

**TIER GEOMETRY:
AN EXPLANATORY MODEL OF VOWEL STRUCTURE**

by

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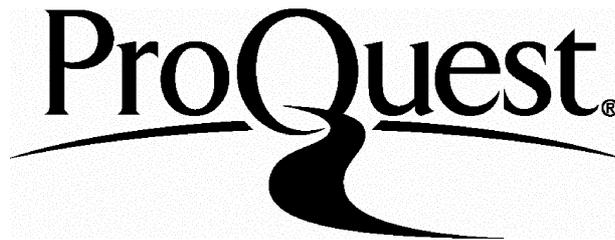
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*for Huja
and my family*

Abstract

A number of constraint-based models of phonology have established a shift in emphasis away from rules and derivations towards a more representationally-oriented view of description. This enrichment of representational structure has led to a significant reduction in the generative power of the phonological component.

This thesis proposes that the advantages of the Element Theory (Kaye *et al.* 1985, Harris & Lindsey 1995) approach to melodic structure — which maintains this trend towards greater generative restrictiveness — may be enhanced by the introduction of an intra-segmental geometry of melodic tiers. A hierarchy of element tiers for vowels is constructed according to the same principles of licensing that control prosodic structure, allowing a unified representational hierarchy that highlights the interrelatedness between melody and prosody. The melodic geometry of a language is built around a limited set of parametric choices that control tier sharing/division, the structural dependency relations holding between elements, and the possibilities for licensing a complement tier (which replaces the notion of melodic headship).

The sub-segmental tier structure of a language provides a melodic template, latently present under all prosodic positions, which delimits the range of oppositions each position may potentially support. This template interacts with only a single kind of lexical activation instruction — ACTIVATE [α] — which typically applies at the skeletal level to give the kinds of 'segmental' contrasts found universally. Licensing Inheritance (Harris 1992, 1997) then applies throughout the unified melodic-prosodic structure, predicting various dynamic phenomena and distributional asymmetries associated with prosodic strength and structural complexity.

Optionally, activation is specified at higher prosodic levels (e.g. foot, word), resulting in the interpretation of a melodic property over a domain larger than the segment. While a word-level instruction ACTIVATE [A] describes height harmony, for example, a similar specification of a complement tier will predict the alternation patterns of tongue root harmony systems. Analyses of languages exhibiting ATR harmony

(Turkana, Bari, Kinande) and RTR harmony (Yoruba, Wolof) demonstrate (i) the restrictive nature of the tier geometry model and (ii) its capacity for incorporating typological variation such as opacity versus transparency and $\mathbf{a}\sim\mathbf{\bar{a}}$ alternations.

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1 *Orientation*

1.1 Theoretical context

1.1.1 The nature of melodic representations

The goal of this thesis is to develop a model of melodic structure which will offer a non-arbitrary account of (i) the cross-linguistic variation observed in the characteristics of different vowel inventories, and (ii) the dynamic behaviour — in particular, patterns of harmonic agreement — affecting the vowel systems of a number of African languages. The model lays its foundation in the prevailing trend towards generative restrictiveness and, accordingly, has the primary aim of imposing limits on the diversity found within systems of contrast and on the possible form of processes targeting vowels. Why, for example, do languages never exploit more than three degrees of lip attitude for contrastive purposes,¹ whereas a four-way height distinction is commonplace? And why is a tongue root contrast in high vowels (e.g. *i~ɪ*) an expected feature of ATR harmony languages such as Akan, while the same feature is typically absent whenever RTR (retracted tongue root) is the harmonically active property (e.g. in Yoruba)? Distributional issues of this sort constitute the focus of the present work, which views such facts not in terms of independent generalizations to be encoded as explicit statements of universal grammar, but rather as a necessary product resulting from the adoption of a restrictive, representationally-oriented approach to phonological well-formedness.

A definition of grammaticality in terms of well-formed representations must begin with a description of the basic units of structure used in the construction of those representations. As far as the structure of melody is concerned, I assume that vowel sounds may be broken down into the three primitive units or 'elements' [A], [I] and [U],

¹See §3.2.3 for a discussion of vowel oppositions in Swedish.

which together mark the boundary points of a triangular vowel space.² This view of melodic organization, which has its roots in early Dependency Phonology (Anderson & Jones 1974), appears in a number of theoretical guises which are described and evaluated in §2.2 below. For the reasons given there, I adopt a version of the triangular approach referred to in the literature as Element Theory — see Kaye, Lowenstamm & Vergnaud (henceforth KLV) (1985) and Harris & Lindsey (1995). The salient characteristics of the Element Theory model (ET) are outlined here, while a more detailed discussion is taken up in the following chapter.

Perhaps the most striking feature of ET is the extent to which its basic assumptions deviate from (and in many cases, directly contradict) those of the 'standard' generative model that emerged following the publication of *The Sound Pattern of English* (Chomsky & Halle 1968 — henceforth *SPE*). This wholesale rejection of the *SPE* approach is highlighted by a number of basic theoretical distinctions that may be drawn between the two competing viewpoints:

Element Theory:

monovalent elements (e.g. [U])

privative oppositions
(e.g. [I]~zero)elements independently
interpretable (e.g. [A]=[ɑ])C~V split structurally defined
(elements cross-categorical)markedness properties inherently
expressed (e.g. complexity)full phonetic interpretability at
all levels*The SPE model:*

bivalent features (e.g. [±round])

equipollent oppositions
(e.g. [-back]~[+back])primes interpretable only within a
full feature matrixfeatures exclusive to C/V categories
(e.g. [±labial] vs. [±round])external markedness metric
(e.g. universal marking conventions)lexically redundant feature values
supplied during derivation

²While there are other elements — such as those relating to tonal and oral/nasal contrasts — which undeniably contribute to the representation of vowels in some languages, these will not be considered here.

In order to tighten its control over the generation of melodic expressions and phonological processes, ET employs only single-valued primes: the monovalent elements [I], [U] and [A] used in the representation of vowels encode palatality, labiality and aperture, respectively.³ On the assumption that a phonological process can only refer to material which is present in a structure, the exclusion of bivalent features has the immediate effect of substantially reducing the number of melodic properties which may participate in dynamic phenomena — e.g. rounding harmony (targeting the [U] element) is predicted as a possible process, whereas an unattested process such as 'unrounded' harmony fails to be captured within the model (cf. spreading of either [+round] or [-round] within a bivalent feature system). The option of recognizing only monovalent primes creates a situation in which all melodic contrasts are defined in privative terms; as just demonstrated, this result has positive implications for generative restrictiveness.

In another departure from the standard model, ET takes the view that each melodic prime may be phonetically interpreted in isolation; this position is formalised by Harris & Lindsey (1995) as the Autonomous Interpretation Hypothesis. So, while the two elements [I] and [U] can potentially combine (i.e. can be interpreted simultaneously) to form a complex melodic expression [I,U] — contributing palatality and rounding, respectively, to the resulting sound \ddot{u} (= IPA [y]) — each element also possesses its own autonomous phonetic identity, [I] as the high front vowel *i* and [U] as its back rounded counterpart *u*. The interpretation of a sole element manifests itself in the absence of any other melodic material, illustrating one of the fundamental tenets of the ET approach, that melodic primes are

small enough to fit inside segments, yet still big enough to remain independently interpretable. The idea is thus that the sub-segmental status of a phonological prime does not necessarily preclude it from enjoying stand-alone phonetic interpretability.

(Harris & Lindsey 1995:34)

³While monovalency cannot be exclusively associated with A-I-U models of melodic structure — for analyses which adopt single-valued distinctive features see, for instance, Cole & Kisseberth (1994), Goad (1991) and Avery & Rice (1989) — it has nevertheless been the case that feature-based approaches have generally taken up the equipollent stance assumed in the original *SPE* model.

This position contrasts directly with the standard view of melodic structure, where it is assumed that no unit smaller than the segment may be realized phonetically (e.g. a lone feature specification [+high] cannot be manifested without the support of additional specifications such as [+back] and [+round] to 'flesh out' the overall phonetic description). In SPE it is fully specified feature matrices, rather than individual features, which are interpretable by the phonetics.

This reference to full phonetic interpretability introduces another aspect of the Element Theory view which sets it apart from the mainstream generative tradition. From the Autonomous Interpretation Hypothesis it follows that even the simplest (i.e. single element) representation in ET need not rely on any 'filling in' mechanism to supply non-contrastive or predictable properties in the way that is customary within most orthodox feature systems. On the contrary, if a melodic structure (whether lexical or otherwise) is fully interpretable, then there remains little motivation for (i) distinguishing between an abstract and a phonetic level of representation or (ii) developing a mechanism for mapping one representation type on to the other. To gain a more detailed insight into the implications of autonomous interpretation and the other theoretical issues outlined here, the reader is invited to consult the references cited above. Other aspects of the ET approach will also come to light during the course of the analyses presented in following chapters. Of greater relevance to this general overview, however, is the role played by Element Theory in an overall theory of phonological processing, to which I now turn.

1.1.2 Grammaticality as structural well-formedness

From the assumption that phonological processes play a role in determining the overall shape of representations, it follows that one of the primary functions of an explanatory theory must be to impose limits on the ways in which a structure can be manipulated by the phonology. Without establishing such limits, a theory would inevitably fail to account for the finite nature of phonological knowledge. However, this task of defining the boundaries of structural change presupposes a more fundamental role undertaken by the grammar — that of predicting the form of a possible representation. Specifically, a

grammar must establish what kinds of structure may potentially serve as the input to, and the output of, a phonological operation. Indeed, the capacity for distinguishing between well-formed and ill-formed structures is traditionally seen as the cornerstone of the generative view of language.

I maintain this basic tenet of the generative approach throughout the present work, where the grammar is presented as a device for creating well-formed representations to the exclusion of everything else — whether such representations are specified as lexical objects or as the output of phonological processes. But how can grammaticality be gauged? What factors determine whether or not a representation is well-formed? Initially, at least, I adopt the Principles-based position advanced by KLV (1985, 1990) and subsequently developed in the Government Phonology literature.⁴ According to this view, all languages must conform to a core set of very general principles of structure which preside over the form of phonological objects. Such universal conditions regulate all aspects of representation and derivation, including prosodic constituency, empty structure, melodic interpretation, locality and structure preservation. Underlying many of the principles advocated by the Government-based model is the notion of licensing, which not only constrains the form of representations in phonology but exerts a significant influence over syntactic structure too. Through a network of asymmetric licensing relations, it becomes possible to unite an array of seemingly disparate representational units into a single, coherent structure; this results from the requirement that every structural unit must be sanctioned or 'licensed' by the presence of another unit which dominates it.⁵ Arguments to support the adoption of a Principles-based approach to well-formedness are set out in §2.4 below.

Although universal principles provide an adequate means of capturing the structural characteristics that are shared by all languages, we cannot ignore the (limited degree of) variation which is nevertheless observed between different systems. For example, while an onset constituent is, without exception, licensed by a nucleus to its

⁴See Brockhaus (1995), Charette (1991), Harris (1994a), Harris & Lindsey (1995) and Kaye (1989, 1995).

⁵The exact nature of structural dominance will be defined below. For a good introduction to the role played by phonological licensing, see chapter 4 of Harris (1994a).

right,⁶ languages do differ with respect to the number of timing positions that can be supported by that licensed onset. Given that the choice is regularly restricted to one of only two possible options (either a single or a binary branching constituent), the facts of cross-linguistic variation can, in this instance, be neatly accommodated by the introduction of a parameter — essentially, a 'switch' device that offers a limited number of choices or 'settings' within a given area of variation. Parameters themselves are assumed to co-exist alongside the set of structural principles as statements of Universal Grammar, their language-specific settings becoming fixed during acquisition.

In the Government-based literature, the notion of parametric variation occupies a central position within the overall view of grammar construction, as emphasized by its alternative description as a 'Principles-and-Parameters' approach (see §2.4 below). Recently, however, the suitability of parameters as a means of encoding cross-linguistic variation has been called into question (Polgárdi 1996), and investigations are under way into the possibility of exploiting the language-specific ranking of universal principles instead. In a move which reflects the advances made within Optimality Theory (Prince & Smolensky 1993), the assumption that representational diversity is based on a selection between various parametric options has given way to an alternative approach which claims that all statements of grammar relating to phonological well-formedness are both prescriptive (i.e. without parametric choice) and universal. The structural differences between language systems are then captured by assuming that individual principles (or 'constraints' — to employ the favoured terminology) may be violated, specifically to ensure that other constraints are satisfied within the same language. To identify precisely which constraints are susceptible to violation in any given system, the theory makes appeal to a language-particular constraint hierarchy which establishes a series of dominance relations holding between all the members of the set of universal constraints.

Although the present work is developed primarily within the context of a Principles-and-Parameters approach, I shall nevertheless introduce a number of instances where different universal principles make conflicting grammaticality predictions. To account for these isolated cases, I explore in §4.5 how the notion of constraint ranking may be successfully incorporated into an otherwise Principles-based description. What this

⁶See the formulation of inter-constituent licensing given in Harris (1994a:159).

hybrid phonology highlights, above all else, is the potential benefit to be gained from blurring the conventional boundaries that mark the assumed incompatibility between different theoretical models. The status of the grammatical tools outlined here — universal principles of structure, language-specific parameters and constraint ranking — will become apparent during the course of the various analyses to be offered in the following chapters.

1.2 The scope of this thesis

1.2.1 Aims and methods

The principal goal of the present work is to develop a restrictive model of vowel representation which has the capacity to describe only the range of vowel systems and dynamic processes actually observed in natural languages. Accordingly, it is intended that the proposed mechanism should provide a non-arbitrary explanation of the limits within which typological variation is evidently contained. As outlined in §1.1.1, the model takes as its point of departure the triangular Element Theory (or ET) approach to melodic composition. Although the ET view has much to offer in terms of restrictiveness and explanatory worth, I aim to demonstrate how its value may be further enhanced by the introduction of an intra-segmental geometry of element tiers. I propose that such a configuration be constructed according to the same general principles of licensing that control the well-formedness of prosodic structure (see §1.1.2). In this way, we can identify a unified representational hierarchy that highlights the interrelatedness between the various melodic and prosodic components of the phonological structure. The melodic geometry of a language is built around a small set of parametric choices controlling (i) tier sharing and division, (ii) the structural dependency relations holding between elements, and (iii) the licensing of a complement tier (where the latter effectively replaces the notion of melodic headship). In §3.2.3 below I argue that an active complement tier has the effect of enhancing the saliency of its head tier: e.g. the contrast between **e** and **ɛ** may be encoded by the active versus inactive status of an [I]-tier complement.

A language's sub-segmental tier structure — defined according to a limited number of configurational options and latently present within every timing position — provides a melodic template which delimits the range of oppositions each position may support. Before elemental material can be phonetically realized, however, the relevant melodic tier(s) must be identified by the lexicon as a potential target for interpretation. I shall propose, therefore, that the melodic template interacts with a single kind of lexical activation instruction, *ACTIVATE* [α] (Backley & Takahashi 1996), which typically applies at the skeletal level to give the kinds of 'segmental' contrasts found universally. In addition to lexical conditions, there are also prosodic conditions which need to be satisfied before an element can be successfully interpreted. Specifically, the melodic structure in question must receive an adequate amount of licensing potential. Following Harris (1997), I assume that the flow of licensing potential is controlled via a mechanism of Licensing Inheritance, which applies throughout the unified melodic-prosodic structure and predicts various dynamic phenomena and distributional asymmetries linked to prosodic strength and structural complexity.

The proposed tier geometry provides the theoretical basis for the thesis, which proceeds by illustrating the model's predictive power in accounting for a range of facts concerning vocalic contrast, distribution, and phonological alternation. The latter focuses primarily on the issue of vowel harmony — often viewed as a challenging testing ground for a restrictive theory of melodic composition — and attempts to develop a generalized analysis of harmonic agreement which will account for the apparent diversity found within the harmony systems observed. The representation of harmony is achieved by means of a simple extension of the proposed framework, in which lexical activation is optionally specified at higher prosodic levels such as the foot and the prosodic word. This results in the 'wide scope' interpretation of any given melodic property: for example, a word-level instruction *ACTIVATE* [A] describes the kind of vowel height agreement found in languages such as Chicheŵa (Harris 1994b), while the word-level activation of a complement tier predicts harmony involving tongue root properties.

1.2.2 Data selection

While the combined application of tier geometry and element activation is intended to influence the analysis of vowel harmony across the full range of observed cases, it is inevitable that the illustrations offered below will be selective and merely implicit of the model's capacity for theoretical explanation. However, by considering some of the more challenging cases of harmonic alternation here (see particularly chapters 4 and 5), it is hoped that the majority of straightforward examples will be accommodated without the need for individual treatment.

As described above, lexical activation provides the necessary melodic context for element interpretation, and will target any individual melodic unit present in the geometric structure; in the case of vowels, this will be any one of the three resonance elements [A], [I] or [U], or their complements. Given that the distributional characteristics of the resonance elements are already well documented in the literature (see the references to ET cited above), I avoid any detailed analysis of their behaviour in relation to the proposed model. On the basis of structures to be motivated in chapter 3, it will become evident that the commonly occurring patterns of labial and palatal harmony (as found in Turkish and other Altaic languages) can be adequately described in terms of the word-level activation of the elements [U] and [I] respectively. Similarly, harmony systems involving vowel height as the active property will refer to [A]-activation specified throughout the word domain.

Rather less apparent are the phonological effects resulting from the selection of a complement tier as the target of activation. For this reason, the latter half of the thesis will focus on harmony systems that are most appropriately analysed in precisely this way. I shall argue that the complement of a single 'colour' tier (shared by the two elements [I] and [U]) may be licensed in some languages; and whenever this unit is identified as a harmonically active property, we observe the patterns of vowel alternation typically associated with ATR harmony systems. I offer analyses of data taken from a number of tongue root harmony systems, including Turkana (Dimmendaal 1983), Bari (Steinberger & Vago 1987) and Kinande (Mutaka 1991); the languages are selected in order to exemplify the degree of diversity found within this typological category. I also consider

a smaller group of languages featuring tongue root retraction (RTR) as the harmonically active property; these include the two Niger-Congo systems Wolof (Ka 1994) and Yoruba (Archangeli & Pulleyblank 1989). My claim is that such systems may be described in terms of the licensing of an active [A]-tier complement — an analysis which captures the relative markedness of RTR harmony languages in addition to their distributional characteristics.

So, it is the behaviour of vowels in tongue root harmony systems which provides the main thrust of the present work. It should be borne in mind, however, that the application of the proposed tier geometric model to the analysis of such systems illustrates only one of the areas of investigation where this theoretical approach is predicted to be of some explanatory value. My intention is that the basic principles to be outlined in the following chapters will subsequently be applied to a range of other vocalic phenomena which the confines of the present work prevent us from considering here.

1.3 Outline

This work divides into two sections, corresponding to the material presented in chapters 2-3 and chapters 4-5 respectively. The first of these is dominated by theoretical arguments which motivate my claims regarding tier-geometric structure, while the second is chiefly concerned with the analysis of natural language data, illustrating some of the potential applications of the proposed model. The discussion is organized as follows.

Chapter 2 reviews some of the significant changes that phonological study has undergone in recent years. In particular, I consider arguments which favour the postulation of a triangular model of melodic representation over a more conventional system of bivalent distinctive features. Although the Element Theory approach is identified as the preferred option, I nevertheless highlight a possible shortcoming inherent in that model's use of melodic headship. This is intended as a background to the introduction of complement tiers in §3.2.3. The second issue discussed in chapter 2 addresses the question of a general shift in emphasis away from a traditional rule-based view of phonology to a more representationally-oriented one. The conception of grammaticality in terms of representational well-formedness is seen as a fundamental characteristic of the proposed

model.

In chapter 3 I formulate the central arguments of the thesis, which are intended to provide a sound theoretical basis for the data analyses that follow. I begin by suggesting ways in which the tri-directional model of melodic structure may be developed in order to enhance its restrictive characteristics. Specifically, I propose that cross-linguistic variation be accounted for by appeal to two areas of structural variation — a sub-segmental geometry of melodic tiers and the option of licensing a complement tier. A range of vowel inventory types is then generated as a result of the various configurational settings available. I proceed in §3.3 by demonstrating how the resulting melodic template interacts with (i) the set of lexical conditions described in terms of element activation, and (ii) the prosodic conditions established by general principles of structure, such as Licensing Inheritance.

Chapters 4 and 5 offer an insight into the ways that a tier-geometric approach may benefit the description of natural language data, and particularly, that of harmonic alternation involving tongue root properties. The proposed analysis is compared with some alternative treatments of ATR harmony — such as autosegmental spreading and headship agreement — which are found to present certain problems relating to overgeneration and structure preservation, respectively. I offer an account of harmony in Turkana, then show how the model might accommodate the kinds of typological variation observed within the set of ATR harmony languages. This is achieved via the introduction of a restrictive form of constraint ranking, which predicts typological diversity affecting, for example, the opacity or transparency of neutral vowels. In chapter 5 I demonstrate how the tier geometry approach to ATR harmony systems may be adapted to the description of languages such as Wolof and Yoruba, which display RTR as the active harmonic property. The proposed model has the advantage of being able to encode, as an inherent property of the representation itself, the distinct markedness characteristics of the two tongue root harmony types.

Finally, chapter 6 summarizes the principal ideas put forward in the thesis, and looks towards the prospect of extending the application of tier geometry to other vowel harmony types, and ultimately, to the representation of consonants.

2 Phonological representations: a shift in approach

2.1 Introduction

This chapter considers two of the ways in which the organisation of phonological information has developed during recent years. First, the set of bivalent articulatory features traditionally employed as sub-segmental properties of melody now face a serious theoretical challenge from a number of privative models of melodic structure which take the three reference points **a**, **i**, and **u** as the only significant units required for the representation of vowels. Second, the reliance on language-specific rules to account for structural variation has given way to an approach that looks to the representation itself for identifying the boundaries within which phonological behaviour appears to be confined. Below I shall outline some recent developments regarding these two theoretical tendencies, my purpose being one of setting the context for the proposals to be presented in the following chapter. In §2.2 I shall conclude that, in the interests of a restrictive model that looks to the fundamental tenets of a generative-based framework, we are compelled to adopt a privative approach to phonological contrast which refers to a triangular vowel space. With respect to the transition from rules to representations, in §2.3 I examine the extent to which this has already been achieved in various current models, and then raise the question of the limits (if any) to which such a tendency can potentially be pushed.

2.2 The nature of melodic structure

2.2.1 Phonological primes

The design problems associated with the SPE model are discussed by a number of different authors including Durand (1995), Harris (1994a), Kaye (1989) and Roca (1994). I shall not, therefore, dwell on the motivation for seeking an alternative way of approaching the question of melodic organisation. Instead, I simply focus on the two broad issues mentioned in the previous chapter — (i) the increasing preference for a triangular vowel space, and (ii) the shift from rules to representations — and show how these have been taken up in a number of current frameworks. Not unexpectedly, both of these trends will feature prominently in the tier geometry model to be developed below.

One of the principal arguments for rejecting distinctive features of the type employed in SPE concerns the monovalency/bivalency split. That is, given the identification of an indissoluble melodic property, say *nasal*, we have the choice of referring to this unit in one of two ways, according to how we understand the nature of the phonological opposition it creates. On the one hand, the presence or absence of this property may be encoded by the presence or absence of the relevant prime in a structure; thus, an expression containing [nasal] contrasts with an otherwise identical expression which lacks [nasal]. This represents the privative, or monovalent standpoint that will be assumed throughout the following chapters. On the other hand, we may choose to make direct reference to orality (the complementary property), in which case we could assign an appropriate value to the prime, such as [-nasal]. This would then contrast with [+nasal] to create an equipollent opposition of the kind favoured by SPE. For a discussion of the issues surrounding the monovalency/bivalency split the reader is referred, in particular, to van der Hulst (1989) and den Dikken & van der Hulst (1988).

