there are 60 more voiced velar nasal continuants than voiced palatal nasal continuants. Nasals or no nasals, bilabial, labiodental, dentoalveolar and velar thus still appear to constitute the simplex zones.

Let us now consider liquids and other approximants. As for the former, let us assume with Maddieson and numerous other phonologists that the group of liquids includes laterals and *r*-sounds. In UPSID the typical situation is that a language has two liquids (41 % of the languages which have liquids), and the overwhelming majority of these have one of each kind (83.1% of the languages with two liquids). Equally typical is the regularity at which they occur at the same place of articulation. 86.5 % of all laterals are produced in the dentoalveolar region with the second most frequent place being retroflex, which, by contrast, is a place associated with only 6.7% of the laterals.[3] With *r*-sounds the picture is almost the same. 86.4 % of the *r*-sounds (316 in UPSID) are dentoalveolar and retroflex again is the second most common type, but only 38, i.e. 12 %, out of a total sum of 316 are articulated at this position.

At first glance the liquid data thus both confirm and disconfirm the general pattern established thus far. The data are confirmatory because liquids are overwhelmingly dentoalveolar, but disconfirmatory because whatever other zones liquids occur at do not have simplex status. However, on closer inspection the latter point is not relevant. The modal number for both laterals and *r*-sounds seems to be 1 dentoalveolar type, cf. the fact that languages with 1 liquid have either a dentoalveolar *r* or a dentoalveolar lateral and languages with two liquids have one of each type (the latter is found in 83.1 % of all languages with two liquids). Any other place of articulation than dentoalveolar is then to be considered marked with liquids (see § 4.2.4 and 4.3.1 for further discussion). Often the exceptional behaviour can be explained in articulatory terms. For example, in the case of laterals the predominance of tip or blade articulations at the dentoalveolar place is presumable due to the greater free air passage that this allows, than would an articulation involving the body of the tongue and the corresponding passive place. Similarly free air passage, and hence maximal effect, probably explains

3. In UPSID retroflex is a place of articulation; for further discussion, see § 4.2.1 below.

the predominance of *r*-sounds produced with the tongue tip at the dentoalveolar zone. The pattern established so far is thus not disconfirmed by liquids, provided we allow for a restricted use of articulatory zones with this sound type.

The evidence provided by the other approximants, i.e. what commonly is referred to as either semivowels or vocoids, points in the same direction. The most distinguished members of this group are /j/ and /w/, i.e. a palatal and a labiovelar approximant (the only other two approximants with different places of articulation, /ɥ/ and /ɣ/, must be regarded as highly exceptional as they occur in less than 2% of the UPSID languages, cf. Maddieson 1984.:92). /j/ and /w/ both occur very frequently, but /j/ somewhat more frequently than /w/ (86.1% *vs.* 75.7%). The high frequency of /j/ seems to pose a problem to the hypothesis made here that palatal is considered a complex zone type. However, it should be observed that /j/ and /w/ are closely related to the high vowels /i/ and /u/ respectively. This means that /j/ sometimes is difficult to differentiate from /i/ and in fact often is used for a high front non-nuclear element in diphthongs. Cross-linguistically, /i/ and /u/ also predict, to a very substantial extent, the presence of /j/ and /w/ (more so in the case of /i/ than /u/). This close affinity makes /j/ and /w/ quite unique among the consonants. The place affiliation of /j/ and /w/ may therefore also be regarded as exceptional. Since they are closely related and indeed in the majority of cases may be said to depend on sound types with a certain place of articulation, the zonal affiliation of /j/ and /w/ is predictable. Consequently, it would be unwise to place too much importance on the high frequency of palatal /j/.

The preliminary conclusion concerning place of articulation and relative complexity that I reached on the basis of the distribution of stops, fricatives and nasals, viz. that bilabial, dentoalveolar and velar are the simplex zone types, is thus also in general supported by the distribution of laterals, *r*-sounds and semivowels, provided we note that the latter have a limited distribution and hence fail to conform to the pattern characteristic of those sound types which make use of all place types. The preferred or unmarked place system for these sound types may then be summarised as in the following diagram:[4]

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4. The articulatory zones entered for the semivowels, i.e. bilabial and velar, are those of /w/. Although /w/ and /j/ behave exceptionally, bilabial and velar have been entered for semivowels because for other sound types they are basic. /j/'s articulatory specification, palatal, is thus left out because for other sound types it is not basic.

(3.4)

	bilabial	labiodental	dentoalveolar	velar
stops:	x		x	x
fricatives:		x	x	
nasals:	x		x	x
liquids:			x	
semivowels:	x		x	

where the dispersion of the x's indicates the preferred articulatory zones of the different sound types. Labial, labiodental, dentoalveolar and velar thus constitute the simplex/unmarked zones, and palatal, uvular and pharyngeal the complex/marked zones.

3.2.4 Saliency and relative zonal complexity. In the nature of things, quantitative research such as that conducted by Nartey and Maddieson has its explanatory limitations. In the words of the Danish humorist, writer and painter, Robert Storm Petersen: statistics can be likened to a lamppost: it is very good to lean against, but it does not illuminate very much. Of course, both Nartey and Maddieson are aware of the limited explanatory power of their statistically based accounts and therefore seek to find support for their universality statements elsewhere. For example, both attempt to link the relative frequency of fricatives with relative intensity, but the results are inconclusive. Maddieson also attempts to link frequency with relative perceptual salience and he finds that the most frequent fricatives and nasals are those most easily identified. But he does not pursue this idea further so the investigation leaves a somewhat speculative impression.

However, this latter idea of Maddieson's is important because it has provided the major stimulus for a recent investigation conducted by Stevens and Keyser (1989) regarding the enhancement and saliency of distinctive features. As we shall see in a moment, Stevens and Keyser provide exactly the kind of support that Maddieson was looking for. Stevens and Keyser's results are thus also highly relevant in the present context.

Stevens and Keyser divide features into two sub-groups according to their relative perceptual saliency: primary and secondary features. The primary features are those which according to their investigation are the most salient ones. This set comprises [sonorant], [continuant] and [coronal]. The secondary features are less salient. Their function is to enhance, but they are restricted in the environment in which they occur, and they differ in the degree to which they enhance acoustic properties of primary features with which they co-occur.[5]

The primary features can combine freely with each other, a property which, if fully exploited, leads to the eight consonant types shown in the rightmost column in (3.5) (cf. Stevens and Keyser 1989:86):

(3.5)

	continuant	sonorant	coronal	segment type
1)	+	+	+	J
2)	+	+	-	W
3)	+	-	+	S
4)	+	-	-	F,H
5)	-	+	+	N,L
6)	-	+	-	M
7)	-	-	+	T
8)	-	-	-	P,K

Although they only represent segment types and not specific consonants, the symbols in the rightmost column are clearly not chosen randomly. If the horizontal rows are made fully specified, the symbols clearly cover the following sound types: palatal semivowel (1), labiovelar semivowel (2), dentoalveolar fricative (3) etc., i.e. the sound types that the letters typically stand for. What is interesting from the present point of view, as Stevens and Keyser point out, is that the rightmost column represents those segments which according to Maddieson are among the ten most common consonants in UPSID. Thus on the basis of Stevens and Keyser's investigation a very good case can be made for postulating that frequency of occurrence is closely linked with perceptual salience. The more frequent a contrast occurs the more perceptually distinct it is and, presumably, the less likely it is to undergo change. The set of segments resulting from combining the primary features are then the most frequently occurring ones.

But how does (3.5) support the conclusions established above concerning the relative complexity of the articulatory zones? Let us again consider the

5. The feature inventory that Stevens and Keyser operate with is, with the exception of a few minor changes, identical to that proposed by Chomsky and Halle in SPE.

segment types in the rightmost column of (3.5). From a locational point of view, it seems reasonable to interpret them as follows:[6]

(3.6)	1)	= palatal
	2) + 6) + 8)	= bilabial or velar or both
	3) + 5) +7)	= dentoalveolar
	4)	= labiodental or glottal

Two zones are uniquely identified, namely palatal and dentoalveolar, whereas bilabial, labiodental and velar, which cannot be distinguished by means of the feature [coronal], do not appear uniquely.[7] Thus it is impossible on the basis of the primary features alone to establish a complete pattern of how saliency and articulatory place interact.

However, incidentally, a subgroup of the secondary features can, when its members are implemented with the appropriate combination of primary features, act with respect to perceptual saliency as if they were primary features (cf. Stevens and Keyser op.cit.:94). Two features are of this kind, namely [anterior] and [lateral]. I shall restrict my attention to [anterior]. Interestingly, when acting as a primary feature, [anterior] gives rise to the following bifurcations of rows 4) and 8) in (3.5) (cf. Stevens and Keyser op.cit.:100):

(3.7)

	continuant	sonorant	coronal	anterior	segment type
4a	+	-	-	+	F
4b	+	-	-	-	H
8a	-	-	-	+	P
8b	-	-	-	-	K

These new segment types cannot but be interpreted as representing labiodental, labial and velar consonants. Thus by including [anterior] among the primary features it is clear that the set which contains the most salient features turn out to specify labial, labiodental, dentoalveolar, palatal and

6. Probably, L stands for lateral, cf. Stevens and Keyser op.cit.: 100. However, since, as we pointed out above, laterals in the overwhelming majority of cases are articulated at the dentoalveolar position, we shall here interpret L as standing for a sound type with these place characteristics.

7. Recall that glottal is not considered an articulatory property, but instead taken care of in the initiatory gesture. Therefore it is not included here.

velar. With the exception of palatal, which behaves idiosyncratically as discussed above in connection with /j/, these are the articulatory zones which I established as simplex or unmarked above. Given that the evidence adduced by Stevens and Keyser may be interpreted with respect to place of articulation as I have suggested, their investigation of saliency then supports the subdivision of the articulatory zones which was postulated above. The articulatory places of the most salient segment types are also the most frequently used places cross-linguistically.

Evidence from both relative frequency and perceptual saliency thus supports the same subdivision into simplex and complex zone types. Accordingly, I shall conclude by introducing some terminology which will enable me to refer to this subcategorisation in a simple way. Henceforth I shall refer to the simplex or unmarked zones as category 1 zone types. This reflects that they have complexity degree 1. Labial, labiodental, dentoalveolar and velar are then category 1 zone types. The remaining zone types, i.e. palatal, uvular and pharyngeal belong to the category 2 zone types, which similarly reflects that they have complexity degree 2. No further subdivision will be needed. Neither the evidence provided by Maddieson nor that adduced by Stevens and Keyser seems to warrant further subcategorisation (for some qualification of this statement, see § 3.3.3 below).

3.2.5 On the unspecified dentoalveolar zone. Among the seven zones proposed above, the dentoalveolar zone differs from the rest by conflating what typically is regarded as two distinct positional classes, viz. dental and alveolar. Clearly such a conflation calls for a comment. Firstly it must be motivated why it is at all appropriate to conflate values of the dentoalveolar region, and secondly why the conflation should affect the passive articulator and not the active articulator.

That conflation is appropriate is motivated by the way languages utilise the potential contrasts in the dentoalveolar region. Theoretically, dental and alveolar together with their respective tongue part opposites, apical and laminal, permit four possible combinations: apico-dental and lamino-alveolar or apico-alveolar and lamino-dental.[8] To my knowledge no language makes use of all four contrasts. Instead languages which make a contrast between dental and alveolar consonants utilise two of these combinations. This means that a contrast between dental and alveolar is usually further intensified by either apical or laminal. The contrast between dental and

8. That more contrasts exist in the dentoalveolar region than elsewhere is due to the greater flexibility of the active articulator in this area.

alveolar is only very rarely a genuine place contrast in which the consonants in question are intensified by the same type of active articulation (either apical or laminal), i.e. kept apart by place alone. For example, in languages such as (Niger-Kordofanian) Temne and Isoko (cf. Ladefoged 1971:39) the contrast between dental and alveolar *t*'s may be described as apico-dental and lamino-alveolar. Similarly, in many Australian languages a dental/alveolar contrast can be described as lamino-dental and apico-alveolar (for discussion see below). That is, the contrast is not only a place contrast but also maintained by means of distinct tongue parts. In so far as this pattern is a recurrent one, fewer than the theoretical four possibilities will suffice to allow for contrasts in the dentoalveolar region, i.e. conflation is an obvious possibility.

But is this pattern a recurrent one? Let us consider UPSID again. There are 24 languages in UPSID which make a contrast between dental and alveolar consonants. Out of these 24 languages, 11 confirm the pattern just described such that the contrast can be handled by, for example, a conflated dentoalveolar zone and different active specifications, whilst only 2, viz. Malayalam and (Amerindian (Mexican Penutian)) Tzeltal, fail to conform to the pattern (in Tzeltal (cf. Kaufman 1971), as in Malayalam, both dental and alveolar sounds are apical).[9] As for the remaining 11 languages, the data in two of them have probably been misinterpreted, viz. (Hokan) Karok (cf. Bright 1957) and (Hokan) South Eastern Pomo (cf. Moshinsky 1974). This leaves us with 9 languages with a dental *vs.* alveolar contrast. As for these 9 languages, I have either been unable to obtain any evidence on the distinction in question (whether it is a genuine one or one accompanied by a difference in active articulation) or the evidence has been inconclusive. But if the ratio (1:6) among those languages with known articulations (2 languages out of 13) corresponds to that found among those languages with unknown specifications, then probably 1 or 2 more languages would require specific reference to a dental and an alveolar place of articulation. Something like 5 or 6, if we - in an attempt to add more certainty to the description - include all those languages with inconclusive evidence, out of 317 languages then probably require specific reference to a dental and an alveolar place of articulation.

9. The difference between /θ/ and /s/ or /ð/ and /z/ which in many languages is a difference between a dental and an alveolar fricative, as in, for example, Greek, (Turkic) Bashkir or (Nilo-Saharan) Tabi (cf. Maddieson 1984:263, 280 & 307) is not included here, as these fricatives also differ in sibilance. They are therefore kept apart in the categorial gesture where this kind of contrast is accounted for (see Anderson and Ewen 1987:§ 4.1.4 for discussion).

Thus less than 1 % of the languages in UPSID fail to conform to the general pattern. The data in UPSID then confirm the pattern that typically not all contrasts in the dentoalveolar region are utilised and consequently that a conflation of the contrasts in this region is justified.

However, although these 24 languages confirm the appropriateness of conflating dental and alveolar as dentoalveolar, the data have the drawback that the majority of these 24 UPSID languages are Australian and consequently fail to constitute a genetically representative set. But there is no reason to believe that such a predominance should seriously endanger the conflation hypothesis. Firstly there are non-Australian languages which exhibit the 'Australian' pattern (typically, according to Yallop (1982) and Wurm (1972), dentals are laminal and alveolars apical in the Australian languages which make this contrast). For example (Amerindian (Northern Penutian)) Nez Perce, cf. Aoki 1970, which has apical alveolars and laminal dentals, and Irish, cf. Ó Cuív 1968, whose (palatalised or velarised) dental and alveolar *t*'s and *d*'s, for those speakers who still use this contrast, also differ in that the former are apical and laminal and the latter only apical. Secondly it is still striking how few languages make a genuine place contrast between dental and alveolar. Thus although a non-representative set of data definitely should caution us against rapid conclusions, the existence of non-Australian data and the few languages with a genuine contrast should not alter the conclusion reached here that conflation is appropriate in the dentoalveolar region.

When conflation is appropriate then the question is which values in the dentoalveolar region should be conflated. As has been made clear, I have chosen to conflate the two places of articulation dental and alveolar into one unspecified dentoalveolar zone. This means that contrasts such as those in Temne and Isoko mentioned above will be distinguished in terms of different specifications referring to the active articulator, whilst locationally they will both be dentoalveolar (I return to how the active articulations should be represented underlyingly in ch. 4 below). But why are values of the passive articulator conflated? Conflation might just as well involve the two active values apical and laminal.

There is not one really compelling argument to support that this conflation should affect the values of the passive rather than the active articulator. Probably the best argument is the fact, as I shall return to in chapter 4, that apicality and laminality will be needed phonologically to account for other consonant contrasts. Hence it is natural to conflate the two passive values dental and alveolar. But this argument suffers from being intrinsic rather than extrinsic. Other factors such as relative complexity does not point one way or the other either. There is no indication that dental and alveolar any more than apical and laminal deviate with respect to relative complexity (and saliency). That the conflation affects the passive parameter thus is a result of the fact the passive articulator is assumed to be basic and that the present description in general is based on this assumption (cf. the discussion in § 3.2.1).

The contention that a conflated dentoalveolar zone should be part of the descriptive framework entails that it is necessary to consider how such languages which make a genuine contrast between dental and alveolar should be allowed for, i.e. languages in which the contrasts in question cannot be accounted for by some accompanying active feature. In UPSID there are two such languages, viz. Malayalam (cf. Maddieson 1984:414, Ladefoged 1971:40) and Tzeltal (cf. Maddieson 1984:374, Kaufman 1971), both of which, as I mentioned earlier, have apical dentals and apical alveolars. Since they are articulated with the apex of the tongue, the members of such contrasts must be accounted for locationally. Thus in very few cases we must accept that dental and alveolar function as individual zones rather than as one conflated place of articulation. But this solution is only acceptable provided it is possible to express that it represents a marked situation.

Malayalam, which is one of the languages in question, seems to confirm that these languages are marked. Malayalam makes a contrast between at least 6 different places of articulation. It is crucial that it makes a contrast between more than 4 places of articulation. Recall that there are 4 simplex zones. A language with 4 contrastive zones where two of these are dental and alveolar would therefore not bring out the markedness of the consonant system, as, typically, all four zones in such a language would be assigned to the simplex category. But with Malayalam this situation does not arise. Malayalam has 6 contrastive places, and Tzeltal, the other UPSID language which requires both the dental and the alveolar zone, also distinguishes between more than 4 places of articulation. Furthermore, Maddieson remarks (1984:32) that none of the languages which have both dental and alveolar consonants have less than 4 and typically they use 5 or 6 places of articulation. It is true, Maddieson does mention languages with 4 place contrasts. But recall that for Maddieson this observation applies to all 24 languages which make a contrast between dental and alveolar places of articulation irrespective of whether the distinction is further intensified by active articulations. However, when these are filtered out, the contrastive places of articulation in the remaining languages appear to number more than the crucial 4.

In other words, a language which makes a genuine contrast between dental and alveolar is likely to appear as marked by virtue of the fact that due to the large number of places utilised either dental or alveolar will be assigned to the complex set. But which should be complex and which should be simplex? Intuitively, most phonologists would probably assign alveolar to category 1, i.e. to the simplex set, and dental to category 2, the complex set. This pattern is also confirmed by the two languages with which I'm most familiar, Danish and English (English has only two dental consonants, viz. /θ/ and /ð/, Danish has none).[10] But more importantly such intuitive judgements and the evidence from English and Danish are also supported by the UPSID data, according to which *s* and *z*, the nasal *n*, laterals and (non-uvular) *r*-sounds are highly likely to be alveolar rather than dental. Consider the following frequency figures for these sounds given by Maddieson (1984:45, 60, 77 and 81):

(3.8)

	dental	unknown dental/alveolar	alveolar
s	33	131	102
z	11	49	36
n	55	155	106
l	31	178	132
r	9	118	135

from which it is clear that alveolar is a considerably more frequently used place of articulation than is dental. And if those sounds with unknown dental/alveolar specifications divide into something approaching the ratio of those with known dental and alveolar places of articulation, as would seem likely, this tendency becomes even more obvious. Thus on the basis of a quantitative examination the conclusion is that in those few languages (two in UPSID) which require separate dental and alveolars zones, the alveolar zone is the simplex one and the dental zone the complex one.

To conclude, in by far the majority of the world's languages an unspecified dentoalveolar zone is sufficient to account for the phonological contrasts occurring in the dental and alveolar region. Often a contrast between dental and alveolar is not within the same series of consonants. Consequently the consonants in question will be kept apart by means of other descriptive dimensions, airstream mechanisms or categorial dimensions, and the consonants in question can just be referred to as dentoalveolar.

10. Although they are best described as pre-alveolar, Danish /t, d, s, n, l/ are normally regarded as alveolar consonants.

If a contrast between dental and alveolar occurs within the same series, a difference in active articulation will usually distinguish the two and specific reference to dental and alveolar places of articulation is still not required. Only in those very few cases where the dental/alveolar contrast is not otherwise distinguished is it necessary to operate with two individual articulatory zones. Clearly, this represents a marked situation, but the languages in question distinguish between more than 4 places of articulation. Consequently, given the universal set of four simplex places of articulation, dental and alveolar will be made to differ in complexity in these languages: alveolar will be simplex, dental will be complex.

3.2.6 Layer 1 summed up. By way of conclusion, let me sum up the main points about layer 1. Layer 1 is made up of a set of articulatory zones. Each of these refers to a restricted area on a parameter which specifies independent values of passive articulation. I term this the oro-pharyngeal parameter. This parameter is divided into seven articulatory zones: labial, labiodental, dentoalveolar, palatal, velar, uvular and pharyngeal (an extra articulatory zone will be added later, see § 4.2.1 below). The individual values are deliberately referred to as zones. The term zone reflects the fact that the exact border lines between the individual places of articulation are not always easy to draw. But it is an important contention of the proposal that these zones differ among themselves with respect to complexity. Labial, labiodental, dentoalveolar and velar constitute the simplex or unmarked set, a set which is labelled category 1 zone types, whilst palatal, uvular and pharyngeal make up the complex set, the category 2 zone types. This subdivision is supported by two facts: the relative frequency of phonological segments (cf. Nartey 1979, Maddieson 1984), and the relative saliency of phonological features (cf. Stevens and Keyser 1989). An examination of frequency and saliency shows that the most frequent place types are also those which the most salient features identify. The proposal that some articulatory zones are simplex and some are complex is thus motivated by directly observable and in fact mutually supporting facts.

An important claim of layer 1 is that dental and alveolar are not independent positional classes, but instead act together in a conflated unspecified dentoalveolar zone. This conflation is motivated by the fact that the distinction between dental and alveolar places of articulation can be maintained in terms of other than strictly positional means, namely in terms of lingual activity, in particular apical *vs.* laminal tongue activity. In this way it is possible to reduce the number of oro-pharyngeal zones, without otherwise increasing the number of descriptive tools. The two lingual components introduced to capture the apical *vs.* laminal distinction will not add cost to the description as they will be needed, as we shall see in ch. 4, for the description of other contrasts. But it should be observed that the description also allows for the possibility of 'dissolving' the unspecified articulatory zone, dentoalveolar, to allow for the few cases where dental *vs.* alveolar represents a genuine place contrast. Frequency data here predict that in this event alveolar has category 1 status, dental category 2 status.

With respect to the requirements formulated in (3.1), the present description so far only meets the first and the last of these, and the last requirement only partially. Thus not only does it not allow for active articulation nor show how (3.1c) and (3.1d) should be observed, but the present description also fails to meet that part of (3.1e) which concerns the expression of relative complexity. For this reason I shall introduce a further layer. The introduction of this will enable me to live up to (3.1e) fully, as well as make it possible to meet, partly or fully, the requirements as yet not complied with. This layer is layer 2.

3.3. Layer 2: the domicile of |i|, |a| and |u|.

Whilst layer 1 describes passive articulation, i.e. fulfils requirement (3.1a), layer 2, given that its function, as anticipated above, is to meet (3.1b), (3.1c) and (3.1e), necessarily plays a much more diverse role than layer 1. But although they clearly serve distinct functions, the two layers also interact. In fact, it is my contention that the articulatory zones together with layer 2 form a web or, as I shall term it, an articulatory network. The horizontal meshes of this network are the two layers, layer 1 and layer 2, whereas the vertical meshes are constituted by the individual zones. The latter are, as it were, prolonged and intersects with layer 2. In other words, layers 1 and 2 represent the longitudinal dimension of the articulatory tube, and the individual zones represent the 'traverse' and 'vertical' locations within the vocal tract. The appearance of this network entails that components of layer 1 and layer 2 may become associated if as a result of this intersection they appear within the same prolonged zone. A given articulation type may then be described collectively by the values of layer 1 and the components of layer 2, i.e. by the associated constituents that occur in the zone in question. I formulate this as follows (the zonal association hypothesis):

> The articulatory description of a consonant in terms of layer 1 and layer 2 is an intersection of the longitudinal (horizontal) layers and the traverse (vertical) articulatory zones defined by the values of layer 1.

> When intersection results in constituents of vertical and horizontal sets co-occurring in the same zone, the constituents in question are associated.

The defining property of the layer 1 values follows from the basicness ascribed to layer 1 (for discussion see § 3.2 above). This basicness in part follows from the fact that phonologically no consonantal place specification can be constituted solely by a layer 2 specification. Layer 2 is constituted solely by the vowel components |a|, |u| and |i|: no other components are assigned to this layer. But the extent to which these components can be associated with the oro-pharyngeal zones is limited and dictated by the way the components are defined. In the following I shall look at how |a|, |i| and |u| disperse among the articulatory zones. An examination of this distribution will also reveal how layer 2 serves to fulfil (3.1b), (3.1c) and (3.1e).

3.3.1 The function and distribution of |a|, |i| and |u|. Recall that when |i|, |a| and |u| are used at layer 2 their use is restricted, in particular they cannot interact in dependency relationships. Imposing this restriction is a consequence of the fact that I reject the idea that two consonants may differ in terms of the relative degree of some place property (see discussion in § 2.2 and for some potential counter-evidence Nolan 1992).

The distribution of |a|, |u| and |i| is best understood by considering how they function. Let us consider |u| first. Above I anticipated that part of the role of layer 2 is to allow for (3.1d), cross-classification. The function of |u| is closely linked with this role. By cross-classification I mean the phenomenon whereby articulatorily distinct classes of sound form a natural class. It is now a widely established fact that in many languages labials and velars constitute such a natural class, and it is an equally well-established fact that what unites them is the property which Jakobson *et. al.* (1952) termed gravity, i.e. concentration of acoustic energy in the lower part of the spectrum (for an extensive treatment of the need for the feature [grave] see Davidsen-Nielsen and Ørum 1978 and Hyman 1973).

In dependency phonology gravity is expressed in terms of the component |u| which is defined as 'roundness' (or 'gravity' or 'flatness')(Anderson and Ewen 1987:206). Thus back vowels, which are grave, all show |u| in their articulatory description. Grave consonants consequently must also involve a |u|-specification. Given the association hypothesis, consonants described in terms of the labial/labiodental and velar zones then show |u| at layer 2. So must in fact uvulars which according to both Davidsen-Nielsen and Ørum (op.cit.) and Ladefoged (1971) also exhibit concentration of energy in the lower part of the spectrum. Some phonologists also include pharyngeals among the grave consonants (cf. again Davidsen-Nielsen and Ørum op. cit.), but since opinions are divided on whether this is an appropriate interpretation (Ladefoged (op.cit.) states they are non-grave), pharyngeals will here be specified as having optional |u|. Given that at last one of its functions is to allow for gravity, |u| will then be associated with labials, labiodentals, velars, uvulars and optionally pharyngeals.

But to which zones should |a| and |i| be assigned? |a|, I contend, should be coupled with the uvular and pharyngeal zones. Association of |a| with U follows both Staun (1983) and Anderson and Ewen (1987) all of whom, following Lass and Anderson (1975:18-19), argue that uvulars as well as having backness characteristics also should be described as low - and |a| is defined as 'lowness'. There also seems to be sufficient evidence to suggest that |a| should be used for pharyngeals (but not necessarily as the only component, see below). For example both Ladefoged (1971) and Davidsen-Nielsen and Ørum (1978) state that [ɑ] is pharyngeal, a claim which would make a specification of the latter as involving |a| natural, given that [ɑ] is {|a|} in dependency phonology. Also the fact that the most obvious feature specification of pharyngeals involves [+low] and [+back] speaks in favour of a |a|-assignment for this zone.

As for |i|, the most obvious association is with P, the palatal zone. This is also in line with previous treatments. Anderson and Ewen (1987:ch.6) describe palatals by means of their |l|-component and |i| and Staun (1983) associates palatality with |i|-ness. I shall then consider this as the most plausible association. Thus the ditribution of |i|, |u| and |a| should be as in (3.9) where the placement along the horizontal axis indicates how they disperse among the zones defined by layer 1:

(3.9)

<table>
<tr><td>P</td><td>F</td><td>T</td><td>C</td><td>K</td><td>U</td><td>Ph</td></tr>
<tr><td>labial</td><td>labio-
dental</td><td>dento-
alveolar</td><td>palatal</td><td>velar</td><td>uvular</td><td>pharyngeal</td></tr>
<tr><td colspan="2">u</td><td></td><td>i</td><td>u</td><td>u,a</td><td>(u), a</td></tr>
</table>

It was established above that the function of |u| is that of expressing gravity. This accounts for the distribution of |u| displayed in (3.9). But we have only considered the possible distribution of |i| and |a|, not their function. What is this then? The answer to this question can partly be found in the previous discussion leading to the assignment summarised in (3.9). What I established there was the plausible consonantal congeners of |i| and |a|, in particular the vowels that they serve to characterise. In other words, part of the function of |i| and |a| is to provide us with a means to characterise vowels and consonants in the same terms. By the distribution proposed in (3.9) we have then met requirement (3.1d). The fact that it is possible to express such relations is important for the formulations of phonological rules (see, e.g., Staun 1983). For example, the dispersal of the vowel components expresses how e.g. palatals are cognate to high front vowels or pharyngeals to [ɑ]. But this is not their sole function. By establishing congeners between vowels and consonants, we have also provided a partial picture of active articulation. For example, the presence of |i| and |a| respectively indicates 'tongue blade raised' and 'back of the tongue lowered', both of which are helpful reference points, but clearly not sufficiently detailed to describe the articulation of a wide range of sound types. In the case of |u| the active implications are far less obvious. Its articulatory definition of 'roundness' can only be relevant with labial consonants, and its association with velars and uvulars is not articulatorily motivated, but exclusively based on its acoustic property of gravity. But nothing prevents us from establishing congeners on the basis of shared acoustic features. Thus (3.9) still expresses the well-known fact that velars are cognate to high back vowels.

Clearly, as just pointed out, the information on active articulation provided by (3.9) is of a very restricted nature. I return therefore to a more detailed description of this kind of articulation in chapter 4. First, however, I must turn to an issue which is closely tied to layer 2 and whose representation involves the invocation of layer 2. This is the issue of how the relative complexity of the articulatory zones established earlier should be expressed.

3.3.2 The expression of relative zonal complexity. Let me begin with a brief recapitulation. In its present form layer 1 is divided into seven articulatory zones (see § 4.2.1 below for a revision). These are subdivided into two types depending on the degree of complexity that they exhibit: category 1, which consists of labial, labiodental, dentoalveolar and velar, is the simplex or unmarked type, and category 2, which consists of the remaining three zones, palatal, uvular and pharyngeal, is the complex or marked type. The motivation for the subdivision into a complex and a simplex set is based on relative frequency of occurrence and relative perceptual saliency. However, it is not enough to be able to account for this difference in complexity. As much recent work on phonological theory has shown, such a difference should also appear directly from the phonological representations themselves. The object of this section is to show how this is achieved in the present framework.

I start with the (trivial) statement that layer 1 and layer 2 have been designed to describe phonological levels. I am deliberately no more specific. I avoid the use of a more specific term because I do not want to commit myself to one particular interpretation of phonological level. Since SPE it has been generally accepted, although not always utilised, to operate with more than one phonological level: in particular the abstract initial lexical level and the equally abstract phonological level. Recently, the idea has been revived that not only several phonological levels are available to the phonologist (cf. the work within what is known as lexical phonology; for an introduction see e.g. Goldsmith 1990, Durand 1989), but also that the nature of the representations of the abstract levels may differ.[11] In the present context the existence of the latter possibility is of particular interest. The work in which this idea has been revived and reconsidered is that of Archangeli (1983 and 1988) on underspecification theory. Archangeli has defended the view that blank (underspecified) representations should be allowed not only derivatively, on which there has been general consensus among generative phonologists for a long time, but also underlyingly which has been considered illegal since Stanley (1967) (although defended by Chomsky and Halle in SPE in one instance, cf. SPE:389). According to Archangeli three types of underspecification may be recognised at the underlying level: non-contrastive underspecification (in which features are left blank because they are non-contrastive), radical underspecification (in which features values are left blank because they are predictable) and inherent underspecification (in which the occurrence of blanks follow from the inherent nature of the features themselves).[12] What is interesting about Archangeli's work from the present point of view is that she sees a correlation between underspecification and relative complexity. Thus underspecification of the second type (radical underspecification) allows for the encoding of relative complexity. Those rules which fill in the blanks of a radically underspecified representation, the so-called default rules and complement rules, may either

11. In what follows I shall use the term underlying level for the initial, underspecified phonological level and lexical level for the last level of the lexical component, whilst phonetic level is the term used for the output of the post-lexical component.

12. Archangeli terms the first of these types of underspecification contrastive specification, but since it refers to a situation where features are left blank, I prefer a term which explicitly reflects this. Therefore I shall prefer the term non-contrastive underspecification.

reflect cross-linguistic generalisations such as those I established on the basis of the works of Nartey, Maddieson and Keyser and Stevens or language-particular facts. The extent to which a given representation exhibits relative complexity is apparent from the use it makes of the universal default rules *vs.* the language-particular default rules. The more language-particular rules are required the more complex a given representation is considered to be.

According to Archangeli, underspecification within a notational system based on monovalent features is of the third type, i.e. of the type named inherent underspecification. Apparently this means that it is not possible to encode or allow for the encoding of relative complexity within a notational system based on monovalent features. Only a notational system capable of expressing radical underspecification may do this. But this seems to be in conflict with another view defended by Archangeli. According to her both inherent and radical underspecifications assume units smaller than the segment as the phonological primes, and in Archangeli's words the 'logical extension of [radical underspecification] leads to the *feature* as the most basic unit' in phonological representations (1988:193). But the problem with this last statement and the afore-mentioned distinction between radical and inherent underspecification is that, in principle, a unary component is as much a feature as a binary or some other kind of feature (although they differ with respect to how they are defined). Therefore radical and inherent underspecification must basically be of the same type. In other words, because they both assume that elements smaller than the segment are atomic, they exemplify the same kind of underspecification. Consequently, I shall assume in the following discussion that inherent underspecification is a variant of radical underspecification.

Before I consider the actual expression of relative complexity and its interaction with underspecification within the notation I have developed here for consonantal place, it is necessary to establish how I imagine the underlying phonological level should be represented. Because I have chosen radical underspecification as the basis of the initial phonological representation, the point of departure for the construction of the underlying level must be that this should contain no redundant information: anything predictable should be left out (this is characteristic of radical underspecification). The question is then what is predictable and what is non-predictable. If we assume that everything which is predictable is non-atomic and everything non-predictable atomic, then, given the basicness of radical underspecification, the feature or the component, in particular the non-redundant features or components, are atomic. The segment, on the other hand, is non-atomic or derived. This is so because linearity - the defining characteristic of segments - is derived or at least minimally operative at the underlying level. This status follows from the fact that the erection of the phonological representation takes as its point of departure the categorial representation, i.e. $|C|$ and $|V|$ or combinations thereof, and sequence is predictable on the basis of sonorancy, i.e. the relative preponderance of $|V|$.[13] The sonority hierarchy predicts, in the unmarked case, that the syllabic nucleus is flanked by segments of decreasing sonorancy. The segment is therefore non-lexical (of course this claim is subject to (language-particular) restrictions, see Anderson 1987), linearisation being predictable from a segment's relative placement along the sonority hierarchy as defined by the relative preponderance of $|V|$. Only onset, on the one hand, and rhyme, on the other, enter into a precedence relation underlyingly. In sum, then, the underlying representation consists of bundles of components, principally non-linearised, except for syllable sub-parts such as onset and rhyme. Consequently, an underlying representation for a word such as English *blend* will appear as in (3.10):

(3.10)

$$\begin{array}{cccc}
/\mathrm{b}/ & \begin{bmatrix} \mathrm{C;V} \\ \mathrm{L} \end{bmatrix} & \begin{bmatrix} \mathrm{V} \\ \mathrm{i;a} \end{bmatrix} & /\mathrm{e}/ \\
/\mathrm{l}/ & \begin{bmatrix} \mathrm{V;C;V} \\ \mathrm{T} \\ \lambda \end{bmatrix} & \begin{bmatrix} \mathrm{V;C} \\ \mathrm{T} \end{bmatrix} & /\mathrm{n}/ \\
 & & \begin{bmatrix} \mathrm{C;V} \\ \mathrm{T} \end{bmatrix} & /\mathrm{d}/
\end{array}$$

13. It might be argued that $|V|$ in some instances is redundant since sonorants can be said to be redundantly voiced, and voicing is associated with $|V|$-ness. Arguably, $|V|$ is then only needed in the specification for obstruents, namely to signal whether they are voiceless or voiced: only in this instance does $|V|$ function contrastively. If this assumption is correct, then $|V|$ is only needed underlyingly when governed by $|C|$, but not when it is governor or when it occurs alone. However, for this assumption to be true it is a prerequisite that the absence or presence of $|V|$ only represents a privative opposition. To the extent that $|V|$ refers to voicing it acts privatively. But $|V|$ is also the specifier of periodicness (cf. Anderson and Ewen 1986:ch.4) which is a gradual property. When this property is taken into account, it is difficult to argue consistently for $|V|$ being predictable and hence redundant.

in which the left-most column is the onset and the right-most column the rhyme. Serialisation of the 'bundles', onset and rhyme, then takes place derivatively and according to rules that need not concern us here, for discussion see Anderson 1987. Underlyingly, the phonological representations are then not segment-based. Segments are redundant. The only non-redundant consecutive elements that occur underlyingly are the syllable constituents, onset and rhyme.

Given that the underlying phonological representation has this shape, relative complexity should then appear from the non-redundant (and non-serialised) componential specifications. The question is how. Let me first recapitulate that it is assumed that the expression of relative complexity is part of underspecification: the latter encodes the former, at least this is the hypothesis of radical underspecification with which I am concerned here. However, so far work on radical underspecification has been based on binary features and not, except for a few studies (see the work of Anderson and Durand 1988, Durand 1990:ch.8 within dependency phonology), on notations based on unary components. But using the unary components of dependency phonology and not binary features makes an important difference. Observe that it is the contention of dependency phonology that relative complexity is built into the componential representations of the underlying phonological representations posited within this model. Relative complexity is specified such that absence of components, or fewer components, in a representation reflects a relatively less complex sound and the presence of more components a relatively more complex sound. For this reason Anderson and Durand (1988) have argued that underspecification already is part of the notation. This follows from the fact that components may be present or absent and this presence *vs.* absence directly reflects markedness. The set of conventions associated with underspecification theory which is largely a legacy from markedness theory is thus simply redundant within dependency phonology. Such external conventions have been incorporated into the phonological representations. Because the latter are based on monovalent components which directly express markedness, relative complexity appears directly from these representations.

But these observations may apply to vowels which are the only sound types that Anderson and Durand examine. But do they also apply to consonants, specifically the articulatory specification of consonants? Let us first consider whether Anderson and Ewen's description of the articulation of consonants succeeds in linking unmarked status with underspecification. This should appear from their representations of the seven main consonantal place types which they propose, all place types which in the present framework will be described in terms of zones at layer 1. I repeat Anderson and Ewen's specifications in (3.11):

(3.11)

bilabial	labiodental	dentoalveolar		palatal
|u|	|u,d|	|l|		|l,i|
		dental	alveolar	
		|l,d|	|l|	
velar	uvular		pharyngeal	
|l,u|	|l,u,a|		|l,u,a|	

For the definitions of the individual components employed in (3.11), see Anderson and Ewen 1986:ch.6 and § 2.2. above. From (3.11) it is clear that there is no consistent correspondence between simplex/complex place types and the proposed representations. The simplex place types, viz. bilabial, labiodental, dentoalveolar and velar, are either represented in terms of one or two components and the complex ones, i.e. the remaining place types, in terms of representations which involve two or three components.

The main problem with Anderson and Ewen's representations is that palatals and velars are not distinguished, despite the fact that palatals are (notoriously) more complex than velars (see further below and for a different interpretation § 3.3.3 below). Perhaps this problem could be solved if the representation for velars were considered to have two components exceptionally. It might be argued then that the three main, and hence simplex, places of articulations, viz. labial, dentoalveolar and velar, would all be marked by one component. Unfortunately, the possibility of establishing a general picture along these lines is disturbed by the fact that labiodental also is a simplex place type and this involves two components. So even if we attempt to stretch Anderson and Ewen's notation beyond what arguably is an acceptable limit, it cannot combine simplicity with underspecification in any consistent way.

But does the representational system proposed here allow simplicity to be linked with underspecification? As I anticipated earlier, this is perfectly possible if layer 2 is invoked. Recall how I argued above that the vowel components at layer 2 enter into an articulatory network in which they become associated with the articulatory zones. I argued that this association is not random, but determined by the way the zones and the components are defined. If we assume that underlyingly, i.e. at the initial underlying phonological level described above, the simplex zones are underspecified in the articulatory network such that they cannot be associated with a layer 2 component, then we can allow for relative complexity at the initial level. Those zones which are either always componentless or may be associated with a |u|-component derivatively, but not with other components, in the articulatory network are unmarked or simplex. They are, as it were, componentless 'by birth'. This absence of components underlyingly distinguishes them from the category 2 types. The latter are not componentless, in particular they are specified by either a single component other than |u| or by |u| plus |a| underlyingly. This fact marks them off as more complex. I summarise these observations in (3.12):

(3.12)

category 1:	labials	labiodentals	dental/alveolars	velars
	P	F	T	K
category 2:	palatals	uvulars	pharyngeals	
	C,i	U,u,a	R,a,(u)	

It might be argued that it would be natural to consider |i| as the unmarked value for palatals, i.e. leave palatals underspecified too and consider it a category 1 type, in particular since it is a very common process for velars to become palatalised under the influence of front vowels, and indeed a much more common process than for palatals to become velarised under the influence of back vowels. Anderson and Ewen mention this fact too (1987:ch.6) and admit that their articulatory description of palatals and velars is encumbered by the weakness that it does not allow for a way of expressing the greater naturalness of palatalisation (their representations for palatals and velars are equally complex). But there is no reason why we should share this worry with Anderson and Ewen. The absence of velarisation seems to follow from the relative scarcity - numerical scarcity, that is, cross-linguistically - of palatal sounds. Since these articulatory assimilations typically affect only sounds of adjoining zones, at least this appears to be characteristic of palatalisation, in the absence of palatals no sounds further forward in the mouth get velarised and fewer instances of velarisation will occur simply. Such assimilation evidence should then not affect the complexity status of palatality and velarity assumed so far.

The solution schematised here permits the expression of relative complexity without the extra use of conventions in the form of default rules and complement rules. The relative complexity appears directly from the phonological representations and it is represented at the first phonological level. I admit that the solution proposed here is not the optimal one. The problem is that the function of the components is solely to express complexity; they do not serve contrastive purposes and arguably radical underspecification is therefore not fulfilled for all zonal representations. We have to live with the fact that such redundancies are not all together absent from the initial phonological level when each articulatory zone is described in terms of individual zonal labels.

The alternative would be to describe place of articulation in terms of unary components. For example, we could posit one component to denote the 'labial' end of the articulatory passive parameter and another to denote the 'pharyngeal' end, and then describe the intermediate values in terms of dependency relations involving these two components. The effect of this would be as shown in (3.13 a&b), which represent an attempt to describe the passive parameter in terms of two unary components, |F| and |R|, defined tentatively as fronted articulation and retracted articulation respectively. (3.13a) represents the five places labial, dentoalveolar, postalveolar (see § 4.2.1 below), palatal/velar and uvular/pharyngeal and (3.13b) the further differentiations (in b. T and D stand for dental and alveolar respectively):

(3.13)

a.

<table>
<tr><td>labial</td><td>dentoal.</td><td>post.al</td><td>pal/vel.</td><td>uvl./phar.</td></tr>
<tr><td>|F|</td><td>|F;R|</td><td>|F:R|</td><td>|R;F|</td><td>|R|</td></tr>
</table>

b.

<table>
<tr><td>P</td><td>F</td><td>D</td><td>T</td><td>C</td><td>K</td><td>U</td><td>Ph</td></tr>
<tr><td>|F|</td><td>|F;R|</td><td>|F;R|</td><td>|F;R|</td><td>|R;F|</td><td>|R;F|</td><td>|R;F|</td><td>|R|</td></tr>
<tr><td></td><td>|</td><td></td><td>|</td><td>|</td><td></td><td>|</td><td></td></tr>
<tr><td></td><td>|F|</td><td></td><td>|R|</td><td>|F|</td><td></td><td>|R|</td><td></td></tr>
<tr><td>(u)</td><td>(u)</td><td></td><td>(u)</td><td></td><td>(u)</td><td></td><td></td></tr>
</table>

But such a solution should only be preferred if it can be shown that there exist a scalar relation between the different places of articulation, and if it allows us to express that the place types differ in complexity. The latter is certainly not apparent from (3.13). The simplex categories (marked (u)) are not those which are represented in terms of fewest components as required. And as for the former there is so far no clear evidence that there exists a scalar relation between all the various places of articulation, as a representation based on dependency relationships predicts. It is true, such evidence exists for some places of articulation, but it is only a restricted set and it is not clear whether the scale works both ways (see e.g. Nolan 1992). So long as such evidence does not include all places of articulation and the complexity problem cannot be solved in another way, we have to make do with less homogeneous solutions such as the one proposed in the previous pages.

3.3.3 The special status of coronal consonants. A discussion of place of articulation and complexity should also consider the special and unmarked status which much recent research has assigned to the so-called coronal consonants (for an extensive discussion see Paradis and Prunet 1991a). Coronals are those consonants which in an SPE-type of framework are specified [+coronal]. Given the definition of this feature, coronals are those consonants which are produced with the tongue blade, but whether [+coronal] covers only those consonants articulated with the blade and not the tip or those articulated with both blade and tip is a matter of some debate. Here I shall assume that coronal refers to any consonant articulated with the blade plus or minus the tip. Thus coronal consonants include: dental, alveolar, retroflex, palato-alveolar and palatal consonants.

It is the contention of many specialists (see the contributions in Paradis and Prunet op. cit.) that coronals, as opposed to labials and velars for example, with respect to a wide range of phenomena behave in a unique way and have properties not shared by any other places of articulation. This special status has led many specialists to suggest that coronals are unmarked, as opposed to labials and velars, and consequently such specialists represent coronals underlyingly in a way which reflects this. The following representation of labials, velars and coronals proposed by Paradis and Prunet (1991b:6) summarises this view on coronals (Paradis and Prunet assume the hierarchical feature representation of feature geometry, cf. Clements 1985, McCarthy 1988 *inter alii*; RN = root node, SLN = supralaryngeal node, PN = place node):

(3.14)	labials	velars	coronals
	RN	RN	RN
	|	|	|
	SLN	SLN	SLN
	|	|	
	PN	PN	

From (3.14) the unmarked status of coronals is apparent from the fact that the place node is absent with this sound type, an empty slot which is then later filled in by a redundancy rule.

How can the framework developed here handle this special and unmarked status of coronals? Immediately, this special status does not seem to be compatible with the two complexity classes, category 1 and category 2, proposed here. Coronality unifies places of articulation which in the present framework are assigned to distinct complexity values, i.e. both category 1 and category 2. In particular, only dental and alveolar (in so far as they do not co-occur) are unmarked in both descriptions, while a large sub-set of the coronal consonants, viz. retroflex, palato-alveolar and palatal, will be marked as complex in the present framework, but unmarked in a framework based on the coronality-hypothesis.