The distinction between a melodic system based on monovalency and one that employs bivalent units is not so trivial as it may first appear. In fact, the choice of one over the other has significant repercussions for the way that language sounds are seen to pattern into particular groupings, and for the way that such groupings, or *natural classes*, function with respect to various phonological processes. We can think of a natural class

as a non-random set of sounds that display common behaviour with respect to distributional regularities and participation in dynamic phonological events. We attribute this uniformity to the assumption that one or more phonological properties — such as the licensing of a particular melodic prime — is shared by each member of the set. In other words, the identification of a melodic prime also identifies a natural class of sounds, the members of which all contain this prime as part of their phonological composition.

To illustrate the different predictions made by privative and equipollent systems, consider the case of a system which employs monovalent primes, and which has a contrast between oral and nasal vowels. This may be captured by lexically associating a melodic unit such as [nasal] to all nasal vowels, while the remaining vowels make no reference to this particular prime, and are therefore interpreted as oral sounds. Let us assume that the system in question also displays a process of nasal harmony, whereby the presence of a nasal vowel results in nasality associating to all of the vowels within a prosodically defined domain. So any nasal vowel acts as a trigger for the harmonic process, thus establishing a natural class of sounds that participate as a single group. Oral vowels, on the other hand, fail to act as triggers in this process, since they do not contain the necessary [nasal] prime. On this basis, we cannot group the oral vowels on a par with the nasal ones, because the members of the former set do not actively participate in the same process as a single unit, and therefore, cannot be considered a natural class in the way that nasal vowels clearly are. Yet, by employing the monovalent opposition between [nasal] and 'zero' we are able to capture this result in the melodic structure itself: the [nasal] prime identifies the natural class of nasal vowels, whereas the absence of any melodic unit common to all oral vowels highlights their status as an arbitrary set.

The drawbacks of employing an equipollent system are clearly manifest when we attempt to describe the same set of circumstances by referring to a phonological opposition based on bivalent features — that is, by using the contrast [+nasal]~[-nasal] in place of [nasal]~'zero'. The melodic unit [+nasal] would capture the natural class of nasal vowels, in the same way as the single valued prime [nasal] was able to do. But significantly, we are also forced to recognize another melodic unit [-nasal], suggesting the existence of another natural class consisting of oral vowels. With regard to the present example, this is not the result we would wish to achieve, as the oral vowels do not behave

as a single unit with respect to a particular phonological event. So, although the melodic unit [-nasal] informally refers to the absence of nasality, it is expressed in a way which compels us to view it on a par with its positive counterpart, such that it predicts a natural grouping of sounds. Furthermore, given the equal status of [+nasal] and [-nasal], we expect one to be accessed by phonological processes just as readily as the other, which amounts to another prediction of the bivalent feature system that lacks empirical support. For example, under an equipollent feature system a harmonic process of vowel *oralisation*, brought about by the melodic prime [-nasal] acting as a harmonic trigger, is expected to be just as widespread as *nasalisation*. There is, however, no evidence to suggest that this might be the case.

This discussion has illustrated that, in the interests of developing a constrained generative model which attempts to exclude all but those processes actually found to occur in natural languages, the binary valued feature system employed in SPE cannot offer the same degree of restrictiveness that may be achieved with a system of phonological contrast based upon monovalent primes. Indeed, in the final chapter of SPE, the authors themselves have acknowledged a certain asymmetry between the two values of a single feature, which could not be directly encoded by the formalism. This led to the postulation of an independent mechanism for establishing the relative markedness of feature values, consisting of cross-linguistic generalisations controlling the choice of one value of a feature, the 'default' or unmarked one, over its opposite value. Here, relative markedness is determined by considering factors such as the extent of a feature value's distribution across different languages, the stage of language acquisition at which it is recognized, and so on.

It is precisely this distinction between the default value and the marked value of a bivalent feature which has fuelled the development of various models of underspecification.¹ Central to this approach is the attempt to exclude from lexical forms all traces of melodic redundancy, leaving only those feature specifications that are necessary for determining the set of lexical contrasts within a system. To illustrate, let me sketch the example of the Yawelmani vowel system around which Archangeli (1984)

¹The reader is referred to Kiparsky (1982), Archangeli (1988), Mohanan (1991) and Archangeli & Pulleyblank (1994) for differing perspectives on the issue of underspecified representations.

develops the theory of radical underspecification. She compares the fully specified underlying system (disregarding any length distinction), which is captured by the feature table in (1a), with the redundancy-free description in (1b), suggesting that the latter contains all of the information necessary for determining the vocalic contrasts of the language.

(1)	a. fully specified		b. underspecified																																								
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The gaps in the underspecified feature matrices are filled in during the derivational process, the precise values being ascertained on the basis of a battery of redundancy rules; these can either reflect language-specific tendencies regarding vowel distribution and behaviour, or they may be motivated on the strength of universal generalisations over the unmarked value of a given feature. Archangeli's model case of Yawelmani is typical in citing both kinds of redundancy.

The question arises as to whether the type of underspecification approach just outlined should be regarded as one which employs privateness or equipollence as the basis for its system of contrast. In the present example it is monovalency which characterizes melodic specification at the lexical level, since only one value of a two-valued feature can ever appear (e.g. [-round] cannot contrast with [+round] underlyingly). Yet, at the level of phonetic representation that is assumed within this underspecification context, both values are indeed referred to. Besides arriving at a fuller phonetic description, we do find some degree of phonological motivation for this — such that we introduce the possibility of the complement value of a feature playing an active role at a later point in the derivation, given the appropriate ordering requirements on rule application. This model of underspecification amounts to a clear acknowledgement of the problems inherent in the SPE use of bivalent features, such that their exclusion at the lexical level can be viewed as an attempt to avoid the over-generation that would

otherwise result. Nevertheless, the notion of equipollence is not altogether rejected, as binary features remain integral to the derivational process that constitutes the 'phonology' component of the model.

The spirit of Archangeli's approach, if not its actual mechanism, will play a central role in the melodic representation systems to be considered below. It seems that, from the middle ground occupied by underspecification theory, the same general theoretical assumptions will allow us to make a relatively smooth transition to a wholly privative conception of melodic opposition. In essence, this move relies on the possibility of collapsing the roles of the two components of the underspecification model — the system of lexical contrast and the independent markedness function — into a unified representation. That is, if we can encode markedness relations directly into the melodic description itself, this allows us to dispense with the need to refer specifically to the presence ([+F]) — and crucially, to the absence ([−F]) — of particular features, in the way that redundancy rules were designed to do. So, by eliminating this derivational procedure involving redundant 'fill-in' values, we need only refer to a set of monovalent features² that manifest the privative approach to phonological opposition which is characteristic of lexical information.

How, then, is markedness to be incorporated into the melodic description, if not via some independent table of preferences for feature values? The solution rests on the postulation of a system of contrast which relies on privativeness from the outset, and which maintains the notion of presence versus absence as the basis for phonological opposition at *all* stages of derivation. Returning to the earlier demonstration of the nasality contrast in vowels, we can select the option of employing the monovalent prime [nasal], the presence of which contrasts with its absence from melodic representation. Hence, a nasal vowel contains this prime in its melodic construction, and contrasts with an oral, but otherwise identical vowel which lacks any reference to [nasal]. But if this means of creating a phonological opposition in the lexicon also proves to be adequate as a basis for interpretation, then we can immediately dispense with the introduction of

²The properties represented by the single-valued elements to be introduced below do not necessarily correspond to those indicated by (the marked values of) the orthodox distinctive features. The element [I], for example, loosely refers to [−back], while [+back] has no equivalent in Element Theory terms.

negative units like [-nasal] in the description of non-nasal expressions. The removal of specific values for features, such as [-nasal] and [+nasal], from melodic representations leaves only [nasal] (as opposed to 'zero') to capture the relevant bifurcation.

Clearly, a system which need only refer to monovalent primes such as [nasal] has a more constrained generative capacity than one which employs the same features within an equipollent mode. This follows from the fact that the bivalent system refers to many more units in its melodic descriptions (e.g. both [+nasal] and [-nasal], as opposed to the single monovalent [nasal]), and therefore, can access a greater number of units which are potentially active in phonological processes. Importantly, however, many of the predictions involving the active status of particular melodic primes are found to be unattested in natural languages; for example, I have already noted that the widespread distribution of *nasalisation* (spread of [+nasal]) fails to be matched by a complement process of *oralisation* (in which [-nasal] could be active). Thus, by favouring a privative approach to melodic contrast over the assumptions of equipollence that are characteristic of SPE, then we are taking a positive step towards reducing the over-generation which typifies the standard generative model, by imposing a greater control on its expressive power.

Returning to the question of markedness, it has been observed that the relative markedness of a particular sound is generally reflected in the number of natural classes to which that sound belongs. In the context of the present discussion, recall our earlier assumption that the identification of a natural class of sounds may be encoded by the existence of a single-valued melodic prime (where all the members of a natural class refer to this prime in their melodic description). The correlation between classes and markedness may be generalized in the following way: the less marked a sound is considered to be, the smaller the number of natural classes it makes reference to in its description. In our terms, the fewer melodic primes specified in the representation of a sound, the less marked that sound is likely to be. To illustrate, compare the high front unrounded vowel *i* with its rounded counterpart *ü*. According to any standard criterion used in the assessment of markedness, the former is less marked than the latter, a conclusion which is borne out by an evaluation metric which considers the number of melodic units required in their description. In the case of *i* we need refer only to the

property of [palatality] in vowels, in order to positively identify a high front unrounded vowel. The sound \ddot{u} also contains [palatality], since it is likewise a member of the class of palatals (which includes i , e , æ , \ddot{u} , ø , and so on). But significantly, \ddot{u} is also rounded, and patterns with other rounded vowels of the set that includes o , ɒ , ɔ , and u . To register this fact, we must make reference to the natural class [labial] (or perhaps [round]) in the phonological description of \ddot{u} , thus creating a difference in the complexity of the two expressions:

$$(2) \quad \begin{array}{l} \mathbf{i} = [\text{vowel}] \\ \quad | \\ \quad [\text{palatal}] \end{array} \qquad \begin{array}{l} \mathbf{\ddot{u}} = [\text{vowel}] \\ \quad | \\ \quad [\text{palatal}] \\ \quad | \\ \quad [\text{round}] \end{array}$$

Clearly, i refers to fewer melodic primes in its representation, and should consequently be deemed less marked (which is, indeed, the desired outcome). This illustration, albeit a simplistic one, demonstrates the way in which a markedness metric may be incorporated into a system of representation which employs melodic units founded on a privative mode of opposition.

In one respect, this may be viewed as a significant departure from the underspecification model outlined above, to the extent that we have united the two principal structural components that were formerly independent of each other — both lexical contrast and relative markedness can now be recovered from a single melodic statement. In another respect, however, the theoretical move just described appears to be somewhat lacking, in that the *function* of the set of redundancy rules (i.e. inserting all missing feature values in order that the string may be fully articulated and/or perceived) has been largely disregarded. What we require is a means of phonetically realising the structures in (2) as they stand, rather than having to depend on additional information regarding interpretation, such as the fact that i is non-round, that both expressions i and \ddot{u} are high, and so on. Specifically, we seek a standpoint from which we may fully interpret melodic primes in isolation from other primes; in other words, each prime must possess its own phonetic identity which it may manifest without support from other

melodic units. This notion has been presented as a viable possibility in Harris and Lindsey (1995), to which the reader is referred for a detailed discussion. As already outlined in the previous chapter, they argue that primes are 'small enough to fit inside segments, yet still big enough to remain independently interpretable' (1995:34). For the structures in (2), this means that a vowel specified only for palatality will be expected to be interpreted as *i*, given the absence of any other phonological properties in its representation. The addition of [round] to the description indicates another palatal vowel, but now with labiality superimposed onto it: hence, the interpretation *ü*.

Having established the benefits of rejecting the bivalency of SPE (and to some extent, of underspecification theory), and instead, favouring a privative approach to phonological contrast in which individual melodic primes are autonomously interpretable, one further issue remains to be addressed: precisely which phonological properties should these primes represent? There is considerable agreement in the recent literature that, in the case of vowels, the traditional vocalic features employed in SPE (e.g. [high], [back], etc.) do not provide the most appropriate context for predicting the limited set of processes which vowels are seen to undergo. Instead, there is now strong evidence which suggests that a set of three basic reference points within the vowel space is sufficient for capturing most of the vocalic contrasts and dynamic phenomena that we would wish to describe. Anderson and Jones (1974) are the first to formally identify the advantages of recognizing such a configuration,³ which they present in terms of

...three principal underlying and abstract 'characteristics' involved in vowel formation — |u| 'roundness', |i| 'frontness', and |a| 'lowness'...
(1974:16)

Some of the arguments in favour of a triangular vowel space are presented in Rennison (1986) and Harris (1994a), to which the reader is referred for a fuller discussion. However, a good deal of the current literature provides a clear indication that the inherent properties of the expressions *i*, *u*, and *a* are in some way fundamental to melodic structure, the robustness of this notion having been endorsed by the eagerness with which

³These basic divisions had already been observed in the earlier literature — see Jakobson and Halle (1956).

the idea has been adopted within different theoretical approaches. In the remainder of this section I shall outline a number of these approaches, all of which assume the validity of a tricorn vowel space and independently interpretable, monovalent primes. I shall attempt to identify some of the problems associated with each one, and show how these problems will influence the formulation of the structural model to be introduced in the following chapter.

2.2.2 Particle Phonology

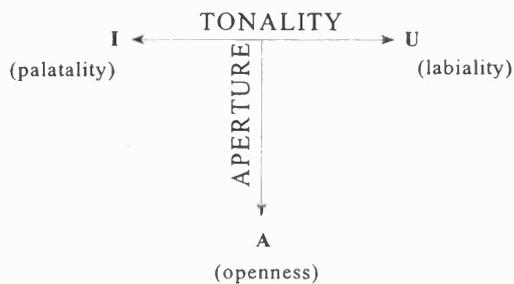
A number of models of sound structure have been built around the significance of the three melodic primes **a**, **i**, and **u**, perhaps the least complex of these approaches being the one to be outlined here. Particle Phonology derives its name directly from the term 'particle', which its chief exponent (Schane 1984a) uses as a label to refer to the melodic primes themselves. It is essentially a theory of vocalic structure, its original motivation stemming from the attempt to develop a formal account of vowel movements which had taken place in the history of English — in particular, the Great Vowel Shift of Early Modern English and the process of lowering that was associated with the phenomenon of Open Syllable Lengthening in Middle English. My primary concern is not with the details of these events, which are presented and discussed in Schane (1984b). Instead, I focus briefly on the precise nature of the particles, and on the way they are organised and manipulated in melodic structure. I shall identify one particular aspect of the model which, to some extent, has the effect of undermining the theoretical worth of the Particle approach.

The system of phonological contrast presented in Schane (1984a) refers exclusively to the three particles **A**, **I**, and **U**,⁴ which are interpretable either alone or in combination. The phonetic signatures of the primes largely correspond to the properties recognized by Anderson and Jones (1974). Although each particle exists independently of the others, Schane does acknowledge a certain relationship between **I** and **U** which sets

⁴While the original source employs lower case letters to identify the particles, here I use the symbols **A**, **I**, **U**. This avoids any confusion between these and the emboldened symbols **a**, **u**, etc., which stand for interpreted expressions.

them apart from the remaining prime A.⁵ As illustrated in (3), this division is founded on the notion that the palatality of I and the labiality of U represent opposing extremes on a single scale of tonality, whereas A occupies a separate axis which denotes degree of aperture. From this characterisation of the three particles we arrive at the triangular figure that is now standardly used in the depiction of the vowel space.

(3)



When in combination, the particles form an unordered set — that is, each makes an equal contribution to the resulting expression. Thus, the different permutations of (single occurrences of) the three primes give the following positions:

(4)

a	i	u	e	o	ü	ö	ə/i
A			A	A		A	
	I		I		I	I	
		U		U	U	U	

Since there is no hierarchical ordering of particles, the expressions {IU} and {UI} are not distinct. It is assumed that the null particle set is significant to the system of contrast in some languages, and manifests itself as a non-peripheral vowel such as ə or i. Thusfar, the assumptions of the model do not make any significant departure from those of other A-I-U systems of representation. However, it is clear that the range (and nature) of contrasts given in (4) does not exhaust all of the possibilities with regard to what is actually observed in the vowel inventories of different languages. In some cases we must

⁵In fact, this basic split had been formalised at a much earlier date and encoded in the Jakobsonian opposition between *compact* and *diffuse*.

recognize more than the three vowel heights, while in other cases the position of the tongue root must be considered.

Here I shall focus on the mechanism by which Particle Phonology increases the number of height distinctions, in order to accommodate vowel systems which register four or more height levels. Rather than opting for an increase in the inventory of primes, the model chooses to exploit the machinery already available to it — namely, the particles A, I, and U. Given that an increase in the number of height contrasts entails a more extensive subdivision of the vowel space along the aperture axis (see (3) above), it is proposed that additional occurrences of the aperture particle A are suitable for encoding height differences in non-high vowels. The widespread seven-vowel system found in Italian, for example, contrasts single and dual appearances of A:

(5)

i	e	ɛ	a	ɔ	o	u
I	I	I		U	U	U
	A	A	A	A	A	
		A	A	A		

In this system the relative lowness of *ɔ*, in comparison with *o*, is captured by the enhancement (that is, the doubling) of the openness or aperture particle in the former; hence, {AU} contrasts with {AAU}.

Yet greater preponderance of the A particle is required in order to capture the vocalic oppositions in Malmö Swedish. The particle representations for the vowels of this system are given in Schane (1995) as follows:

(6)

i	e	ɛ	æ	ɯ	ö	u	o	ɒ
I	I	I	I	I	I			
	A	A	A	U	U	U	U	U
		A	A		A		A	A
			A					A

While the formalism is evidently capable of capturing the phonological contrasts of even the most complex of systems, there are two obvious problems which emerge from the short overview presented here. First, if multiple occurrences of the aperture particle are permitted, then we would predict the possibility of finding other vowel inventories that require the postulation of multiple values for I or U. However, it seems unlikely that we would uncover any direct evidence to support this prediction: for example, a four-way rounding contrast in non-high vowels is generated by the Particle model — encoded as $\{A\} \sim \{UA\} \sim \{UUA\} \sim \{UUUA\}$ — but is almost certainly unattested in any natural language.

The second problem addresses the unconstrained nature of the particle stacking system that has been illustrated in (5) and (6). Clearly there must be a limit to the number of height distinctions that may be observed in any one language — up to a maximum of five or six, perhaps. Yet the generative capacity of the model appears to be limitless, given the valid move within Particle Phonology of introducing an additional token of the A particle into the structure whenever a further height opposition is to be incorporated into the description. The fact that we are dealing with a system of n -ary feature values, together with the inevitable over-generation that accompanies it, is reinforced by the notational device proposed in Schane (1995) for characterizing the particle structures of particular languages:

(7) *Notational conventions for the natural classes derived from i e ε:*

$$\begin{array}{ll}
 i \sim e & \{I A_0^1\} = \{I (A)\} \\
 e \sim \epsilon & \{I A_1\} = \{I A_1^2\} = \{I A (A)\} \\
 i \sim e \sim \epsilon & \{I A_0\} = \{I A_0^2\} = \{I (A) (A)\}
 \end{array}$$

This illustrates Schane's proposal for specifying the minimum and maximum number of A particles that participate in any one system of contrasts. Clearly, either option leaves open the possibility of unrestricted generative capacity: the subscript/superscript numerals may potentially represent any value at all, while the pattern of parenthesized particles is susceptible to infinite recursion.

Since the advent of the tricorn approach to vowel representation, it has been acknowledged that a simple combination process involving only the bare primes is inadequate for capturing all of the vowel contrasts that may actually be observed. In order to increase the number of oppositions available within its formalism, the Particle model permits multiple occurrences of the melodic prime A to register degrees of aperture, which is exploited to varying degrees according to the needs of individual systems. However, as the examples above amply demonstrate, this mechanism can only be regarded as a retrograde step, since the problem of overgeneration, which had been so characteristic of the earlier generative approach, has now been re-introduced in an equally damaging way. Although the structural proposals to be presented in the following chapter are largely sympathetic to the assumptions on which Particle Phonology was founded, it is clear that any reliance on the notion of a melodic stacking system, akin to that posited by Schane, must be avoided in the interests of restrictiveness. A similar criticism of the Particle approach has been levelled by proponents of Dependency Phonology, to which I now turn.

2.2.3 Dependency Phonology

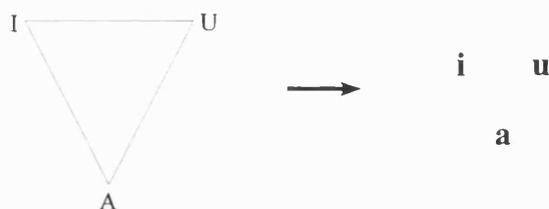
Although we find some degree of variation between the range of models developed within the Dependency framework, there is, nevertheless, a set of core assumptions common to all of these, summarized in Anderson and Ewen (1987).⁶ Like the Particle approach, Dependency Phonology (henceforth DP) recognizes the three monovalent primes (the label 'component' is customarily used in the DP literature) A, I, and U as the basic building blocks of melodic structure. However, in contrast to the simple juxtaposition or co-existence of primes that is characteristic of the Particle view, the DP model chooses to exploit the possibility of allowing structural relations to hold between the individual atoms of a single melodic expression. This enrichment of sub-segmental organisation thus represents an alternative means of attempting to bolster the generative

⁶Most of the ideas presented in Anderson and Ewen (1987) can be traced back to earlier work in Dependency Phonology. In particular, see Anderson & Jones (1974) and Anderson & Ewen (1980).

capacity of the three components, but with the specific aim of avoiding the problems associated with multiple occurrences of any one unit. For the main arguments in support of the DP view of melodic structure, the reader is referred to van der Hulst (1988a, 1988b, 1989). In §3.2.1 below I examine some of the issues arising from this theoretical standpoint, and then go on to consider recent advances — in particular, the theme of Radical CV Phonology (van der Hulst (1994, 1995)) — that have developed from the original DP model.

In keeping with the conception of a tricorn vowel space defined by the three basic resonance properties (i.e. those corresponding to the corner vowels **a**, **i** and **u**), the emphasis on privativeness is maintained within the DP approach. As I suggested above, this allows for markedness relations to be directly encoded in the representation itself. Beginning with the interpretation of the three primes individually, this gives us the unmarked inventory shown in (8):

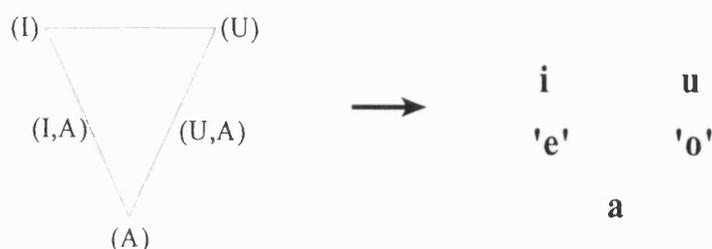
(8)



This configuration, together with the markedness implications that it carries, is fundamental to both the Particle and the DP view of melodic structure. Similarly, the following stage along the markedness continuum is reached via the same means within both approaches. This is illustrated in (9), where the straightforward combination of the tonality components⁷ with A creates two mid vowels, thus yielding the widely distributed five vowel system:

⁷In the DP literature it is customary to enclose the melodic components within verticals: |a|, |i|, and so on. However, for the sake of consistency, I shall continue to employ upper case symbols throughout.

(9)



The system of contrasts shown in (9) highlights a particular characteristic of the DP model which it shares with Particle Phonology, and indeed, with other tricorn approaches to be outlined below. I refer to the fact that we cannot presume any precise, one-to-one correspondence between the *representation* of a phonological object and its *interpretation*. That is, we can expect to find a certain degree of variation in the interpretation of a particular melodic expression across different languages. The phonological system in (9), for example, provides a suitable description of the vowel systems of both Zulu {i,u,ɛ,ɔ,a} and Swahili {i,u,e,o,a}, despite the clear phonetic difference that may be observed in their respective mid vowels (phonetic data taken from Maddieson (1984)).