However, the two positions can be reconciled. A closer inspection reveals that it is probably appropriate to make a distinction between [+anterior] and [-anterior] coronals. The evidence for this is: a) that the frequency figures used to defend the universal status of coronals refer to dentoalveolar, i.e. to the [+anterior] subset (Paradis and Prunet 1991b:1), b) that the transparency effect of coronals - i.e. the ability of a feature to allow another feature to spread across it - seems also to be bound to specifically the [+anterior] subset (Paradis and Prunet 1990) (or to velars, which poses a serious problem to the coronality-hypothesis (cf. Paradis and Prunet 1991b:10)) and c) that in a discussion of the interaction of coronals and speech errors both Stemberger and Stoel-Gammon (1991) and Béland and Favreau (1991) conclude that only [+anterior] coronals lack place features, i.e. are unmarked or simplex.

If indeed the tendency that the [+anterior] coronals single out as a separate class is as general as the afore-mentioned evidence suggests, then the coronality-hypothesis will fit in rather nicely with the complexity values ascribed to the articulatory zones in this study. [+anterior] coronals cover dentoalveolar; the special and unmarked status of [+anterior] coronals thus corresponds to the simplex status of the dentoalveolar zone established here.

But there are further implications of the coronality-hypothesis which we should consider here and which have consequences for the present study. The point of the hypothesis is not only that coronals are special, but also that the [+anterior] coronals occupy a unique position. This means that dentoalveolar should appear as a special class in the underlying representation. This can be expressed in feature geometry along the lines shown in (3.14). But it is in fact also how this zone type appears in the present framework. If we recall the layer 1 and layer 2 representations proposed in (3.9) for the oro-pharyngeal parameter, then the special status of the dentoalveolar zone is directly apparent from the fact that dentoalveolar is the only zone which is not associated with a layer 2 component underlyingly or derivatively. In other words, absence of a specification is again a characteristic of simplicity, in this case of - one might say - further simplicity.

It may be that the special status of the [+anterior] coronals is reconcilable with the simplex categories of the present framework. But what about the [-anterior] coronals? As I discussed earlier, the evidence adduced to defend the special status of coronals is based very much on the [+anterior] set, whilst the [-anterior] set seems to play a much less conspicuous role. I contend that this is because this set is radically different to an extent which is not fully recognised by the adherents of the coronality-hypothesis. If we recall which places of articulation are singled out when we examine the relative frequency and relative perceptual saliency of speech sounds (cf. § 3.2.4 above), none of the [-anterior] ones are among these. But these two parameters are essential in a universal characterisation of place types and as long as they fail to identify [-anterior] coronals as unmarked the latter are best not treated as unmarked underlyingly. This interpretation does not exclude that coronals act together as a special class at some derived level.

To conclude, it is undoubtedly correct that the behaviour of coronals warrants that this class be associated with a representation showing simplicity. Underlyingly this should probably only include the [+anterior] subset, whilst the [-anterior] subset only joins the coronal class derivatively. With a little modification a representation based on (some version of) feature geometry can express the different complexity values of these two subsets. But the special status of the [-anterior] subset does not follow naturally from the representation. This is characteristic of the present representation, on the other hand, in which the dentoalveolar consonants are the only class of consonants which are not associated with one or more layer 2 components. In other words, the present framework is able to express that not only labial, dentoalveolar and velar are unmarked, but also that the dentoalveolar zone occupies a special position among this simplex set.

3.3.4 Concluding remarks. It is my hypothesis, then, that the consonantal place contrasts should be divided into two classes: a marked type and an unmarked type. This subdivision is supported by saliency and relative cross-linguistic frequency and, in part, by the work on the so-called coronals. Underlyingly, these two complexity values are expressed in terms of radical underspecification, i.e. a representation which leaves no room for predictable features or components. The simplex sounds are simply those which are underspecified, the complex ones are those which are not. In a model based on unary components underspecification entails absence of components. But since absence of components always has been linked with simplex sound representations in dependency phonology, underspecification is already part of the dependency-based representation. It is, as it were, built into the representation. Consequently, it is not necessary to introduce new conventions and rules to express underspecification in this model. Such extra machinery is reserved for the standard feature-based frameworks and their many offshoots including such which operate with some feature hierarchisation like, for example, feature geometry.

CHAPTER 4

LAYER 3: ACTIVE ARTICULATION.

4.1 To which gesture does active articulation belong?

4.1.1 Preliminary. Chapter 3 was devoted primarily to a description of passive articulation, i.e. to that part of the locational articulation which involves the non-movable articulators. To allow for this part of the locational articulation of consonants I set up layer 1 and layer 2. But active articulation is as much a part of the locational articulation as is passive articulation. Chapter 3 did not specifically deal with the former, i.e. the movable side of locational articulation. The description of active articulation was limited to a specification of which vowels are congeners of which consonantal place types, a specification which was expressed at layer 2. However, quite clearly layer 2 is not able to allow for subtle active articulation types, in particular it cannot allow for such properties as laterality, apicality, laminality and retroflexion, all of which are active articulation types which also play an important part contrastively in the world's languages. Evidently, this limited application is unacceptable.

The object of this chapter is to remedy this deficiency and posit a third descriptive layer which can allow for those active articulations which layer 2 was unable to handle, i.e. such articulation types as laterality, apicality etc. However, before I embark on a detailed account of how such active articulation types should be described and what form such a new descriptive layer should have, it is necessary to consider a more general question, namely the question of whether such active articulation types really belong in the articulatory gesture. It is necessary to consider this question i) because it is not obvious that all these active articulation types should be described along with such properties as labiality, velarity etc., and ii) because it is not uncommon to see some of these articulation types (for example laterality) treated as manners of articulation. The latter in particular is a potential problem because if there is any correspondence between manner of articulation and the phonological gestures assumed here (cf. ch. 1 and § 4.1.2 below), manner of articulation corresponds to the categorial gesture and not to the articulatory gesture which is the object of the present investigation. The need for looking into this question is also apparent from the way such active articulation types are treated in feature geometry (see. e.g. Clements 1985, McCarthy 1988, Rice and Avery 1991). In feature geometry, which is also a feature-organising model, all such articulation types are not necessarily assigned to the tier or node (roughly gesture in the present framework) which subsumes place of articulation nor are they necessarily all assigned to the same tier or node. In the following I shall therefore consider the geometrical proposals concerning these articulation types in so far as they prove valid and contribute to a resolution of the problem.

4.1.2 Active articulation in dependency phonology. Dependency phonology, to which the present framework is indebted, regards the active articulation types as divided into two groups: one group which comprises all types except lateral and which belong in the articulatory gesture exclusively, and another which belongs in both the articulatory and the categorial gesture and which comprises just lateral. This distinction is best understood if we recapitulate the motivation for subdividing the phonological segment into articulatory and categorial gestures.

The distinction between articulatory and categorial gesture presupposes a set of (universal) distinctive features and is a result of a refinement of the standard feature theories (cf. Jakobson *et al.* 1952, SPE, Ladefoged 1971). More particularly, it is a result of a refinement which orders features into sub-groups (gestures) on the basis of their phonological behaviour.[1] A classic example which illustrates the advantage of ordered features is the characterisation of homorganicity. Consider, for example, homorganic lengthening in Old English (cf. Lass and Anderson 1975:appendix II, Anderson and Jones 1977:§ 5.7), a sound change which lengthens a short vowel before a sonorant plus another sonorant or non-sonorant consonant which agrees with respect to place of articulation with the first consonant. If homorganicity is formulated in a framework whose features are unordered and discreet, the environment of this rule will have to be described in terms of pairwise agreement between all features specifying place of articulation. If, on the other hand, all place features are grouped into a sub-segment, or gesture, which specifies just locational properties, the environment would appear as shown in (4.1) (using SPE-features):

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1. A model such as dependency phonology thus rejects unordered and discreet features as they are found in all standard feature frameworks. Although they all arrange their features into sub-groups, the standard feature frameworks do not make use of these sub-groups (SPE, for example, operates with the sub-groups, cavity features, manner of articulation features and others). It is therefore true to say that it is only with the formulation of such notational theories as dependency phonology, and later feature geometry, that the ordering of features has become real. It is only in these models that ordered features are used to describe phonological rules.

(4.1) $\begin{bmatrix} +\text{cons} \\ +\text{son} \end{bmatrix}$ $\begin{bmatrix} +\text{cons} \\ +\text{voice} \end{bmatrix}$
α[artic] α[artic]

which captures the fact that the core of this lengthening environment is agreement of all place features, a fact which is expressed by the α[artic]-specification.

(4.1) clearly demonstrates the advantage of ordering those features which specify place of articulation into one sub-set, the articulatory gesture. It is this set as a whole which agrees in the homorganic environment in question (cf. also arguments for the place tier in feature geometry), and given that the set of clusters involves /rd/, /rl/, /ld/, /rn/, /rθ/, /nd/, /ŋg/ and /mb/, it is clear that quite a diverse set of active articulation types is involved.

Another well-known argument for this sub-structuring within the segment is the change of voiceless stops to [ʔ] and voiceless fricatives to [h] (two processes common in the phonology of English, cf. Lass 1976). Again these rules support the same division. Such rules involve the deletion of all the locational features so what remains after the deletion is [consonantal], [vocalic], [sonorant], [voice] and [continuant], i.e. all the features which constitute the categorial gesture. In other words, all other features denoting locational properties including such active articulation properties as laterality, apicality etc. again act together by virtue of being the target of the deletion rule.

The presence of such explicit evidence clearly supports a single hierarchy covering locational properties including active articulation types. However, it is also the hypothesis of dependency phonology that there is a further refinement to be captured as specified above. Lateral, as pointed out, deviates from the rest of the articulations specified in the articulatory gesture. It is special because unlike any of the other active articulation types it has the characteristics of a manner feature, a property which should make it incompatible with an articulatory assignment.

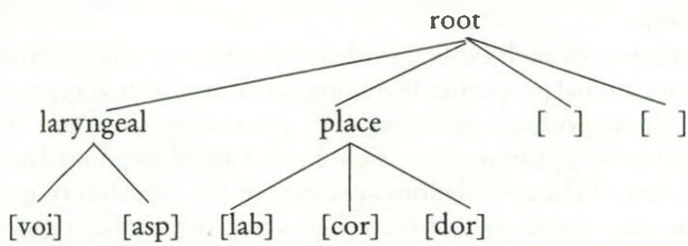
Manner of articulation, as opposed to place of articulation, refers to the various ways articulations may be accomplished in. For example, articulators may close off the vocal tract, they may narrow the space in the tract or, as in the case of many laterals, they may close off the tract centrally but remain open at the sides. If laterals with this 'manner' aspect are associated with the articulatory gesture, we will have a situation where one articulatory feature will describe the way in which others are realised.

This situation does not harmonise well with the view that features within the same gesture behave in a uniform way (which is the implicit assumption of the gesture hypothesis). Consequently, laterals should be described in the gesture in which such generally characterising features are allowed for, i.e. in the categorial gesture. But since laterals at the same time are predominantly coronal universally, a fact which has led many phonologists to consider coronal the basic feature of laterals, laterals should also have an articulatory specification. As we shall see below (§ 5.4), such a double or bi-gestural specification for laterals is also supported by phonological evidence.

It is fairly clear, then, that the active articulation types, i.e. such articulatory properties as apicality, laminality with the exception of lateral, should be accounted for in the articulatory gesture exclusively, i.e. belong in the same hierarchy as common-or-garden and uncontroversial place properties like labiality, velarity etc. Laterality, however, must receive special treatment. Its additional 'manner' properties requires a categorial representation too. Lateral is then a feature which should appear not only in the articulatory gesture but also in the categorial gesture.

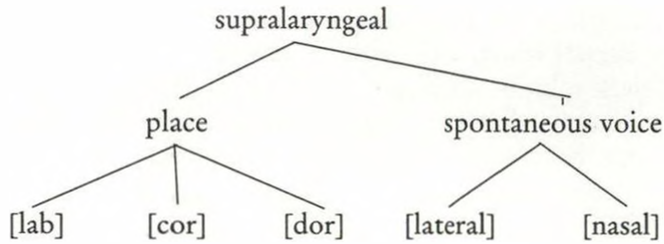
4.1.3 Active articulation in feature geometry. Like dependency phonology feature geometry (cf. Clements 1985, McCarthy 1988, among others) assumes that segments are not unordered feature bundles but have hierarchical internal structure. Although there is some disagreement about the exact hierarchisation, one common version adopted now is as shown in (4.2):

(4.2)



That is, there is fairly general agreement that the internal structure of segments have three organising nodes, root, laryngeal and place, all of which are motivated by the fact that they act as units in, for example, assimilations, dissimilations and reduction processes. What there is disagreement about is how many and which features fail to participate in such processes and therefore either hang piecemeal from the root node (the empty slots in (4.2)) or are bundled together under further root nodes as outlined in (4.3):

(4.3)



which has a supralaryngeal node between the root and the place nodes plus a further node, spontaneous voice, subsuming lateral and nasal (cf. Clements 1985, Rice and Avery 1991 among others). It has also been proposed that some of the major class features are bundled together and assigned to the root node, but exactly which and how many of the major class features are involved in this assignment is a matter of some dispute too; see McCarthy (1988) and Kaisse (1992), among others, for discussion of this issue.

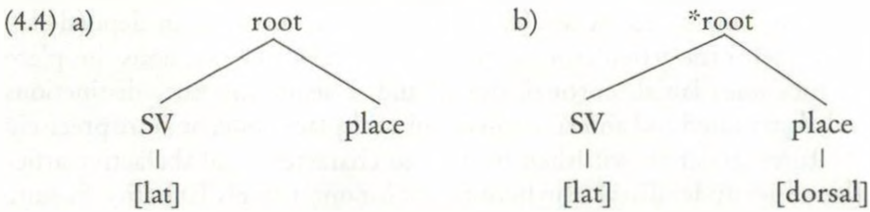
This is not the appropriate place and time to evaluate the different versions of feature geometry. Let us instead concentrate on whether feature geometry helps us establish where the active articulation types belong segment-internally. All versions of feature geometry assume a place node and the arguments for it are the same as those adduced in dependency phonology for the articulatory gesture (cf. § 4.1.1). In all versions this place node subsumes labial, coronal, dorsal and, usually, the finer distinctions round, distributed and anterior. Given this, the place node, or more precisely the features under it, will then be able to characterise all the active articulation types under discussion here except for one, namely laterality. Feature geometry thus confirms the hypothesis that active articulation types, with one exception, are exclusively locational (or in geometrical terms that they are all are assigned to the place node).

The exception, as just mentioned, is laterality just as it was an exception in dependency phonology, but, as in the dependency description, its exceptional status does not exclude a specification in terms of the place node, but merely that the place specification alone will not suffice. However the description of laterality in feature geometry has been a matter of some dispute and a single node description was at first thought to suffice. In particular, it was at first a dependent of the manner node (Clements 1985 and McCarthy 1988), but as this node was shown to be redundant (McCarthy op.cit.), lateral was assigned directly to the root node (Kaisse 1992, Iverson 1989) or made dependent on the coronal node, a sub-node of the place node (McCarthy op. cit. and Paradis and Prunet 1991b). Finally, as a fourth possibility, lateral was assigned to a separate node, spontaneous voice, as shown in (4.3) which is the position argued for by Rice and Avery 1991.

Of these solutions, Rice and Avery's is the most interesting. What makes it interesting is that it not only proposes that lateral should be a place dependent, but also that it should be a daughter of the spontaneous voice node, a node which roughly covers sonorancy. However, the former is not present in the phonological representation; it is underspecified. According to Rice and Avery laterals are coronal, but since coronal is the unmarked place specification for laterals, a coronal node under place is not found underlyingly. Laterals, they claim, cannot tolerate any specification beyond the place node, a situation they summarise in the 'structural complexity constraint' (Rice and Avery op.cit.:115):

> specified SV [spontaneous voice, J.S.] structure implies lack of specified place structure, and specified place structure implies lack of specified SV structure

This constraint allows a representation like (4.4a) but prohibits one like (4.4b) (cf. Rice and Avery op.cit.:114):



Thus if we disregard the existence of dorsal laterals (cf. § 4.5 below) which require a phonological representation such as the prohibited (4.4b) and which therefore present a serious problem to Rice and Avery's account, their analysis certainly captures the important facts about laterality. It captures the fact that laterality consists of two articulatory properties, properties which entail that, underlyingly, it should be specified at both the coronal node and at another node. This double representation for laterals allows for the almost universal coronal articulation of laterals and for the equally universal status of laterality as a manner of articulation.

Feature geometry thus confirms the hypothesis with respect to the classification of the active articulation types which has been proposed in dependency phonology, namely that the active articulation types should be specified in terms of the place hierarchy, and that laterality occupies a special position among the active articulation types requiring a bi-nodal representation of which one is location and the other roughly sonorancy.

4.1.4 Overview of chapter 4. I'm now in a position to embark on the actual account of active articulation. In the light of the previous discussion (§§ 4.1.1 - 4.1.3), it is beyond doubt that this account, with the exception of certain aspects of laterality, should be kept within the range of the articulatory gesture. As we saw above, there is sufficient phonological evidence to substantiate this hypothesis. As it happens, there is also phonetic evidence which supports the assignment of the active articulation types to the articulatory gesture. Such evidence has been provided by Catford (1977). According to him speech production involves three components, two of which are more basic than the third. One of the basic components is 'articulation' (the other is initiation) which is subdivided into 'location' and 'stricture type' (op.cit.: ch. 7 & 8). Catford's subdivision does not match the division proposed in dependency phonology between articulatory and categorial gesture. His 'articulation' only partly corresponds to the articulatory gesture; he includes phonetic events in his 'articulation' which in dependency phonology are categorial. But it is important to observe that Catford sees both locational properties and phenomena like apicality etc. as events of basically the same type; they are regarded by Catford as belonging within the same component.

Whatever the exact motivation may be for placing active articulation in the articulatory gesture, the data I shall consider in this chapter will all concern the underlying phonological level. The range of active articulation types I shall consider include not only the afore-mentioned apicality etc., but also such articulations as taps, flaps and trills. Some of the components I shall introduce to capture the various active articulation types will be assigned more than one function. In such cases I shall show that this approach does not lead to a confusion of phonological contrasts.

Clearly it is not enough to state that such and such an articulation type should be described in terms of such and such a component. It is also necessary to motivate why it must be specified at a separate layer. One active articulation type, viz. retroflexion, is exceptional in that it has a greater effect on the descriptive framework as a whole than any of the other active articulation types which will be described in terms of layer 3. Consequently, I begin with a consideration of retroflexion.

4.2 The function of layer 3

4.2.1 Retroflexion: an argument for a third layer and an extra zone. The reason why retroflexion occupies a special position is best illustrated by considering some relevant data discussed by Ladefoged (1971). The data come from (Dravidian) Telugu, Kannada and Malayalam. Let us first consider Malayalam. In this language dental, alveolar and retroflex *t* and *n* are phonemic. To account for these contrasts, Ladefoged proposes the following representations (cf. op.cit.:40):

(4.5)	dental	alveolar	postalveolar
	/t̪/	/t/	/ṭ/
	/n̪/	/n/	/ṇ/

From (4.5) it is clear that Ladefoged regards this contrast as one of place. In other words, Ladefoged has reinterpreted retroflex as a positional class just like dental and alveolar and termed it postalveolar. This reinterpretation can be motivated on two grounds: firstly, it is not possible to distinguish the three consonants in question in terms of active articulation as they are all apical (recall that Malayalam (cf. § 3.2.4 above) is one of the few languages which makes a genuine contrast between dental and alveolar places of articulation, i.e. a language in which the contrast between dental and alveolar cannot be distinguished in terms of a difference in lingual activity); therefore it is obvious to resort to a positional solution. Secondly, this reinterpretation is quite natural on phonetic grounds (cf. Maddieson and Nartey's positional class retroflex), as retroflexion is typically bound to a positional area which extends from postalveolar to prepalatal (cf. Catford 1977:ch.8). For Ladefoged such a reinterpretation is even more obvious as this new postalveolar place can simply become a value of his multivalued feature [articulatory place].

But unfortunately for Ladefoged this postalveolar value is not sufficient to account for the data from the two other Dravidian languages, Telugu and Kannada. In these languages alveolar, postalveolar and retroflex fricatives contrast, all of which also involve the tip of the tongue (cf. Ladefoged 1971:48):

(4.6)	alveolar	postalveolar	retroflex
	/s/	/ʃ/	/ṣ/

Since retroflex has already been reinterpreted as postalveolar, the latter two cannot be distinguished unless an additional place of articulation is introduced. But it is not clear what this should be. Instead Ladefoged speculates that perhaps a solution would be to specify the contrast either in terms of a difference in secondary articulation or in terms of grooved *vs.* split fricatives, but in the end he offers no definite solution.

Although it is unfortunate that Ladefoged is unable to allow for the data in (4.6), the existence of these Dravidian contrasts makes two facts clear. First, they emphasise that it is necessary to have a positional class such as postalveolar (we shall see below that this class will be needed for other purposes too); and second, that this positional class is not sufficient, but must somehow be supplemented with a descriptional device which can allow for such contrasts as those displayed in (4.6).

Given the form it has now, the present model is clearly unable to allow for these two types of contrast. Consequently, it is necessary to amend the original framework in two ways. First by introducing an extra articulatory zone which, following Ladefoged, I shall term the postalveolar zone, and second by introducing a new articulatory layer which I shall refer to as layer 3 and which will be used to specify a range of different tongue articulations. This expansion, as I shall return to in a moment, will enable me to account for the problematical data in question.

Let us first consider this expansion in a little more detail, in particular let us begin with the new postalveolar zone. Just like Ladefoged's postalveolar value, this new postalveolar zone is intended to cover an area on the oro-pharyngeal parameter which extends from the postalveolar to the palatal area. The function of the postalveolar zone will be analogous to Ladefoged's postalveolar value. Retroflex sounds, typically, will be described in terms of this zone, but - as is also apparent from Ladefoged's description, cf. (4.6) - those sound types traditionally named palato-alveolar will be assigned to this category too, as I shall return to shortly. Given the terminology introduced above in §3.2, the introduction of the postalveolar zone then represents an expansion of the vertical categories, i.e. that half of the articulatory network which describes individual places of articulation and which determines the location of association. The introduction of a new zone also entails that it is necessary to establish the relative complexity of this zone. Whether the postalveolar zone belongs to category 1, the simplex zone types, or to category 2, the complex ones, is then an issue I shall return to below, see §4.3.

The introduction of layer 3, by contrast, involves the addition of a new horizontal level. The function of layer 3 will be to specify contrastive lingual activity, in particular to act as intensifier of the small difference of place. Layer 3 consists of two sub-layers: the dorsal sub-layer and the non-dorsal sub-layer, as illustrated below:

non-dorsal dorsal

lingual layer

I shall sometimes refer to layer 3 as the lingual layer. This will be needed when, for example, phonological processes involve both the dorsal and non-dorsal sub-layers (see also Anderson and Ewen's component |l|, cf. 1987;ch.6 and the discussion in § 4.4). The two sub-layers refer to different parts of the tongue. The dorsal sub-layer refers to that part of the tongue which stretches from where the lamina ends to the tip of the epiglottis, thus including at least a part of the radix. Sounds made with this part of the tongue are characterised by relatively fixed tongue movement. The non-dorsal sub-layer, by contrast, refers to a part of the tongue which is much more flexible. The non-dorsal part includes the sub-lamina, the apex and the lamina. The greater flexibility of this part entails that the non-dorsal sub-parts are not necessarily associated with the immediately opposite passive counterparts. This is highlighted by the way the sub-lamina is used in the production of retroflex sounds. But also the pattern typical of many Australian languages in which alveolar apicals and laminal dentals regularly occur illustrates this flexibility. Thus whilst the zonal counterpart of the dorsal sub-parts typically are those which lie immediately above the sub-parts in question, there is no such clear and firm relationship between the non-dorsal sub-parts and the corresponding passive places.

The claim that layer 3 represents a horizontal extension is a consequence of the fact that the components assigned to it may combine with the entire set of articulatory zones in the articulatory network. Not all components, however, will be associated with both the dorsal and the non-dorsal sub-layers. Of the four components that will be assigned to layer 3, only one will be associated with all of layer 3; the rest will be non-dorsal exclusively. Altogether, the non-dorsal sub-layer will play a much more dominant role in the phonological description than the dorsal sub-layer. This follows from the greater flexibility of non-dorsal articulation. As may be expected, greater flexibility leads to greater phonological variety.