To illustrate further, we may assume the simple three-vowel systems of Amuesha {e,o,ɐ} and Shilha {i,u,ɐ} to be identical in terms of their phonological make-up (most likely, simple tokens of the three vocalic primes). Conversely, any given vowel sound may receive a range of different phonological descriptions, depending on its behaviour with respect to natural classes and its contrastive status within particular phonological systems. Although clear objections to this purely 'phonological' stance have been raised in the literature (notably, Lass (1984a) and Crothers (1978)), I shall maintain the view taken in DP and other triangular-based models, such that phonetic sensitivity does not necessarily constitute the principal criterion in the identification of phonological categories.⁸ This position is endorsed by S.R. Anderson (1985) in his discussion of Trubetzkoy's understanding of the structure of phonological systems:

⁸The question of the non-phonetic basis of melodic units is fully motivated in chapter 3.

In general, it is not possible to tell from the phonetic properties of a segment in isolation...just how it should be characterized phonemically. This is because it is not merely its phonetic identity that matters phonologically but, more importantly, what other segments it is opposed to in the language in question (1985:96).

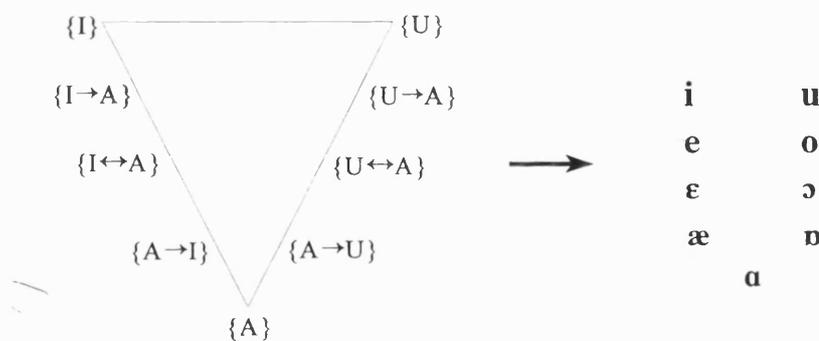
Beyond the stage of five-vowel systems, the two models are seen to diverge. In order to generate larger and more marked inventories, Particle Phonology introduces multiple values for its aperture particle, thus opening the way for potentially unchecked overgeneration. Within DP, on the other hand, a rather more constraining mechanism is employed whereby the operation of component fusion shown in (9) is developed to allow not only simple co-existence, but also asymmetric fusion in a single expression. The fact that components may contribute to a resulting complex expression in unequal proportions is captured within the formalism by proposing a series of dependency relations of the sort given in (10). A comma separating fused components indicates simple, unordered combination, as in the mid vowels of (9). The presence of an arrow, on the other hand, represents a governing relation in which a prime located at the head of an arrow is governed by, or dependent on, the other prime in the expression.

- (10) a. {I,A} = e c. {I→A} = e
 b. {I↔A} = ε d. {A→I} = æ

In the canonical five-vowel system, a front mid vowel *e* may be represented by means of the simple co-occurrence of I and A, as in (10a), since no distinction need be made between this and any other combination of these two components. However, another symmetrical fusion operation involving the same units is shown in (10b), the double headed arrow indicating a relation of mutual dependency (as opposed to the absence of dependency in (10a)); in this case, the I component governs the A component *and vice versa*. Anderson and Ewen (1987) emphasize that these two kinds of symmetrical combination are not equivalent. Whereas the expression {I,A} implies that there is no contrast (within the same system) between this and any other combination of the same components, as illustrated in (9), the bi-directional governing relation in {I↔A}

subsumes the existence of both $\{I \rightarrow A\}$ and $\{A \rightarrow I\}$, from which it is constructed. The asymmetric dependency relation that characterizes these latter expressions, and which is illustrated in (10c) and (10d), indicates that the components involved in such a compound are present in unequal proportions — specifically, that one, the governor, preponderates over the other, the dependent. In terms of interpretation, this preponderance translates into relative prominence. For example, in $\{I \rightarrow A\}$ the I component (the governor) makes a greater contribution to the interpreted expression than does its dependent A: hence, palatality (the defining property of I) is perceived as being more salient than openness (the contribution of A), and the relatively close palatal vowel *e* results. By reversing the direction of the dependency relation $\{A \rightarrow I\}$ we arrive at an expression in which openness dominates (and is, therefore, more prominent than) palatality, thus yielding the relatively open front vowel *æ*. Preponderance relations may be observed more clearly by referring to the vowel space itself:

(11)



The illustration in (11) shows how the relative preponderance of components corresponds to their proximity to the relevant pole in the vowel space. Thus, in the case of the compound $\{U \rightarrow A\}$, the dominance of U dictates that the expression should be located closer to the labiality pole than the aperture pole. Compare this with the proximity of $\{A \rightarrow U\}$ to $\{A\}$, where it is the A component which is dominant over its dependent U. Also note how the relatively marked status of the hypothetical inventory in (11) is reflected in the fact that a fuller range of combinatory possibilities is invoked in its

phonological description. Both uni-directional and mutual dependency relations are required, both of which are unnecessary in the simpler, and universally unmarked system given in (9).

Central to the DP approach, then, is the notion that the three primary vocalic properties may be subject to intra-segmental organisation, such that they may exist in unequal proportions, in accordance with a restricted set of operations controlling component fusion. Despite the availability of this apparently powerful apparatus, however, it seems that the output from this generative mechanism still falls somewhere short of the desired goal, in terms of both the number and the nature of vocalic contrasts found across different languages. One particular source of opposition not yet considered is that relating to the property which corresponds to the SPE feature [\pm ATR]. In response, Anderson and Ewen (1987) postulate an additional component denoted by 'T', which signals the presence of advanced tongue root. However, a number of problems arise as a direct consequence of this move. Besides the issue of potential overgeneration, which I address presently, it seems that the introduction of an ATR component forces us to accept a certain degree of redundancy in the melodic structure, since there are aspects of the ATR distinction which are already encoded by the dependency relation itself. This point is illustrated in (11), where the difference in dependency relation between $\{I \rightarrow A\}$ and $\{I \leftrightarrow A\}$, for example, reflects a difference in tongue root quality between the respective interpretations e and ϵ . In addition, I suggest that the ATR component T does not share the same 'primitive' status that is common to the three established melodic primes. For instance, we predict that it should be present in the melodic structure of only a subset of the world's languages, as not all systems exploit tongue root position as a source of contrast. Furthermore, it is not at all obvious how T should be interpreted independently of other melodic material, or how it should participate in dependency relations. In sum, the difficulties that arise from the introduction of additional primes seem to outweigh the advantages that may be gained.

Nevertheless, these problems for the DP approach are compounded as a result of yet another melodic unit being added to the inventory of vocalic primes. In order to provide adequate phonological descriptions of central vowels such as ə and ɨ (which cannot easily be associated to any of the properties inherent in the three 'corner' primes),

Anderson and Ewen (1987) choose to follow Lass (1984b) in positing a separate centrality component which they represent as Θ .

- (12) a. *Wapishana* {**i,u,a,i**} b. *Gadsup* {**i,u,ɜ**}
- | | | | |
|---|----------|---|----------|
| I | U | I | U |
| | Θ | | Θ |
| | A | | |

While this unit is clearly useful in characterizing systems such those shown in (12) — to describe the non-peripheral vowel of *Wapishana* (Arawakan) in (12a) and the non-high vowel of a triangular system like *Gadsup* in (12b) — it does, however, suggest the same problems of overgeneration and non-primitiveness that we have already encountered. With a basic vocabulary consisting of five atoms A, I, U, T, and Θ , together with the range of possibilities (see (10) above) regarding their combination, the model becomes a powerful generative device capable of producing a set of oppositions numbering at least several hundred. Indeed, in the model set out in Anderson and Ewen (1987), such overgeneration would be the inevitable result in a system which requires the participation of all five components — that is, in a language containing a (non-reduction) central vowel and an ATR contrast.⁹ The reader is referred to Anderson and Ewen (1980:§4.2) for a discussion of the ways in which component combinations may be further enhanced — for example, by introducing embedded structure and a negative operator, as in the expression $\{\sim\{I,U\}\rightarrow A\}$ used to represent the back unrounded vowel \mathfrak{x} .

To summarize, in the interests of restrictiveness, the DP view of vocalic representation rejects the system of particle stacking that is central to the model developed by Schane (1984a, 1995). As an alternative means of increasing generative capacity, DP employs a number of additional melodic units to supplement those which mark out the triangular vowel space.¹⁰ Although the DP structure does offer a way of

⁹Lass (1984b) succeeds in representing the ATR distinction within DP by referring only to a centrality component.

¹⁰However, see the discussion of van der Hulst (1989) in §3.2.1 below.

encoding the relative markedness of expressions without incurring any additional cost, the model does have several shortcomings. Aside from the issue of overgeneration, we have seen how the primes themselves do not form a natural set, to the extent that some appear less universally basic than others. This lack of unity between the vocalic components of DP provides a strong indication that we should, after all, confine our melodic inventory to the three basic primes employed in Particle Phonology. This conclusion will be reflected in the proposals to be set out in chapter 3.

One additional question which I have yet to address concerns the theoretical validity of the proposed dependency relations. In view of the fact that a similar type of asymmetry between melodic primes is employed in the Government/Licensing approach to phonological representation, I raise this matter in the following section, where the relevant characteristics of this model are discussed.

2.2.4 The Government/Licensing approach

The view of phonological structure which I discuss in this section does not represent any unified theoretical standpoint, but rather, constitutes a set of core assumptions that are common to a number of phonological models, all of which have their origins in the *Theory of Charm and Government* first presented in KLV (1985). While the central notion of 'charm' has since fallen out of favour, other fundamental aspects of the original proposals have been maintained and subsequently developed under various different guises. One particular area of development is represented by the structural model that is set out and motivated in Harris (1994a). This work highlights the concept of licensing as a central property which plays a pivotal role in the amalgamation of all melodic and prosodic units into a single, coherent structure. Its assumptions will prove to have a strong influence on my own proposals, to be discussed in the following chapter, particularly with regard to the basic principles of licensing that collectively serve to determine structural well-formedness. Although the fundamental tenets of the Harris (1994a) model will be assumed throughout this work, I shall avoid any detailed review of its theoretical characteristics until these become directly relevant to my discussion.

area of the vowel space characterized by the [U] element than the [A] element). In contrast, (13b) contains the same two elements but with the headship roles reversed; the resulting compound will thus be interpreted along the same [U]-[A] trajectory, but in this case the openness of the [A] element will dominate, yielding what is essentially an open vowel with additional labiality. (13c) merely illustrates that if a single element is present in an expression, it conventionally assumes head status.

The head/dependent relations just outlined are clearly reminiscent of the asymmetric dependency relations described for DP in (10c) and (10d), where the head element or component makes a greater contribution to the interpretation of a compound expression than do its dependent(s). In fact, the conception of intra-segmental asymmetry within Element Theory appears identical to the notion of asymmetric dependency which lies at the heart of the DP approach, in terms of its motivation, its implementation, and its effect on phonetic interpretation. The question of whether or not the representation of headship is the same in both DP and GLP, however, is less certain.

In DP the headship distinction is typically expressed as in (14), where a vertical line indicates a head and a slanting line shows dependent status:

- (14) a. headed (= [$\underline{\alpha}$]) b. headless (= [α])
- $$\begin{array}{cc} | & | \backslash \\ \alpha & \bullet \alpha \end{array}$$

The headless expression in (14b) may alternatively be described as 'empty-headed', given that it consists of a head containing an empty node marked • which governs a dependent element α . It has been noted by Harry van der Hulst (p.c.) that the equivalent GLP representations [$\underline{\alpha}$] and [α] — which appear, at least superficially, to be distinguished merely by the use of a simple diacritic — are in fact used as a shorthand way of expressing these same structures illustrated in (14). While this is clearly a natural assumption, I am nevertheless unaware of any explicit references made within the GLP literature to configurations of this type in relation to intra-segmental relations. In contrast, we do find instances (see Cobb (1997), for example) where the Government-based literature explicitly rules out the possibility of generating empty-headed expressions such as ($@, \alpha$), on the grounds that [$@$] cannot be treated as a legitimate unit of melodic

possibilities for component combination. Indeed, the option of symmetric element fusion is available to Element Theory too, although no formal distinction is made between simple combination (as in {U,A}) and mutual dependency (such as {U↔A}, for example). In GLP terms, two or more elements may fuse to form a complex melodic expression, but without any reference being made to headship. Thus, the compound in (16c) may potentially contrast with both (16a) and (16b).

(16)	a.	o	b.	o	c.	o
		U		U		U
		A		A		A

By comparing (a) with (c) in (16) we discover that properties of headship in Element Theory may be directly invoked in the representation of ATR distinctions, since the removal of the dependency relation in (16a) results in the loss of ATRness, as shown in (16c). Accordingly, within this theoretical context it is assumed that systems which exploit ATR as a contrastive property do so by differentiating between headed and headless expressions. Harris and Lindsey (1995) illustrate this structural representation of tongue root quality by citing the case of Akan, a West African language in which ATR behaves as an active harmonic property. Typical of such vowel harmony systems is the division of the inventory into two complementary vowel sets, the members of one set appearing to the exclusion of all other vowels within a given prosodically-defined span (frequently, the word). Thus, the distribution of Akan vowels within a word produces two distinct harmonic sets,¹³ as shown in (17). Harris and Lindsey make a phonological distinction between them in terms of the presence or absence of a melodic head.¹⁴

¹³Low vowels do not show the same harmonic behaviour as other vowels. See §4.4 for a re-analysis of ATR harmony in Turkana, a language similar to Akan.

¹⁴Strictly, they depict a non-headed expression as one which is headed by a 'dummy' or neutral element [@]. Since [@] signals the absence of any 'true' resonance properties, I take the terms *headless* and *[@]-headed* to be equivalent.

(17)	a. ATR		b. non-ATR	
	[I]	i	[I]	ɪ
	[U]	u	[U]	ʊ
	[A,I]	e	[A,I]	ɛ
	[A,U]	o	[A,U]	ɔ

On this basis, harmonic agreement across a domain (i.e. within a span of non-low vowels) may be characterized not by the presence of a particular melodic property, but in terms of headship harmony — vowels must either be all headed expressions, or otherwise must all be non-headed. There are clear advantages to be gained from this approach to tongue root distinction, the most significant being that the active participation of ATR in harmony systems may be captured without the need to refer to any independent ATR element. Nevertheless, I suggest that we do encounter problems of incompatibility when we employ this device of headship distinction in expressions consisting of only a single element, as in the high vowel contrasts of (17).

The notion of headship was taken up in KLV (1985) as a property found in melodically complex expressions, which served to capture the unequal contribution made by the different elements in that expression. As I have already outlined, its function was to identify a single element, the head of the expression, as having relative prominence within the resulting complex melodic unit. In other words, headship was used to describe the way in which elements were fused together. But by exploiting headship in the distinction between ATR and non-ATR expressions, the original conception of headship as an *asymmetric relationship* — that is, one involving two or more units — can no longer be maintained, since we must account for melodic units consisting of only a single element, as well as ones represented by complex expressions. The contrast between **u** and **ʊ**, for instance, is illustrated in the respective representations as headed [U] and non-headed [U]. Yet the rather more familiar conception of headship refers not to a property of a single element, but to an asymmetric dependency relation between elements co-occurring within an expression. And in view of this established usage, it is difficult to view headship as something of an absolute value which is identifiable by examination of a single element in isolation. If we choose to pursue this latter conception of headship, it becomes difficult to ignore the clear link between a lexical contrast based on the

distinction between, say, [U] and [U], and the system of binary features which the present tricorn approach so vehemently denies. In other words, the contribution made by headship to the [U]~[U] opposition could just as easily be encoded by a two-valued distinctive feature such as [\pm advanced].¹⁵

Besides the issue of headedness within simplex expressions, I focus on one further problem which emerges from the deployment of head/dependent relations within Element Theory. The identification of an element's status as either a head or a dependent has proved crucial to the description of a number of harmonic phenomena; and, as I shall demonstrate, some of these descriptions have far-reaching consequences for the degree of restrictiveness that may be achieved within the model. In some cases, the participation of an active element [α] is restricted to those instances where it is lexically present as the head of an expression. In other cases, an element plays a harmonically active role only as a dependent. An example of the latter is found in the analysis of Chicheŵa height harmony, as proposed in Harris (1994b). Here, headship is employed in order to capture the generalisation that the element [A] spreads from the mid vowels **e** (I,A) and **o** (U,A) but not from the low vowel **a**, where it assumes head status (A). The harmonic pattern is thus described by referring to the spreading of dependent [A].

The analysis of Tigré vowel harmony found in Lowenstamm and Prunet (1988) also relies on the notion of headship, but exploits it in a rather different way. Instead of utilising head status or dependent status to identify the active unit in a harmonic process, it is the head status of a particular element which becomes the property of an entire domain, as the following examples demonstrate. (Instances of ə in (18) are transcribed ä in the original source).

- | | | | | | |
|------|----|--------------|---|------------|----------------|
| (18) | a. | səlsələt | | 'bracelet' | |
| | b. | səlsələt + u | → | səlsələtu | 'his bracelet' |
| | c. | səlsələt + a | → | salsalata | 'her bracelet' |

Briefly, the alternation between **a** and ə depends on the presence of a low vowel later in

¹⁵Alternatively, the binary feature could be replaced by an otherwise equivalent monovalent element pertaining to ATRness. The postulation of a fourth prime would, however, re-introduce some of the problems already encountered with the DP model, as I have sketched in §2.2.3.

the word (vowel harmony applies leftwards in this system). The addition of the low vowel suffix *-a* in (18c) has the effect of lowering the central vowels of the noun, resulting in the interpretation [salsalata]. In contrast, the central quality ə is retained in the absence of a following *a*, as in (18a) and (18b). Lowenstamm and Prunet account for this in the following way. The low vowel is taken to be the interpretation of the element [A] as a head, and is therefore represented phonologically as [A]. The central vowel ə, on the other hand, consists of the same sole element [A], but in a less salient guise. Hence, it assumes the role of a dependent element and the expression is represented as [A].¹⁶ The harmonic pattern shown in (18c) is then characterized by appeal to the notion of 'head harmony', whereby all the vocalic expressions within a domain must contain the same element as a head. In [səlsələt] the vowels are all headless. However, when a suffix containing an [A]-headed expression is added, as in (18c), a head-switching operation is observed in the harmonising vowels, causing lexical [A] to be interpreted as [A].

So, headship has been invoked in the description of harmonic phenomena in two different ways. In Chicheŵa (Harris 1994b) it was used to distinguish two distinct representational objects, headed [A] and dependent [A], only one of which was shown to be active in the harmony process. On the other hand, in Tigré (Lowenstamm and Prunet 1988) all the vowels in a given environment are required to share the same element as a head, which is achieved via a head flipping operation that allows the lexically given expression [A] to be interpreted as [A]. In evaluating this mechanism of head-switching, we are forced to consider a much wider issue which concerns the restrictions that may be placed on the possible interpretation of a given lexical form. In the KLV tradition it is assumed that only two structural operations are permitted: linking (the insertion of an association line) and delinking (the deletion of an association line). The former rules out the possibility of adding to an expression any melodic material which does not have a local source, while the latter allows the non-interpretation of lexically given material under certain conditions. The question we must now address is whether a mechanism which, as in Tigré, converts a non-head [A] into its headed

¹⁶In Tigré there is a lexical contrast between the two central vowels ä and ĩ. The latter can be described in terms of the absence of all resonance elements, resulting in the representation [ə]. For details regarding the interpretation of melodically empty nuclear expressions, the reader is referred to Charette (1991).

counterpart [A], can also be considered a permissible phonological operation, even though it does not involve either of the procedures just mentioned. Charette and Göksel (1994, 1996) consider the issue of the vowel harmony found in various Turkic languages, and offer an analysis which involves the switching of elements between head and dependent status. They claim that this is possible under the strict control of language-specific licensing constraints; however, it is the precise nature of these constraints, rather than their theoretical implications, which are the focus of their discussion.

Harris (1994b) is clear that head-switching cannot be successfully accommodated within the restrictive model of GLP, citing the principle of Structure Preservation (henceforth SP) as the potential barrier. The notion of SP was first invoked by Selkirk (1982) in order to restrict the output of resyllabification rules, requiring the derived structures to conform to the syllable template of the language in question. A similar approach to SP was taken by Kiparsky (1985) in relation to melody, where it is argued that phonological rules may not be used to derive melodic expressions which are not already present as contrastive units at the lexical level. However, a rather different view of SP is assumed by Harris, who employs the notion as a means of constraining the ways in which structural relations are manipulated during the course of derivation. Specifically, it is argued that 'lexically established dependency relations remain stable under spreading' (1994b:535) — that is, the relations that hold between units at the lexical level must always remain intact. This clearly presents a problem for the head harmony analysis under discussion here, assuming that 'dependency relations' can be equated with melodic headship.

So, in the case of Tigré, where the lexically specified expression [A] is interpreted as [A] under the influence of a dominant [A]-headed vowel, it is reasonable to claim that this swapping of heads within an expression amounts to an illegal operation and, specifically, a violation of SP in terms of a change in dependency or structural relations. A similar criticism in the context of SP can be levelled against the analysis of ATR harmony just described above. We have seen that the representational difference between an ATR expression and its non-ATR counterpart is taken to be one of headship, so that e [I,A] contrasts with ε [I,A]. But in advanced/retracted alternations under harmony conditions, the same head-switching operation must be invoked, since the phenomenon

cannot be explained in terms of either spreading or delinking. Backley & Takahashi (1996) make the same observation in relation to ATR harmony in Maasai, treating this as another instance of SP violation.

In short, the head/dependent relations employed in Element Theory do raise a number of theoretical issues. Specifically, their potential for generating lexical contrast in simplex expressions forces us to consider [U] and [U], for example, as distinct phonological objects. I have suggested that this may not be too far removed from a system which makes use of bivalent melodic units. In addition, those cases where headship properties are actively involved in the description of harmonic patterns (that is, instances of headship harmony) rely on a systematic head switching operation in order to obtain the desired vocalic agreement. In the absence of such cases, the model is dependent on only two basic structural operations — spreading and delinking — and the question immediately arises as to whether the introduction of a third device may have a detrimental effect on the restrictiveness of the model, by predicting many other examples of head flipping which are not actually observed. In any case, the practice of manipulating the headship properties of expressions appears to create difficulties for the strict interpretation of Structure Preservation that is assumed within the GLP approach.

2.2.5 Summary

From the above discussion it has become clear that, in the interests of constraining the generative capacity of our model, we are unable to maintain the equipollent view of phonological contrast which characterized the SPE approach to melodic representation. In its place, the concept of a triangular vowel space marked out by the three (monovalent) corner primes A, I, and U has taken hold in a variety of differing forms. I have described ways in which these tricorn models fall somewhere short of the desired level of restrictiveness, and in the following chapter I attempt to formalize the nature of vocalic opposition in such a way as to overcome some of the problems inherent in the views just outlined. Specifically, in order to constrain generative power, we must seek an alternative to the multiple occurrences of primes proposed in Particle Phonology; and similarly, we

must avoid the postulation of additional melodic units, as proposed for DP in Anderson and Ewen (1987).

The exploitation of headship properties in Element Theory creates a number of difficulties too. For example, the notion of dependency is all but lost when single-element expressions are involved. The potential contrast between a headed element [$\underline{\alpha}$] and its non-headed counterpart [α] creates a situation in which we must recognize two different kinds of α , suggesting either the introduction of a form of bivalency, or otherwise an expansion of the inventory of melodic units available to the phonology. Additionally, we are forced to increase the number of possibilities for manipulating lexical forms, in order to accommodate cases of so-called head agreement. In view of these conclusions, I shall attempt to formulate an approach to vocalic representation in chapter 3 which makes no direct reference to inherent headship or dependency relations between the three melodic primes. This is preceded by a brief discussion of the second issue raised in §2.1 — the shift in emphasis from rules to representations.

2.3 Defying the rules

Having considered some of the ways in which our conception of melodic structure has developed, I now examine the notion of derivation — an issue which has also been the subject of radical revision. Once again, my point of departure is the standard generative model represented by SPE, which constitutes the main source of impetus for the theoretical shift under discussion. From a classical SPE viewpoint, phonological information was shared between the lexicon and the phonological rule component. The role of the former was to store in memory linear strings of segment-sized feature bundles, which would then become accessible to the rule component. The function of the latter was to mould these strings into a form that would reflect the regularities in phonetic realisation which typified a particular linguistic system. The rule formalism that was developed to carry out this task of manipulating lexical forms proved more than capable of capturing the patterns it set out to describe. At the same time, however, it was noticed that the descriptive power of these rules could also allow for the characterisation of non-

attested patterns, thus losing sight of the principal tenet of the generative framework on which the model was founded.

Given that the standard model proved equally adept at describing impossible patterns as it was at capturing observed ones, it was acknowledged that such an approach could not be maintained within any restrictive theory of phonological organisation. In response, a principal aim of theorists became one of developing a means of reducing the generative power of the derivational model, an issue which has already been discussed in §2.2 with regard to melodic structure. Below I examine a number of ways in which the matter of overgeneration has been tackled in the recent literature. I shall suggest that the most encouraging moves have been made by those who have recognized the rule formalism itself as being the fundamental flaw in the overall design of the original generative framework. Rather than attempting to develop strategies for repairing and renovating what remains an inefficient and ill-conceived mechanism (by introducing additional devices such as markedness theory, for instance), clear benefits have come from the more radical move of attempting to eliminate the most problematic element of the SPE model — the rule component — in favour of developing the structural properties of the representation instead. This section will be principally concerned with the motivation behind this shift in emphasis from rules to representations, and will consider the degree to which the most restrictive of current approaches has succeeded in arriving at a workable model of phonological organisation. Anticipating the proposals to be put forward in chapter 3, I shall then consider the prospect of any scope for yet further development in this trend towards a structure-oriented view of explanation in phonology.

As I have already indicated, the early generative model expressed in SPE assumed a set of lexical forms which were structurally very basic — essentially, no more than a linear string of feature bundles corresponding to independent, phoneme-sized units of melody. The lexicon, therefore, could make little reference to the phonological characteristics of a language. Instead, general properties of pronunciation were identified within a separate module of the grammar, where patterns of realisation were represented by means of a re-write formalism which allowed for the insertion and deletion of features, as well as the substitution of one feature (or one feature value) for another. In addition, a set of morphological properties was also included in the inventory of units available to

the phonology.

The richness of the re-write vocabulary meant that a vast number of phonological operations could be generated and used to manipulate lexical strings in the derivation of phonetically realizable forms. The generative possibilities were then compounded by the fact that a potentially unlimited number of re-write rules could be employed in the course of a single derivation; furthermore, their order of application could be controlled via stipulation. For a period following the publication of SPE, a principal aim of phonologists had become one of developing and refining the rule-based mechanism to a level which would allow a precise representation of all phonological regularities across different languages. For an insight into the way the classical generative model has been employed in the description of phonological patterning, the reader is referred to the examples of derivational analysis cited in Kenstowicz and Kisseberth (1979).

It has since been acknowledged, however, that the unconstrained nature of the SPE rule formalism has made a significant contribution to the model's ultimate failure to provide a workable representation of phonological behaviour. Specifically, unattested patterns and processes could be described just as easily as observed ones, thus jeopardizing the very essence of the generative viewpoint.¹⁷ Two particular aspects of the early rule-based approach share much of the responsibility for this excessive generative power. First, the emphasis on language-specific regularities, rather than universal generalisations, meant that the number of rules or operations required in the description of phonological systems *en masse* was very large. Of course, this number of permissible processes, each represented by a particular rule, then entailed an even greater number of derivational possibilities, thus predicting an almost infinite number of possible grammars.

Second, the notational conventions established for the representation of re-write rules permitted an arbitrary association between the trigger of a process and its target: this stems from a lack of interdependence between the description of a rule's context of operation (that is, the material to the right of the slash) and the structural change itself. To illustrate, consider the following rules which are proposed by Kenstowicz and Kisseberth (1979) in the analysis of vowel length phenomena in Yawelmani.

¹⁷For a discussion of the problems associated with the derivational aspect of SPE, see Durand (1995), Harris (1994a) and Kaye (1989).

- (19) a. *lengthening rule* $V \rightarrow [+long] / _ C V$
 b. *shortening rule* $V \rightarrow [-long] / _ C C$

The fact that both processes take place in a pre-consonantal environment can be disregarded by the formalism; in fact, it is the material to the right of the first consonant which provides the crucial context for each rule. In other words, no locality requirements are imposed upon trigger and target, resulting in an arbitrary relation that can also generate well-formed, but highly unlikely processes such as those in (20):

- (20) a. $V \rightarrow [-long] / _ + C V$
 b. $V \rightarrow [-long] / C V C _ V V + C$

An apparently unlimited amount of melodic material may intervene between trigger and target without hindering the operation of the rule. It is clear how overgeneration is the inevitable result within such a system where a process can take place without making any formal link with the immediate environment in which it occurs.

The obvious mismatch between the generative output of the model and the observed limits of phonological behaviour quickly brought about a radical revision in the way that sound systems were represented. In direct response to the problem of overgeneration, it was recognised that substantial benefits could be gained from a shift in emphasis away from the language-specific rules of SPE, towards more general patterns which could apply to the phonological structure of language as a whole, rather than to the phonology of any specific system. In many ways, this ousting of re-write rules by more general, cross-linguistic principles mirrors the theoretical moves which had been made within generative syntax some years earlier.

Attempts at curbing the excessive capacity of the model also involved an effort to reduce the arbitrariness that resulted from the absence of any adjacency requirement between the trigger of a process and its target (see (19) and (20) above). A direct response to the question of independence between a process and its context may be found in the notion of multilinear structure, first presented in Goldsmith (1976). According to this view, which is now fundamental to most current thinking in phonology, all operations

must conform to a principle of locality which requires that units involved in any structural process be adjacent, and thus, mutually 'visible'. The fact that adjacency cannot always be equated with juxtaposition in the segmental string (as confirmed by cases of vowel harmony, for example) provided the initial motivation for the idea that phonological units may be arranged on a number of autonomous levels of structure. As I have indicated, the spirit of the earliest autosegmental representations is still very much in evidence throughout the range of theoretical approaches documented in the current literature.

Clear advantages have been gained from the rejection of SPE linearity in favour of an autosegmental view of phonological structure. Although the move has involved a substantial increase in the structural complexity of representations (see §2.4 below for an insight into the nature of this complexity), it has been shown how this additional cost can be immediately offset by a gross simplification in the derivational aspect of the processing machinery. Specifically, it is assumed within non-linear approaches that the number of permissible operations which may be used in the manipulation of structural units can be greatly reduced, perhaps to only two basic ones — in which a formal association between such units is either created or destroyed. The benefits of an impoverished derivational component stem largely from the notion that its basic characteristics must essentially reflect universal properties. We arrive at this conclusion by assuming that the handful of operations which are permitted by the grammar are sufficiently general as to encompass the full range of attested phenomena found across different languages. In this way we confront the problem of overgeneration in SPE, which we have seen to come, at least in part, from the priority given to the formalisation of language-specific processes in terms of individual rules. By shifting the emphasis away from particular linguistic systems towards universal generalisations, it may also be argued that we move a step closer towards a realistic conception of phonological behaviour that is modelled on our general cognitive attributes.

If we focus solely on two basic operations, those of spreading (the introduction of a structural association) and delinking (the removal of an association) within the context of a multilinear representation, then we also create an environment where the possibility of a locality requirement on phonological events may be seriously maintained. As just noted, the lack of such a condition in the standard generative model was shown

to be a contributing factor to the problem of excessive output. Further, it was pointed out that the conception of melodic structure in terms of a single linear string prevented us from imposing a requirement to the effect that the trigger and target of a process be adjacent; its failure was particularly apparent in cases of long distance assimilation, such as vowel harmony. Within an autosegmental approach, however, we may achieve locality even in those instances where melodic material intervenes between trigger and target, simply by confining the locality relation to a specific level of structure.

So, although the shift in emphasis from rules to representations ultimately reduces to a case of simplification in one area of the grammar (the derivational component) at the expense of enrichment in another (the representational structure), there are obvious benefits from this redistribution of information in terms of restrictiveness within the model. First, we can make a direct connection between a process and the environment where it occurs; this is achieved by referring to a principle of locality which is assumed to apply to all structural operations. Second, the focus on cross-linguistic generalisations, rather than on batteries of rules relating to the characterisation of specific phenomena, entails a simplification of the formalism with which such patterns are expressed. By severely reducing the generative capacity of the rule component, we automatically restrict the number of derivational possibilities to a level which more closely reflects the kinds of phonological regularities observed within natural language. In the following section I focus on some of the assumptions that are central to the GLP approach (see Harris (1994a) and references cited above), in order to illustrate the degree to which the rules-to-representations transition has thusfar progressed. I shall then consider whether there remains any scope for further development, a question which will be investigated more thoroughly in the next chapter.

2.4 Phonology without rules: a principles/parameters approach

In §2.2.4 I addressed the issue of melodic structure from the GLP standpoint. Here I turn to the question of structural representation, where the main points of reference are Charette (1991), Harris (1994a) and KLV (1985, 1990). I shall suggest that the theoretical

approach represented by these works may be viewed as one of the most restrictive available, in terms of the level of control imposed upon possible processes and outputs. We may attribute part of this success to the wholesale rejection of the notion 'phonological rule', in the sense that the traditional SPE-type rule formalism is discarded within GLP, and also in the sense that its priorities lie firmly with the identification of universal, rather than language-specific regularities. In essence, the GLP approach may be viewed as representative of the current tendency in phonology to favour the syntax-based conception of grammatical organisation, where the replacement of specific transformation rules by more general well-formedness constraints had become established at a much earlier date.

Current approaches to syntactic structure are largely united in their attempts to uncover the representational properties which are common to language as a whole, thus establishing a 'core' grammar which we may use to identify the finite set of possible language systems as distinct from the potentially infinite set of impossible ones. Beyond the similarities predicted by these universal characteristics, however, there is also a certain degree of variation to be found between the grammars of individual systems. It is now widely assumed, at least within the field of syntax, that the observed limits of such variation may be defined with reference to a small number of parameters, similarly contained within the universal component; these offer a limited range of options regarding certain structural variables, which different languages take up in different combinations to yield the kind of typological diversity that we must account for. As indicated in the previous chapter, it is essentially this notion of universal principles of well-formedness, supported by a limited number of language-specific parameters, which forms the basis of the GLP approach to phonological structure.

With regard to the rules-to-representations transition discussed above, proponents of GLP claim that the set of universal principles and parameters they employ effectively eliminates the need to refer to the vast majority of structural operations that were required in the standard generative model. The principles of GLP are formulated in very general terms, and mainly pertain to conditions on syllable structure, to the licensing relations that hold between prosodic units, and so on. In other words, the principles collectively constrain the form of representations. To illustrate, (21) shows the phonological

licensed,²⁰ with the exception of the head of that domain; this condition is spelled out by the **Phonological Licensing Principle** (Kaye 1990a) which, in this instance, allows the leftmost nuclear position in (21) to remain unlicensed. The presence of onset constituents is sanctioned by the nuclei they precede, as determined by **Onset Licensing** (Kaye 1990a). Notice that not all pre-nuclear material is automatically syllabified into an onset, as the consonant cluster in *hemp* illustrates. **Coda Licensing** (Kaye 1990a) describes a specific kind of licensing relation that is permitted between a rhyml complement position (here, the nasal consonant) and an onset immediately following it. Such a relation must conform to the **Complexity Condition** (Harris 1990), whereby the asymmetry of the licensing relation is reflected in the relative complexity of each melodic expression. This licensing relation manifests itself in the sharing of resonance properties (here, labiality) between the two positions involved.

While we may go on to identify a number of other general principles²¹ which also play important roles in determining the well-formedness of (21), I shall nevertheless postpone any explicit mention of these until they are directly relevant to my arguments. It is hoped that, even from this brief overview, the reader will have gained an insight into the very general nature of the principles formulated within GLP. Recall that these principles, as with those formulated within syntax, are intended to reflect universal properties of language. Assuming that these properties are largely structural ones, then we may infer that a phonological structure which fails to conform to these general principles cannot constitute a well-formed representation. In this way, GLP may be viewed as a generative model of the strictest kind — only representations which follow the established set of universal principles will be generated, immediately ruling out the creation of impossible forms. Of course, there remains the empirical question of the degree to which GLP has succeeded in modelling a universal phonology of language via its set of principles. The issue of the precise form of a core grammar is constantly under scrutiny, and readers are referred to the sources cited above in order to evaluate for

²⁰Asymmetric licensing relations are assumed to hold between x-slots on the timing tier. However, I shall frequently refer to these positions in terms of the higher prosodic constituents onto which they are projected.

²¹In particular, the **Licensing Inheritance Principle** (Harris 1992, 1997), which will make a significant contribution to the discussion in §3.3.2.

themselves the merits of the GLP conception of universal constraints.

As mentioned at the outset, the initial motivation for the shift in focus from rules to structures was the attempt to impose severe restrictions on the generative potential of the model. How, then, does GLP succeed in maintaining the desired level of restrictiveness with respect to the question of phonological derivations? It seems that, as a direct consequence of its richness of structure, it is the representation itself which is capable of carrying a substantial part of the explanatory burden — we have seen how the idea of a *possible structure* has effectively taken over from the notion of a *possible rule* or *possible process* (where 'possible' may be equated with any object generated by the grammar). With much of the explanatory work now being undertaken at a structural level, we are then in a position to relieve the derivational level of most of its former responsibilities. Specifically, it has been argued from an early stage (KLV 1985, 1990) that only two basic structural operations are permitted within the general GLP approach — those relating to the creation (i.e. spreading) and the deletion (i.e. delinking) of an association line between units. In this way, the powerful derivational component, which had been formerly embodied in a potentially infinite class of re-write rules corresponding to observed phonological events, has now been reduced to a minimal set of operations which demonstrate the kinds of local phenomena that are attested in all natural languages. Of course, the desired curtailment of the expressive power of the model immediately follows from this drastic reduction in the number of derivational possibilities.

Although sketchy, this introduction to the GLP approach has demonstrated the extent to which the transition from rules to representations has been undertaken. From the standard generative model, with its rich rule formalism, powerful derivational component, and impoverished phonological structure, we have moved to a vastly more constrained model which places its explanatory burden squarely on the representation itself, thus requiring only a minimal number of structural operations to encode phonological events. But does GLP mark the end of this transition? Or is it conceivable that representations could be enhanced yet further, to allow an even greater reduction in the derivational vocabulary?

It is precisely this possibility of further structural enrichment which I shall explore in the following chapter, the purpose of this move being two-fold. First, the shift in

emphasis from rules to representations has dominated the course of phonological research for over a decade, and the onus is on current theories to investigate the limits to which significant theoretical tendencies of this kind may be taken. Second, there is an area of uncertainty within GLP circles as to the conditions under which the two structural operations of spreading and delinking are permitted to take place. Disagreement arises from the question of whether these constitute formal operations, akin to SPE-type processes, the application of which needs to be specified in every case, or whether they may take place as an automatic consequence of structural properties already present in the representation. Although the latter option is to be favoured (in the interests of reducing the amount of stipulation required in the description of phonological events), it is far from clear how the notion of automatic spreading, for example, is to be sufficiently restricted so as to rule out the problems of overgeneration that the model has been designed to overcome. In the absence of any formal means of constraining the structural operations employed within GLP, we should not ignore the potential benefits, in terms of generative restrictiveness, of reducing, or perhaps eliminating even this basic derivational device. This would, of course, be offset by a further enhancement of representational properties, as indicated above.

The general nature of this enhancement should now be apparent from the discussion of melodic structure in the previous section. In §2.2.5 I concluded that the pursuit of a highly constrained generative model should involve the manipulation of only the three privative units A, I, and U, which mark out a triangular vowel space. In response to cases of undergeneration, we should resist the temptation to introduce additional melodic units into the phonology (see §2.2.3 for some criticisms levelled at the standard DP model); similarly, the notion of multiple tokens of a single unit should ideally be avoided (see §2.2.2 concerning Particle Phonology). Furthermore, the way in which headship properties are represented in GLP (see §2.2.4) is not without a number of specific problems, which we must also seek to overcome. With all this in mind, in the following chapter I attempt to develop an enriched model of melodic structure which possesses a significant degree of explanatory potential in its own right. As I have already suggested, my ultimate aim is to all but eliminate the structure-changing procedures which have, to a greater or lesser extent, characterised each of the representational models

considered above.

3 *The structure of melodic expressions*

3.1 Introduction

In §2.2 I summarized the salient characteristics of several approaches to melodic representation that have featured in the recent literature. While acknowledging the valuable contribution that these models have made to our understanding of phonological organisation, I have also considered some of their shortcomings, particularly with respect to the issue of generative restrictiveness. In conclusion, we have arrived at a set of criteria that we should ideally like to fulfil, in order to develop a phonological model that reflects as closely as possible the variety of vowel inventories, vocalic contrasts, and harmonic alternations that we observe across the world's languages. These criteria include the postulation of only three unary primes, representing specific resonance properties, which collectively define a triangular vowel space. But in view of the apparent problem of undergeneration that results from this basic configuration, we are compelled to seek ways of increasing generative capacity. Crucially, however, these should not rely on the presence of any additional melodic atoms or any intrinsic properties of headship or dependency. Aside from purely melodic criteria, we should not lose sight of the benefits that have been gained from the shift in emphasis towards structure-oriented representations, which I outlined in §2.3 above. The effects of this tendency — to play down the derivational aspect of representations in favour of developing their purely structural properties — will be in evidence in the proposals I present here.

In this chapter I assume a basic tri-directional model of melodic representation, and present arguments for the enrichment of its structure along two separate axes of variation. These are discussed in §3.2, where I explore the possibility of specifying a geometric arrangement of melodic tiers (see §3.2.2) which will impose restrictions on both the number and the nature of phonological contrasts that may be generated within any one system. In addition to the proposed geometry, I introduce the notion of complement tier (see §3.2.3), which will allow us to express the kinds of oppositions that

fall outside the scope of basic element combination; the proposed idea is designed to overcome some of the problems encountered above with regard to the established idea of headship. It will be claimed that the two structural devices to be introduced here interact with very general principles of licensing, to be discussed in §3.3, to yield a typology of vowel inventories and dynamic harmony processes which closely reflects the degree of cross-linguistic variation actually observed. My principal aim, therefore, is to formulate a small set of parametric choices that may be incorporated into a universal grammar of representational well-formedness. The suitability of the proposed model will be illustrated throughout the remainder of this work, where analyses of various harmonic phenomena will be offered.

3.2 Melodic architecture

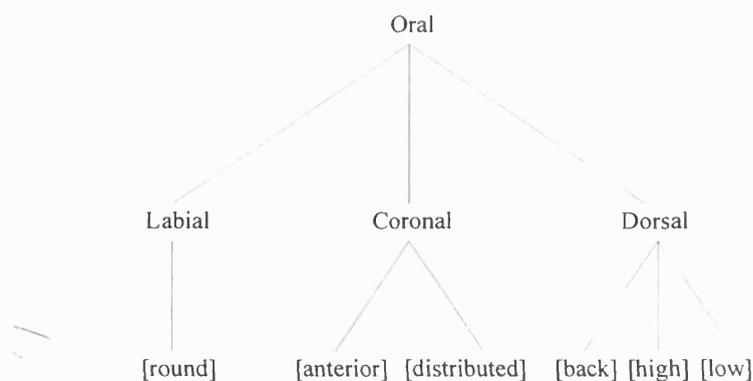
3.2.1 Geometric relations in phonology

Since the mid-1980s there have been many attempts to introduce some form of sub-segmental geometry into melodic representations, by postulating a structure in which melodic units are hierarchically arranged so as to reflect certain dependency or implicational relations holding between them. The geometric model proposed in Clements (1985) sparked a flurry of interest in this area, the same fundamental idea being taken up shortly afterwards by Sagey (1986), McCarthy (1988), Halle (1992), and several others. Common to all but the most recent geometric models is the use of bivalent distinctive features, similar to those employed in SPE. In addition, each is primarily concerned with the internal composition of consonants. Thus, owing to the large number of individual features involved, the resulting feature trees tend to be relatively large and structurally complex. Generally, such trees are constructed around articulatory-based groupings of melodic units.

The initial motivation for intra-segmental geometry comes from the observation that only a subset of all possible feature combinations is ever exploited in the construction of a language's inventory of contrastive sounds; moreover, the same

combinations are seen to occur across many different languages in a way that is clearly systematic. For example, the fact that (the marked value of) the feature [distributed] can never contribute to the description of a low vowel may be captured by positing the hierarchical structure in (1). A basic assumption of the model is that a *bona fide* melodic expression (i.e. one belonging to the universal set of potentially contrastive segments) can be generated by selecting a single articulator (e.g. labial, dorsal, etc.), together with the appropriate dependent feature(s), from a cavity node such as Oral.¹ Since the representation of a low vowel involves a specification of the feature [low], which is a dependent of the Dorsal articulator, the same representation cannot also make reference to [distributed], which is dependent on the presence of the Coronal node. The co-occurrence of the two features [low] and [distributed] is thus ruled out, as this may only be achieved by the (illegal) selection of more than one 'primary' articulator in the description of a single segment.

(1)



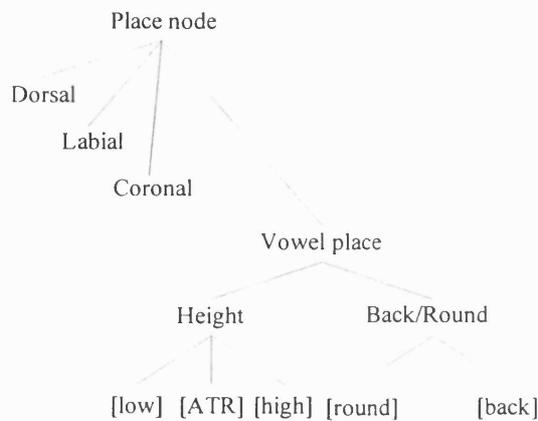
Whilst filtering out unattested feature associations, the design of geometric models is also intended to capture the appropriateness of combinations that regularly do occur. The hyponymous relation between Labial and [round], or between Dorsal and [back], where the properties of the articulator node are inherent in the chosen terminal

¹The cavity nodes Nasal and Pharyngeal, together with their respective articulators and terminal features, have been omitted from (1). Similarly, the root node and its dependent structure features (e.g. [strident], [lateral], and so on) are absent. For reference, Kenstowicz (1994:146) offers a fuller illustration of the feature tree outlined here.

feature, is encoded in the dependency relation that exists between the two. Despite the choice of terminology, however, the precise nature of this relation is rather different from the notion of dependency as it is employed in Dependency Phonology (see §2.2.3 above). Within DP, the identification of a head/dependent component is based on the relative prominence of that unit in a complex expression. In other words, dependency makes reference to the melodic properties of a particular segment. In contrast, the kind of feature geometry model under discussion here typically employs the idea of a dependency relation only in terms of *dominance* within the feature hierarchy — the 'dependency' relation may be interpreted as an implicational statement, such that the presence of a unit in the melodic structure implies or entails the presence of the unit immediately dominating it. Thus, we cannot identify the feature [distributed], for example, without also recognizing the Coronal articulator. Clearly, the links between terminal features and their superordinates are not entirely arbitrary, to the extent that they do reflect the physical limitations imposed upon speech sounds by the human vocal organs. Nevertheless, such links represent what is essentially a *structural* dependency, or *dependency of occurrence*, as opposed to the purely melodic or *inherent* dependency (see Ewen 1995) that is central to DP.