The following four components will be assigned to layer 3:

|l| retroflexion	|λ| laterality
|t| apicality	|f| laminality

|l| should not be confused with Anderson and Ewen's |l|-component which they define as 'linguality', cf. 1987:ch.6, but which here will be used for

retroflexion. |t| and |λ|, on the other hand, are similar to Anderson and Ewen's |t| and |λ| components except, as discussed in §2.2 above, that they are not allowed to enter into dependency relationships with one another or other components. However, the components may combine, just as I shall argue that there are non-dorsal articulations which are most appropriately described by more than one occurrence of the same component. |λ| is the component which is dorsal as well as non-dorsal; the other three are only associated with the non-dorsal sub-layer. All four components function contrastively in one or more languages, as will become apparent below. But they will more often be used derivatively than underlyingly and a great number of languages will only require them derivatively.

Let us now once again consider the fricative data that Ladefoged was unable to account for and which were displayed in (4.6). Given a postalveolar zone and a layer referring to active articulation such as layer 3, in particular the availability of a component |l|, which directly refers to the characteristic curling back of the sublamina found with retroflex sounds, the contrasts in (4.6) may now be differentiated in the following way (T stands for dentoalveolar and Po for postalveolar and 1. and 3. refer to layer 1 and layer 3 respectively):

(4.7)

		/s/	/ʃ/	/ṣ/
artic.	1.	T	Po	Po
gest.	3.			l

From (4.7) it is apparent that the difference between, on the one hand, /ṣ/ and /ʃ/ and, on the other, /s/ is one of place, whilst the difference between /ʃ/ and /ṣ/ is one of active articulation, viz. presence *vs.* absence of |l|, the component denoting retroflexion. Thus, thanks to the expansion suggested here, it is now not only possible to assign individual phonological representations to the three fricatives, but they are also described in what seems an intuitively natural way.

When retroflex sounds may be characterised in two ways, either positionally or in terms of the active articulator, as proposed here, then it is necessary to decide how a single retroflex contrast should be represented. Should the postalveolar zone or the retroflex component be invoked first to account for such a language? The roles assigned to layer 1 and layer 3 answer this question. The role of layer 1 is that of being the defining element of the articulatory network whereas the role of layer 3 is that of intensifier. This makes layer 1 more basic than layer 3. The basicness of the former is emphasised by the fact that an underlying representation must always be specified for layer 1; layer 3 (and layer 2), on the other hand, cannot alone constitute an underlying representation. A description of a language with only one postalveolar/retroflex contrast will then always use the postalveolar zone first to account for a contrast involving such a sound type.

4.2.2 Palatoalveolars and more support for a third layer and an extra zone. The expansion I have proposed here enables us to account for data which at least Ladefoged is unable to allow for. But the amount of data considered is very limited and in no way genetically representative, as it involves only fricatives from two Dravidian languages. Therefore it must be shown that other data can be characterised equally satisfactorily with this new expanded version. However, the expansion also embodies the claim that the class of palato-alveolars is not a true positional class (cf. (4.7)), but that locationally they should be interpreted as postalveolar. An attempt to justify the propriety of expanding the descriptive framework must then also examine the appropriateness of this interpretation. I consider first some further evidence which highlights the need for an expansion and then the motivation for abandoning the palato-alveolar class altogether.

Further evidence illustrating the need for a postalveolar zone and a third articulatory layer such as layer 3 comes from the two (Australian) languages Alawa and Aranda (cf. Maddieson 1984:326 & 330). The stop series of these two languages are characterised by having what Maddieson refers to as palato-alveolar along with, in the case of Alawa, alveolar and retroflex and, in the case of Aranda, dental, alveolar and retroflex contrasts. With the expanded version proposed here, i. e. with a postalveolar zone and a layer which is able to describe non-dorsal articulation, the stop series in these two languages can be described in a straightforward way as displayed in (4.8), where /t̠/ and /d̠/ represent palato-alveolar stops:

(4.8)	Alwa:			/d/	/d̠/	/ḍ/
	artic.	1.		T	Po	Po
	gest.	3.				l
	Aranda:		/t̪/	/t/	/t̠/	/ṭ/
	artic.	1.	T	T	Po	Po
	gest.	3.	f	t		l

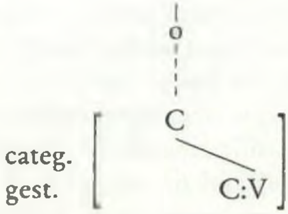
Again, as in (4.7), it is an interplay between the articulatory zones and the layer 3 components |l|, |f| (laminality) and |t| (apicality), that keeps the stops series distinguished (I return to the motivation for the distribution of |t| and |f| in § 4.2.3 below). And again a framework like Ladefoged's would not be able to differentiate all the stops in these series. It is true, Arandan /ṭ/ and /t/ can be differentiated within his framework, but Ladefoged would not be able to distinguish between /t̠/ and /ṭ/, nor the Alawan /d̠/ - /ḍ/-contrast, just as he was unable to distinguish the fricatives in (4.6).

But how does Maddieson, who is the source of the data, propose to describe the two series in question? This is perhaps an unfair question since the object of Maddieson's study is to formulate generalisations concerning phonological inventories and not to set up a universal feature theory. Consequently, we should be careful not to ascribe too much importance to his classifications. But his tabulations are interesting in one respect because they represent a long-standing tradition in the classification of speech sounds. According to Maddieson /d̠/ and /ḍ/ in Alawa and /t̠/ and /ṭ/ in Aranda differ in place, the former member of these pairs being palato-alveolar the latter postalveolar. In other words, for Maddieson (and for many other phonologists) it is quite possible to operate with the place of articulation palato-alveolar along with postalveolar. But if, as we saw in connection with (4.7), it is doubtful whether palato-alveolar represents a genuine place of articulation, Maddieson's tabulations are unsatisfactory. Provided that this can be substantiated, the data from Alawa and Aranda highlight the need for an alternative description involving a postalveolar zone and an extra articulatory level, as suggested in the extended version here.

What is the motivation for abandoning palato-alveolar then? Why should sounds such as /ʃ, ʒ, tʃ, dʒ/ locationally be described as postalveolar and not as palato-alveolar which is the label traditionally applied to them? Before I attempt to answer these questions there is an issue I must settle first. /ʃ, ʒ, tʃ, dʒ/ do not constitute a categorially homogeneous class. /tʃ/ and /dʒ/ belong to the class of affricates, whilst /ʃ/ and /ʒ/ are fricatives. Such affricates invariably raise the questions: are they single (complex) segments or do they represent two consecutive elements? I shall not here repeat the pro's and con's of the two positions (see e.g. Lass 1984:ch.2, Sommerstein 1977: ch.2 for a summary). The important thing is that the place description will vary depending on which of the two positions is taken. Following most specialists nowadays, I shall assume here that affricates are single segments and accordingly the description will reflect this.

Although I assume a single segment analysis, the fact remains that the controversy over whether /tʃ/ and /dʒ/ should be one or two segments will probably never be conclusively settled. As a consequence the single segment representation of affricates ideally should reflect that they are neither clearly one nor clearly two segments. The question is then how we combine a single segment interpretation with the view that two consecutive phonetic events are involved. Ewen (1982) and Anderson and Ewen (1987) have suggested a solution to this problem. Such an intermediate status can be expressed if segment internal adjunction is permitted as part of the segment internal description, at the same time as the association between the suprasegmental and the segmental levels occurs via a single path, i.e. as represented in (4.9):

(4.9)



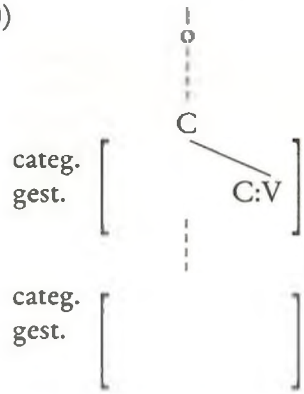
in which the consecutively ordered internal structure of the categorial representation is associated, as indicated by the broken lines, with a single segmental node, the latter of which conveys the single segment information.

But why is this important for an articulatory description of the affricates in question? It is important because if the single segment hypothesis is valid, then the articulatory specification must also obey this. This means that, although it may allow adjoined components internally, the categorial gesture in the way it interacts with the articulatory gesture should conform to this hypothesis and exhibit inter-gestural association via a single path only. We can formulate this as in the intergestural association hypothesis:

> Intergestural association between categorial components and components of other gestures other than via a single path is illegal unless the association with the suprasegmental level occurs via more than one node.

The nature of a phonological unit can then probably be determined on the basis of whether it obeys this hypothesis or not: if it does it is a segment and if it does not it is a prosody. For the representation of the relationship between the categorial gesture and the articulatory gesture with affricates the intergestural association hypothesis has the effect displayed in (4.10):

(4.10)



where the broken lines again indicate association and the articulatory gesture is left unspecified. Thus the reason why it is necessary to opt for one or the other interpretation of affricates is that if the single segment solution is opted for, as here, then the articulatory specification of affricates should be considered a description of the sound type as a whole, rather than of the individual projections of the consecutive units of the categorial gesture.

But what should the articulatory specification then be? Observe first that whatever it is it is also shared by /ʃ/ and /ʒ/. As observed already, the affricates /tʃ/ and /dʒ/ and these two fricatives are traditionally described as palato-alveolar. For example, all 146 instances of some variant of /ʃ/ or /ʒ/ occurring in UPSID are characterised in this way, as are indeed all instances of /tʃ/ and /dʒ/ in the same sample. However, over the years phonologists have objected to the label palato-alveolar. Lass (1976:189), for example, has argued that /ʃ/ and /ʒ/ really are palatalised alveolars and that English /ʃ/ and /s/ therefore do not differ in place of articulation but in tongue shape: /ʃ/ has doomed blade, /s/ hollow blade.

But if /ʃ/ and /ʒ/ are palatalised sounds what is their primary place of articulation? Lass is not quite specific about this, but observes that alveolar is the best candidate in which case the only feature that keeps /s/ apart from /ʃ/ is palatalised. But he notes at the same time that their primary location varies considerably and may for some speakers be quite posterior to /s/. Catford also discusses the location of these two fricatives, but, unlike Lass, describes /ʃ/ and /ʒ/ as either apico-postalveolar or lamino-postalveolar (1977:152-53). Furthermore, Catford does not restrict his data to English, but also considers evidence from other languages. His description thus points in the direction of postalveolar as the appropriate place of articulation for these consonants. Ladefoged, finally, also rejects the palato-alveolar interpretation and observes on the difference between English /s/ and /ʃ/: 'the only way to differentiate between these two sounds....is by calling [/s/] apical alveolar and [/ʃ/] apical postalveolar. But if we do this we cannot differentiate between an apical and the apical postalveolar which we previously called retroflex' (1971:48). I interpret this such that if the distinction mentioned by Ladefoged can be maintained in some other way, the place descriptions in question should be maintained for /s/ and /ʃ/. As we have seen, this is perfectly possible within the present framework in terms of layer 3. Ladefoged's observations thus support Catford's conclusion that the primary place of articulation is postalveolar.

Probably, then, despite Lass's suggestions - and even his observations are not unequivocal - it is reasonable to regard the primary articulation of /ʃ/ and /ʒ/ as postalveolar. As a result I shall henceforth assume that what is referred to as the palato-alveolar class, i.e. /ʃ/ and /ʒ/ and /tʃ/ and /dʒ/, should be specified as postalveolar. In view of this, we can now allow for the difference between English /s/ and /ʃ/ as in (4.11):

(4.11)		/s/	/ʃ/
	1.	T	Po

i.e. as a difference in place of articulation, or more particularly as a difference in zonal affiliation. Thus I follow Lass and Ladefoged and reject palato-alveolar as a true positional class.

However, describing /ʃ/ and /ʒ/ as postalveolar leaves us with a problem: there are more languages than Telugu and Kannada (cf. (4.6)) in which either /ʃ/ or /ʒ/ or both co-occur with other postalveolar or retroflex fricatives or both co-occur with other postalveolar or retroflex fricatives. Before I say anything conclusive about the locational description of /ʃ/ and /ʒ/, it is necessary to determine whether such languages can be accounted for with the new place description of /ʃ/ and /ʒ/ as postalveolar.

In UPSID there are 11 languages in which either /ʃ/ or /ʒ/ or both co-occur with other postalveolar or retroflex fricatives. Of these 11 languages, 9 make a contrast between (either dental or alveolar) /s/, /ʃ/ and retroflex /s/ (in the case of (the Amerindian Arawakan language) Wapishana it is not /ṣ/ but laryngealised /ẓ/, cf. Maddieson 1984:404), whilst two languages have phonemic /ʃ/ and /s/. The contrasts in the 9 languages are parallel to those illustrated by Telugu and Kannada in (4.6). The difference between /s/ and /ʃ/ in these 9 languages is then one of place, /s/ is dentoalveolar and /ʃ/ postalveolar, while the other two postalveolar sounds are kept apart by means of the presence *vs.* absence of the layer 3 component |l|.

In the remaining two languages, on the other hand, only /ʃ/ and retroflex /s/ contrast. In these no place contrast is therefore involved. Instead they are kept apart in terms of presence *vs.* absence of |l|. It looks then that the situation exemplified by Kannada and Telugu (cf. (4.6)) is quite typical of fricative systems in the dentoalveolar/postalveolar area. Systems with fewer contrasts do not constitute a problem. And if we utilise the full potential of layer 3, even more complex systems can be accounted for.

Thus it seems well-founded enough to expand the descriptive model as I have proposed here with a postalveolar zone and an extra layer. Not only does the extra articulatory zone provide a location in which retroflex sounds naturally belong, but this zone also represents an appropriate place for the description of what traditionally has been termed palato-alveolar sounds. And no phonological contrasts are left unaccounted for despite the fact that retroflex and palato-alveolar sounds now are associated with the same zone. Layer 3, in particular the component |l|, ensures that they are kept apart. But although the evidence considered here and in the previous section clearly justifies an expansion, it still remains to be demonstrated that layer 3 has other functions than that of describing sublaminal articulation. This function in itself would hardly be sufficient to justify the introduction of a separate layer. Therefore it is necessary to show how layer 3 enables us to allow for contrasts which it otherwise would be difficult - if not impossible - to describe. The first type of evidence concerns apicality and laminality.

4.2.3 Apicality and laminality. It is perhaps difficult to understand that apicality and laminality should provide evidence for layer 3, as there so far has been fairly general consensus that no or very few languages make a contrast between apical and laminal in the same place, although either can be used with both dental and alveolar places of articulation. This is the reason why Ladefoged, for example, does not consider apicality and laminality as phonological, but describes them as 'intensifiers of the small differences in the place of articulation' (1971:39). However, as is apparent from the discussion of the dentoalveolar zone above (cf. § 3.2.5) it is possible in a few well-defined cases to regard apicality and laminality as phonologically contrastive, viz. in those ca. 20 languages in UPSID in which dental and alveolar places of articulation are distinctive. There are two ways in which such a contrast can be allowed for: either by introducing a dental and an alveolar zone and account for the contrast by means of these two zones, or by assigning the contrasting sounds to one articulatory zone and differentiate them by means of separate active specifications. Above I opted for the latter solution and the motivation for this was that in the majority of these languages the place contrast between dental and alveolar is further emphasised by a difference in lingual activity, namely either apical or laminal, and that probably less than 1% of the languages in UPSID make a genuine place contrast between dental and alveolar. Given this interpretation, apicality and laminality should be assigned phonological function, and given their phonetic properties this is then an argument for the introduction of a descriptive level such as layer 3.

Let us then consider how |t| and |f| are used. Their use can best be illustrated by looking at a sample of the ca. 20 languages in which apicality and laminality function phonologically (see also (4.8) above). Let us consider three languages, each of which illustrates different ways in which the two components keep dentals and alveolars apart. The languages are: Temne, (Australian) Pitta-Pitta and Irish. Temne (cf. Ladefoged 1971:39 and § 3.2.5 above) illustrates a common pattern: dentals are apical and alveolars laminal. Pitta-Pitta exhibits the pattern typical of many Australian languages which make a contrast between dental and alveolar: dentals are reinforced by a laminal articulation and alveolar by an apical articulation (cf. Dixon and Blake 1979).[2] Finally, Irish (cf. Ó Cuív 1968) exhibits a third pattern. Here the difference between (palatalised and velarised) dental and alveolar *t*'s and *d*'s (for those speakers who still use this contrast) is reinforced by alveolars being apical and dentals both apical and laminal. I summarise the three ways in which |t| and |f| function phonologically as in (4.12)(/d'/ in Irish stands for a palatalised plosive):

2. Pitta-Pitta is not a language in UPSID, but it is reported to exemplify the typical Australian pattern whereby the dental *vs.* alveolar place contrast is reinforced by laminal and apical respectively (for this general claim, see Dixon and Blake 1979, Yallop 1982 and Wurm 1972). Since I have been unable to obtain any definite information on the Australian languages in UPSID in which this contrast is found, the pattern exhibited by Pitta-Pitta will be taken as representative. Of course Pitta-Pitta in itself is quite sufficient as a sample language, as are in fact a number of other Australian languages not in UPSID (Tasmanian and the language of which Margany and Gunya are dialects, cf. Dixon and Blake 1979, to mention some). So if the Pitta-Pitta-based predictions concerning the UPSID languages fail to hold true other languages can be shown to illustrate this particular use of the components |t| and |f|.

(4.12)	Temne:		/t̪/	/t/
		layer 1:	T	T
		layer 3:	t	f
	Pitta-Pitta:		/t̪/	/t/
		layer 1:	T	T
		layer 3:	f	t
	Irish:		/d̪’/	/d’/
		layer 1:	T	T
		layer 3:	t,f	t

where the difference between the plosives within each of the three languages can be read off directly from the layer 3 representations, i.e. by the way |t| and |f| are distributed. It may be argued that the representations in (4.12) are, as it were, overspecified. For example, in Temne one layer 3 specification, say |t|, would suffice to distinguish the two stops in question, i.e. one segment type could be left underspecified. However, an underspecified representation would require that the relative complexity of apicality and laminality be established (recall how underspecification was linked with relative complexity above). But since I shall claim that layer 3 acts independently of complexity, the latter being determined by layer 1 and layer 2 jointly, this is not an issue that need detain us (see § 4.3 below for further discussion).

Clearly the evidence for a third layer adduced here hinges on the assumption that it is appropriate to describe the dental/alveolar contrast in non-locational terms. The motivation for this is that in general very few languages distinguish genuinely between these two places of articulation and that the difference can usually be maintained in a nonlocational way, either, if the contrast is within the same series, in terms of an active reinforcement, or, if it is within a distinct series, typically in the categorial gesture.[3] The function of layer 3 is to allow for this active reinforcement. Without this descriptive layer a range of phonological contrasts would be left unaccounted for. Admittedly, the motivation for introducing layer 3 is thus not external, but follows from the way the framework as a whole is constructed. But any framework encounters such difficulties when the introduction of individual parts should be argued for. In the present framework the lack of

3. By series I mean, cf. Maddieson 1984:25-26, a set of stops, fricatives etc. which share some categorial and or initiatory specification such as, for example, voicelessness, voice, aspiration or some other airstream mechanism.

direct external evidence is compensated for by the way that the layer 3 components can be reused for other contrasts and by the way that layer 3 generally acts with respect to relative complexity.

For the moment, then, |t| and |f| only serve to keep the dental/alveolar contrast apart in those 20 languages in UPSID which exhibit this contrast, plus in whatever other (Australian) languages that make a contrast between dental and alveolar places of articulation. Only in these cases do apicality and laminality function phonologically. But |t| and |f| will also be needed to describe other levels than the underlying phonological level in other languages. In the former capacity |t| and |f| provide arguments for a third descriptive layer. However, there exists more evidence which confirms the need for a layer such as layer 3, evidence which requires other components than |t| and |f|.

4.2.4 Laterality I: overview. One potential piece of evidence is the well-known contrast lateral *vs.* non-lateral. Laterals are widespread cross-linguistically and almost all languages in UPSID have one or more laterals. In UPSID there are four categories of laterals: lateral approximants, lateral taps and flaps, lateral fricatives and lateral affricates. The approximant - or the voiced approximant - is by far the most common type of lateral. Out of the 418 laterals in UPSID, 333 are of this type and of these 312 are of the plain voiced type. Fricative laterals constitute the second largest group, 45 in all, of which 34 are plain voiced ones. Affricate laterals come in third with 29 instances in UPSID of which most are voiceless and only 4 plain voiced. The taps and flaps constitute the smallest group. Only 10 instances of this type occur in UPSID, and 9 of these are plain voiced ones. Thus, *ceteris paribus*, a lateral will typically be voiced and its absence in a language should be considered highly marked.

To be more specific, using the dimensions of active and passive articulation, the lateral *par excellence* is not only a voiced approximant, but it is also a dentoalveolar produced with the tip or the blade of the tongue. In UPSID 87% of all laterals are of this type (cf. Maddieson 1984:77). With respect to active and passive articulation, the remaining laterals divide into two groups: one which is also articulated with the tip or blade but at a different place - this is the group referred to by Maddieson as retroflex and palato-alveolar - and another which is produced with the body of the tongue and whose primary place is either palatal or velar. The latter type is the rarest; there is only one velar lateral in UPSID, but other languages are reported to have velar laterals, see Ladefoged 1971:54 and Ladefoged, Cochran and Disner 1977. Palatal laterals are slightly more common.

In general, a lateral sound is produced by lowering the sides of the tongue at the same time as there is firm contact along the central axis of the tongue. During the production of a lateral, air then flows out along the channels formed between the lowered tongue sides and the molar teeth. Typically the central contact involves the tip or blade, but the contact can be dorsal rather non-dorsal. An often overlooked characteristic of laterality is that it also involves one of the longest constrictions in speech production. No other sound type involves the lowering of one or both tongue sides along with a relatively long central constriction. This makes laterality articulatorily quite unique.

Normally the phonological relevance of laterality is never questioned. The UPSID sample confirms the appropriateness of this assumption. The 418 laterals in the sample are all taken to be phonemic. More specifically, we may illustrate the phonemic status of laterality with a) English and Danish which have contrastive lateral and non-lateral approximants, b) (Niger-Kordofanian (Bantoid)) Zulu which has contrasting lateral and non-lateral fricatives (cf. Ladefoged 1971:54), c) Punjabi which has contrasting retroflex lateral and non-lateral flaps (Maddieson 1984:271) and d) (Amerindian) Tlingit (cf. Maddieson op.cit.:368) which has lateral affricates (both voiced and voiceless) that contrast with non-lateral affricates.

4.2.5 Laterality II: feature accounts. Phonologically, laterality has so far typically been described in terms of a unique primitive, i.e. one not applicable to other contrasts. This is a consequence of the articulatory uniqueness of laterality alluded to above. In feature-based descriptions this primitive is the binary feature [lateral], in component-based descriptions the component |λ| (cf. Anderson and Ewen 1987:ch.6). However, recently Spencer (1984) has questioned this unique primitive assumption. Spencer argues that it is unnecessarily costly that laterality is characterised in terms of a unique primitive (the binary feature [lateral] - Spencer works within a SPE-type of framework) when the sole function of this feature is to identify typically one segment in a language. This limited function - he argues - hardly justifies the introduction of a feature, in particular when this feature plays no or only a very limited role in the statement of phonological rules. Consequently, Spencer proposes to capture the contrast lateral *vs.* non-lateral in terms of other features and argues that the feature [distributed] can handle the lateral/non-lateral contrast, and consequently he can eliminate the feature [lateral] all together.

In fact, Spencer dispenses not only with [lateral] but also with [anterior] and replaces them with [apical], [dental] and [labial]. We need not here go into the motivation for this reconstruction. [apical] and [dental] are not directly relevant for the characterisation of laterality. They are primarily used to distinguish apical from laminal and dental from alveolar, whilst [labial] covers that range of sounds identified by the old feature [anterior] which is not covered by [apical] and [dental]. What is important is that [lateral] is replaced by [distributed] and that it is only relevant for continuant sounds.

The relevance of Spencer's conclusions here is that if [lateral] can be dispensed with and its function taken over by [distributed] and if this reconstruction can be said to represent a clear improvement, then a primitive referring to laterality need not be part of the present framework. But is this new system of Spencer's actually an improvement? It is if it is able to fulfil the following requirements: if it can i) provide an exhaustive description of all existing laterals, ii) allow for the possible natural classes that laterals enter into and iii) in general supersede former descriptions. As for being exhaustive, this is refuted by the contrast between voiced flaps and voiced lateral flaps found in (Nilo-Saharan (Eastern Sudanic)) Logbara, (Indo-Pacific (Central New Guinea)) Kewa and (Amerindian (Paezan)) Paez (cf. Maddieson 1984:307, 360, 395), a contrast which Spencer's system cannot account for, as [distributed], which identifies laterality, is only relevant for continuant sounds, and flaps, according to Spencer, are non-continuant (cf. Spencer 1984:25-6). Spencer's system cannot allow for various natural classes either. A case in point is Scottish Gaelic, cf. O'Dochartaigh 1978 and Anderson and Ewen 1987:ch4. As discussed by O'Dochartaigh and Anderson and Ewen, in some Scottish Gaelic dialects laterals on occasion form a natural class with /n/, a class that does not include /r/ and which, in terms of relative degree of sonority, is different from both the class containing /r/ and a third class containing /m/. An adequate description of such Scottish Gaelic sonorants requires that they be specified in three different ways. But at the same time the description of these three classes should express that all three types are members of the same major class, viz. the class of sonorants. Anderson and Ewen devise a way to allow for these classes, as I shall discuss below. But it is difficult to see how these classes can be expressed within Spencer's system, even with the alterations that he suggests. It is true, this is not due to an inadequacy of Spencer's system, but a problem for all systems based on binary features. It is a result of the general inability of feature-based frameworks to express relative sonorancy, but it does not increase the credibility of Spencer's account.

The improvement of Spencer's analysis must then lie in the identification of laterality with distributivity and in the other changes which arise in the wake of this identification. Spencer summarises the function of his feature [distributed] as follows: 'The feature [distributed] is thus used to distinguish sibilants in Polish and /l/ - /r/ pairs in many languages. It still serves to distinguish bilabial from labiodental fricatives, since these are both continuants' (1984:40). The function of [distributed] and the other features that Spencer introduces appears directly from his table 11 (op.cit.:37). It is not quite clear from the subsequent discussion and comment whether this includes the mentioned Polish distinction (for a discussion, see SPE:314). In any case, the table includes an extremely varied set of fricatives and consequently illustrates the power of Spencer's system. But what is important from the present point of view is that as the fricatives are specified in this table, the feature [distributed] has no distinctive function. The eleven fricatives listed there can be distinguished without invoking [distributed]. In fact, the same seems to apply to the distinction between bilabial and labiodental which, according to the above quotation also is kept apart by means of [distributed]. As far as I can see, this contrast can be maintained by means of Spencer's [labial] and [dental], namely as [+labial,-dental] and [+labial,+dental] respectively. In other words, what is left for [distributed] to distinguish is the lateral/non-lateral contrast underlyingly. But this is exactly the role of the feature [lateral]. Spencer's point that the feature [lateral] can be dispensed with because it only serves to distinguish a single contrast thus loses its force: his feature [distributed] seems to serve exactly the same purpose. Thus with respect to laterality, Spencer's analysis does not lead to new insights (it does in other ways, but these are not relevant here). Therefore I shall assume that a primitive which specifically refers to laterality is needed in the phonology.

4.2.6 Laterality III: hierarchical accounts. Given this assumption, the question is then what this primitive should be and where in the representational system laterality should be specified. In the introduction to this chapter I pointed out that there is now fairly general agreement that laterality should be doubly specified phonologically, but not necessarily underlyingly. As outlined there, this is the position defended by Rice and Avery (1991) in a recent study within feature geometry. They argue that laterality should be specified in terms of the SV-node (spontaneous voice node) and under the coronal node which is a dependent of the place node (cf. figure (4.3)). But, so Rice and Avery argue, because coronal is the unmarked place feature of laterals universally, only the SV-specification is present underlyingly; the coronal specification is underspecified underlyingly and hence not directly visible but may be present derivatively.

Anderson and Ewen (1987:ch.4 & 6) also operate with two specifications for laterals; firstly an articulatory one involving the component |λ| which is assigned to the articulatory gesture and which, obviously, specifies the place characteristics of laterals. And secondly they specify laterals in the categorial gesture as {|V;C:V|}, a representation laterals share with other liquids. In addition Anderson and Ewen argue, as observed earlier (cf. § 4.2.5) that in some instances it is necessary to introduce a special categorial representation. This is necessary in order to account for the natural class which laterals enter into in some dialects of Scottish Gaelic. As pointed out above, in some dialects of Scottish Gaelic laterals can form a class with the nasal /n/, a class which with respect to sonorancy is different from both the class which contains /m/ and the class which contains other liquids. To characterise the /l, n/-class, which is less sonorant than the one containing non-lateral liquids (cf. Ó Dochartaigh 1978), Anderson and Ewen propose a representation which compared with the 'normal' liquid representation has an extra |C| added to it, i.e. has the form {|V;V:C;C|}. But it is required only when a phonological complex situation such as that found in Scottish Gaelic occurs.

Whilst Rice and Avery in their description explicitly state that only the SV-representation is present underlyingly, Anderson and Ewen are less specific on this issue. They seem to assume that it is only the articulatory representation which is needed at the underlying phonological level. This is not surprising when the categorial representation for laterals is non-unique in dependency phonology, except in such exceptional cases as the mentioned dialects of Scottish Gaelic. In other words, the fact that laterals are coronal and that this place is unmarked with this consonant type is not reflected by the dependency representation.

Although it can allow for the unmarked place of articulation of laterals, Rice and Avery's account is not necessarily superior to Anderson and Ewen's proposal. For example, Rice and Avery is unable to express the natural recurrence properties of laterals (cf. the Scottish Gaelic data). Their description probably could be made to do this, but even this would not dispense with all the problems because Rice and Avery quite obviously cannot allow for dorsal laterals, the existence of which is ruled out by their 'structural complexity constraint' (cf. § 4.1.3). There is no point in pursuing the difference between the two accounts further. What is important here is that a comparison makes it quite clear what the account within the present model should be able to cover.

4.2.7 Laterality IV: the present framework. Let us now turn to an account of laterality within the present framework. To summarise the previous discussion, such an account should be able to capture the following: i) that laterality is a bi-gestural phenomenon, ii) that there exist dorsal as well as non-dorsal laterals, iii) that the latter are the unmarked type and iv) that the expression of natural recurrence can cover such data as those found in Scottish Gaelic.

To capture laterality I shall use the two representations proposed by Anderson and Ewen: the articulatory representation |λ| and the categorial representation |V;V:C|. |λ| will be assigned to layer 3, as a lateral involves a particular lingual activity. But unlike any of the other layer 3 components, |λ| is not restricted to the non-dorsal sub-layer. The occurence of palatal and velar laterals, although they are rare, entails that it must be associated with all of layer 3. Thus the English /r/ - /l/ contrast will be distinguished by absence versus presence of |λ|, as will the contrast between palatal /j/ and /ʎ/ in Spanish. Similarly in (Indo-Pacific (Central New Guinea)) Yagaria the contrast between /j/ and the velar lateral /ɠ/ will be maintained (along with different place specifications) by means of |λ|: the former lacks it the latter has it.

But are the |λ|-specified consonants also specified for |V;C:V|? In Anderson and Ewen's notation, as discussed above briefly (cf. § 4.2.6), they are probably. Anderson and Ewen's categorial specification, |V;C:V|, is not unique for laterals; it is also shared by other liquids so for simple distinctive purposes both representations are needed. A similar solution will be adopted here. But it will not involve such redundancy as Anderson and Ewen's solution may be criticised of. This has to do with the status of the layer 3 components. As observed already, and as I shall argue later, the layer 3 components do not contribute to complexity. Complexity follows from the articulatory network as expressed in the two complexity categories, unmarked category 1 and marked category 2. And given i) that liquids, and in particular laterals, universally are dentoalveolar and only very rarely are produced at other places, and ii) that dentoalveolar is the most simplex of all the simplex places of articulation (cf. the special status assigned to [coronal], see § 3.3.3 for discussion), layer 1 predicts that only other laterals than dentoalveolar ones are complex, i.e. belong to category 2. In other words, a bigestural representation involves no redundancy. Invocation of layer 3 is cost-free as relative complexity appears from layer 1.

|λ| is then used to specify dorsal as well as non-dorsal laterals. But it cannot allow for the natural recurrence properties of laterals. To express membership of the group of sonorants, the categorial representation must be invoked, but, as argued by Anderson and Ewen, this has to be modified to

allow for such classes as those found in some dialects of Scottish Gaelic. I propose that to allow for such data Anderson and Ewen's specially designed representation with an extra subjoined C should be used.

The present account thus fulfils the requirements that laterality is bi-gestural. It can also allow for the fact that laterals are dorsal as well as non-dorsal and that the former are complex and the latter unmarked. Finally it can express the unusual natural recurrence found in Scottish Gaelic. The account, as do most other representational frameworks, also recognises the fact that it is necessary to operate with a primitive which uniquely identifies the lateral articulation. Given the phonetic property of this, a special descriptive device which can specify such an articulatory property must then be part of the representational model. In the framework developed here the lingual layer referred to as layer 3 is one such appropriate device.

4.2.8 Interlude - tongue root movement. Before I provide further evidence which supports the introduction of layer 3, I shall briefly consider another phenomenon which also concerns phonologically relevant tongue activity. In the discussion of phenomena relating to tongue activity, Anderson and Ewen also discuss tongue root movement and how it should be allowed for in their framework. Although it falls outside the domain of layer 3, as I have defined it, I shall devote a brief interlude to this kind of activity, since it is typically considered together with phenomena which I have associated with layer 3.

To allow for tongue root movement Anderson and Ewen first posit a component |r|, 'retracted tongue root' (cf.1986:244-45), but after a brief discussion this is replaced by the component |α|, 'advanced tongue root'. They motivate this substitution by the (alleged) dominance of languages showing advanced tongue root *vs.* non-advanced tongue root rather than retracted tongue root *vs.* non-retracted tongue root. Whatever the exact characterisation, the mechanism in question probably should be accounted for in their framework by means of one or the other component. But given that we have associated layer 3 primarily with the flexible, non-dorsal part of the tongue, we cannot allow for the tongue root phenomena in terms of this layer. Instead, since the advanced *vs.* retracted types of movements seem to contrast nowhere, the 'passive' layer 1 seems to be sufficient. Phonologically the pharyngeal zone of layer 1 will then suffice, and if it is necessary to specify whether the tongue root is advanced or retracted - for example at non-lexical levels - this can be expressed at layer 2 in terms of the presence *vs.* the absence of the component |i|.

4.2.9 Flap, tap and trill. Let us now consider the third type of evidence which, I shall claim, will support the introduction of layer 3. The evidence concerns *r*-sounds, in particular approximant *r*, flaps, taps and trills. However, not all variants of these *r*-types will be relevant. I shall confine myself to those which share the categorial specification of a unilaterally governing |V|, i.e. to the sub-class which may be characterised as the non-fricative sonorant *r*'s. This excludes the Czech fricative trill /r/ and the (Sino-Tibetan (Sinitic)) Mandarin /ž/, both of which are less sonorant-like and more fricative-like than the sonorant *r*-s (see Anderson and Ewen 1987:ch.4 and Spencer 1984 for discussion). Furthermore I shall exclude those *r*-types which are produced with some kind of secondary articulation (palatalisation etc.). I assume they will be treated in the same way as their congeners without secondary articulations (plus, of course, a specification for the secondary articulation which will not concern me here; see ch. 5 for discussion). The relevant data thus consist of plain voiced non-fricative trilled, approximant and tapped and flapped *r*-s.

Underlyingly, layer 3 - in particular the non-dorsal sub-layer - will only be needed to describe these *r*-types when two or more of them co-occur within the same language. The occurrence of just one of these *r*-s will not require more than a categorial specification. The phonetic gesture involved in the production of these *r*-types is such that layer 3 is needed. The latter, it should be recalled, refers to a lingual activity which involves a particular non-dorsal point of the tongue and to the way a particular non-dorsal part of the tongue participates in the production of sounds. Let us then consider languages which have at least two contrasting *r*-types of the relevant type in their inventories.

Ladefoged has adduced evidence which demonstrates that taps and trills function contrastively within one language (1971:50 ff.). In Spanish /D/ and /r/ contrast as in the pair /peDo/ 'but' and /pero/ 'dog'. The majority of taps and trills in the world's languages, including Spanish, are produced with the tip of the tongue. I have already proposed a non-dorsal component at layer 3 to allow for sounds articulated with the tip of the tongue, viz. the component |t|, apicality. I propose to capture taps and trills in terms of this component too. This will not only bring out their shared articulatory properties, but also economise on the use of components. However, taps and trills are clearly distinct. Thus if |t| should be used for both, it is clearly necessary to refine the representation so that they are distinguished underlyingly. Crudely speaking, the difference between taps and trills consists in whether the apex makes a single flick or whether it performs a series of repetitive flicks. I emphasise that this is only a crude characterisation of the difference. The frequency at which taps (and flaps) can be produced is very low compared to the frequency at which the repetitive flicks characteristic of trilled sounds may be made. The phonetic gestures involved in the production of these two sound types are thus quite distinct. But this difference should not preclude a phonological description in terms of the same component. There is no reason that this kind of phonetic detail should not appear from the phonological representations, as long as it is apparent that the same articulators are involved in the production of trilled and non-trilled sounds. For this reason I shall use |t| for both sound types in question and distinguish them by means of one versus two occurrences of |t|. Thus the articulatory representation of Spanish /D/ and /r/ should be as in (4.13):

(4.13)

	/D/	/r/
layer 1	T	T
layer 3	t	t,t

Normally two identical components cannot alone describe a single node in dependency phonology, but the absence of this possibility in earlier dependency-based work follows from the fact that specified nodes enter into strength relationships with other specified nodes, and the single occurrence of two identical components would result in an over-strong specification (for a relaxation of this condition, see also § 2.2 above). However, no such strength relationship is purported to exist between the articulatory components used here (cf. discussion in ch.:2). Thus the double specification does not violate this otherwise basic principle of the dependency-based notation.

Flaps also contrast with other *r*-types. In (Afro-Asiatic (Chadic)) Hausa, for example, the flap contrasts with the trill, as in the minimal pair /bárà/ 'servant', /bárà/ 'begging' (Maddieson 1984:318).[4] Whilst taps involve a momentary 'aimed' flick of the apex, flaps are characterised by an apical flick occurring as the tongue tip hits a passive articulator on its way back to its rest position. Moreover according to both Ladefoged (1971:50) and Catford (1977:129), the flap is produced with the tongue tip curled back and up, a fact which makes Catford refer to it as 'the retroflex flap'. To allow for these

4. Ladefoged (1971:51) charts Hausa as a language which makes a contrast between /D/ and /r/. The discrepancy between Maddieson and Ladefoged's interpretation of the Hausa data is due to the fact that the tap may be allophonically a trill in this language (cf. Ladefoged ibid.).

articulatory features, I shall represent the flap in terms of |t| in combination with |l|. |t| then specifies that the apex is involved in the production of a flap and |l| that the tongue tip is curled back and up for this kind of articulation, as described by Ladefoged and Catford. The Hausa minimal pair will thus appear as in (4.14):

(4.14)

	/r/	/ɾ/
layer 1	T	T
layer 3	t,t	t,l

in which the layer 3 specifications directly reflect the difference between the two *r*-types.

The component |t| will be needed for one more *r*-type namely, the voiced approximant /ɹ/. However, the number of languages which has this *r*-type is in fact quite small. In UPSID 26 languages have an alveolar or retroflex /ɹ/, and of these 19 make a contrast between the approximant and some other *r*-type. In one instance this other *r*-type is the tap, viz. in (Australian) Tiwi. Tiwi would thus seem to pose a problem because in this language the component |t| will be needed to specify two *r*-sounds, both of which are categorially identical. However, a closer examination reveals that they also differ with respect to place: the approximant is postalveolar, whilst the tap is dentoalveolar. The two *r*-s in Tiwi may then be differentiated as in (4.15):

(4.15)

	/D/	/ɹ̣/
layer 1	T	Po
layer 2	t	t

and if necessary the two *r*-types could be distinguished derivatively by /ɹ̣/ also being specified for |f|. In the remaining 18 languages the approximant contrasts with either the trill, /r/, or the flap, /ɾ/. Thus Alawa and (Australian) Burera which contrast /ɹ/ - /r/ and /ɹ/ - /ɾ/ respectively should be characterised as suggested in (4.16):

(4.16)

Alawa:	/ɹ/	/r/	Burera:	/ɹ/	/ɾ/
layer 1:	T	T		T	T
layer 2:	t	t,t		t	t,l

from which it is apparent that the existing components can also allow for such contrasts underlyingly. But derivatively it will be necessary to devise some means of representation which will enable us to characterise the different qualities of the Tiwian *r*-types. Typically, this will involve |f| for the approximant.

As with the stop representations proposed in (4.9) above, it might also be argued of these *r*-types that they need not both be specified underlyingly. The contrast could still be maintained with just one of them specified; that is, we could leave one of them underspecified. But underspecification requires that relative complexity is established for the contrasting *r*-sounds so that the simplex one is underspecified. However, since layer 3, as I shall argue later on (cf. § 4.3 below), on the whole can be argued to act independently of complexity, the layer 3 representations suggested in (4.15) will not add cost to the grammar. Of course, this does not mean, that the layer 3 components can be used indiscriminately. Metatheoretical requirements of maximal simplicity must still be observed, just as the over-use of primitives underlyingly should be avoided.

The number of languages which require layer 3 underlyingly is in fact quite small. An examination of UPSID reveals that by far the most common pattern is for a language to have just one phonemic *r*-sound. Out of the 200 *r*-languages in UPSID, only 31 have two or more contrasting *r*-s. [5,6] In the majority of the *r*-languages layer 3 will therefore not be needed underlyingly. But it is required derivatively and it will be needed for the description of the phonetic level. However, despite its limited application, it is difficult to see how it could be replaced by some other descriptive device. Given a system in which a series of articulatory zones constitute the corner-stones of the description, it is necessary to have recourse to a descriptive device which allows us to account for those instances where dorsal and non-dorsal activity is contrastive.

5. The figure 200 includes all those languages in UPSID with at least one *r* of the voiced non-fricative sonorant type (without secondary articulation) and with known manner of articulation. It should be observed that almost 11% of the *r*-sounds have unknown manner of articulation, simply because the sources used to compile UPSID fail to provide it. This adds a measure of uncertainty to the conclusions drawn on the basis of the *r*-types found in UPSID.
6. There are 34 instances of (plain voiced) *r*-contrasts in UPSID. This figure includes only those contrasts which differ in manner of articulation (trill, flap etc), but not such which can be differentiated in terms of place of articulation, as, for example, the contrasts found in Pashto, (Australian) Kariera-Ngarluma and (Australian) Arabana-Wanganura and (Dravidian) Kurukh (cf. Maddieson 1984:269, 330, 332 and 414).

4.2.10 On the multiple function of |t| and |l|. Clearly, in a description which assigns the two layer 3 components |t| and |l| a multiple function, it is necessary to ensure that this multiple function does not result in a confusion of phonological contrasts. It should be quite clear whether the presence of |t| refers to /D/ or to an apical obstruent and whether the presence of |t,l| has the function of referring to /r/, as in for example Hausa, or some other retroflex sound type. Therefore, I have examined all the languages in UPSID with respect to potential contrasts which might constitute counter-evidence to this proposed double function.

With respect to |t,l|, to take this specification first, a case of potential confusion is an inventory in which the plain voiced flap is also retroflex or an inventory in which retroflex and non-retroflex flaps contrast. Such contrasts are potentially problematical because |l| also specifies retroflexion, as we saw above in § 3.4.2. However, an examination of UPSID reveals that relatively few languages have retroflex flaps either alone or contrasting with non-retroflex flaps. In the 88 languages in UPSID which have plain voiced flaps, only 10 have the retroflex variant and of these only two languages make a contrast between retroflex and non-retroflex flaps, viz. Bengali and (Austro-Asiatic (Munda)) Kharia (cf. Maddieson 1984:270 & 321). The 8 languages with single retroflex flaps do not constitute a descriptive problem. On the assumption (cf. also Maddieson op.cit.:ch. 5) that flaps are liquids, the retroflex flap can be distinguished simply by being assigned to the post-alveolar zone at layer 1, irrespective of whether it occurs in languages with other retroflex consonants or other *r*-types. Thus (Australian) Maung, which is one of the languages with a retroflex flap, should be described as shown below. For illustration I have included other retroflex consonants and *r*-sounds which are also found in Maung (see Maddieson 1984:324):

(4.17)
Maung

	/t/	/ṭ/	/n/	/ṇ/	/ɹ/	/ɾ̣/
artic. gest.	T	Po	T	Po	T	Po
categ. gest.	C	C	V;C	V;C	V;V:C	V;V:C

At the underlying phonological level, |t,l| (and hence the non-dorsal sub-layer) is thus not required to identify the retroflex flap. The reason why |t,l| need not be invoked underlyingly in those languages in which retroflex flaps occur alone is that retroflexion may be expressed both as a place - the postalveolar zone - and in terms of the non-dorsal component specification |l|. And, *ceteris paribus*, a description in terms of an articulatory zone will be preferred before layer 3 is invoked, as discussed above in § 4.2.1.

The reinterpretation which leads to the introduction of the postalveolar zone also explains why the contrast retroflex *vs.* non-retroflex flap can be handled without resorting to |t,l|. As observed above, this contrast is found in two languages in UPSID: Bengali and Kharia. Again it is not necessary to invoke the specification |t,l| for any of them, but as in (4.17) we can describe the retroflex member in terms of the postalveolar zone, and the non-retroflex one in terms of the dentoalveolar zone. (4.18) gives the Bengali flaps in question plus, for comparison, other retroflex/non-retroflex contrasts:[7]

(4.18)		/t/	/d/	/ʈ/	/ɖ/	/ɾ/	/ɽ/
	artic. gest.	T	T	Po	Po	T	Po
	categ. gest.	C	C;V	C	C;V	V;V:C	V;V:C

The retroflex/non-retroflex flaps in Bengali - or Kharia for that matter - need not be specified any further than in (4.18), as neither language has any other *r*-sound in its inventory. On closer inspection, the potentially problematical data with contrastive retroflex flaps thus do not challenge the double use of |t,l|. However, although it may not be needed for the retroflex flap, |t,l| will be required for the description of such languages as, for example, Kurdish, (Nilo-Saharan (Eastern Sudanic)) Maasai, (Semitic) Arabic and Burera (cf. Maddieson 1984:269, 302, 310 & 325). All these languages make a contrast between plain flaps and trills in the same place of articulation, or for such languages which show a contrast between flap and lateral flap in the same place of articulation as (Nilo-Saharan (Central Sudanic)) Logbara and (Indo-Pacific (Central New Guinean)) Kewa (Maddieson 1984:307 & 360). Neither of these contrasts can be handled in the categorial gesture, as in the languages summarised in (4.17) and (4.18). Instead they have to be given individual representations in the articulatory gesture, since the contrasting sound types are categorially identical. For these layer 3, and in particular |t,l|, has to be invoked underlyingly.

7. (4.18) might just as well represent a sample of the Kharia consonant system. With the exception of a little less than a handful of consonants, the consonant inventories of the two languages are identical.