Despite the relatively strong tendency towards the development of consonantal feature hierarchies, the issue of geometric structure in vowels has by no means been neglected. Odden (1991) argues for the geometry in (2), which is motivated by the same basic assumptions that drive other hierarchical models — namely, that every node or feature may be accessed by attested vocalic processes, and that no process need refer to more than a single constituent in its description.

(2)



Further, a close similarity can be observed between this configuration and the geometric model developed by Clements (1991a). The latter may be noted for its attempts to accommodate into the hierarchy the functional overlap displayed by certain place features across vowel and consonant categories. The constituency given in (2) does offer a certain degree of restrictiveness, in terms of the way that unattested phenomena fail to be predicted by the model. However, we cannot ignore the relatively weak explanatory basis for the particular geometric relations that are assumed. For instance, why should the split between Height and Back/Round be favoured over an alternative division, such as Round vs. Back/Height? One proposal made in Odden (1991) suggests that acoustic similarity may be partly responsible for the given groupings of terminal features. For Odden, Clements and others, however, greater significance lies in the fact that only the groupings given in (2) actually reflect the patterns observed in natural languages. Yet, by building a model of observed patterns primarily on the basis of the patterns themselves, the potential for objective (i.e. external) evaluation is inevitably diminished.

The approach to feature geometry presented in Goad (1991) makes something of a departure from the articulator-based models of the kind considered above. Instead, the focus shifts towards a more 'phonologically' oriented view of melodic organisation, motivated by patterns of feature co-occurrence observed cross-linguistically. Goad's arguments are built around the observation that the dependency relations employed in feature geometric models are essentially a formalization of the positive constraints

controlling feature combination. Since the presence of a dependent feature entails the presence of its superordinate, we predict that both units are permitted to co-occur in the phonological description of an expression.

However, the recent literature — and in particular, the body of literature concerned with phenomena such as vowel harmony — seems equally concerned with constraints which *prevent* the co-occurrence of certain features. How, then, do negative conditions of this kind become incorporated into the structural dependence model? Goad introduces the possibility of expressing complementary relations within the hierarchical structure, in order to account for restrictions such as * $[+low, +ATR]$.

(3)

(a) *dependency*

α
|
 β

(b) *complementarity*

|
 α/β

(c)

V
|
[high]
|
[low]/[ATR]

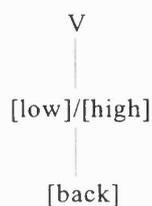
The geometric structure in (3c), which is offered as an example in Goad (1991), illustrates (i) dependency relations, indicating that both [low] and [ATR] may link to a vowel that is specified for [high], and (ii) a complementary relation that prevents the model from generating a low vowel which is marked as [+ATR]. The motivation for this particular hierarchy appears to be purely phonological — or, at least, no obvious articulatory explanation for the complementarity of [low] and [ATR] presents itself. That is to say, the structure is argued for solely on empirical grounds. Yet this inevitably leads us back to the criticisms levelled at the feature geometry proposed in Odden (1991), outlined immediately above. Given a model which can posit a complementary relation between the features [low] and [ATR], we predict that the same model will also generate a range of other grammars, in which other feature combinations are similarly related. On this basis, the number of grammars generated will clearly exceed the number attested. I suggest that the basic conception of complementary relations between melodic units is

a viable one — indeed, the related notion of tier sharing² will figure prominently in the following discussion. However, these examples have illustrated that the need to control potential overgeneration remains a central issue, even within 'restrictive' models that promote segment-internal geometric organisation.

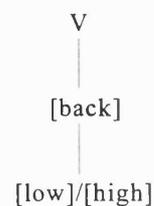
As indicated above, we can identify a similarity between feature complementarity and the concept of tier sharing. The latter is proposed in KLV (1985), where it is assumed that an element is free to combine with another element residing on a separate melodic tier; on the other hand, if two elements occupy the same tier, then they are prevented from fusing. The idea of a structure composed of melodic tiers is taken up by Mester (1988), who makes the additional assumption that the individual tiers within a melodic representation are geometrically arranged — in his terms, they are subject to 'dependent tier ordering'. In Mester (1988) it is claimed that some dependency relations between features are universal (such as that involving [coronal] and [distributed], already encountered above), while others are controlled by language-particular settings. It is largely within the set of vocalic features that parametric variation is employed, the specific settings being based around observations of morpheme structure constraints, harmonic patterns, and so on. The following exemplify the language-specific structures which are proposed by Mester, to take account of vowel distribution in these systems.

(4)

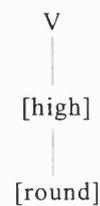
(a) *Ngbaka*



(b) *Ainu*



(c) *Yokuts*



Mester defends the use of parametrically variable dependency relations by demonstrating

²See KLV (1985) and Rennison (1987).

the suitability of particular melodic structures, such as those given in (4), for describing the characteristic patterns of particular systems. It is unclear, however, what determines the choice between the postulation of a relation that is universally applicable and one that is subject to parametric control. Equally unclear is the extent to which the set of geometric possibilities is actually exploited. Given the five vocalic features [high], [back], [low], [round] and [ATR], together with the available options regarding the sharing and ordering of tiers, I suggest that many of the permutations generated by the model will fail to be matched by attested phonological systems.³ What Mester's proposals seem to indicate is that a constrained model of parametrically controlled tier dependency can only be achieved if we begin with a greatly impoverished set of melodic primes, thus immediately restricting generative output to a more realistic level. Throughout the remainder of this section I shall build on the idea of incorporating a geometric structure into the tri-directional model of melodic representation that was motivated in §2.2 above.

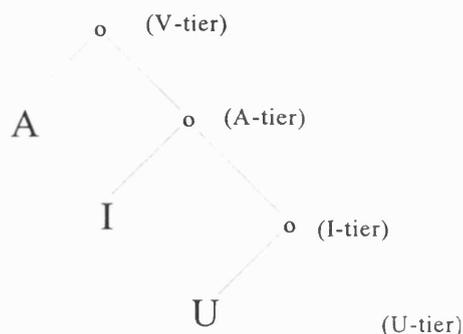
I have shown that, within the context of feature geometry, the term 'dependency' is widely employed in the description of a dominance relation holding between units at adjacent levels of the geometric hierarchy. However, in van der Hulst (1989), where a similar hierarchical structure is proposed, we abandon this use of the term and return to a notion of dependency which refers to the melodic asymmetry assumed within the DP framework outlined in §2.2.3. The basic vocabulary of the model presented by van der Hulst comprises the three unary vowel components of DP, as discussed in the previous chapter, together with the set of dependency relations⁴ associated with the standard DP approach. The melodic structure is then further enriched by the addition of dominance relations between the melodic components. Following Humbert (1989), van der Hulst (1989) claims that the geometric arrangement given in (5) serves two functions: first, it provides a basis for predicting the nature of various vocalic phenomena such as parasitic harmony (which he illustrates with reference to Kirghiz), and second, it assists in

³With a maximum of two features sharing a tier, a total of 44 different geometric structures are created. As nothing prevents us from ruling out tiers containing more than two units, the potential generative capacity of the model must greatly exceed this number of possibilities.

⁴Van der Hulst (1988a) also introduces the possibility of a component acting as both governor and dependent within the same expression; thus, {I} may potentially contrast with {I→I}. The reader is referred to van der Hulst (1989:262) for details of the way in which this device effectively dispenses with the need for an independent ATR prime.

developing 'a more precise phonetic interpretation calculus' (1989:264).

(5)



I assume that the identification of observed patterns of distribution and assimilation plays an important role in motivating the construction of most geometric models. In this respect, van der Hulst's proposals are not unconventional. Rather less orthodox, however, is his attempt to develop a phonetic interpretation calculus purely within the scope of the three monovalent primes. The following paragraphs offer merely an insight into the fundamentals of the model, while the reader is referred to the original source for a fuller description.

In an approach that is highly reminiscent of the Element Theory employed in KLV (1985), van der Hulst assumes a dual interpretation of the components I and A, the choice depending on whether each prime acts as a head or a dependent.⁵ The phonetic parameters for each tier are as follows. As the table indicates, both properties contribute to the interpretation of a component when it is present as a head.

⁵Because the U component is located at the bottom of the hierarchy, it has no potential dependent prime, and therefore, must always assume dependent status itself. Consequently, U has only a single interpretation.

(6)		<i>dependent</i>	<i>head</i>
	I-tier:	ATR	ATR, palatal
	A-tier:	open	open, pharyngeal
	U-tier:	round	—

Under the condition that components must be associated to the V-tier to be interpreted, a precise phonetic interpretation results from the requirement that some components must pass through higher tiers in order to achieve this association. To illustrate, I compare the two structures that give the respective interpretations **e** and **æ**. Both contain the components I and A, but differ in terms of the dependency relation involved (heads are represented by vertical lines, dependents by slanting lines).



[open, palatal, ATR] = **e** [open, pharyngeal, ATR] = **æ**

Following the 'standard' version of DP, the properties contributed by the head of the expression are more prominent than those provided by the dependent; in the case of **e**, therefore, palatality preponderates over openness. It should also be noted that, as with the other tri-directional models reviewed in chapter 2, a precise phonetic description is not the intended outcome here. This point is reinforced by van der Hulst:

The exact nature of this relationship [between head and dependent features] is a matter of the overall vowel system, and may also be language-specific — i.e. the phonetic target position of a low mid vowel need not be exactly the same in all languages having this phonological category of sounds (1989:266).

From the facts presented above, it is clear that we require a means of reducing the

generative output of the dependency/geometry model proposed in van der Hulst (1989). Specifically, we must incorporate a mechanism that places restrictions on the way in which components combine in particular systems, and on the appropriateness of components to act as heads or dependents. It may be the case that the dependency relation is not even relevant to the vowel systems of some languages. The necessity for a range of such choices is acknowledged by van der Hulst, who suggests that a typology of vocalic systems can be achieved via a number of parameter settings⁶ of the following form:

(8) *Are there any head-dependent relations?*

Yes A: Is government bidirectional on the A-tier?

Yes → Two series of mid vowels

No → Does A govern I/U?

Yes → $\epsilon/\text{ɔ}$ type vowels

No → e/o type vowels

Yes B: Is government bidirectional on the I-tier?

Yes → Two types of rounded vowels

No → Does I govern U?

Yes → front rounded vowels

Whether or not parameters of this sort can be shown to truly reflect the various stages of language acquisition and development (particularly with regard to vowels) remains a matter for future research. However, the proposals presented in van der Hulst (1989) do appear to offer alternatives to some of the problems inherent in other generative models highlighted in the previous chapter. In particular, the inventory of melodic primes has been drastically reduced, cross-linguistic parameters have largely replaced the need to refer to language-specific structures, and the burden of explanation, in terms of both the distribution and dynamic behaviour of vowels, has been placed squarely onto the representation itself.

Let us briefly consider the theoretical cost of this advance towards a more highly

⁶Further parameters are cited by van der Hulst to take account of the 'incomplete' representations of central vowels, back unrounded vowels, etc. These have been omitted from the present discussion.

constrained view of vocalic structure. Although the geometric structure in (5) is assumed to be universal, the model relies on a selection of parameters to restrict the options (regarding component combination) available to different languages. In addition, an asymmetric dependency relation serves to increase the number of potential contrasts without the need for an increase in the number of melodic primes. Together, these two independent mechanisms create a view of segment-internal organisation that is considerably complex,⁷ despite the claim that this complexity is based entirely on binary structures and a series of binary parametric choices. It remains an empirical question as to whether the set of possible grammars generated by the model provides a sufficiently close match for the kind of cross-linguistic variation observed. But, despite the large and elaborate systems that are predicted to result from some parameter settings, the overall impression is encouraging.

In view of the conclusions drawn from the discussion in chapter 2, however, we must recognize one aspect of the van der Hulst model which indicates the need to exercise some degree of caution. I refer to the issue of the dual interpretation of components, and more generally, to the validity of asymmetric dependency relations within expressions. In §2.2.4 I identified the problem of concealed bivalency, where the unary characteristics of melodic primes are challenged by the claim that the primes are subject to more than one interpretation, according to their status as either a head or a dependent. In GLP, for example, a lone headed U element is interpreted as **u**, while the same element as a non-head is interpreted as **ʊ**. In the extended DP model discussed here, the difference in interpretation for a single component can be rather more significant. By referring back to (6) we can see that, for instance, headed-I contributes palatality to an expression, whereas dependent-I introduces ATRness.

Although van der Hulst emphasizes that a phonological connection between these two properties can be established, it is clearly a weaker link than the one which, for example, unites **u** and **ʊ** as instantiations of a single melodic unit. In terms of natural

⁷Given the possibility of all parameters choosing the YES option, we predict a system which includes (at least) two series of mid vowels, two types of rounded vowels, back unrounded vowels, central vowels, front rounded vowels, and perhaps other marked properties besides. As van der Hulst acknowledges, his proposals offer only a suggestion of the type of parameter set that would need to be formulated.

classes, it is extremely doubtful whether we could identify a single group which consisted only of palatal expressions (containing I as a head) and ATR vowels (containing dependent-I). We would, thus, be forced to admit that heads and dependents behave as distinct representational objects, a conclusion which is supported by the way in which each can be used to identify a separate natural class of sounds. So, although the number of individual vocalic primes has been kept to a minimum, we could interpret the dependency relation employed in the van der Hulst model as a device which effectively expands this inventory of melodic objects, by introducing a separate tongue root component in the form of a dependent-I. For more general arguments against the notion of the dual interpretation of melodic primes, the reader is referred back to §2.2.4 above.

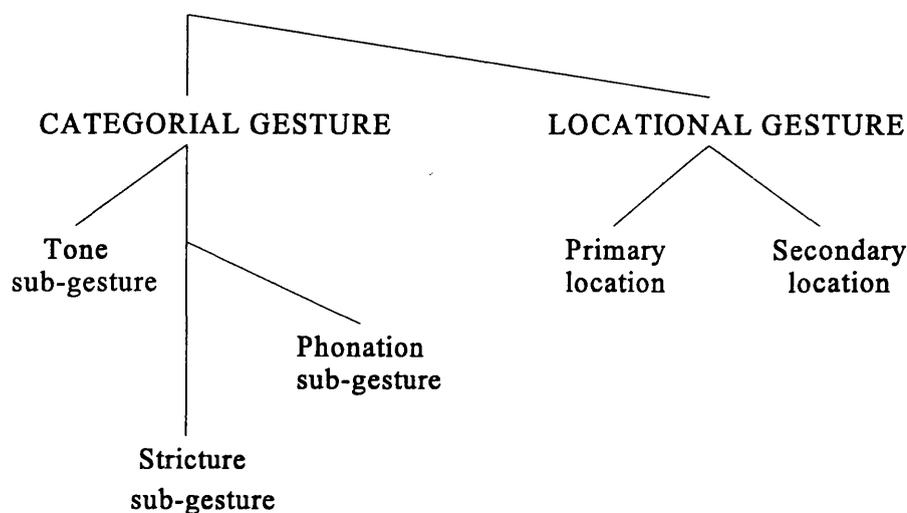
By comparing the feature-based geometry of Mester (1988) with the tri-directional view of vowel representation adopted in van der Hulst (1989), it becomes clear that any move towards enhancing generative restrictiveness can only follow from a commitment to reducing the number of melodic atoms available to the phonology. More recent work by van der Hulst (1994, 1995) has shown how this assumption can be carried to its limits. Under an approach labelled Radical CV Phonology, van der Hulst proposes that all categorial distinctions — not only those contrasts involving place of articulation, but also the kinds of oppositions that crucially refer to manner and stricture properties, to airstream mechanism, and even to tonal specifications — may be expressed in terms of the two unary primes $|C|$ and $|V|$. Although these primes are to be identified as independent melodic units, their apparently complementary characteristics are indicative of their status as the extreme points on a single scale of sonority. Van der Hulst expresses this position from the outset:

...the central claim of Radical CV phonology is that the polar C/V opposition is absolutely central to the architecture underlying the system of potentially distinctive phonological categories (1994:444).

Not unexpectedly, such an impoverished view of the melodic vocabulary leads to the postulation of a rather detailed representational hierarchitectre; the complexity of this structure derives, once again, from the fact that two independent relational mechanisms are deployed in the description of segmental material. The first involves a

geometry of *gestures* and *sub-gestures*,⁸ these constituents serving as organising nodes which represent broad melodic categories such as 'tone' and 'phonation'. The proposed geometry is illustrated in (9) below.

(9)



The geometric arrangement given in (9) is intended as a universally fixed configuration, comprising gestural nodes that may be viewed as informal labels for particular categories identified in terms of the melodic primes $|C|$ and $|V|$. Specifically, it is within these gesture constituents that van der Hulst employs a second relational device, one involving dependency between $|C|$ and $|V|$. It is assumed that every sub-gesture of the hierarchy houses one token of each prime; these tokens are then permitted to combine within their respective geometric constituent, according to a strict syntax of melodic fusion. For the purposes of the present discussion — which is primarily concerned with melodic geometry, and with some of the ways that geometric structures have been implemented within different theoretical frameworks — it seems appropriate to offer only the broadest outline of this mechanism controlling combinatory possibilities

⁸The notion of *gesture* is taken from the 'standard' Dependency Phonology literature, where it has played a central role in segmental description for some time (see Anderson and Ewen (1987) for details). However, the original DP proposals concerning the specifics of the hierarchy itself have been thoroughly revised within the Radical CV Phonology model.

(for fuller details, see references cited above). Here, I note only the use of 'embedded' dependency relations, which allow for the generation of complex melodic structures in the following way. The two unary primes $|C|$ and $|V|$ may combine in an asymmetric fashion, where the properties of the head are seen to preponderate, in terms of the interpretation of the resulting melody unit, over those of its dependent. Following the DP notation employed in the previous chapter, we arrive at a structure such as $\{|V| \rightarrow |C|\}$. The output structures from this fusion operation are then permitted to contract further dependency relations with each other, yielding combinations such as $\{(|C| \rightarrow |V|) \rightarrow (|V| \rightarrow |C|)\}$. It is largely this potential for 'double' dependency relations within each sub-gesture which allows the generative capacity of the model to reflect those levels corresponding to empirical data.

As already indicated, the same two primes $|C|$ and $|V|$ are assumed to be present in every sub-gesture of the geometry; accordingly, they are observed to contribute to the description of a variety of quite distinct melodic properties — from specifications for place of articulation to characteristics of tone and phonation-type. As a consequence, it seems possible to pin down only a very general interpretation of the two melodic objects in question. In order to identify a more precise definition of the acoustic or articulatory signatures of $|C|$ and $|V|$, it becomes necessary to refer not only to the objects themselves, but also to their location within the gestural hierarchy.⁹ It is this aspect of van der Hulst's Radical CV model that sets it apart from previous geometric approaches, to the extent that the hierarchical configuration itself makes a crucial contribution to the interpretation of individual melodic atoms: to take the melodic structure $\{|C| \rightarrow |V|\}$ as an example, this translates into the property 'spread glottis' within the phonation sub-gesture, but encodes 'labialized' or 'round' within the secondary sub-location.

So, the geometric arrangement shown in (9) may be considered to have a dual role: first, in common with other geometric models, it is present in an organisational capacity and serves to identify particular sub-segmental properties that can display autonomous behaviour; and second, it plays a necessary part in determining the precise interpretation of all melodic expressions — whether simplex, such as $|V|$, or compound,

⁹In fact, the interpretation of a melodic prime within this Radical CV Phonology approach must take into account *three* independent factors — the identification of the prime as either $|C|$ or $|V|$, its status with respect to head/dependency relations, and its location within a particular sub-gesture.

such as $\{|C|\rightarrow(|V|\rightarrow|C|)\}$. It is this latter function which marks something of a departure from the established view of a melodic geometry, thus warranting the inclusion of the Radical CV model in this brief overview of the development of hierarchical phonological structure.

It will become apparent that there are appreciable theoretical differences between the proposals put forward in van der Hulst (1994, 1995) and the position to be adopted in this work. Following the standard DP model, it is assumed within Radical CV Phonology that the headship status of individual melodic primes is directly reflected in the way those primes are interpreted; in other words, any one component may be subject to a range of possible phonetic interpretations, depending on the nature of the relational properties involved. In direct contrast, I shall consider an alternative to this approach in §3.2.3, where the preponderance of one prime over another can be only achieved in a structurally dynamic way. But besides the question of dependency relations, we may refer to a rather more obvious representational divergence, stemming from the choice of which monovalent primes are to be employed. In contrast to the minimalist set employed in RCVP — comprising the atoms $|C|$ and $|V|$ — I shall pursue a representational model which recognizes the three triangular reference points [I], [U] and [A], as utilised in van der Hulst (1989). An interesting question arises from the possibility of perhaps identifying a sufficiently close correspondence between the three tricorn elements and particular $|C|$ - $|V|$ configurations, in which case the apparent differences could be treated more in terms of notational variation, rather than theoretical incompatibility. However, for the purposes of the present study, which will focus primarily on the harmony characteristics of vocalic systems, I shall continue to employ the resonance elements [I], [U] and [A] as the basic properties of vowel melody; my motivation stems largely from the regularity with which harmonic descriptions must identify the members of this set as harmonically active units.

While the model proposed in van der Hulst (1989) may be viewed as a geometric treatment of an essentially DP approach to melodic organisation, a parallel development has also been taking place within the general framework referred to above as GLP. I refer particularly to the work of Rennison (1987, 1990), which has been principally concerned with attempts to superimpose the restrictions of a feature geometry onto the overall view

of melodic structure assumed by Element Theory. The remainder of the present discussion owes much to the insights of Rennison, who, in the context of vowel representations, focuses his attention not on the vocalic elements¹⁰ themselves, but rather, on the melodic tiers on which those elements reside. His claim is that element combination is constrained by the language-specific configuration of these tiers — that is, by the way in which these element tiers can be linked with one another and with the timing tier. This contrasts directly with the van der Hulst model, where the structural hierarchy is universal, and cross-linguistic variation is determined by parameters controlling the governing relations between melodic primes. The distinction between the two approaches is emphasized in Rennison (1990):

The present model does not attempt a rigid *universal geometry* of phonological elements; indeed, I would be surprised if one could be found at all. Instead, it gives a framework within which language-specific geometric (and other) parameters can be set. (1990:183)

The parameters that Rennison employs are chiefly concerned (i) with tier sharing — that is, they control which particular elements reside alone on their own tiers in any one language, and which are located on the same tier — and (ii) with 'visibility'. This latter notion represents the restrictions imposed within individual systems on the set of possible associations that may hold between the different tiers of the structure. It may be stipulated, for example, that a phonological process links elements of one tier not directly to the skeleton, but to an element on another tier (if one is available). Alternatively, it may be possible that the elements of two tiers are mutually exclusive, where only one of them can associate to a single position on the timing tier. For Rennison, therefore, the kind of variation observed between different systems, in terms of vowel inventories and also dynamic processes, may be accounted for via specific parameter settings regarding tier conflation and the postulation of further constraints on tier visibility.

The view of structural dependency I propose here follows Rennison, in that I assume the particular arrangement of melodic tiers to be determined on a language-

¹⁰Besides the three Element Theory primes A, I, and U, Rennison employs two further units which denote ATRness and labiality (where U represents velarity). In view of the arguments in §2.2.3, these additional units will not be incorporated into the model developed here.

specific basis. However, I shall make the further claim that all permutations of tier conflation/division are expected to yield possible, and ideally, attested vowel systems, thus reinforcing the fundamental goal of generative restrictiveness. Given the fact that no less than five melodic primes (and hence, potentially five separate tiers) are assumed by Rennison, it is of little surprise that not all possibilities regarding tier conflation and visibility are actually exploited. Additionally, he makes a number of *a priori* assumptions regarding the way in which tiers are predicted to split; in 5-vowel systems, for instance, where a two-tier structure is required, he claims that 'usually, perhaps always, the feature [A] occupies a tier of its own, and [I] and [U] share a single tier' (1990:347). In the absence of any purely phonological motivation for this outcome, I suggest that other geometric permutations, which are indeed generated by the model, can be identified in the representations of observed systems.

So, the fundamental assumptions of Rennison's approach to tier geometry will be adopted here as the basis for a highly constrained model of vowel structure. My aim is to demonstrate that a desirable level of restrictiveness can be achieved by adhering, as closely as possible, to the following assumptions:

- that all tier configurations generated by the relevant structural choices will correspond to possible language systems
- that as few *ad hoc* statements as possible will be required in order to rule out unattested configurations predicted by the grammar
- that the idiosyncratic properties of individual systems may be largely interpretable by referring to independently motivated principles of licensing, rather than to language-specific stipulations regarding distribution and dynamic behaviour
- that some indication of relative markedness should be encoded in the representational structure.

The following sub-section will be primarily concerned with the set of possible geometric configurations generated by the parametric choices controlling tier conflation and division. The discussion will be centred on the resulting patterns of vowel distribution and contrast across different languages, and I shall demonstrate how even the most

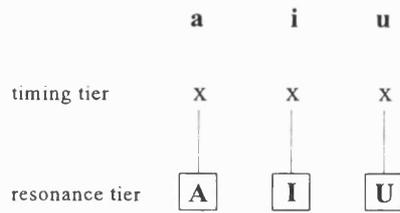
marked of vowel inventories may follow directly from particular geometric settings. As for the range of harmonic alternations displayed in natural languages, these will also be shown to derive from particular tier configurations. Dynamic harmony processes will be explored more fully in subsequent chapters, where I illustrate the ways in which particular structural configurations interact with general licensing principles, to yield various idiosyncratic properties that are found in a number of vowel harmony systems.

3.2.2 Tier geometry

One of the defining characteristics of the resonance elements [I], [U], and [A] refers to the way in which their interpretation closely mirrors the smallest and simplest vowel inventories.¹¹ These typically consist of the three 'corner' vowels **i**, **u** and **a**, and constitute the vocalic system of numerous languages such as Warlpiri and Classical Arabic. As pointed out by Harris (1994b), this simple system also defines the initial stage in first language acquisition. In these 3-vowel systems the elements are unable to fuse, and we may capture this fact, in accordance with the conventions of Element Theory, by assuming that all three primes reside on the same melodic tier.

¹¹As discussed in the previous chapter, we expect some degree of phonetic leeway between different systems that share the same phonological characteristics. This is to be expected within a model which views melodic elements as cognitive categories (representing acoustic targets), rather than interpretive objects.

(10)



The claim that all three elements occupy a single tier finds support in Rennison (1987), where the harmonic behaviour of a number of three-vowel languages is explored. The postulation of only one resonance tier leads us to expect that vowel harmony involving a particular element will be blocked by the presence of any other vowel (i.e. by any other element located on the same tier). This expectation is confirmed by data from the Australian language Djingili, where [I] harmonizes in an unbounded manner, and both [A] and [U] block the propagation of this harmony. Similarly, in another Australian language, Nyangumarda, a harmonic span (which may be initiated by any resonance element) is terminated by any specified vowel. The harmonic blocker itself then begins a new harmonic domain.¹² As will be shown to be the case with all melodic configurations, we must allow for the possibility of recognizing an additional vowel (of varying quality) which may be interpreted in the absence of any lexically specified resonance elements. Thus, a 4-vowel system may potentially be generated by the unmarked structure in (10). This option is taken up in a number of languages, such as Giver and Wapishana, the vocalic inventories of which are given in Crothers (1978) as {i,a,u,w} and {i,a,u,ɨ} respectively.¹³

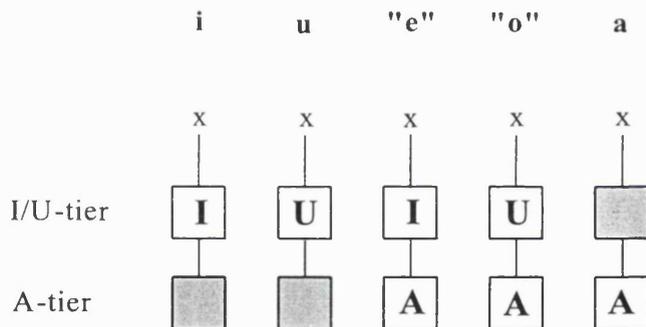
In order to generate a system of greater complexity than that described by (10), the resonance tier must be allowed to divide, thus permitting one or more elements to occupy their own independent tier(s). Following tier division, the primes belonging to separate tiers may fuse to create complex melodic units. Empirical evidence seems to

¹²Below, I shall argue for a view of harmony domains which rejects the notion of multiple spreading, and instead, builds on this idea of spans of activation along a single melodic tier.

¹³I assume there to be little to separate the two non-peripheral vowels **i** and **w** in terms of vocalic quality; any discernible differences that may be detected can be taken as purely phonetic in nature. The phonetic interpretation of empty nuclei is examined in Charette (1991).

weigh heavily in favour of the [A] element being the first to break away from the single resonance tier, leaving the remaining primes [I] and [U] to share what I shall refer to as a 'colour' tier. The resulting configuration is given in (11) below, where the two mid vowels are shown as "e" and "o" in order to highlight the lack of phonological significance (within such five-vowel systems) between the various possible phonetic interpretations of these expressions (e.g. the choice between e and \epsilon as the interpretation of the expression [I,A] has no bearing on the *phonological* identity of the front mid vowel).

(11)

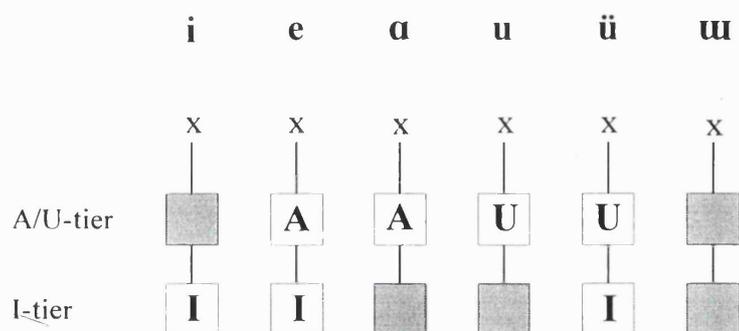


This describes the very common 5-vowel system which typically contrasts two heights, front and back, with a single low vowel. Allowing for some degree of phonetic variation, this inventory is found in countless languages such as Spanish, Japanese, Georgian, and Hawaiian. It should be noted that no reference need be made here to headship properties, since the tier arrangement in (11) generates all and only those contrasts which make up the symmetrical five-vowel system being described.

At present there appears to be little phonological motivation — either theory-internal or from the phonological literature in general — for choosing [A] as the element which most readily breaks away to occupy its own tier. There is evidence to suggest that [I] and [U] do share some acoustic characteristics which are absent from [A]; in fact, the Jakobsonian opposition between *compact* and *diffuse* encoded this very distinction. And Rennison (1987) chooses to follow Jakobson by grouping together [I] and [U] as 'colour' elements, while [A] is distinguished acoustically for its 'sonority' properties. But although

this observation highlights the nature of the element split, it remains intuitively lacking in terms of *explanatory* value. In fact, without any convincing phonological explanation as to why it should be the [A] element which resides on an independent tier in (11), then we expect that both [I] and [U] should also be able to detach in the same manner within other vowel systems. Indeed, there is some indication that other tier configurations are exploited in 5-vowel systems, albeit in a very small number of languages. For example, the vowel inventory of the Caucasian language K'ürì, as given in Lass (1984b), comprises the set {i,e,ɑ,u,ü}; the same source also reports the Altaic language Chuvash as having a similar underlying system {i,ɛ,ɑ,u,ü,ʉ}. In these cases the elements [A] and [U] are apparently unable to fuse, given the absence of non-high, back, rounded vowels such as **o**, **ɔ**, and **ɒ**. Yet both systems do contain a front, rounded vowel, requiring [I] and [U] to reside on separate tiers. In view of these facts, the following tier configuration seems appropriate for each.

(12)



The arrangement of tiers in (12) generates the system of contrasts found in Chuvash and K'ürì (the latter does not license a phonologically empty vowel position) by exploiting all permissible combinations of elements.

Given the possibility of this configuration, we should also predict that the [U]-tier may break away to leave [A] and [I] as tier sharers. This would generate a small (i.e. maximally six) vowel system which lacks non-high front vowels (since [I] and [A] cannot fuse) but which does contain a front rounded vowel (as [I] and [U] reside on separate tiers and are thus free to combine). Wikchamni appears to qualify as such a system, with its

inventory consisting of {i,u,a,ü,o}. However, it should be borne in mind that both Wikchamni and Chuvash represent very unusual (perhaps unique) vowel systems, and that, consequently, the tier configurations required to generate these inventories must be considered highly marked. The fact remains that statistically the most favoured five and six vowel inventories involve a separate sonority or aperture tier (henceforth I shall follow the usual practice of employing the labels *aperture tier* and *[A]-tier*), and thusfar the motivation for this appears somewhat elusive.

Central to Element Theory, as well as to most other tri-directional models of vowel representation, is the idea that basic markedness properties should be directly encoded in the representation itself. This matter was addressed in §2.2.3 with specific reference to Dependency Phonology. In terms of the present model, this markedness function may be roughly equated with structural complexity. We have seen that there are grounds for assuming that the least marked vowel inventories are those comprising the three corner vowels **a**, **i**, and **u**. The unmarked status of this basic triangular system suggests that the configuration given in (10) approximates to the way in which resonance characteristics are organised within Universal Grammar — that is, the three basic primes are housed on a single 'resonance' tier, and are, therefore, unable to fuse. The facts of language acquisition would seem to support this position, where the absence of any other contrastive vowel sounds in the language learner's input allows this basic structure to be adopted and employed in the adult phonology without any modification. This would be the case for a child acquiring Moroccan Arabic, Cree, or any other system employing only the three corner vowels, as his or her first language.

Three-vowel languages, however, form a minority grouping, and the majority of infants are exposed to language data which exhibit a greater number of vocalic oppositions than this. It appears that UG provides us with the earliest stage of linguistic development — a melodic baseline — where only the simplex categories [A], [I], and [U] are recognized. Let us now follow Harris (1994b) in making the assumption that this is followed by a later stage of acquisition which is marked by the perception of compound melodic expressions as linguistically significant objects. This point in a child's language development is characterised by a split in the resonance tier where, as we have seen, any one of the three vocalic elements may break away to occupy its own tier. Harris refers to

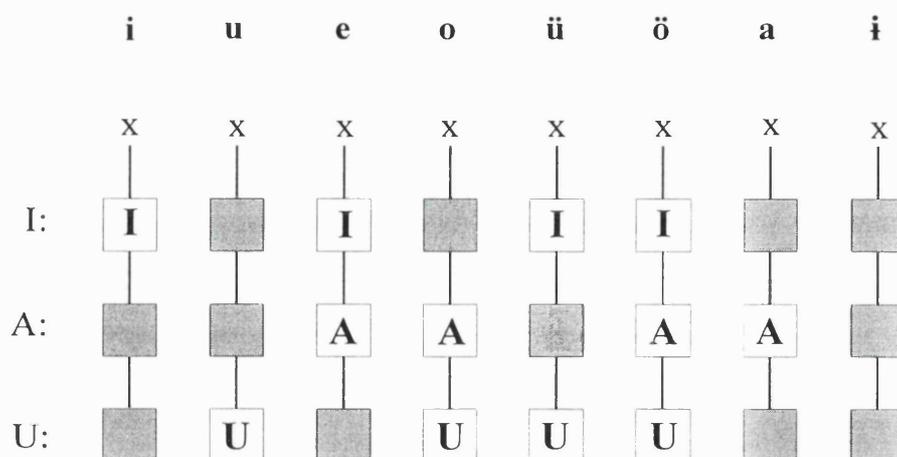
this mechanism as the 'autosegmental unpacking of melody' (1994b:528). The precise nature of the resulting two-tier configuration is, of course, determined on empirical grounds. If the language learner perceives the mid vowels *e* and *o* as independent phonological categories, then the vocalic tier structure is adapted accordingly and [A] gains independence. Alternatively, if the input vowel system is that of K'ürí, where *e* and *ü* (but not *o*) are picked out as lexically contrastive units, then it must be the element [I] which detaches from the resonance tier. No split in the remaining tier, shared by [A] and [U], is motivated, since the linguistic input does not identify any object such as *o*, that involves the combination of these two elements.

According to the findings of the Stanford Phonology Archiving Project, which has collected data on the segment inventories of over 200 languages,¹⁴ these two structural possibilities — either a single resonance tier or a two-tier configuration — account for well over half of the vowel systems surveyed. However, as illustrated by inventories such as Chukchi and Chuvash, which comprise the vowel sets {*i, u, ε, ɔ, a, ə*} and {*i, ε, a, u, ü, ʉ*} respectively, the mechanism of a single tier split allows us to generate maximally only a six vowel system. In order to take us beyond this number of contrasts we must initiate a second tier division, which will result in a more complex geometric configuration that allows for each resonance element to occupy its own separate tier. Statistical data suggest that only a small minority of known languages actually exploits this possibility of a 3-tiered hierarchy, thus making the arrangement in (13) a relatively marked structure.¹⁵

¹⁴The Stanford Project provides the source for the survey of vowel system typology presented in Crothers (1978), which is referred to above.

¹⁵For the purposes of the present argument we may assume that the exact location of the tiers in relation to each other has no bearing on the typological predictions made by the geometric structure. However, see §3.3.3 below for suggestions as to how the relative ordering of melodic tiers may indeed become significant.

(13)



In keeping with the spirit of the triangular model, this increase in markedness corresponds directly to the degree of representational complexity involved. A typical inventory generated by a second tier split is found in languages such as Hungarian and Turkish; the latter system, which is illustrated in (13), also exploits the possibility of allowing a phonologically empty nucleus, thus increasing the size of the inventory to eight vowels. Once again, such a configuration will be constructed in the grammar of a language learner only if the relevant cues (i.e. the appropriate type and number of lexical oppositions) are available as linguistic input. It seems that vocalic structure — and specifically, tier structure — is never more complex than is necessary.

Thusfar, the discussion has centred on relations holding between the different resonance tiers, and has illustrated a variety of inventories encompassing the following typological range:

<i>No. contrastive vowels</i>	<i>Example systems</i>
3	Cree, Moroccan Arabic
4	Giver, Wapishana
5	Spanish; K'üri; Wikchamni
6	Chuvash; Chukchi
7	Hungarian
8	Turkish

No direct reference, however, has been made to the relationship between melodic tiers and the timing tier. This link between the melodic hierarchy and the prosodic structure will, nevertheless, be shown to contribute significantly to the predictive power of the present model, and will be developed in some detail below. In §3.3.2 I formalise this connection between melody and prosody by appealing to the notion of Licensing Inheritance; and in later chapters I demonstrate the nature of this connection by offering analyses of harmonic phenomena in the context of a restrictive model of tier geometry. This issue of licensing within melodic structure is preceded by a short discussion on the notion of complement tiers, which will encompass the kinds of systemic diversity not yet accounted for by basic tier configuration alone.

3.2.3 Complement tiers

Section 2.2.4 indicated some of the potential problems arising from the notion of an inherent dependency relation, as it is employed in Element Theory. Specifically, I noted the difficulties associated with Structure Preservation,¹⁶ and also pointed out the damaging effects of head switching on the overall restrictiveness of the model. Thusfar I have motivated a representation of melodic structure that makes no reference to any headship relation within individual expressions; instead, all contrasts have been encoded simply in terms of the presence or absence of element material. Nevertheless, we cannot ignore the set of phonological oppositions that may be created by referring to the property ATR; and, as we have already observed, the standard Element Theory approach relies on the notion of melodic headship in the description of this property. Yet we have seen that it is precisely this deployment of headship within the scope of a single melodic tier (e.g. in order to distinguish between ATR \mathbf{u} [U] and non-ATR \mathbf{u} [U]) which proves difficult to reconcile with the original role of headship as an *asymmetric* association existing between *different* elements in a complex expression. It may be suggested that, from this position, it seems only a moderate (but retrograde) step which leads us back towards the

¹⁶I return to the issue of Structure Preservation in chapter 4, and show how a restrictive interpretation of SP may be maintained alongside the theoretical proposals introduced here.

acceptance of two-valued features.

In the range of vowel systems surveyed in the previous section, ATR was present only as a phonologically redundant property; that is, we found no instances in which the presence of ATRness in a vowel was crucial to that vowel's phonological identity. For example, the inventory of the language Giver comprises the vowel set {i,u,a,ɯ}; but although the set contains ATR high vowels, these do not stand in phonological opposition to any non-ATR expressions that are otherwise identical. Consequently, there is no purely phonological motivation for making any reference to tongue root quality in their representations.¹⁷ However, we do encounter a sizeable number of languages where ATR exists as a phonologically significant property. Nowhere is this more apparent than in those systems where the same property shows harmonically active behaviour. Such a phenomenon is common to many West African systems, for instance, in which the vowel inventory is divided into two sets — one ATR and the other non-ATR — where one category occurs to the exclusion of the other in a given domain. Within an ATR span, those vowels which are represented within Element Theory as lexically headless (i.e. non-ATR) are compelled to align themselves, and are accordingly interpreted as headed expressions. I have already described how this operation is typically achieved, by switching head status from a 'dummy' dependent element ($(@,\alpha)$) to a resonance element that is lexically present (see §2.2.4 for a discussion of Tigré). However, I have just pointed out that this move ought to be questioned on two counts: first, it may constitute a violation of SP; and second, it forces us to expand the repertoire of permitted operations within autosegmental phonology beyond those involving spreading and delinking.

The Sudanic language Maasai (Tucker & Mpaayei 1955) illustrates the general characteristics of an ATR harmony system, which comprises the following vowel inventory:

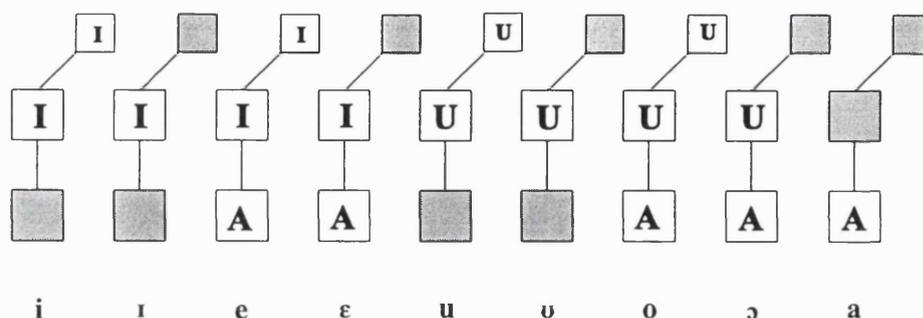
¹⁷I shall argue below that melodic categories identified by the phonology need not show any direct correlation with phonetically defined descriptions of vocalic quality; in some cases, then, the precise interpretation of a phonological expression can only be determined within the context of the system to which it belongs.

(14)	<i>ATR set</i>		<i>non-ATR set</i>
	i	u	ɪ
	e	o	ɛ
			a

Following the patterns of geometric organisation discussed in the previous section, we may describe the Maasai system as one employing a shared colour tier (consisting of the elements [ɪ] and [ʊ]) and an independent aperture tier. In this way, three distinct vowel heights may be generated, while the presence of rounding in front vowels is categorically ruled out. These conditions are similar to those which hold for common 5-vowel inventories such as Spanish, for example. Additionally, however, the Maasai system involves opposition along another dimension, which I have described as tongue root advancement or ATRness. I shall claim that this additional property may be accommodated by allowing a melodic tier to license a complement.

Here I introduce the notion of complement tier, presented in Takahashi (in preparation) and illustrated in Backley and Takahashi (1996). This provides us with an alternative means of representing ATRness, which I attempt to integrate into the tier-geometric model outlined above. I shall claim that, by representing the headed/headless distinction in a way that modifies representational structure (and affects structural complexity) — namely, via the postulation of a complement tier — the problems arising from head switching may be successfully overcome. I argue for the representation in (15) for systems such as Maasai, where a complement tier (contributing ATRness in non-low vowels) is superimposed on to a basic five-vowel configuration to yield a three-part melodic structure consisting of a colour tier, its complement, and an aperture tier.

(15)



I follow Takahashi (in preparation) in assuming that the phonetic effects of a complement tier, or [comp], are such that the acoustic properties of its host tier become enhanced. We may note a similarity between this position and that assumed by the RCVF view (van der Hulst 1994, 1995) discussed in §3.2.1 above, to the extent that both models allow a single element/component to be enhanced by a structurally dependent occurrence of the same prime. The same is also true of the model of vowel structure developed in van der Hulst (1988b), which is discussed and evaluated in §3.2.4 below. A comparison between the structure proposed in (15) and that employed in the representation of the 5-vowel system in (11) serves to highlight one of the fundamental assumptions of the present work — namely, that the phonetic factors just referred to (i.e. the augmentation of particular melodic properties) fail to override systemic considerations when determining the phonological identity of an individual sound. So, while the active or inactive status of [comp] will provide the grammatical apparatus for distinguishing between vowels such as *i* and *ɪ*, for example, the initial motivation for including the structural object [comp] in the representation of a sound must come only from the specific organisation of the contrastive (i.e. phonological) system to which that sound belongs. This position then leads to the striking prediction that, for example, the (phonetically ATR) high vowels *i* and *u* of a five-vowel language such as Spanish actually differ in terms of their phonological composition from the phonetically similar vowels *i* and *u* present in a language such as Maasai, where ATRness is exploited as a contrastive property. In Spanish, the high vowels may be represented in terms of an active colour tier alone, for the reason that any qualitative changes involving only the saliency

of [I]/[U]-resonance — such as the change from the phonetically ATR vowel *i* to its 'lax' counterpart *ɪ* — cannot have any phonologically significant effects within this system. In direct contrast, a similar qualitative change observed in a language like Maasai *must* have some kind of dynamic effect on the phonological structure, since such a change has the potential to encode lexical distinction. Accordingly, a colour tier [comp] is introduced into the melodic configuration in (15), in order to capture the categorial distinction between ATR and non-ATR expressions.

Of course, the assumption that phonological categories need not be wholly sensitive to phonetic properties must somehow be reconciled with our views concerning the acquisition of those categories in infancy. However, since I have already touched upon the question of the acquisition of a language-specific melodic structure in §3.2.2, I shall avoid any parallel discussion here. It should be sufficient to note my earlier claim that UG provides the infant language learner with a melodic tier configuration of minimal complexity — for vocalic expressions, this will presumably be a single resonance tier housing the three monovalent primes [I], [U] and [A]. In addition to this simple structure, UG must establish and delimit the ways in which the structure may be augmented to accommodate the full range of attested phonological systems. This is expressed in terms of two parametrically determined areas of structural variation: tier division and the licensing of a complement tier. With respect to either of these, an increase in the complexity of melodic structure (either through tier division or the addition of a complement tier) can only be motivated on purely phonological grounds. If an infant's input system is that of Spanish, then the lack of any phonological distinction between the members of an advanced/retracted pair of sounds automatically denies that infant the necessary motivation for increasing the complexity of his/her melodic structure (by licensing a complement tier); any such increase would inevitably bring about a certain degree of representational redundancy. In contrast, Maasai infants must, at some stage of their linguistic development, begin to perceive a categorial distinction between the members of sound pairs such as *o/ɔ* and *i/ɪ*, in which case they are prompted to expand their sub-segmental structure as required. To reiterate what I have alluded to above, it seems that melodic structure is never more complex than it needs to be. This position leads to a situation in which the precise interpretation of a given melodic expression can

only be determined by taking into account the entire system of phonological oppositions to which that expression belongs. Any one vowel sound may be subject to a variety of different representational treatments in different languages, according to the nature of the systemic contrasts in which it may be involved.