We can illustrate this with Maasai and Logbara. Maasai makes a contrast between dentoalveolar voiced trills and dentoalveolar voiced flaps. Since these sounds are categorially identical and produced at the same place, they must be distinguished at layer 3. In particular |t,t| versus |t,l| must keep them apart, i.e.:

(4.19)

Maasai:		/r/	/ɾ/
	artic.gest. 1.	T	T
	3.	t,t	t,l
	categ.gest.	V;V:C	V;V:C

Similarly in Logbara dentoalveolar voiced flaps can be either lateral or non-lateral. Unless we want to represent them as just lateral *vs.* non-lateral liquids, they should be assigned these representations:

(4.20)

Logbara:		/ɾ/	/ɺ/
	artic.gest.1.	T	T
	3.	t,l	t,l λ
	categ.gest.	V;V:C	V;V:C

Clearly, there are then instances in which |t,l| is needed at the underlying phonological level.

Let us now turn to the other double use of the layer 3 component |t|. At first glance its double use looks more like a potential source of confusion. To recapitulate, |t| functions both as specifier of apicality and of tapped *r*-sounds plus alveolar approximant /ɹ/. In the first function, |t| is only required phonologically in those (ca. 20) languages where dental and alveolar places of articulation function contrastively. For reasons which were given in § 3.2.4, I described such contrasts in terms of a difference in 'active' articulation, viz. in terms of apical *vs.* laminal, rather than as a place difference. Thus a potential case of confusion is when these ca. 20 languages either also have phonological taps, which require |t| for their specification, or the dental/alveolar contrast includes consonants classifiable as liquids. The presence of liquids will make it impossible to identify those sounds described by means of |t| as taps or as some other apical liquid.

However, the number of potential candidates of either type is small. Only 7 out of the 317 languages in UPSID have (phonological) taps and in only two of these languages, viz. Malayalam and (Australian) Tiwi does the dental *vs.* alveolar contrast function phonologically at the same time, and only in one language, (Amerindian) Araucanian, is the dental *vs.* alveolar place contrast functional among liquids. The dental *vs.* alveolar contrast in the two languages Tiwi and Malayalam illustrates the two ways in which I have accounted for this difference. Tiwi represents what I have regarded as the typical pattern. In this language the contrast is not regarded as locational, but instead maintained in terms of the two 'intensifiers' |t| and |f|. In fact, Tiwi exhibits the typical Australian pattern whereby dentals are laminal (|f|) and alveolars apical (|t|). But Tiwi is problematical because it also requires |t| phonologically to describe the tap (and an approximant *r*-type as I pointed out above cf. (4.15)). Whether this multiple function of |t| leads to the confusion of phonological contrasts is best answered by considering how the relevant Tiwian consonants should be characterised. I give them in (4.21):

(4.21)

	/n/	/n/	/D/	/l/	/ḷ/	/ɹ̣/
artic. 1.	T	T	T	T	Po	Po
gest. 3.	f	t	t	λ	λ	t
cat.gest.	V;C	V;C	V;V:C	V;V:C	V;V:C	V;V:C

From (4.21) it is apparent that no confusion arises from the double use of |t|. If segments are identically specified at layer 3 either layer 1 or the categorial specification ensures that the phonological segments in Tiwi are kept clearly apart. And observe that this applies not just to the |t|-specified obstruents and the tap but also to the two *r*-types /D/ and /ɹ/ which are still kept distinct despite their identical |t|-specifications (cf. § 4.2.9 above, in particular (4.15)). Contrary to expectation, the contrasts found in Tiwi thus do not constitute a problem for a description which assigns a multiple function to the components at layer 3, as proposed here.

Malayalam, which is another potentially problematical language, points in the same direction as Tiwi. Like Tiwi, Malayalam also has a phonemic tap, but unlike Tiwi Malayalam is one of the very few languages (see § 3.2.5 above for discussion) in which the dental *vs.* alveolar contrast is not describable in terms of apical *vs.* laminal. Because they are all apical, the relevant contrasting consonants must be described in terms of two independent articulatory zones, dental and alveolar. |t| (and |f|) are therefore not required to keep dentals and alveolars apart in Malayalam. Thus |t| is only needed to specify the tap. Moreover, the contrast between dental and alveolar is only relevant among nasals. Thus, should the situation arise that |t| and |f| were to become needed phonologically for the dental/alveolar contrast, this would still not result in a confusion of phonological segments, as the tap is a liquid and hence categorially distinct from nasals. On the other hand, it is quite clear that |t| has to be present with the tap, for otherwise we are unable to distinguish it from /r/ which also occurs in Malayalam. I summarise the description of the relevant Malayalam consonants in (4.22) (in which I have, temporarily, abandoned the capital place abbreviations to be able to refer to both dental and alveolar places of articulation):

(4.22)

		/n̪/	/n/	/D/	/r/	/l/
artic. gesture	1.	Dent.	Alv.	Alv.	Alv.	Alv.
	3.			t	tt	λ
categ. gesture		V;C	V;C	V;V:C	V;V:C	V;V:C

In other words, an interplay of the subdivided dentoalveolar zone, the layer 3 component |t| and the categorial gesture keeps the Malayalam sonorants distinct. Again, then, there is no indication that |t| as specifier of both phonological apicality and phonological taps will lead to the confusion of underlying phonological representations.

As pointed out, Araucanian could also be a problem for an analysis assigning a double function to |t|. However, again this suspicion is not confirmed by a closer inspection. Araucanian is the only language in UPSID which has contrasting dental and alveolar liquids. Because liquids and the tap have identical categorial specifications, there is the danger that the tap cannot be differentiated from the other liquids. But firstly Araucanian does not have phonological taps. Confusion between this sound type and another |t|-specified liquid is therefore not possible. And secondly should the tap become contrastive in the language, confusion would still not arise because the |t|-specified lateral would also be assigned |λ|. Thirdly it is not clear whether the dental *vs.* alveolar contrasts in Araucanian at all can be described in terms of |t| *vs.* |f|. Araucanian could be a language, like Malayalam, i.e. require that the contrast be described in terms of two component zones, the dental and the alveolar zones. It is not clear from Echeverria and Contreras 1965 whether it is a genuine place contrast or whether it can be described in terms of one articulatory zone and two 'active' components. But whatever the exact nature of the contrast, it is clearly possible to handle the contrast within the framework I have established here, even if the tap should become phonological. Either the contrast will be accounted for in the categorial gesture or in terms of the layer 3 component |λ| or in terms of the sub-zones dental and alveolar.

Thus, in general, there is no indication that assigning a multiple function to |t| and |l| will lead to phonological contrasts being confused. An inspection of the potentially problematical languages in UPSID confirms the viability of such an approach. Evidently one of the reasons why no underlying segments are confused is that with layer 1 at hand we can refer to up to 7 or 8 place values. Thus a contrast will often be accounted for in terms of these values and layer 3 will only be required in special instances. The implication of this is that layer 1 must represent a valuable way to describe consonantal place and, equally, that the components |t| and |l| must describe important active gestures.

4.2.11 Layer 3: summary. Before I turn to two issues which follow from introducing a new articulatory layer and an extra articulatory zone, let me briefly draw together some of the main points made so far in this chapter. The chapter has so far made two points clear: firstly that it is essential to have a third descriptive level which can account for the active articulatory properties that I have termed dorsal and non-dorsal; and secondly that we need what I have termed the postalveolar zone, a zone which will enable us to refer to a location which is postalveolar and prepalatal. Support for layer 3 is partly found in the conflation of the two articulatory zones dental and alveolar; when this is not bifurcated into its constituent zones, the distinction between these two places is maintained by means of active specifications, viz. layer 3 components referring to apicality and laminality. Other support for layer 3 comes from the need to make distinctions among sonorant liquids. In particular, laterality requires an individual phonological representation, as do languages with contrasting *r*-types. Since these liquid types are identically specified in the categorial gesture, the co-occurrence of two or more of them requires - when they are articulated at the same place - a representational means which can refer to another articulatory property. Layer 3 which refers to dorsal or non-dorsal tongue activity is one such natural representational device.

The phonological function of retroflexion also supports the introduction of layer 3. Postalveolar consonantal contrasts within the same series (stop, fricative etc.) highlight this; for example, contrasts of this kind in some of the Dravidian languages cannot be distinguished without a layer 3 component referring to the retroflex gesture of the tongue. In addition, retroflexion also provides support for the introduction of the postalveolar zone. The interpretation of this active phonetic gesture as a passive place has long been accepted as a commonplace analysis. What makes it more attractive here is that the basic role assigned to the articulatory zones in the present framework readily allows for such a reinterpretation. And when the locational class usually referred to as palato-alveolar turns out to be better characterised as post-alveolar, the relevance of this new zone gains further support.

In all, the data considered in this chapter thus emphasise the appropriateness of the two expansions suggested. With these expansions we are able to describe a wide range of phonological contrasts in a wide range of languages, contrasts which otherwise would be left unaccounted for. It is also worth observing that despite the variety of these contrasts, the suggested expansions are quite limited. This is a consequence of assigning the new components more than one function and describing what otherwise is regarded as distinct consonants in terms of the same articulatory zone.

But the expansions I have suggested here raise two further questions: what is the complexity status of the new postalveolar zone - does it belong to category 1 or category 2 - and how does layer 3 contribute to complexity? These two questions must be dealt with before it is possible to close the discussion of layer 3.

4.3 Layer 3 and relative complexity.

4.3.1 Relative complexity and the postalveolar zone. Recall that the post-alveolar zone was introduced to fulfil two functions: firstly to act as a positional class for the (reinterpreted) retroflex sounds, and secondly to constitute the primary place of articulation for the class of fricatives and affricates commonly referred to as palato-alveolars. Clearly the introduction of a new articulatory zone requires that its status as complex or simplex be established. Above (cf. § 3.2) the relative complexity of the articulatory zones was established on the basis of Nartey's and Maddieson's quantitative research and Stevens and Keyser's examination of saliency. By combining the results of these two studies, it was possible to subdivide the articulatory zones into two distinct categories, a simplex one and a complex one. In order to determine the relative complexity of the postalveolar zone, the same procedure will be followed here. Thus each major consonant category (stop, fricative and sonorant) will be examined with respect to the frequency and the saliency of the retroflex and palato-alveolar members.

Let us look at the stops first. The evidence from the relative frequency of plain retroflex stops clearly suggests that the postalveolar zone should be considered complex, i.e. belong among the category 2 types. Firstly, only 11 % of the languages in UPSID, or 36 out of the 317 languages in the sample, have retroflex stops. By comparison the category 1 types (for stops: bilabial, dentoalveolar and velar) have near universal status (in UPSID), there being only 5 languages which have stops at two places of articulation. Secondly, stop systems with more than three places only add retroflex fairly late and only after other places have been utilised. Complex status also appears, if not explicitly then implicitly, from Stevens and Keyser's investigation of saliency. None of Stevens and Keyser's segment types that arise as a result of combining what they call the primary features, which are the simplex ones, can plausibly be interpreted as covering the postalveolar place of articulation. For stops they are bilabial, dentoalveolar and velar. The evidence from both frequency and saliency among plain stops is thus only reconcilable with a complex status for the postalveolar zone.

But how does this complex status match with the behaviour of the two stop affricates /tʃ/ and /dʒ/ which, it should be recalled, are described as postalveolar (for convenience I shall often refer to them as palato-alveolar)? With these it is not quite so evident that they are articulatorily complex. The problem is that among the class of affricates the palato-alveolar ones are by far the most common. There are 263 palato-alveolar as opposed to, for example, 158 dentoalveolar affricates in UPSID. This could be interpreted as suggesting that, universally, postalveolar is the unmarked place of articulation for an affricate. Quite possibly this an appropriate observation. But when we take into account that there are 59 languages with palatal or palato-alveolar stops *vis á vis* 314 with bilabial, 316 with dentoalveolar and 315 with velar stops, then it is clear that seen in a larger context the 'palato-alveolar' stop affricates - and hence the postalveolar zone - should be considered complex. The relatively large number of 'palato-alveolar' affricates is probably due to the fact that affrication achieves optimal effect in this area, a hypothesis which explains why affricates are not distributed over a wide range of articulatory zones.

But if these quantitative arguments are felt to be somewhat problematical, particularly in view of the limited zonal distribution of the stop affricates, a more compelling argument in support of complex status for the postalveolar zone is the fact that the presence of postalveolar /tʃ/ and /dʒ/ typically presupposes the use of three other places of articulation. The most common pattern is that postalveolar affricates are added to the near-universal stop places, bilabial, dentoalveolar and velar. Given that the maximal number of unmarked articulatory zones for stops is three, the postalveolar zone necessarily must be complex. Thus when both quantitative and systemic evidence is taken into account, it is clear that the postalveolar place of articulation of /tʃ/ and /dʒ/ should be classified as complex.

Let us now turn to the fricatives and again start with the retroflex ones. In both Maddieson's and Nartey's studies there is very little evidence on the retroflex fricatives. Unlike with stops, Maddieson does not specifically examine frequency and place of articulation with this sound type. The only clues to the relative complexity based on frequency therefore appear from the frequency of occurrence of the fricative types in general. But one such type is the retroflex fricative and from the evidence adduced it is apparent that retroflex fricatives are scarce. The voiceless retroflex /ṣ/ is the ninth most frequent fricative among voiceless fricatives and its voiced congener the ninth most frequent fricative among the voiced fricatives. This cannot but be interpreted as evidence of retroflex - and hence the postalveolar zone - being complex.

But other evidence also seems to support a complex status for this fricative type. Typically the stage at which retroflex is invoked contrastively among fricatives is very late cross-linguistically. Maddieson does not specifically mention how many place contrast have to be invoked before retroflex is used, but typically in languages with 3 contrasting fricatives not one of these is retroflex. Nor is this the case - again typically - in languages which have 7 or more contrasting fricatives (languages with 4, 5 or 6 contrasting fricatives do not deviate basically from a 3 fricative language, as they, as a rule, use voicing to expand the inventory). Such late invocation of retroflex fricatives clearly also points to a complex status for the postalveolar zone. Finally, as with stops, there is again nothing in Stevens and Keyser's saliency investigation to suggest that retroflex fricatives should be simplex. No fricative which is positionally close to retroflex/postalveolar appears as one of those sound types which Stevens and Keyser consider as salient and hence unmarked. In sum, as with retroflex stops, the evidence from retroflex fricatives quite clearly suggests that the postalveolar zone should be assigned to the complex zone types, i.e. should be classified as belonging in category 2.

Again we must ask whether this status is compatible with the behaviour of /ʃ/ and /ʒ/ which I have described as positionally postalveolar. At first glance /ʃ/ and /ʒ/ seem to pose a problem, because, as pointed out in § 3.2.2 above, /ʃ/ is the second most frequent voiceless fricative (after /*s/). But as I discussed in § 3.2.2 there is no contradiction in this observation, because postalveolar sounds, and postalveolar fricatives in particular, are not among those which Stevens and Keyser list as the most perceptually salient. Also the fact that a language typically has two fricatives and that these typically are /*s/ and /f/ supports the interpretation that postalveolar is complex. Labiodental, therefore, is a more likely simplex candidate than postalveolar, a fact which is also confirmed by Stevens and Keyser's examination of saliency. On the basis of both saliency and systemic and quantitative evidence, there are thus sufficient grounds for regarding the postalveolar zone as complex among fricatives.

The quantitative distribution of both stops and fricatives thus strongly suggests that the postalveolar zone should be interpreted as complex. The way place contrasts are increased in obstruent systems generally also supports this hypothesis. Typically a postalveolar stop or fricative is added only after the basic place contrasts for the two obstruent types have been invoked. And finally the saliency evidence provided by Stevens and Keyser also emphasises, if not explicitly then implicitly, that postalveolar consonants should be regarded as complex, saliency not being a characteristic of consonants articulated at this place. It remains now that we see whether this pattern is also typical of the sonorant consonants, i.e. nasals, laterals and *r*-sounds, but not the semi-vowels /j/ and /w/ which, with respect to place of articulation, invariably are palatal and labio-velar respectively.

Nasals, laterals and *r*-sounds all have retroflex and 'palato-alveolar' variants. Let us first consider nasals. The total number of plain voiced nasals in UPSID is 934. Of these 934 nasals 316 are dentoalveolar, 299 are bilabial and 167 are velar, whilst the retroflex and palato-alveolar number 20 and 17 respectively. In other words, there is a considerable gap between the relative frequency of what I have termed the simplex places of articulation and postalveolar. Similarly, retroflex and 'palato-alveolar' nasals are invoked typically only as a fourth possibility and the former only as an alternative to a (more frequent) palatal nasal when several nasal place types occur in languages. Both this last behaviour and the frequency figures are only compatible with a complex status for the postalveolar zone.[8]

It is less easy to interpret the frequency figures of laterals. As observed in § 4.2.4 almost all laterals cluster around the dentoalveolar zone (87% of all laterals in UPSID). However, in a way this lack of place variation confirms the pattern established so far for the postalveolar zone. It seems to be a general fact universally that if a given sound type is positionally restricted, the place of articulation it is produced at is dentoalveolar (cf. the unmarked status of coronal consonants). For laterals this is probably explicable in the

8. According to Maddieson (1984:63) 'the most usual third nasal is velar...[but] there is a very strong minor pattern which includes a palatal or palato-alveolar nasal instead of a velar one.' But although they are thus relatively more frequent than palatal (non-nasal) stops, nasals in the palatal area cannot be said to provide sufficient evidence to change the complexity hierarchy among nasals. There seems to be some factor operating with nasals which favours palatal ones to an unusual degree. This factor probably explains why palatal /ɲ/ also occurs without there being a non-nasal obstruent congener (cf. Maddieson 1984:65), something which is highly exceptional.

way that this is the place where it achieves its maximal effect, or, to quote Maddieson 'the preference for tip or blade articulations for laterals is presumable related to the greater opportunity to provide a free air passage behind the front closure if the body of the tongue is not involved in the articulation'(1984:77). Laterals then confirm the hypothesis that postalveolar is a complex place type by simply not 'choosing' postalveolar as their preferred place of articulation.

The *r*-sounds follow the pattern of laterals. Like laterals, *r*-sounds are articulated at a limited number of places. In UPSID about 86% of all *r*-sounds are dentoalveolar whilst retroflex *r*-sounds constitute 12% and palato-alveolar 0.6%. As with laterals, the retroflex subtype is the second most common type. But again this should not be taken as evidence of postalveolar being simplex in the absence of other places of articulation. It seems fair to claim that *r*-sounds also achieves maximal effect if articulated in this area. That is, a hunched tongue back, as opposed to a tip or blade articulation, would not allow the free air passage which is an important element of most vocoid sound types. It is thus predictable that dentoalveolar is the preferred place of articulation for a *r*-sound (this does not exclude places of articulation that are associated with parts of the body of the tongue; these will be marked, however). In view of this, it seems reasonable to say that also the *r*-evidence supports a complex interpretation of postalveolar.

It is thus quite clear that the postalveolar zone has complex status. Both relative frequency, systemic facts and relative saliency support this interpretation. It is true, the evidence is less obvious in the case of laterals and *r*-sounds than in the case of other sonorant and non-sonorant consonant types in the absence of a full range of articulatory zones with *r*-s and *l*-s. However, this is not to be taken as counter-evidence since the restricted locational variation with *r*-s and *l*-s is perceptionally explicable, as they achieve maximal effect at a limited range of articulatory positions. It is also attributable to the generally simplex status of the so-called coronal consonants. I conclude therefore that category 1 remains unchanged. Category 1 still only comprises the four simplex zone types, bilabial, labiodental, dentoalveolar and velar. The new postalveolar zone does not belong here, but is complex and should be assigned to category 2.

4.3.2 Relative complexity and layer 3. So far relative complexity has been established for the articulatory zones only, that is for layer 1. This has been a fairly straightforward task, given that both relative frequency and relative saliency in general support that only bilabial, labiodental, dentoalveolar and velar are assigned simplex status. However, relative complexity has not been established for layer 2. As discussed in § 3.3 this is a consequence of the subsidiary role assigned to layer 2. It is my hypothesis that layer 1 and layer 2 jointly constitute the articulatory network. In this the stationary places of articulation are assumed to be basic. Consequently no articulatory representation of a consonant lacks a layer 1 specification and association between layer 1 and layer 2 is therefore determined by the former. The subsidiary role which thus is assigned to layer 2 involves that layer 2 does not specify complexity. Complexity already appears from the layer 1 specifications, a state of affairs which is also supported by the fact that layer 2 only specifies a limited range of articulation types, whereas layer 1 allows for a full range of place types. Determination of complexity is then naturally associated with layer 1. The question is then whether layer 3, like layer 2, also does not contribute to complexity. In previous sections of this chapter I anticipated that this is in fact an appropriate interpretation. I shall now try and specify why this is so.

Recall that the function of the components assigned to layer 3 is such that they are invoked, typically, when the contrasts in question cannot be distinguished in terms of layer 1 (and layer 2). This is the reason that the layer 3 components were described as intensifiers of the small differences of place: they specify extra phonetic gestures of active articulation. But layer 3 is far from always required underlyingly. Nor does it allow for a full range of articulation types. Instead it specifies particularly non-dorsal articulations, just as no sound type can be described with respect to place solely in terms of layer 3. Clearly these facts make it difficult to link layer 3 with complexity, just as it is difficult to claim that layer 2 should be linked with complexity. This difficulty is also highlighted by the fact that such properties as frequency and saliency are not directly applicable at layer 3. For example, one component, viz. |λ| (laterality), represents a very common sound type and also one which is highly salient (this is due to the predominantly coronal properties of laterals), whereas others represent more or less rarely used active gestures. For these reasons it is best to assume that the expression of complexity lies outside the domain of layer 3, but remains a layer 1 matter.

It should be observed, however, that although it is in principal determined by layer 1, the markedness value of layer 3 is not completely independent of the sound type which the layer 3 component specifies. Take laterality, for example. All other than dentoalveolar laterals are rare. That is, the typical lateral is articulated in the dentoalveolar area and with the tip or blade of the tongue. But there exist palatal and velar laterals too and, as is apparent from chapter 3, palatal and velar consonants are respectively complex and simplex - at least when complexity is determined by frequency and saliency in general. If this pattern is applied to laterals, then velar laterals would appear simplex (whilst palatal laterals would remain complex as other palatal consonant types). But a complex status for velar laterals conflicts with their extremely low cross-linguistic frequency of occurrence; only one language in UPSID has a velar lateral. However, as discussed in § 4.2.7, layer 1 may be said to allow for this situation too. Recall that one zone is more simplex than any of the others, viz. the dentoalveolar zone. And this is precisely the zone at which laterals almost exclusively occur. One may say, then, that layer 1 predicts that when a sound type is articulatorily restricted to one place this place is the dentoalveolar zone (cf. the discussion of the special status of coronality in § 3.3.3). There is then nothing exceptional in the way laterals pattern. The articulatory restriction of laterals cross-linguistically makes the occurrence of a velar lateral highly complex, irrespective of the complexity status of this place of articulation with other consonant series.

A similar exceptional behaviour is characteristic of *r*-sounds. They are also predominantly dentoalveolar and again this is explicable in terms of where vocoid consonants achieve maximal effect (cf. the special status of coronals). Consequently, other than dentoalveolar articulations will for this sound type also be interpreted as complex.

4.3.3 More on the expression of relative complexity. It was argued above that the underlying phonological level should show as little redundancy as possible. In practice this meant that only non-redundant componential information and syllable sub-parts such as onset and rhyme were specified. All other information, because it is predictable, should be left out. Following the work of Archangeli (1983, 1988), the term used for such reduced representations which exclude everything predictable is underspecification. But as the concept has been used here, and more generally by Archangeli, underspecification also involves a claim about markedness. *Ceteris paribus*, the unmarked or simplex sounds are also the underspecified ones. In dependency phonology relative complexity has always been expressed in terms of underspecification such that a simplex sound is associated with a simpler representation, i.e. one involving fewer components than the representation for the corresponding complex sound. Thus no extra mechanisms such as default rules and complement rules (cf. the discussion in § 3.2.2) are needed in dependency phonology, unlike in, for example, binary feature frameworks. As a consequence, the simplex zones, labial, labiodental, dentoalveolar and velar, were all represented as involving fewer components underlyingly than the remaining zones, i.e. those representing complex place types.

Because the layer 3 components in themselves do not contribute to complexity, it is irrelevant to speak of underspecification at layer 3. Similarly it is irrelevant to speak of default rules and complement rules - rule types which are important in underspecification theory (cf. Archangeli 1989). Complexity, underspecification and default/complement rules are only relevant at other descriptive layers.[9]

When the layer 3 components are independent of complexity, their presence in the representations does not count. They are cost-free. However, there exists an important relationship between the layer 3 components and the articulatory network, a relationship which further supports the cost-free hypothesis. It is the property of the layer 3 components discussed above that they with respect to location almost always are associated with the dentoalveolar zone. The reason why this supports a cost-free hypothesis is that the dentoalveolar zone is the most simplex or unmarked of all the simplex or unmarked articulatory zones. In other words, when the layer 3 components are used it is in combination with a simplex primitive. Thus $|\lambda|$, for example, only adds cost to the grammar when associated with other zones than the dentoalveolar zone. And this is not a property which has to be specifically stated. It is a property which follows automatically from the fact that dentoalveolar zone is represented as the most simplex of all simplex zones

Clearly it is necessary to develop a more refined notation for expressing the interrelation between underspecification and such factors as cross-linguistic recurrence and general saliency of phonetic parameters. The solution I have suggested here is in no way definitive, but I am convinced that simplicity in a notational model based on monovalent components should be expressed in terms of underspecification manifested as absence of components. Future research must refine the method of representation, in particular it must develop appropriate rules for the expression of derivative representations. But it must also look for further evidence which will

9. The rules which fill in the underspecified layer 2 components, the absence of which indicates which articulatory zones are simplex, cf. § 3.3.2 above, should look as follows exemplified by L, the labial zone:

$$[\,] \rightarrow |u| \;/\; \overline{\begin{bmatrix} \text{L} \\ \text{layer 2} \\ \text{[+segment]} \end{bmatrix}}$$

which reads: derivatively the layer 2 value associated (in the articulatory network) with the labial zone is $|u|$. Similar rules can be constructed for the other underspecified zonal labels.

confirm or disconfirm that the subcategorisation into complex and simplex classes is exactly as I have suggested here.

4.4 Concluding remarks. This chapter has made two facts clear. Firstly, it has made it clear that to describe articulatory place it is necessary to have recourse to a descriptive layer which in detail can allow for dorsal and non-dorsal tongue activity. And secondly it has made it clear that the articulatory zones posited so far are not sufficient, but that an extra post-alveolar zone should be added to the set of articulatory zones.

Without the former layer many *r*-sounds and laterals, as well as in some cases retroflex and flapped sounds, will simply not receive a unique underlying representation. Moreover, layer 3 also enables us to distinguish between dental and alveolar place contrasts when this is necessary. The two components |t| and |f| ensure this. By 'entrusting' the expression of this contrast to this third layer, we keep the number of articulatory zones as low as possible, a fact which conforms well with the rare occurrence of the dental/alveolar contrast. At the same time, this has the advantage that the component |t| is not restricted to approximant *r*-sounds and trills.

As regards the extra articulatory zone, this is essential to characterise not only retroflex sounds, but also the articulatory place in terms of which those sounds which traditionally are termed palato-alveolar should be described. Thus the proposals of this chapter also confirm the observation made by both Lass and Ladefoged that palato-alveolar is not a true positional class.

Another important point made in this chapter is that layer 3 does not contribute to complexity. Its status as the host of 'intensifiers' entails that its contribution to complexity is marginal. This is further emphasised by the fact that the layer 3 components almost always are associated with the dentoalveolar zone. Of all the simplex zones this zone occupies a special position by being the most simplex of all the simplex zones. For this reason the markedness value of the layer 3 components automatically follows from the value of the layer 1 zone. Consequently the layer 3 components are simplex and in fact can be used freely in the representations, their complexity being determined elsewhere.

Layer 3 specifies dorsal and non-dorsal articulations. As such layer 3 has the function which Anderson and Ewen ascribe to their component |l| which they define as linguality (1987:ch.6). Anderson and Ewen motivate this component by some observations of Lass's (cf. Lass 1976:ch.7, 1984: ch.11). Lass has pointed out that in the history of English, for example, there occur regularly natural classes such as palatals/velars, dentals/velars, dentals/palatals/velars one or more of which may moreover include high vowels.

Lass therefore proposes a feature, 'linguality' which can capture any of these natural classes. Anderson and Ewen's |l|-component is modelled on this feature and designed, among other things, to capture such classes. Given the recurrence of such classes, it should also be within the capacity of layer 3 to capture the same classes. And this is quite clearly the case. Recall that in § 4.2.1 it was pointed out that layer 3 is a super-layer which consists of the two sub-layers, the dorsal and the non-dorsal layers as expressed in the figure below (repeated from § 4.2.1):

t, f, l, λ	λ
non-dorsal	dorsal
lingual	

The natural classes referred to by Lass can be captured in terms of the super-structure, the lingual level. These classes will simply be lingual or described in terms of whatever component is chosen to represent this super-layer. Thus the environment in which diphthongisation before dentoalveolars, postalveolars and velars which occurs in some American English accents, cf. [kæint] 'can't', [fIiʃ] 'fish' [bæig] 'bag', can be characterised as in (4.22):

(4.22)	layer 1	T	Po	K
	layer 3		lingual	

The advantage of the lingual layer is that it represents a clearly definable physiological property, a property which -probably even cross-linguistically - functions to define recurrent natural class such as, for example, dentals, palatals, velars. It is a means we need for the formulation of rules so that disjunctive component specifications can be avoided, but unlike any of the other phonologically functioning modules (for the lack of a better term to refer to both components and layers), it is only used derivatively. By contrast the dorsal and non-dorsal sub-layers function contrastively, i.e. are found underlyingly. Their components may be found at the underlying level as well at derived levels as, for example, in the specifications of natural classes.

CHAPTER 5
CO-ARTICULATION

5.1 Preamble. It was assumed in the preceding chapters that the locational characteristics of a consonant involve a single and unmodified articulation. But it is well-known that the locational properties of a consonant may not always be singular and unmodified. The place of articulation of a single consonant can also involve co-articulation. The two most common types of co-articulation are secondary articulation and double articulation. Secondary articulation is a co-articulation in which a single segment has one primary stricture modified by one or more strictures of a lesser strictural degree which are produced by articulators not used in the primary stricture. Double articulation, on the other hand, is when a single segment has two articulations of the same strictural degree.

Usually the term co-articulation does not include other types of articulation. However, here I shall extend the term so it also includes nasality. The motivation for this is that nasal resonance is always combined with some oral articulation, either such that the nasal cavity acts as a concomitant resonator or such that it acts as the single escape channel for the compressed air. The former comes closest to co-articulation proper, but because the latter also involves, at least partially, the simultaneous use of two articulatory events, it may also be included under the heading co-articulation. But in order to accept that nasality is a type of co-articulation it is crucial to abandon the view that co-articulation cannot involve two so different parameters as stricture and resonance. It must be accepted that concomitant articulations do not necessarily have to belong to the same articulatory parameter, and it must be accepted that a co-articulated consonant can have a single stricture. For this reason it will still be necessary to deal with the place of articulation of the nasal consonants along with other single-stricture consonants.

In this chapter I propose how these three types of co-articulation should be captured within the representational framework proposed here. In dealing with each type I shall discuss how it has been accounted for in the standard feature-based notations and the standard and non-standard versions - if any - of dependency phonology. I begin with secondary articulation.

5.2 Secondary articulation

5.2.1 Other accounts of secondary articulation. Let us begin by establishing how many types of secondary articulation we should recognise. The most common types of secondary articulations are labialisation, palatalisation, velarisation and pharyngealisation. For example, Maddieson (1984) reports that no other types exist in the UPSID-languages, except for laryngealisation and glottalisation, which should not be accounted for in the articulatory gesture. For Ladefoged (1971) these four types are also basic. Catford, however, seems to recognise at least a fifth type, labiodentalisation (1977) and in addition mentions that also postalveolarisation and uvularisation are possible secondary articulations. The status of the latter two seems uncertain, however. The former has a very limited occurrence and the latter is usually described as either velarisation or pharyngealisation. Thus if we accept that uvularisation probably is non-unique, but still follow Catford and include labiodentalisation, then there are five types of secondary articulation to account for: labialisation, labiodentalisation, palatalisation, velarisation and pharyngealisation.

Usually labialisation and labiodentalisation are not kept distinct. I do not know whether those languages which have labiodentalised consonants also have labialised consonants. But I suspect that the two types of secondary articulation are mutually exclusive, in which case we need not devise individual phonological representations for the two types. As long as this remains an open question, I shall assume that they are non-distinct. This leaves us with the original four types, labialisation, palatalisation, velarisation and pharyngealisation.

How has secondary articulation then been described phonologically so far? In SPE, with the exception of labialisation, secondary articulation is allowed for in terms of a plus value for one or more of the tongue body features [high], [low] and [back] added to a non-tongue-body consonant, i.e. one which is [+anterior] and/or [+coronal]. This treatment has the advantage that tongue-body features for secondary articulation are the same as those for the corresponding primary articulation. But it means that it is not possible to describe a palatalised, velarised or pharyngealised tongue-body consonant such as the palatalised velars found in, for example, Lithuanian (cf. Maddieson 1984:264). This is clearly a weakness in the SPE-treatment. Labialisation in SPE is characterised in terms of the feature specification [+round].

Ladefoged treats secondary articulation as a 'co-articulation' in which the primary articulation has a vowel-like characteristic added to it, i.e. a specification involving the features [front] and [high]. For example, /kʲ/ a palatalised velar, would be specified as [velar, front and high] by Ladefoged. Because Ladefoged operates with a multivalued feature [articulatory place] (of which 'velar' is one value) which specifies place of articulation, no confusion arises in Ladefoged's treatment when a tongue-body consonant is palatalised, velarised or pharyngealised. Thus Ladefoged avoids the problem encountered by SPE that the representation predicts that a tongue-body consonant cannot have another tongue-body articulation as secondary articulation. In Ladefoged's framework labialisation is also treated by adding the feature specification [+round].

In the standard version of dependency phonology, secondary articulation is given a rather obvious interpretation. Consonants which have secondary articulations are represented with the specification for the secondary articulation simply subjoined to the specification for the primary place of articulation. Thus palatalisation and velarisation, for example, appear as in (5.1) (cf. Anderson and Ewen 1987:247):

```
(5.1)        l              l
             |              |
             |              |
            l,i            l,u
        palatalised     velarised
          alveolar       alveolar
```

Labialisation likewise involves a subjoined representation, viz. a subjoined |u|, no matter whether labialisation is the co-articulation of a labial or non-labial consonant, i.e.:

```
(5.2)        l              u
             |              |
             |              |
             u              u
```

It is thus an important feature of Anderson and Ewen's account of secondary articulation that a representation may contain more than one instance of the same component. This spells out the additive role of secondary articulation and clearly shows how the primary stricture is ranked higher than the secondary stricture.

5.2.2 Secondary articulation in the present framework. Within the framework presented in this monograph, secondary articulation can also be given a rather straightforward interpretation. But unlike in the account of primary articulation, it is necessary to invoke dependency in its simplest form. Thus in order to show how secondary articulation is additive, I shall make use of the asymmetric subjunction relation.

Let us first make a distinction between, on the one hand, labialisation and, on the other, palatalisation, velarisation and pharyngealisation. The first involves no tongue activity whereas the latter are produced with the body of the tongue. Let us focus on the secondary articulations involving the tongue-body first. Palatalisation, velarisation and pharyngealisation can all be represented by subjoining the layer 2 components |i|, |u| and |a| respectively to the appropriate primary specification:

```
(5.3)     primary      primary        primary
           artic.       artic.         artic.

             i           L,u              a
        palatalised   velarised    pharyngealised
```

The extra specification of velarisation in the form of the component 'L' indicates that it is |u|-ness of the kind produced with the tongue. 'L' is the cover symbol for a component covering any activity involving either the dorsal or non-dorsal part of the tongue, i.e. any activity which is described in terms of the lingual layer (layer 3), cf. § 4.2 1.

The 'L' specification is necessary because |u| will also be needed for the representation of labialisation, the other type of secondary articulation. Given that it is defined by Anderson and Ewen as 'roundness' (or 'gravity' and 'flatness')" (1987:206), |u| must also act as subjoined element in a co-articulation involving labialisation:

```
(5.4)     primary
           artic

            |u|
```

Apart from enabling us to distinguish between labialisation and velarisation, the presence of 'L' also helps explain the greater naturalness, cross-linguistically, of velars becoming palatalised in the environment of a front vowel than palatals becoming velarised in the environment of a back vowel.

Velarisation is in the present interpretation simply a more complex process involving the addition of both | u | and linguality.

The present account also makes it possible to represent labials with added lip-rounding. This class will be characterised by | u | subjoined to a primary specification involving the labial zone. Double secondary articulations can also be given an obvious representation. Thus the labialised and velarised stops reported to occur in some variants of Irish (cf. Maddieson 1984:263) will have | u | and | u |, | L | subjoined to the primary specification.

In all, the solution presented here, although in no way complete, thus seems to capture the most important facts about secondary articulation namely: i) that the primary and secondary articulations at the same place are produced with the same part of the tongue, ii) that a tongue-body consonant can have another tongue-body articulation as secondary articulation and that labial consonants can have added lip-rounding, and iii) that one primary articulation can be modified by two secondary articulations.

I shall not make a secret of the fact that the present account is unable to allow for all aspects of secondary articulation. For example, it is not clear whether all kinds of rounding should be represented in terms of a subjoined | u |. According to both Ladefoged and Catford rounding may involve either lip protrusion or lip compression. The latter is found in Swedish (cf. Lass 1984: ch. 5), but it is not clear how it should be accounted for if employed as a secondary articulation, but a new component would seem to be required for this type of labialisation. There is also the problem of labiodentalisation. If this is distinctive along with labialisation, it is also necessary to propose a new component for this type of articulation. Problems such as these still await a solution

5.3 Double articulation.

5.3.1 Other accounts of double articulation. It is characteristic of a segment with double articulation that it is produced at two places of articulation simultaneously and that they have the same strictural rank. For example, English /w/ is a labial-velar: it is both labial and velar at the same time and the labial and the velar strictures are of the same strictural degree.

Double articulation usually involves the bi-labial, dentoalveolar, palatal and velar places of articulation. Typically, bilabial is combined with one of the tongue-based articulations. A combination of two tongue-based articulations is less common (only 1 language in UPSID), probably because this does not involve two independent articulators. Double articulation seems to be more common among stops, approximants and nasals than among fricatives. Co-articulated consonants are represented by the two relevant symbols tied together with a bar. Thus the dental-palatal stop and nasal in Maung are written /t̪͡c/ and /n̪͡ɲ/. Two co-articulated consonants, however, are always represented with a single symbol, viz. the labial-velar and labial-palatal approximants /w/ and /ɥ/.

It has proved difficult to account for double articulation in binary feature-frameworks such as SPE. The problem is that in such models co-articulated consonants will have to be treated either as if they represent one primary articulation modified by a secondary articulation, or as two consecutive segments, one for each stricture. For example, the labial-velar /k͡p/, found in many languages, must be treated either as a labial with velarisation or a velar with labialisation (SPE:311). But clearly this interpretation fails to distinguish double articulation from secondary articulation, just as it fails to express the fact that double articulation involves two articulations of the same strictural degree. The other solution available within a standard feature-based framework is equally unsatisfactory. To treat a co-articulated consonant such as /k͡p/ as a /k/ followed by a /p/ conflicts with the fact that a co-articulated consonant is a single phonological segment. Indeed, the reason why a SPE-type of framework is unable to allow for double articulation but has to resort to one of the solutions presented here is that it has no mechanism which can link two place specifications with a single segment.

In a framework like Ladefoged's, on the other hand, in which place of articulation is described in terms of a multivalued feature, double articulation receives a straightforward interpretation. To account for /k͡p/, for example, Ladefoged simply adds the value labial-velar to his multivalued feature [articulatory place]. This way there is no clash with the representation of secondary articulation, just as the single segment hypothesis is not violated, the value labial-velar being used to specify a single segment. It is true, labial-velar does not cover all the different types of double articulation, but these can be allowed for by adding more values to the feature [articulatory place].

In dependency phonology double articulation can be given a rather obvious interpretation too. A consonant with two equally important strictures is simply characterised for both in the articulatory gesture such that neither representation is dependent on the other (cf. Anderson and Ewen 1987:250):

(5.5) categorial gest. {|C|}

artic. gest. {|l,u|,|u|}

which is the representation for /k͡p/. |l,u| is the articulatory representation for velarity and |u| covers labiality. The fact that the two places of articulation have the same strictural rank is indicated by the comma between the vertical bars which denotes simple combination. The sequential non-distinctness of the two place specifications is apparent from the fact they are associated with the same categorial representation.

5.3.2 Double articulation in the present framework. The properties available within the framework presented here also allow double articulation to be represented in a rather obvious way. Double articulation is simply represented in terms of a combination of two layer 1 specifications. The fact that the relation between them is one of combination ensures that they have the same strictural rank. And the other important feature of double articulation, sequential non-distinctness, is - as in the standard dependency-based account - expressed by associating the articulatory representation with the two zone labels with a single categorial representation. Thus I propose that the labial-velar /k͡p/ should appear as follows:

(5.6) categorial gest. {|C|}

artic. gest. {|L,V|}

This interpretation of double articulation clearly raises the question of what the complexity status of such co-articulated consonants is. I shall try and answer this question by examining the labial-velar consonants since these, except for the two dental-palatal consonants found in Maung, are the only co-articulated consonants found in UPSID.

In fact, I assumed earlier (cf. § 3.2.4 above) that the labial-velar approximant /w/ is simplex. I assumed this because it is composed of two places which individually are simplex, but I provided no arguments in support of this position. However, simplex status is supported by the structure of the inventories which have labial-velar obstruents and nasals. If we consider the 31 UPSID languages which have labial-velar obstruents and nasals then, except for one language, these languages all have simple labial and velar consonants as well. In other words, it is a general pattern that the presence of a labial-velar presupposes the presence of simple labials and simple velars. Now this dependence means we cannot establish the relative complexity of labial-velar in the same way as we established relative complexity for the other place types. All the other place types are independent of each other and this independence - one might argue - reflects that the speaker in principle is free to choose from a range of independent place types. But for labial-velars there is no such free choice: labial-velar is only chosen once labials and velars have been chosen also and labial and velar are simplex places of articulation. This dependence and the fact that labial and velar individually are simplex strongly suggest that labial-velar should be analysed as simplex.

If labial-velar is simplex it is also possible to explain another structural property of the inventories which have labial-velar and nasal obstruents. It is characteristic of such inventories that labial-velar is invoked early and not when other complex places of articulation have been used. In many of the 31 languages referred to in the preceding paragraph, the simple places of articulation used are bilabial, dentoalveolar and velar only. If labial-velar were complex, one would expect it to be invoked only after some of the complex simple places such as palatal, postalveolar, uvular have been used. But this does not seem to be the case. In most cases labial-velar co-occurs only with simplex places of articulation. This behaviour is explicable if labial-velar has simplex status.

Naturally, the fact that labial-velar's component places of articulation individually are simplex makes it easier to opt for simplex status. When this is not the case as in the Maung dental-palatal nasal and stops, then we probably have a complex place type. The labial-palatal approximant found in French, among other languages, should then also be considered complex.

5.4 Nasals and nasalisation.

5.4.1 Introduction. I described co-articulation above (cf.§ 5.1) as an articulatory event which involves two concomitant articulations. I also emphasised that these articulations need not both involve stricture but can be a combination of stricture and resonance. For this reason I treat nasality as a type of co-articulation.

The mechanism involved in the production of nasality is a very simple one. If the velum (or soft palate) is lowered so that air can escape out through the nose a nasal sound is produced; if the velum is raised the sound is oral.[1] But it is necessary to distinguish between two types of nasals: nasals proper and nasalised sounds. The two types differ according to whether the air escapes out of the nose only or out of the mouth and the nose simultaneously. If air escapes out of the nose only, the nasal is a 'proper' nasal such as /m/, /n/ or /ŋ/. In these an oral closure blocks the air so it can only escape out through the nose. If there is no oral closure, on the other hand, but the oral quality is coloured by the extra air passage created by the lowered velum, the sound is nasalised. Thus with a nasalised sound the nasal cavity acts as an extra resonator.

But there are more distinctions to be made among sounds produced with a lowered velum. Nasalisation can be of different degrees. According to both Ladefoged (1971:35) and Catford (1977:139), this is found in (Mexican) Chinantec, a language which makes a distinction between oral vowels, lightly nasalised vowels and heavily nasalised vowels. A further distinction involving nasality is the nasally released consonants found in, for example, Aranda. Unlike the familiar sequences such as, for example, English [-dn-], [-bm-] and [-gŋ-] in which the stops are released nasally and the nasals syllabic, cf. words like, *'sudden' 'submerge'*, *'organ'*, these consonants are single segments and contrast with single segments with an oral explosion. Probably this is what is often referred to as postnasalisation which, like prenasalisation, refers to a situation where nasality does not accompany a single segment throughout its articulation. Lastly there is the possibility that sounds produced with a lowered velum involve turbulence at the velic and nareal orifices, that is, turbulence caused by a narrowing of the nostrils or the velic orifice. In all likelihood, the velic narrowing is responsible for the various degrees of nasalisation found in for example Chinantec. Various degrees of nasalisation and velic narrowing should then probably be treated as the same phenomenon.

With respect to natural recurrence, nasal consonants lead a double life. On the one hand, they form a natural class with other sonorant consonants by virtue of their shared acoustic properties, and, on the other, they form a natural class with nasalised consonants and nasalised vowels. Thus although it involves a single and simple articulatory mechanism, nasality is associated with two clearly distinct phonetic parameters.

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1. There also exist sounds with a lowered velum which are based on an ingressive airstream. Here I shall confine myself to those based on an egressive airstream, as the two types will not differ representationally.

Needless to say, an account of nasality must be able to account for all the possible aspects of nasality. Firstly, it must be able to handle all sound types which involve a lowered velum: 'true' nasals and nasalisation, including different degrees of nasalisation, pre-nasalisation and post-nasalisation and the possible turbulence created at either end of the nasal tube. Secondly it must be able to allow for the behaviour of nasals with respect to natural recurrence. As in the above sections of this chapter I shall first consider how nasality has been dealt with in the past in the standard notations. Next I consider how nasality has been accounted for in standard dependency phonology as well as in a non-standard version of this model, and finally I propose a solution within the present framework which is compatible with the structural properties outlined so far.

5.4.2 Other accounts of nasality: SPE. In SPE a sound produced with a lowered velum is specified [+nasal]. Together with the other features set up by Chomsky and Halle, [+nasal] will keep most nasal or nasalised sounds distinct at the underlying level. Prenasalisation and postnasalisation are potential exceptions, as SPE cannot express sequential ordering within the segment. Similarly it is impossible to allow for various degrees of nasalisation within this framework. Another problem for SPE is natural recurrence as determined by acoustic properties. It is not possible within SPE to express that nasals and other sonorant consonants make up a natural class without using disjunctive feature specifications. By contrast, the other potential natural class, that of 'true' nasals, nasalised consonants and nasalised vowels, is directly expressible within SPE in terms of the specification [+nasal].

5.4.3 Other accounts of nasality: Ladefoged. Ladefoged sets up two features to account for nasality: a feature [nasality] and a feature [prenasality]. Typically [nasality] can assume only two values: the value 1 for sounds produced with a lowered velum and the value 0 for sounds produced with a raised velum. In a few languages, Chinantec for example, [nasality] will be multivalued to allow for the various degrees of nasality. The object of [prenasality] is to allow for prenasalised sounds and again it can assume only two values.

Ladefoged's attempt to account for the relative duration of some nasal sounds in terms of [prenasality] represents a step forward as compared with SPE. But he is still unable to account for postnasalisation although this can probably be accommodated for quite easily by redefining [prenasality]. Also Ladefoged is unable to allow for the natural classes referred to above which involve sonorant consonants and nasals without using disjunctive feature specifications. On the other hand, the natural class involving nasals and nasalised sounds may be expressed directly in this model. Although Ladefoged's treatment thus represents an improvement as compared with SPE, some refinements are still called for.