Implicit in the set of proposals presented here is also the rather less controversial claim that we also find a reversal of these circumstances, where the same phonological expression may be phonetically interpreted in a number of different ways across different languages: the melodic object [U], for example, may manifest itself as **u** in one language and as **ʊ** in another. So, how can this latter correspondence between a phonological object and the interpretation of that object be squared with the proposals set out here concerning the acquisition of a sound system? I shall adopt the view that the three universal melodic primes [A], [I] and [U] are represented in UG as specific areas within the acoustic space; following Stevens (1968), I assume these regions to be identifiable on the basis of their well-defined acoustic characteristics.¹⁸ So UG provides us with a definition of, for example, [U]-ness in terms of a particular acoustic region; the cross-linguistic variation we find in the precise interpretation of the phonological expression [U] may then be captured by referring to the observed differences in the exact acoustic specification (within the given region) of that expression in individual languages. By analysing the appropriate acoustic measurements, for example, we could determine whether the two high vowels of Spanish were 'closer' than the equivalent vowels in Hawaiian, or whether the reverse was in fact the case. And yet, whatever the outcome of this comparison, I suggest that the result would reveal little about the phonological organisation underlying each system (I assume their respective vowel systems to be identical in terms of their phonological representation).

The question of system-specific variation within phonological categories has, for some time, been the subject of general debate in the phonetics literature. The experimental work of Lindblom and others¹⁹ has attempted to show how perceptual contrast may be seen to influence the phonetic shape of vowel systems. What their

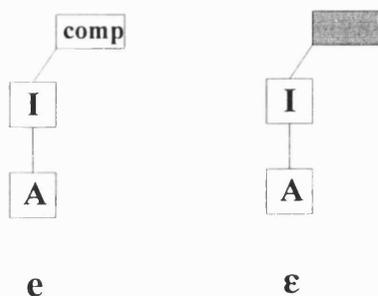
¹⁸Stevens coins the label 'plateau' for these regions of the acoustic space; he maintains that plateaux are stable and insensitive to articulatory errors and imprecision.

¹⁹See Liljencrants and Lindblom (1972), for example.

findings suggest is that the fewer phonological contrasts a language exploits (and accordingly, the more clearly defined the acoustic differences are between phonologically significant sounds), the greater is the potential for phonetic variation, both language-internally and between phonologically similar systems. On this basis, we might expect to observe a considerable degree of variation in the interpretation of high vowels across different languages employing a triangular 3-vowel system. In contrast, we predict that larger vowel systems — where an opposition between high and mid is typically exploited — will fail to accommodate the same level of phonetic flexibility. Assuming that each phonological category corresponds to a particular region of the vowel space, as already discussed, we may infer that the size of each acoustic target area should be inversely proportional to the size of the contrastive vowel set — that is, the larger the vowel system, the smaller the phonetic range for each contrastive sound. In general, this prediction is borne out by the empirical evidence, thus lending support to the notion of wide acoustic targets as a characterisation of the broadest phonological categories [A], [I] and [U].

Returning to the question of complement tiers, it is clear that this notion directly parallels the way that the more traditional idea of headship status affects the interpretation of an expression: if we compare [L,A] with its headless counterpart [I,A], we find headedness translating into the relative salience of the expression's colour property (in this case, palatality). It seems, then, that the phonological opposition encoded in (16a) is all but identical to that given in (16b) — in other words, that the concept of complement tier is, in fact, merely a notational variant of the established headship distinction.

(16)

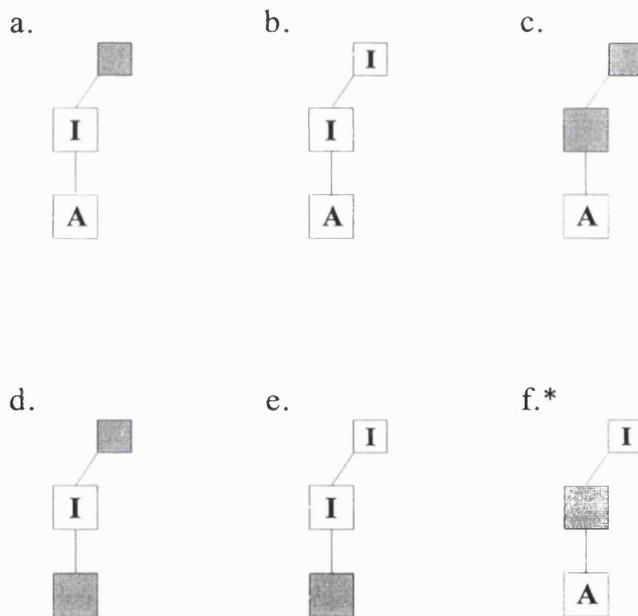
a. *complement tier*b. *headedness*

To some extent this is indeed a valid observation, in that the respective contributions of traditional headship and the notion of complement tiers to the encoding of lexical distinctions are largely the same. I aim to demonstrate below, however, that there are particular benefits — largely concerned with issues surrounding generative restrictiveness — to be gained from adopting the structure in (16a), these advantages becoming apparent when the idea of a complement tier is taken up in conjunction with the notion of element activation.

It is important to note that the addition of, say, an [I]-comp to a melodic expression does not constitute any increase in the number of *tokens* of the [I] element present in the structure. In other words, the introduction of a [comp] does not imply any kind of element stacking system, akin to that assumed in the standard Particle Phonology approach (Schane 1984a, 1995). In the latter, a potentially unrestricted number of tokens of any given prime could be employed in order to generate a potentially unlimited set of phonological contrasts (see discussion in §2.2.2). In theory, a grammar could therefore support the unlikely opposition between the expressions (IIIA) and (IIIIA), where the additional token of [I] in the second structure is intended to contribute to the greater salience of palatality inherent in that structure. In contrast, the proposed notion of complement tier closely reflects the head/complement relation as it is used elsewhere in phonological representation. For example, it is maximally binary; thus, in the same way that a nuclear head may license, at most, a single complement position, a melodic prime

such as [I] is similarly restricted to one complement. Furthermore, following the way in which a nuclear complement is dependent on the presence of a non-empty head position, we assume that an [I]-comp cannot be interpreted unless its head element is also interpreted. Hence, the structures in (17a) through to (17e) are well-formed, while (17f) is ungrammatical. This serves to highlight the asymmetric dependency which necessarily holds between a head [α]-tier and its complement tier. There is ample justification, therefore, for treating a complement tier not as an additional token of an element, but rather, as a controlled means of expanding the phonological properties of an expression's lexically specified head.

(17)



Assuming the template employed in (17) to be a suitable melodic configuration for ATR systems such as Maasai, we may now reinforce our earlier proposal that the option of licensing a complement belongs to the set of parametric choices controlling the shape of possible sub-segmental geometric structures. So, besides the potential for tier sharing and tier division, the internal geometry of expressions may also exploit the possibility of licensing a complement tier. I propose this option to be encoded via a parameter of the form **LICENSE [COMP] — YES/NO**, which is presented in such a way as

to restrict the number of complement tiers to one per language system. So, in the same way that a language's tier structure is permitted to contain only one reference to the [U] element, for instance, a vowel template can similarly make only a single reference to [comp]. Notice the impracticalities of allowing UG to recognize a battery of more specific parameters such as **LICENSE [I]-COMP — YES/NO**. First, this would allow for the generation of systems containing anything up to three separate complement tiers (i.e. one per individual resonance tier) — an undesirable outcome from the point of view of restrictiveness (a point to be illustrated in §3.2.4 with reference to model of vowel structure proposed in van der Hulst (1988)). Second, until the basic organisation of the three elements in terms of tier sharing/division has been settled in the language learner's grammar, the relevance or appropriateness of any parameter controlling the addition of an [α]-tier complement cannot be established. Instead, I propose a very general parameter such as **LICENSE [COMP] — YES/NO** to determine whether the tier structure is to be enhanced in this way. Following the selection of the 'yes' option, a further parametric setting will be required, in order to identify which of the resonance tiers will play host to the licensed [comp].

The addition of a complement tier, which may be viewed as a mechanism for enhancing what is a rather impoverished (i.e. basic A-I-U) system for generating vocalic contrasts, may be directly compared with the more established ET approach to melodic representation, where inherent dependency relations are assumed to be present from the outset. In the latter, what is required is, not a means of increasing generative capacity to match the empirical facts, but instead, a way of controlling the overgeneration of possible grammars that the headship model naturally produces in its unchecked form.

In van der Hulst (1998b) this is achieved via the postulation of 'governing restrictions' that place a ban on certain melodic fusion combinations. A similar approach is also adopted in the recent Government-based literature, where 'licensing constraints' perform an identical role. These constraints, as they are presented in Cobb (1997), for example, may take one of three possible forms:

α must be licensed(where α can be 'operators' or A, I and/or U) **α doesn't license β** (where variables can be A, I and/or U, and also β can be 'operators') **α must/cannot be a head**(where α can be A, I and/or U)

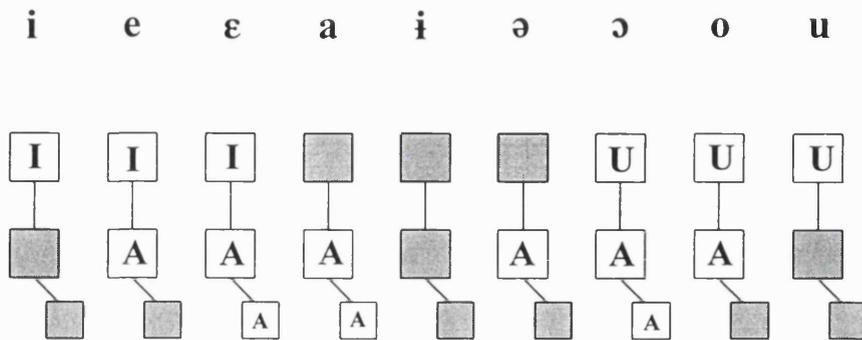
The degree to which these can collectively overgenerate typological possibilities is evident from a closer consideration of only one of the above. Using the formula *α must be licensed*, we produce seven different constraints, for instance, and predict each to be attested in one grammar or another. Coupled with a similar level of generative output derived from the other formulae given above, we arrive at an undesirably large set of typological options which is likely still awaiting empirical justification. Furthermore, given this sizable number of possible grammars, it is inevitable that some will include licensing constraints which are in conflict with each other. In principle, for example, we are unable to rule out a system in which *A must be licensed* and *A must be a head* can co-exist.²⁰

Let us now return to the case of Maasai illustrated above, where it is the shared [I]/[U]-tier that is selected for complementisation. However, the Maasai example may not represent the only option available to us with regard to the licensing of [comp]. It is an empirical question as to whether it is only the colour tier that can potentially license the complement tier, or whether the [A]-tier may also be able to do so. For reasons to be discussed in §3.3.2, an [A]-comp is predicted to be far less likely to occur than an [I/U]-comp. However, there appears to be no motivation for entirely ruling out the possibility of a complement tier being licensed by the [A]-tier. Indeed, a structure which exploits this configuration is required in those (relatively rare) systems that employ a three-way contrast among central vowels, where **a**, **ə**, and **i** are lexically contrastive. The Austronesian language Cham (spoken in Vietnam) provides an illustration of this tier arrangement, in which there is a colour-aperture split but the [A]-tier, rather than the [I/U]-tier, licenses a complement. (18) demonstrates the generative capacity of this

²⁰See Cobb (1997), who acknowledges this issue of typological overgeneration with respect to licensing constraints.

structure, which suitably describes the set of vocalic oppositions exploited in the example language, Cham.

(18)



A word of explanation is perhaps in order here, to clarify the reasoning behind the structure in (18). Once again, a particular melodic configuration is constructed by the language learner in such a way as to accommodate the full set of phonological oppositions in the most efficient manner possible — that is, by invoking a minimum amount of structural complexity. Despite the apparent ATR contrast in mid vowels (e.g. ATR *e* versus non-ATR *ε*), the motivation for positing a colour tier complement is relatively weak, since there is no parallel distinction exploited in high vowels (between *u* and *ɔ*, for example). As an alternative approach to the representation of the *e/ε* opposition, I shall suggest that, rather than choosing to enhance palatality in the description of the sound *e*, we may instead expand the aperture dimension in the phonetically 'lower' vowel *ε*. This is achieved by allowing the [A]-tier to license a complement.

Further support in favour of this move comes from the set of contrasts exhibited in Cham between the central vowels *i*, *ə* and *a*. In all of the vowel systems considered above, we have allowed for the possibility of phonetically interpreting a phonologically 'empty' slot, which typically translates into a schwa-like central vowel. Clearly, if a system does exploit this representational possibility, then an upper limit of one such vowel must obtain, since any relevant opposition is encoded in terms of 'empty' versus 'non-empty'. So, we can easily find languages which make a distinction between two

central vowels — **i** versus **a**, for instance. In the case of Cham, however, there are two potential candidates for the phonologically empty slot, **i** and **ə**, one of which must be expressed in terms of non-empty melodic structure. In view of the height difference between these sounds, it seems reasonable to attempt a distinction in terms of the presence/absence of the aperture element [A]; specifically, I assume [A] to be present only in **ə**, the lower of the two. Finally, we may choose to enhance the aperture dimension of **ə** by allowing [A] to license a complement; with no contribution from either of the colour elements, we then arrive at a lowered version of **ə**, which corresponds to the low vowel **a**.

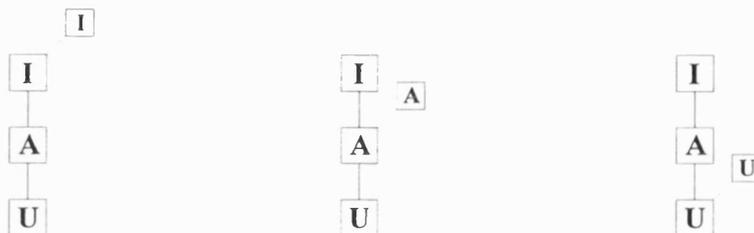
The discussion in chapter 5 will investigate the reasons behind the relatively marked status of the configuration used in (18).²¹ The same discussion will also serve to highlight the advantages that may be gained from assuming the notion of complement tier as a means of element enhancement, rather than the more conventional formulation of melodic headship. In anticipation of these arguments, however, let us consider one clear difference between the two approaches, since it relates directly to the question of markedness just raised. A lack of equivalence between the concepts of headedness and complement tiers can be seen in the characterisation of, for instance, the canonical 5-vowel system found in Spanish and numerous other (unrelated) systems. As (11) illustrates, the redundant status of licensed complements is reflected in their absence from the tier geometry of these languages — indeed, the simplicity of the melodic structure of these systems mirrors their relatively unmarked status cross-linguistically. On the other hand, if the role of headship is maintained as a valid one, then every element must be specified as either a head or a dependent, even in those systems where this information is phonologically redundant. Within the present model, therefore, complexity of structure can be indicative of relative markedness, as a result of encoding headship in a representationally dynamic way. Recall that a similar correlation between complexity and markedness was highlighted during the earlier discussion of tier geometry.

As a further illustration of the association between structural complexity and typological markedness, I introduce some relatively rare vowel inventories that are

²¹See also the analysis of Wolof vowel harmony in Backley (1997).

characterized by the addition of a complement tier to a 3-tiered structure. If each resonance element occupies a separate melodic plane, and each may potentially license the complement tier, then a three-way typology is predicted by the model, as illustrated by the example languages here:

- (19) a. Alsatian German b. Akha c. Stockholm Swedish

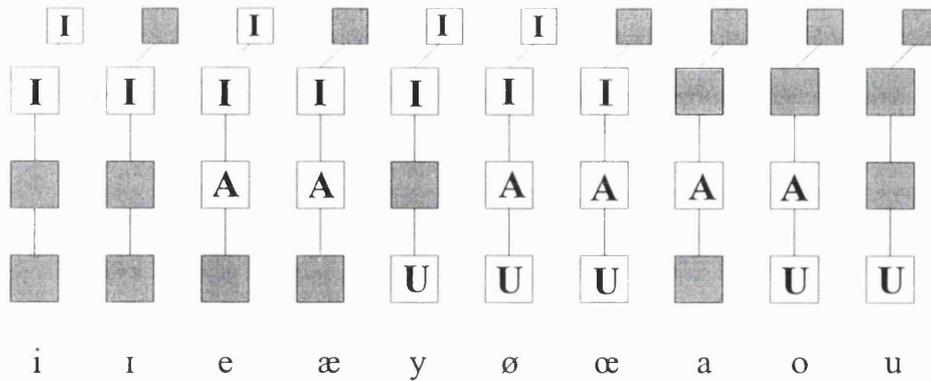


In a language employing the structure in (19a), we predict an asymmetry with respect to the behaviour of the two tonality elements [I] and [U] — which is indeed observed in the vowel system of Alsace German. Specifically, the contrast encoded by the [I]-tier complement creates an ATR opposition in palatal vowels — $i \sim \mathbf{i}$ and $e \sim \mathbf{\ae}$ ²² — but not in rounded vowels ($*\mathbf{u} \sim \mathbf{u}$). The sub-segmental melodic structure employed in this language generates the following inventory:²³

²²The sound $\mathbf{\ae}$ is described in Keller (1961) as 'a very advanced low-tongue vowel', thereby justifying its inclusion in the palatal set. In Strasbourg it is pronounced as a slightly less open $\mathbf{\epsilon}$.

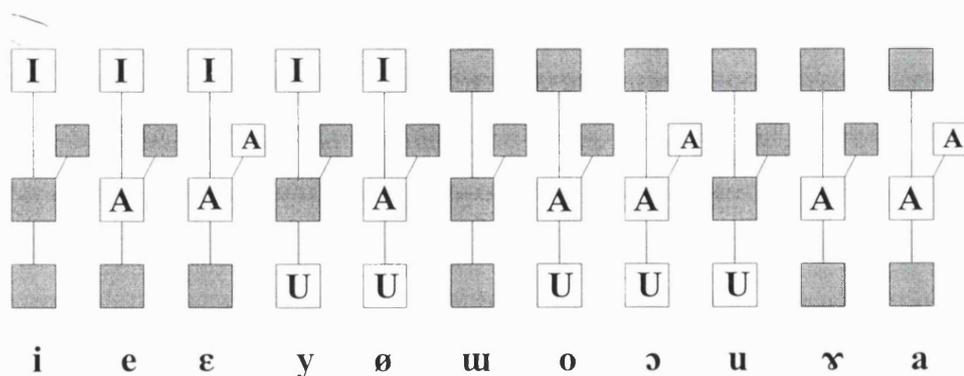
²³While Lass (1984b) reports an additional member $\mathbf{\epsilon}:$ in the long vowel inventory, it is argued in Keller (1961) that this vowel in fact corresponds to a diphthong of \mathbf{ai} or \mathbf{ei} quality throughout most of Alsace.

(20)



While Alsatian German augments the range of palatal contrasts via the licensing an [I]-tier complement, Akha²⁴ exploits an [A]-comp to enhance the aperture dimension instead. The configuration in (19b) allows all three resonance elements to combine freely, and additionally, creates a 3-way height opposition **ɯ**~**ɤ**~**a** in central vowels. I assume **ɯ** to be the manifestation of an empty nuclear position, which is lowered by the activation of [A] to give a mid back unrounded expression **ɤ**. Further lowering is then achieved by the additional activation of an aperture complement, resulting in a maximally open vowel **a**. The inventory of Akha is generated as follows:

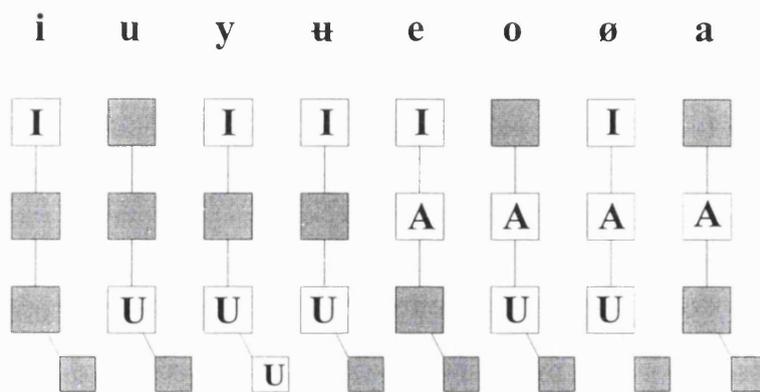
(21)



²⁴A language of the Burmese-Lolo group, spoken in Laos, Eastern Burma and Thailand. See Lewis (1968).

This system may be compared with a geometric structure of similar complexity, in which the third possibility in (19) — an [U]-tier complement — is exploited. The configuration given in (19c) defines the vowel inventory of (Stockholm) Swedish, which distinguishes between three high rounded vowels $u \sim y \sim \text{ʉ}$. These contrasts are obtained as follows:²⁵

(22)



From the present investigation of tier geometry and the licensing of complement tiers, we arrive at a position where we are able to recognize a particular geometric structure for individual languages — established according to a restricted set of empirically motivated choices — which may be seen as a kind of **melodic template** from which we derive the full set of vowel oppositions for any given language. In other words, the language-specific template takes on the role of delimiting the range of contrasts that may be exploited within nuclear positions. In §3.3 I shall embark on a more detailed investigation into the melodic template and its behaviour with respect to other aspects of the grammar. This is preceded, however, by a brief discussion of the model of vocalic structure presented in van der Hulst (1988b). Despite notational differences, the model of Tier Geometry just outlined has much in common with van der Hulst's proposals; for this reason, I consider some of the relative advantages and drawbacks of each approach.

²⁵The variety of Swedish spoken in Stockholm differs from the standard system in its lack of an $e \sim \epsilon$ opposition. See Sigurd (1965).

3.2.4 A Dependency Phonology alternative

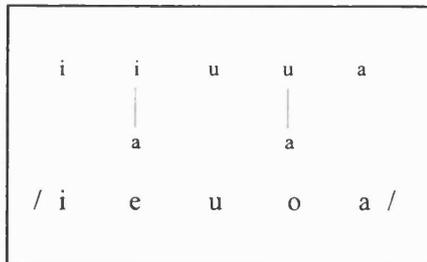
The geometric model of vowel structure presented in van der Hulst (1988b) is described by the author as a development of both Dependency Phonology (see references in §2.2.3) and Government-based Phonology (§2.2.4). In view of these theoretical origins, we might expect — and indeed, we can identify — at least some degree of common ground shared between this earlier model of van der Hulst and my present proposal. Both, for example, recognize the three single-valued 'corner' primes A, I and U as the basic units of vowel melody. Furthermore, both generate contrasts involving other (i.e. non-corner) vowels by means of the combination of these basic primes. However, the precise way in which primes are permitted to combine marks a clear point of divergence between the two approaches.

Van der Hulst remains loyal to the standard DP model by assuming that A, I and U combine in an asymmetric fashion. So, in any complex expression, one element is designated the head of that expression, and 'governs' one or more dependent elements with which it co-occurs. The asymmetry of this dependency relation manifests itself in the relative salience of the head element's acoustic properties within the resulting compound. That is, an element's contribution to the overall interpretation of a complex unit is determined partly by that element's status as a head or a dependent. A similar position with respect to element fusion also obtains in Government-based models, for which the term *inherent* dependency (Ewen 1995) provides a suitable description. This compares with a rather different kind of dependency relation adopted in the present proposal. Here, the relation holding between different primes — or more accurately, between the tiers housing those primes — may be referred to as a *structural* dependency, more akin to the *dependency of occurrence* that is developed in a number of feature geometry models of the late 1980s (see §3.2.1 for discussion), where the precise interpretation of an element, or its contribution to a complex expression, is not affected by the dependency relation.

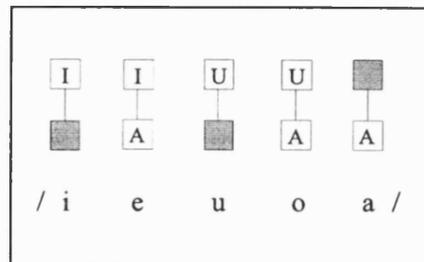
To illustrate the effects of either maintaining (as in van der Hulst (1988b)) or rejecting (as in Tier Geometry) inherent dependency between melodic primes, let us consider how the unmarked 5-vowel system may be represented under each approach.