5.4.4 Nasality in dependency phonology. In Anderson and Ewen's standard model (1987), nasality is specified not only in the categorial gesture but also in the articulatory gesture, more particularly in what they call the oral-nasal sub-gesture. The categorial representation for nasals is |V;C| which reflects the predominant sonorant characteristics of nasal sounds. In the oral-nasal sub-gesture nasals are marked by the component |n|, the presence of which, we are led to assume, specifies a lowered velum. This double specification is motivated by the two distinct phonetic parameters which characterise nasality (cf. § 5.4.1 above).

Whatever its virtues, this treatment of nasality raises a number of questions. Is it really necessary to specify nasality in two gestures? Are these gestures necessarily the articulatory gesture and the categorial gesture? Is it not a problem that the sole function of the oral-nasal sub-gesture is to allow for one aspect of nasality? Is it not counter-intuitive that the 'true' nasals /m/, /n/ and /ŋ/ are not necessarily specified for the component |n| which designates a lowered velum? Clearly, these questions highlight that the standard account within dependency phonology is in want of a revision.

5.4.5 An alternative dependency account. The misgivings which such questions express are also shared by Davenport (1992) who, as a consequence, has proposed an alternative account of nasality within dependency phonology. His misgivings about the standard account can be summed in the following way: i) it is spurious to assign nasality to a sub-gesture, the oral-nasal sub-gesture, when the sole function of this sub-gesture is to host a component specifying a lowered velum, ii) arguably nasality is an airstream mechanism and consequently should be assigned to the gesture describing this kind of mechanism, i.e. the initiatory gesture, iii) the standard categorial specification for nasals, |V;C|, i.e. |V| governing |C|, fails to capture the fact that in some languages, Welsh for example, stops and nasals form a natural class. As a result of these misgivings, Davenport sets up a new description of nasality. This involves two modifications: a reallocation of the nasality component to the initiatory gesture and a change of the categorial specification of nasals to |C;V|, the representation for voiced stops. Thus /b/ and /m/ in his new treatment are specified as:

(5.7)		/b/	/m/
	categ. gest.	{|C;V|}	{|C;V|}
	init. gest.		{|N|}

Nasals are then no longer doubly specified since they share their categorial representation with voiced stops. Only the now reallocated nasality component (N) keeps them distinct.

Davenport points out that an advantage of such a categorial characterisation of nasals, is that it enables us to show that the change found in Celtic languages by which a nasal (/m/) can change to a voiced fricative is the same as the equally common change by which a voiced stop becomes a voiced fricative. Because both voiced stops and nasals have the same categorial representation, viz. |C;V|, these two changes will be seen as the same process, namely a lenition process, i.e. an increase in |V|-ness (for the characterisation of lenition and strengthening in dependency phonology, see Anderson and Ewen 1987:176). However, if the categorial representation of nasals is |V;C|, as in the standard account, the change of /m/ to a voiced fricative will be seen as the opposite, i.e. as a strengthening process, and the clearly parallel nature of the two processes will be lost.

But, as conceded by Davenport, this description has a drawback. By describing nasals as voiced stops categorially, it is impossible to represent the sonorant parameter of nasal sounds, that they form a natural class with other sonorant consonants and occupy a position close to vowels on the sonority hierarchy. If we want to capture the shared properties of voiced stops and nasals in the Celtic languages this is the sacrifice we have to make, when the notation cannot allow for the double nature of the nasal category.

The other parameter characteristic of nasality, the parameter which turns nasals and nasalised sounds into a natural class, is allowed for in Davenport's treatment in terms of the initiatory component |N|. Thus a nasalised vowel and a nasalised voiced fricative are associated with the following representations:

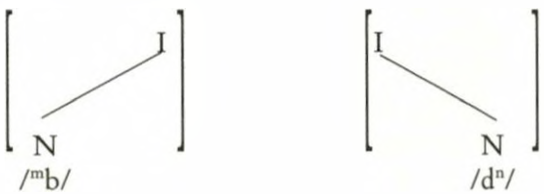
(5.8)		/ã/	/Ṽ/
	categ. gest.	{|V|}	{|C:V;V|}
	init. gest.	{|N|}	{|N|}

Different degrees of nasalisation, as in Chinantec, are also captured in terms of |N|, either such that the initiatory and the categorial gestures enter into dependency relations, if such intergestural relations are considered appropriate (cf. Anderson and Ewen 1987:ch.5), or in terms of an interaction between an initiator velocity component |I| and |N| if such intergestural relations are rejected (cf. Davenport and Staun (1986)). The first solution is given in (5.9a) the second in (5.9b):

(5.9)		/a/	/ã/	/ã̄/
	(a)	{|V|}	{|V|}	{|N|}
			{|N|}	{|V|}
	(b)	{|V|}	{|V|}	{|V|}
		{|I|}	{|I;N|}	{|I:N|}

Pre-nasalisation and post-nasalisation also receive a straightforward interpretation in Davenport's account. Such segments involve both precedence and dependency within the initiatory gesture, i.e.

(5.10)



which, given that they will be associated with a single segment node, reveals the complex status of such consonants, i.e. that they are single segments but involve precedence at the same time.

Davenport's alternative account thus represents a step forward. The reallocation of |N| to the initiatory gesture makes the oral-nasal sub-gesture redundant. This is clearly an advantage as its sole function was to allow for a lowered velum. The conflation of the representations for voiced stops and nasals proper in the former is also an advantage, as it reveals the shared properties of these two sound types which behave alike in Celtic lenition processes. Unfortunately, the conflation of nasals and voiced stops in the categorial gesture also has a drawback. With such a characterisation, it is now impossible to reflect the clearly sonorant rather than obstruent qualities of nasals proper, that is, that nasals proper occupy a position close to vowels on the sonority hierarchy.

5.4.6 Another alternative account of nasality. An important claim in Davenport's description of nasality is that such a description should be able to express that nasals proper may structure not only with voiced stops but also with sonorant consonants. In addition, as I pointed out earlier, a description should be able to allow for other natural classes and, not least, the relative sonorancy of nasals proper (plus degree of nasalisation and pre-and postnasalisation). To the extent that it is impossible for a single representation to handle all aspects of nasalisation, it will be necessary to supplement with an extra representational device. This is the reason that Anderson and Ewen posited two representations for nasality: an articulatory and a categorial one. Davenport avoided a double representation by conflating the representation for nasals and voiced stops and reallocating the nasal component to the initiatory gesture. His account is thus distinguished by greater simplicity.

But as I pointed out his account has a drawback: the relative sonorancy of nasals proper is left unexpressed. The object of this section is to propose a description of nasality within the structural framework proposed here which can allow for all aspects of nasality. It is inevitable that this will involve some double specification given the complex nature of nasality. I explore first how it is possible to represent that nasal sounds form a natural class not only with voiced stops but also with sonorant obstruents. The greater structure available here will then decide that a further component referring to a lowered velum should be articulatory rather than initiatory.

The categorial gesture is the place to search for a representation which may serve the double role of expressing that nasals proper may structure both with stops and with sonorant consonants. Let us then consider a sample of representations set up in the categorial gesture of dependency phonology (for a full discussion, see Anderson and Ewen 1987: ch.4):

(5.11)	C	C,V	C	C,V
			V	V
	voiceless stops	voiceless fricatives	voiced stops	voiced fricatives

$$\begin{array}{ccc} V & V & V \\ | & | & \\ C & C,V & \\ \text{sonorant} & \text{liquids} & \text{vowels} \\ \text{obstruents} & & \end{array}$$

The categorial gesture describes a scale. At the one end we have |C|, maximum consonantality, at the other end |V|, maximum periodicity. These two ends represent voiceless stops and vowels respectively. Other sound types are represented as values in between these two extremes and specified in terms of interactions of the two components |C| and |V|, interactions which involve asymmetric or symmetric dependency relationships or both. Thus as we move from the |C|-end towards the |V|-end, |V|-ness increases and |C|-ness decreases and similarly as we move from the |V|-end towards the |C|-end, |C|-ness increases and |V|-ness decreases. As a consequence, the |C| - |V| scale reflects relative sonority perfectly and as such is ideal to describe the sonority hierarchy.

It is apparent from (5.11) that the two representations of interest here are |{V;C|} (sonorant obstruents including nasals) and |{C;V|} (voiced stops). Davenport's point was (op. cit.) that these two representations are not conflatable and that as a consequence it is not possible to express that they specify a natural class. However, a closer examination reveals that one configuration has not been utilised so far, viz. the representation which combines the representation of voiced stops and sonorant obstruents, i.e.:

(5.12)

$$\begin{array}{c} C,V \\ | \\ C,V \end{array}$$

It is no accident that this representation has not been employed before. It designates a sound type which is ambivalent. It is neither clearly obstruent nor clearly sonorant and consequently impossible to place on the sonority hierarchy. But this is exactly the quality that we want to capture here. We want a representation which covers the voiced obstruent configuration as well as the obstruent sonorant configuration. But observe that in order to fulfil this double role the representation in (5.12) must contain exactly the components specified, i.e. a |C,V| governed by |C,V| (i.e. what linearly is represented as {|C,V;C,V|}, no more no less. The fact that it must contain a

|C,V| over a |C,V|, ensures that not other sound types such as a fricative - voiced or voiceless - or another sonorant obstruent such as, for example, a lateral is included in the representation.

My proposal is then that in languages such as, for example, Welsh a nasal which has features in common with voiced stops and with sonorants is represented as in (5.12). Otherwise a nasal is simply {|V;C|}, the standard representation for a nasal. But clearly neither representation is sufficient to allow for the other type of natural recurrence, the natural class of nasals proper and nasalised sounds. It is still necessary to posit a representation which refers to an articulatory mechanism and which allows for this class. Davenport, as was apparent from the discussion above, suggested an initiatory component, |N|, to capture natural recurrence; this made sense because nasality in one way is an airstream mechanism, which naturally belongs in the initiatory gesture. On the other hand, this solution also had a drawback: it disguised the fact that nasality involves the lowering of the velum.

It is my contention that the fact that nasality involves a lowered velum is expressible in a way which is compatible with the structure of the articulatory gesture as outlined in the previous chapters. Consider again layer 1 as it was described in chapter 3. Here I described it as consisting of a series of articulatory zones: labial, dentoalveolar, palatal etc.. These articulatory zones represent a series of locations along the roof of the mouth plus the lips (layer 1 was referred to as the oro-pharyngeal parameter). It is characteristic of these zones that they are all used to describe non-movable places of articulation. However, as is well-known two of these zones refer to locations which are also movable, viz. the velar zone and the labial zone. In other words, just as it was possible to divide layer 3 into two sub-layers (one referring to non-dorsal articulations and one referring to dorsal articulations, cf. § 4.2.1) layer 1 can be divided into sub-units according to whether the locations are movable or non-movable.

(5.13) B F D Po P V U Ph

non-movable

movable

However, the distinction between movable and non-movable only concerns individual zones, viz. the bilabial zone and the velar zone, and probably only the latter needs a phonological specification to allow for this possibility. If labiality or rounding is needed phonologically this can be taken care of by layer 2 representations, in particular in terms of the component |u|, as was pointed out above in § 5.2.2. For the movable velum, on the other hand, we require an individual specification to refer to a lowered position. I suggest this is $|V_m|$. Languages which make a contrast between nasalised and non-nasalised vowels require this specification for the nasalised variant. This is then the only type of vowel which requires a specification for layer 1.

Nasalisation essentially involves the addition of an extra resonance feature to another basic articulation. In this respect it is similar to secondary articulation which is characterised as the modification of a basic or primary articulation by adding a secondary articulation. Above I represented secondary articulation in terms of subjunction such that the modifying articulation is subjoined to the primary articulation. Given the similarity between nasalisation and secondary articulation, I shall adopt a similar representation for nasalisation. Thus a nasalised /e/ will be characterised as follows:

(5.14)
$$\begin{array}{c} \{|i;a|\} \\ | \\ |V_m| \end{array}$$

in which the representation for nasalisation ($|V_m|$) is subjoined to the basic articulation ({|i;a|}). Underlyingly nasals proper are not marked $|V_m|$; it is only derivatively they are associated with this representation, something which agrees well with the fact that natural classes, including such which may contain nasals proper and nasalised sounds, are typically found in phonological rules.

Pre-and postnasalisation need not be specified in terms of $|V_m|$, underlyingly; the categorial representation will suffice and $|V_m|$ will again only be needed derivatively. Pre-and postnasalisation differ according to whether |V;C| is left-adjoined or right-adjoined. Thus prenasalised /^{m}b/ in (Niger-Kordofanian (Bantoid)) Luvale and post-nasalised /b^{m}/ in Aranda appear as in (5.15):

(5.15)

$$/{}^{m}b/ \quad \begin{bmatrix} & C;V \\ V;C & \end{bmatrix} \begin{matrix}\text{categ.}\\ \text{gest.}\end{matrix} \qquad\qquad /b^{m}/ \quad \begin{bmatrix} C;V & \\ & V;C \end{bmatrix} \begin{matrix}\text{categ.}\\ \text{gest.}\end{matrix}$$

in which /^{m}b/ and /b^{m}/'s status as single segments is apparent from the fact that adjunction occurs within a single gesture.

In order to account for the various degrees of nasalisation degrees found in, for example, Chinantec (cf. above), both Anderson and Ewen (1987) and Davenport (1992) invoke dependency relations. Here I shall adopt a similar approach, although I have argued against invoking dependency to account for place contrasts among consonants. But not only is this a natural way to allow for such contrasts, given that such contrasts are due to different velic openings, but it is also appropriate because according to the few sources available to me, different degrees of nasalisation are only found among vowels but not among consonants. Consequently, such contrasts will be accounted for by positing dependency relations between a vowel component and $|V_m|$. Thus the minimal set /ha/ - /hã/ - /hã̃/ occurring in Chinantec should be represented as in (5.16):

(5.16)	/a/	/ã/	/ã̃/
	$\vert a \vert$	$\vert a;V_m \vert$	$\vert V_m;a \vert$

This is probably the only instance where a layer 1 value is involved in dependency relations. But it does not interact with another consonantal place primitive, but with a vowel primitive which may interact freely.

Let me try and sum up the main points about the representation of nasality. A nasal's core representation is categorial. Either it is the original (standard) representation $\{|V;C|\}$, or it is the ambivalent $\{|C,V;C,V|\}$. The latter is used in the few instances where nasals structure both with voiced stops and sonorant obstruents, as in some Celtic languages. Cross-linguistically this is a marked situation and the more complex representation $\{|C,V:C,V|\}$ appropriately reflects this. As regards natural recurrence, i.e. the ability to allow for the natural class of nasals proper and nasalised sounds, the core representation is supplemented with an articulatory representation. This is $|V_m|$ which refers to the movable 'passive' articulator, the velum, and whose presence specifies a lowered velum. The natural class of nasals proper and nasalised sounds is thus characterised by the presence of $|V_m|$ in the articulatory gesture. Finally pre-nasalisation and post-nasalisation are characterised by adjoining core specifications to the basic representation and different degrees of nasalisation in terms of dependency relations between $|V_m|$ and the relevant articulatory component. For clarification I list the four types in (5.17):

(5.17)

$$\begin{array}{ll} \text{arctic. gest.} & \left[\begin{array}{c} \\ \quad\quad \\ \end{array}\right] \\ \text{categ. gest.} & \left[\begin{array}{c} V;C \\ \\ \end{array}\right] \end{array} \qquad \begin{array}{ll} \text{arctic. gest.} & \left[\begin{array}{c} \\ \quad\quad \\ \end{array}\right] \\ \text{categ. gest.} & \left[\begin{array}{c} C,V;C,V \\ \\ \end{array}\right] \end{array}$$

typical nasal — atypical nasal (e.g. Welsh /m/

$$\begin{array}{ll} \text{artic. gest.} & \left[\begin{array}{c} V_m \\ \\ \end{array}\right] \\ \text{categ. gest.} & \left[\begin{array}{c} V \\ \\ \end{array}\right] \end{array} \qquad \begin{array}{ll} \text{artic. gest.} & \left[\begin{array}{l} V_m;a \\ \\ \end{array}\right] \\ \text{categ. gest.} & \left[\begin{array}{l} V \\ \\ \end{array}\right] \end{array}$$

nasalised vowel — heavily nasalised /a/

$$\begin{array}{ll} \text{categ. gest.} & \left[\begin{array}{ll} & C;V \\ V;C & \end{array}\right] \end{array} \qquad \begin{array}{ll} \text{categ. gest.} & \left[\begin{array}{ll} C;V & \\ & V;C \end{array}\right] \end{array}$$

/ᵐb/ — /bᵐ/

The representations summarised in (5.17) are all underlying ones. This is the reason that only the necessary component specifications occur in the gestures listed. Such underspecified representations are then filled in, if necessary, at derived phonological levels, for example at levels where natural classes have to be specified when they form part of phonological rules.

The question is then whether the present account gives a full picture of nasality and whether it can be said to represent a step forward. It is certain that it covers all aspects of nasality which have to be specified at the underlying level, and it is equally certain that it can express natural recurrence directly. It is the second question, whether it represents an improvement, which is difficult to answer. Here the representations {|C,V;C,V|} and the articulatory $|V_m|$ are crucial: do they represent real improvements? I cannot but see that the former is an appropriate way of expressing the double nature of some (Celtic) nasals, that they both with respect to sonorancy and with respect to natural recurrence play a double role. By comparison Davenport's account cannot fully allow for this fact as his categorial representation for nasals is identical to that of voiced stops, and Anderson and Ewen's solution is also inadequate as it excludes voiced stops. {|C,V;C,V |} is then an improvement.

The appropriateness of $|V_m|$ is much more difficult to justify. It is a result of an attempt to strike a balance between Anderson and Ewen's standard account and Davenport's recent alternative. $|V_m|$ avoids the problem of Anderson and Ewen's oral-nasal subgesture - whose sole function is to specify nasality - because it does not represent an entirely independent specification, but is part of a larger structure, a structure which refers to passive places of articulation including such as can also themselves move (lips and velum). And as compared with Davenport's account, it has the advantage that it refers directly to the fact that nasality involves a lowered velum. Davenport's account does not allow for such a direct reference to this crucial articulatory property.

In sum the advantages of the present account is that it can allow for those cases where nasals have a double status, it can allow for the sonorancy properties of nasals and nasalised sounds and it is able to express that nasality involves the lowering of the velum. The problem that remains is that it is necessary to specify nasality in two different gestures and that one specification is not needed underlying but the other is. Thus, probably, a better understanding of how nasality (and in fact laterality which shares the double specification with nasality, cf. § 4.2.4 above) should be represented requires that the concept of gesture and the internal structure of phonological segments be reconsidered and reinterpreted, perhaps along such lines as suggested in feature geometry.

CHAPTER 6
CONCLUDING REMARKS

It is apparent from the previous chapters that dependency applied in accordance with the homogeneity assumption, i.e. such that only monovalent dependency-interacting components are used, will fail to describe primary consonantal place in an appropriate way. Instead the study has shown that a much less homogeneous approach should be adopted, an approach which draws on different types of phonological primitives, including the monovalent components characteristic of dependency phonology. But although it rejects the eponymous dependency relation proper, the description outlined here should still be seen as belonging within the tradition of dependency phonology. It makes extensive use of monovalent components which are a trademark of dependency phonology, and, not least, it assumes that all other internal segment hierarchies except for the consonantal place hierarchy - and even this is not entirely free of dependency relations - should be characterised in terms of structures involving various types of governor/dependent relationships.

The descriptive system which is set up to replace the standard dependency account of consonantal place consists of 3 layers. It may be summarised as in (6.1):

(6.1)

layer 1	articulatory zones
layer 2	the components: |i|, |a|, |u|
layer 3	the components: |λ|, |l|, |t|, |f|

Layer 1 and layer 2 constitute the articulatory network, a descriptive subsystem which allows for 8 locational classes: bilabial, labiodental, dentoalveolar, postalveolar, palatal, velar, uvular and pharyngeal. The articulatory network ensures not only that vowels and consonants be described in terms of the same components, but also that consonants can be accounted for with one set of primitives and vowels with a different set of primitives. The first fact follows from the way the two layers are associated in the network, and the latter from the fact that for consonants layer 1 is ranked higher than layer 2 and consequently that the vowel components are not obligatory for consonants. Layer 3, on the other hand, stands outside this network. It specifies dorsal as well as non-dorsal activity and allows for active articulations such as apicality, laminality and laterality.

This study has also shown how places of articulation should be divided into a simplex and a complex category. This subdivision of the articulatory zones is supported by two factors: relative frequency of occurrence and relative perceptual saliency. On closer examination, these two factors support each other such that the most frequent places of articulation are those at which the most salient consonants occur. Consequently, those places which are frequent and salient, viz. bilabial, labiodental, dentoalveolar and velar are assigned to the simplex or unmarked category and those which are not, viz. postalveolar, palatal, uvular and pharyngeal, to the complex or marked category.

It is also part of this monograph's hypothesis that it is not necessary to introduce new rules to express the simplex status of bilabials, labiodentals, dentoalveolars and velars. Recently simplicity, or unmarked status, has been linked with underspecification, such that simplex sounds are underspecified underlyingly. When stated within a standard feature-based framework, underspecification requires rules to express the cross-linguistic markedness conventions. But not in the present framework. Underspecification is already a part of dependency phonology so that, *ceteris paribus*, a unmarked sound will automatically be marked as such by virtue of requiring fewer components underlyingly. Hence there is no need for default rules and complement rules.

Finally 'feature economy' has played an important role in the construction of the present representational system. This is apparent from the conflation of the dental and alveolar places of articulation into the single dentoalveolar place of articulation. This conflation is motivated by the existence of only very few languages which make a genuine place contrast in this area without also differing in whether the apex or the lamina is involved. But this reduction of the contrastive 'components' is also a feature of layer 3. Four components belong at this level and they are used not only for the dental *vs*. alveolar contrast, but also for various *r*-sounds such as approximants and trills. In fact, both obstruents and sonorant consonants may be specified in terms of layer 3 components, if not phonologically then derivatively.

The desire to reuse primitives has also in part motivated the introduction of the specification $|V_m|$ to characterise nasalisation. $|V_m|$ refers to a lowered velum and is used to describe nasalisation phonologically. The reuse of the label 'V' (velar) means that no extra component referring to the lowered velum has to be introduced. But in another respect a co-articulation such as nasalisation also adds more structure: along with another type of co-articulation, viz. secondary articulation, nasalisation is the reason that the dependency relation is not altogether abandoned for the description of consonantal place. For these two types of secondary articulation the subjunction relation will be used, as this will capture their essentially additive nature.

Needless to say, the description of consonantal place presented here should in no way be regarded as the final solution. It is a proposal which is meant as an alternative to a strict dependency-based solution and a result of the alleged inapplicability of strict dependency to consonantal place. This does not mean that the future will see no description which employs dependency for the place description of consonants, but only that if a strict dependency approach is adopted it must fulfil the following conditions: i) provide convincing arguments for describing the entire articulatory parameter, active or passive, as a gradual one (for discussion of this see Nolan 1992), ii) provide a convincing set of components in terms of which this parameter can be described and iii) permit that underspecification matches the complexity categories established on the basis of relative frequency and relative saliency. All three conditions should be met; otherwise a less strong view on dependency should be adopted.

An argument for seeking a solution on the basis of the strictest dependency view is found in the cross-planar discipline known as structural analogy (Anderson 1985, 1986). Basically the claim of structural analogy is that unique structural properties should be avoided unless they follow from idiosyncrasies of planes and levels. In one form structural analogy has led to the following assumption (cf. Staun 1992):

> Optimally, components of distinct alphabets which are neither generically identical nor able to participate in mutual interactions of the same kind are illegal.

If the components of the syntactic plane are unary and readily may enter into dependency relationships as has been suggested in Staun (op.cit.), then the assumption just quoted -in the optimal instance - will render the description presented here 'illegal'. In other words, another argument for attempting to make the description of consonantal place fully comply with the dependency concept, is that this would satisfy the structural analogy assumption. But we have to make the situation optimal first, i.e. justify the full invocation of dependency. Finding this motivation is what future work must strive for.

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