Superficially, the respective configurations appear fairly similar:

(23) a. van der Hulst (1988b)



b. Tier Geometry



However, (23a) incorporates an asymmetric dependency relation which encodes the relative saliency of the primes *i* and *u* in mid vowels. This is reflected in the interpretation of these vowels as 'high/tense' *e* and *o*, rather than as the lax equivalents *ɛ* and *ɔ*. Yet it would seem that the inclusion of this dependency relation is to some extent redundant, in view of the fact that the system does not rely on this asymmetry for contrastive purposes. It could be argued that the dependency relation is there primarily as a means of gaining a more precise description of the phonetics. This line of argument, however, leads us to the question of what the melodic configuration of a language with lax mid vowels, such as Zulu /*i* *ɛ* *u* *ɔ* *a*/, would look like. If Zulu were described using the same basic structure — but crucially, without exploiting any inherent dependency relations (which I suggest would be the most likely approach²⁶) — then it would be tempting to conclude that the system /*i* *ɛ* *u* *ɔ* *a*/ must be more marked than /*i* *e* *u* *o* *a*/, given that the former requires an additional structural mechanism (i.e. the $\alpha \rightarrow \beta$ relation) in its construction. This prediction will, of course, need to be matched against the empirical evidence.

Both models, tier geometry (TG) and van der Hulst (1988b), recognize the need to place restrictions on which elements may co-occur. TG starts out with the minimalist assumption that no elements can combine (i.e. the three elements reside on a single resonance tier), and then proceeds with positive statements, which are established during

²⁶This assumption is based on the 3-way contrast of standard Dependency Phonology between *e* (*i*→*a*), *ɛ* (*i*,*a*) and *æ* (*a*→*i*).

early acquisition, determining which element(s) may separate from this base tier and become available for element fusion (§3.2.2). In contrast, van der Hulst implies a quite different learning process, given that his restrictions on element fusion are typically expressed as negative conditions: for example, the 5-vowel system in (23a) is constrained by the condition 'a cannot govern *i* or *u*'.²⁷ The implication, therefore, is that a relatively large set of expressions is available initially to the language learner, which is then reduced as the relevant restrictions on element combination are established as part of the grammar. This approach to the delimitation of fusion possibilities is explored in some detail within a Government-based model in Cobb (1997).

Returning to the question of a theoretical cross-over between TG and van der Hulst (1988b), it is noteworthy that both opt for a system of vocalic contrast containing neither an ATR prime nor a centrality prime. Van der Hulst identifies phonological ATR (that is, potentially contrastive ATR) with the presence of dependent *i* in the melodic representation. As just outlined in the previous section, on the other hand, TG introduces the notion of complement tier as a means of encoding tongue root distinctions. The possibility of enhancing the tier-geometric structure by the addition of [comp] clearly serves to boost the generative capacity of the model to a more realistic level, thus fulfilling a role similar to that carried out by the inherent dependency relation of van der Hulst. By way of a somewhat incongruous comparison, the presence of [comp] in a TG structure may be equated with the *suppression* of van der Hulst's redundancy rule given in (24).

(24) *Universal Redundancy Rule*

$$f \rightarrow \begin{array}{c} f \\ | \\ f \end{array}$$

This rule assigns a dependent element identical to the governor, except in cases where a language supports a contrast between *f* and (*f*→*f*). So in the vowel system of (23), the

²⁷Using van der Hulst's proposed geometric structure, this dual condition may be collapsed into the single statement 'a cannot govern *y*', where *y* is a node dominating both *i* and *u*.

three corner vowels will in fact be represented as ($u \rightarrow u$) etc.; this permits a 'full' interpretation of the relevant prime, given that some of an element's realisational properties are sensitive to its headship status (e.g. u as a head = velar constriction, while u as a dependent = rounding). Clearly, tongue root harmony systems provide a case where f and ($f \rightarrow f$) are potentially distinctive, since oppositions such as $i \sim \mathbf{i}$ and $\mathbf{u} \sim \mathbf{u}$ are created in precisely this way. Equally clear is the equivalence of the structural tools employed by the two approaches for encoding this kind of contrast: aside from notational conventions, there appears little to separate (25a) from (25b).

(25) a. van der Hulst: $\mathbf{u} \sim \mathbf{u}$

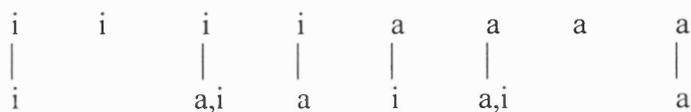


b. Tier Geometry: $\mathbf{u} \sim \mathbf{u}$

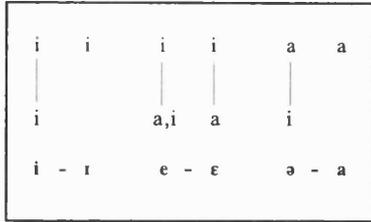


However, the fact that TG allows for the licensing of only a single complement tier in any one melodic template, whereas van der Hulst permits the opposition illustrated in (25a) to apply to any element or element compound (subject to any language-specific restrictions on combinations), entails a significant difference in the respective output capacities of the two models. To demonstrate, let us compare the range of expressions generated by each, when only two elements are involved. While TG produces a maximum of five contrasts, van der Hulst can create 8-way opposition:

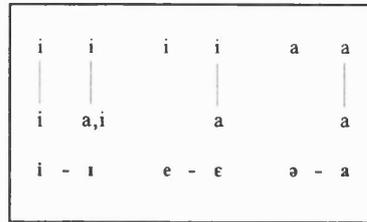
(26) Van der Hulst:



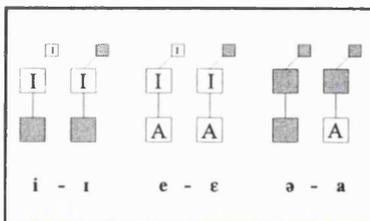
(27) a. Van der Hulst:
i-based system



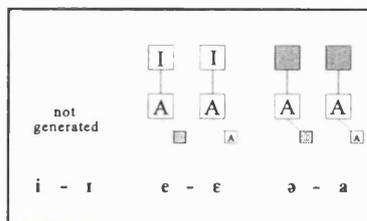
b. Van der Hulst:
a-based system



c. Tier Geometry:
[I/U]-tier comp



d. Tier Geometry:
[A]-tier comp



Although the two models appear well matched in terms of their descriptive potential, it is significant to note TG's inability to generate a tongue root contrast in high vowels in those systems exploiting an aperture tier complement (27d). As I shall demonstrate in chapter 5 below, this melodic template is appropriate for the capturing the behaviour of vowels in those languages typically analysed in the literature as involving [-ATR] harmony. This set includes Yoruba, Chukchee, Wolof and Nez Perce, all of which have vowel inventories lacking the contrasts *i*~*ɪ* and *u*~*ʊ*. Van der Hulst (1988b) describes several of these same systems using an *a*-spreading analysis and a representation system based around that shown in (27b). He is forced, however, to make use of a somewhat arbitrary stipulation which restricts melodic complexity: specifically, his complexity condition imposes a ban on expressions containing two dependent elements, thereby eliminating the non-ATR high vowels from the contrastive set.

What this comparison indicates, above all else, is the clear difference in emphasis between the two structural models. On the one hand, TG may be viewed primarily as a generative device, the principal aim of which is to create well-formed vowel systems to

the exclusion of all non-attested ones. Consequently, the opposition 'gap' just observed cannot be ignored by the grammar. In van der Hulst's model, on the other hand, such instances of overgeneration do not present crucial problems and can be resolved on a fairly *ad hoc* basis, since the author's primary concerns would appear to be centred rather on the description of a much broader range of languages and on the more subtle differences separating the phonological behaviour of these languages (e.g. issues relating to neutral segments, parasitic harmony, and so on). To permit a more refined analysis, van der Hulst employs a number of additional representational tools which are not available to TG. Some of these are outlined here with reference to his analysis of Kpokolo.

A challenge for both structural models is presented by the 13-vowel system of Kpokolo, an ATR harmony language discussed in Kaye *et al.* (1985). In van der Hulst's approach the vowel set is represented as follows:

(28)	ATR:	/	i	e	ɨ	ə	u	o	/	
			i	i	u	u	u	u		
			i	a,i	i	a,i	u,i	a,u,i		
	non-ATR:	/	ɪ	ɛ	ɨ	a	ɜ	ʊ	ɔ	/
			i	i	u	a	u	u	u	
				a			a	u	a,u	

Immediately apparent from (28) is the presumed overgeneration that must inevitably result from the possibilities for element combination which are exploited in this system. On the basis of the representation for **o**, there appears no limit to the number of dependent elements sharing the same head within an expression. This freedom of occurrence therefore allows for the potential generation of many expressions that are not contrastive in the language — such as (a→a) and (i→u,i). Some of these will be ruled out by a government restriction (e.g. 'i cannot govern u'), while others would seem to remain untreated.

So Kpokolo provides us with further evidence for the relatively low priority given to generative restrictiveness in the van der Hulst model. As I have already stressed, the emphasis is placed instead on capturing phonological detail that lies beyond the purely

contrastive. To accomplish this, additional tools are incorporated into the framework, as the author demonstrates in his discussion of Kpokolo. Aside from the governing restrictions already mentioned, van der Hulst allows for the possibility of an element switching its status from head to dependent (cf. arguments presented in §4.3.3.1); this comes about as a way of accommodating the harmonic spread of the *i* element, which cannot be governed by *a*. A degree of underspecification also features in his analysis, derived from the use of the empty node *y* as a distinctive unit. The value of *y* is then filled in via the postulation of an ambient element (*u* in this case), thereby serving as a language-particular redundancy rule.

The benefits of employing a more powerful descriptive apparatus are clear from the way in which van der Hulst's model is able to capture (i) the full set of surface vowels and (ii) the harmonic patterning observed in this large and relatively marked system. In comparison, the TG model (with its single complement tier) significantly undergenerates — most notably in its failure to describe the $\text{ə} \sim \text{i} \sim \text{ɪ} \sim \text{ɜ}$ opposition in central vowels. Even if we were to relax the restriction of allowing only a single [comp], and instead employ a melodic template in which both the [I/U]-tier and the [A]-tier were each able to license their own respective complements, then we would still be unable to encode this 4-way split in central vowels.

Instead, I offer a tentative TG solution to the Kpokolo case which treats this system in the same way as a 'standard' 10-vowel ATR harmony language such as Bari. This means that the split between ATR and non-ATR is symmetrical, in that each of the five non-ATR vowels shown in (29) has an advanced counterpart with which it alternates under harmony conditions.

- (29) ATR: i u e o ə
 non-ATR: ɪ ʊ ɛ ɔ ʌ

Notice that the ATR version of **a** is a schwa, which I shall argue in §4.5.4 below is to be represented as the interpretation of an empty nuclear position. This leaves the remaining central vowels $\text{i} \sim \text{ɪ} \sim \text{ɜ}$ to be accounted for. From the limited amount of data available, it appears that these are all non-contrastive within the system. More specifically, they are all reduction vowels resulting from a process of unrounding which is active in the

phonology of Kpokolo: the relevant alternations are $u \sim i$, $u \sim i$ and $ɔ \sim ɜ$. On the basis of the non-lexical status of these three vowels, I suggest a provisional TG analysis which views *all* central vowels in this system as the manifestation of a melodically unspecified position, with any discernible differences in quality between them as being purely phonetic in nature.

Whether these suggestions can form the basis of a viable analysis of the Kpokolo vowel system is, admittedly, highly questionable. For the purposes of the present discussion, however, the issue is also relatively trivial. More important is the way in which the Kpokolo example highlights an underlying difference in approach between the two models of vowel structure being compared. The emphasis on generative restrictiveness in TG prevents the model from making appeal to the likes of ambient elements and additional distinctive nodes such as y . Similarly, it restricts the way that the asymmetric fusion of elements can come about — namely, by allowing no more than a single [comp] in any one language. Consequently, its domain of description is also restricted, in this case to the range of lexically distinctive sounds. In contrast, van der Hulst (1988b) employs headedness relations between elements, thereby creating a model with significantly more expressive power. This enhanced capability allows even the largest of vowel systems to be described with relative ease; furthermore, it predicts a range of facts relating to phonological behaviour that lie beyond the descriptive scope of TG. These benefits, in terms of an explanatory model of vowel structure, are gained by adopting a somewhat less rigid view of generative restrictiveness.

3.3 The role of licensing in melodic structure

3.3.1 Element activation

In §3.2 it was proposed that parametric settings controlling tier geometry and the licensing of a complement tier allowed us to recognize a particular geometric structure for individual languages that may be seen as a kind of **melodic template** from which we derive the full set of vowel oppositions for any given language. The same view is

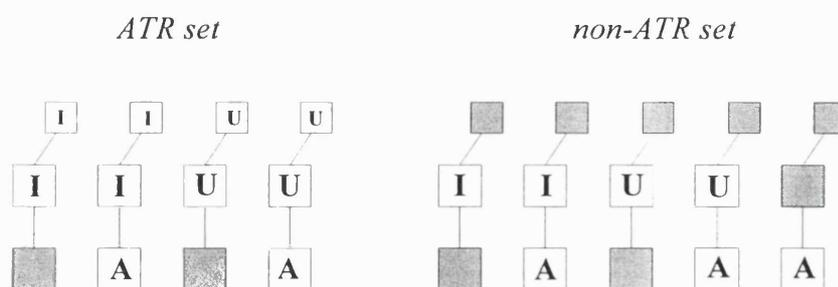
maintained in Backley and Takahashi (1996), where it is further proposed that the melodic template is actually *present* under each nuclear slot, in the form of a full set of elements. I shall follow this latter assumption throughout the remainder of this discussion, thus forcing a radical revision of the way in which lexical oppositions are expressed. If an element template, such as the one shown in (17), contains a full set of elements and resides under each nuclear slot, then it is clearly inappropriate to maintain the conventional approach to melodic opposition, which is captured in terms of the presence vs. the absence of particular elemental material. Instead, the ubiquitous presence of a prime forces us to investigate an alternative means of encoding lexical contrast, which I express in terms of element activation.

If we assume a full set of melodic primes, or elements, to be licensed by each nuclear position, then clearly we can no longer rely on the simple presence of particular elements as the basis for determining lexical contrast. Instead, I shall claim that any individual element contributes to the overall interpretation of an expression only if that element has been activated; inactive elements fail to be interpreted, and are therefore only latently present in the structure (the shaded boxes in (15) represent inactive elements). By what means, then, does an element become active? I propose that activation is essentially a lexical instruction. Thus, the melodic properties of a morpheme (which are, of course, idiosyncratic) are specified in terms of a series of activation codes or 'instructions' occurring at different points throughout the length of the phonological string. So, the vowel in the English word *foot* is represented in the lexicon by the single instruction **ACTIVATE [U]**. On the other hand, a melodically complex expression, such as a front mid vowel, is encoded lexically by means of (at least) two simultaneous activation instructions, **ACTIVATE [I]** and **ACTIVATE [A]**.

Having argued for a rejection of the conventional view of element headship, I consequently deny the lexical vocabulary the capacity to express anything other than the simple active or inactive status of individual melodic units. The instruction **ACTIVATE DEPENDENT-[A]**, for example, does not constitute a well-formed component of the grammar. Yet we must be allowed to incorporate the set of melodic oppositions which refer to the unit labelled [comp], in order to include the kinds of tongue root contrasts we have observed in ATR languages such as Maasai. Within a system of element activation,

the representation of ATR may be captured in much the same way as other melodic properties are described — by specifying an active [comp] as part of the phonological composition of a vowel. To illustrate, let us return to the representation of Maasai vowels already discussed, where we find that the two harmonic sets, ATR and non-ATR, are structurally distinct — they are identified by an active and inactive complement tier, respectively. This is shown in (30).

(30)



Accordingly, we expect the lexical specification of the vowel *i*, for example, to contain the instruction **ACTIVATE [COMP]**, which is lacking from the lexical description of this vowel's non-ATR counterpart *ɪ*.

I have already remarked on a particular feature of the ATR property in Maasai, such that, whenever it is present in a morpheme, its interpretation is extended to encompass the remaining vocalic expressions within the same word domain too. In other words, the language exhibits dominant ATR harmony. I suggest that this harmonic behaviour may be formalised by referring to the same operation **ACTIVATE [COMP]**, but by ruling that, in the case of Maasai and similar harmony systems, this instruction be specified at the level of the prosodic word. Indeed, I claim that it is this word-level activation of [comp] which gives Maasai its particular harmonic characteristics. The issue of wide scope (i.e. prosodically related) activation will be the subject of a number of analyses to be offered in later chapters.

In chapter 4 I focus on the question of ATR harmony, and discuss the advantages in accounting for the phenomenon in terms of [comp] activation, rather than by means of the established Element Theory approach employing head alignment (Harris and

Lindsey 1995) or H(ead)-licensing (illustrated in Cobb 1995). For the purposes of the present discussion, however, let us simply note the way in which lexical activation may be invoked as a very general mechanism for specifying melodic descriptions. As Backley and Takahashi (1996) claim, the general lexical instruction **ACTIVATE** [α] may apply to any of the resonance elements [A], [I] or [U], either within the scope of a single nucleus or across a wider domain. In the latter case, harmonic extensions involving, for example, palatality or rounding, are predicted to occur. Also, the lexical instruction may be equally applicable to other units of the melodic structure, such as [comp]; and again, the harmonic behaviour of active [comp], or ATRness, can be captured in a uniform manner. The table in (31) suggests a range of harmonic patterns that could be accounted for in terms of this single structural mechanism.

(31) **ACTIVATE** ' α '

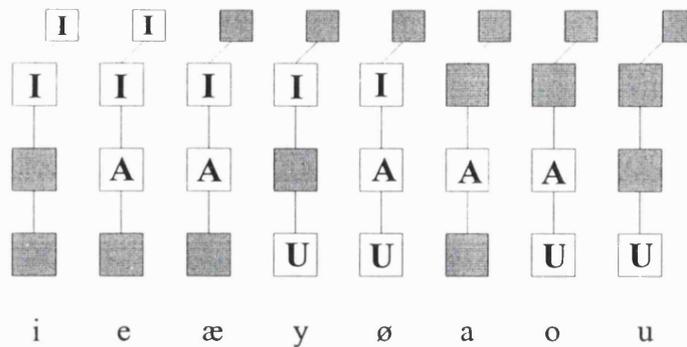
Type of harmony	Alignment target
palatal harmony	[I]
rounding harmony	[U]
tongue root harmony	[comp]
height harmony	[A]
nasal harmony	[L] ²⁸

A description of palatal harmony — as found in Finnish, for example — will typically proceed by identifying a word-level instruction **ACTIVATE** [I]. Using the same melodic template proposed for the vowel system of Alsatian German in (19a) above, the set of contrasts exploited in Finnish is represented as follows.²⁹

²⁸See Nasukawa (1995), who argues for the representation of nasality as the [L] element.

²⁹Although this point is not central to the present illustration of palatal harmony, I propose that the Finnish system of contrasts is constrained by Licensing Inheritance (to be discussed in §3.3.2 below). Specifically, if [I] licenses a [comp], then there remains sufficient licensing potential to sanction only one further dependent (= the [A]-tier). Without licensing a [comp], on the other hand, [I] can dominate both the [A]-tier and the latter's dependent, the [U]-tier too. That is, [I] can license,

(32)

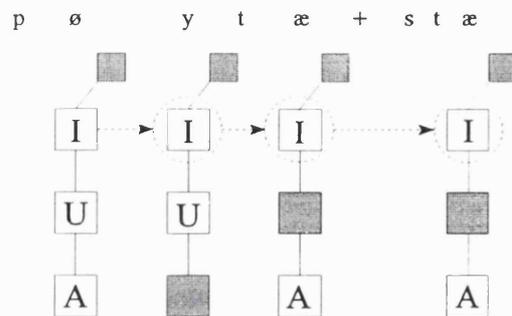


The front vowels { æ y ø } and the back vowels { a o u } cannot co-occur in native Finnish words; the two remaining vowels { i e } are neutral to harmony and behave transparently. What we observe is regular agreement in terms of the front~back division within the word domain (which includes stem+suffix structures). This renders the following forms grammatical with respect to frontness harmony:

- (33) a. $\text{pøytæ} + \text{stæ}$ 'table (relative)'
 b. $\text{pouta} + \text{sta}$ 'fine weather (relative)'
 c. værtinæ 'spinning wheel'

(33b) gives an example of a back vowel word, while (33a) and (33c) show the effects of harmonic agreement with respect to palatality — that is, [I]-ness. Additionally, the form værtinæ 'spinning wheel' demonstrates the transparency of the neutral vowel i . I shall propose that the instruction **ACTIVATE [I]** is specified as a word-level property in this language, whereas the instruction **ACTIVATE [COMP]** is restricted to the lexical (i.e. segmental) level of contrast. This identifies only the vowels { æ y ø } as harmonic triggers, each allowing its specification for [I]-activation to extend throughout the prosodic word domain. The basic mechanism of wide scope activation is illustrated in (34):

(34)



Here the word-level marking for 'frontness' radiates throughout the domain, allowing the selection of the palatal alternant of the elative suffix *stæ~sta*. Besides this *æ~a* alternation, two other front~back alternations *y~u* and *ø~o* are also observed. Together they create a regular harmonic pattern that may be characterized in terms of the activation of the [I] element.

Cases of rounding harmony will, of course, receive a parallel treatment within the tier geometric model, the only significant difference being that a word-level instruction **ACTIVATE [U]** will be involved, instead of one referring to [I]. The Altaic system Kirghiz provides a suitable example, where the following data show how the presence of rounding (or [U]-ness) in verbal suffixes can be determined by a round vowel in the stem. This language uses the same system of vowel contrasts as Turkish, which is outlined in (13) above.

- (35) a. *kil + di* 'do (past definite)'
al + di 'take (past definite)'
- b. *tut + du (= tuttu)* 'hold (past definite)'
bol + du 'be (past definite)'

In the (35b) forms, the word-level specification of [U]-activation manifests itself in the suffix vowels, highlighting the regular alternation *u~i*. This reflects a more general pattern involving other vowel pairs, such as *y~i*, and can be represented in the same way as palatal harmony was illustrated in (34) — namely, by an extended span of element activation along the relevant melodic tier. Somewhat predictably, cases of vowel height

harmony, represented by a word-level instruction **ACTIVATE [A]**, are subject to a similar treatment. The reader is referred to §5.3.4, where an example of [A]-harmony in Chicheŵa is offered. Additionally, the data analyses in chapter 5 will be devoted to cases of vowel harmony in those languages where an [A]-tier complement is identified as the harmonically active unit. While **ACTIVATE [A]** and **ACTIVATE A-[COMP]** will both be shown to be involved in contrasts based primarily on vowel height, it will emerge that these two typological possibilities are nevertheless distinguishable on the basis of (i) the size and shape of the respective vowel systems generated and (ii) the harmonic alternations derived from the status of the [A]-complement tier as either active or inactive.

So, the analyses of harmonic phenomena to be offered in chapters 4 and 5 will serve to demonstrate the very general applicability of the activation mechanism. On the one hand, it is appropriate to the description of minimal lexical oppositions, such as the vowel contrast observed between the strings *foot* and *fit*. The melodic difference between these two morphemes may be described by positing differing activation instructions in their respective lexical forms. The fact that this lexical difference is confined to a single nucleus is, we may assume, an indication of element activation having been specified at the lowest level of the prosodic structure. So, activation at the level of the skeletal tier (i.e. that consisting of the terminal units of the prosodic tree) may be used to formally encode melodic information conventionally referred to as 'segmental'.

On the other hand, I have just illustrated that the activation mechanism also appears suitable for capturing the kinds of melodic effects observed across larger domains such as the prosodic word. I shall claim that instances of wider scope element activation follow from the relevant lexical instruction(s) being specified at higher levels of the prosodic structure, anchored to constituents such as the syllable, the foot, and so on. This assumption is by no means an innovative step; indeed, the essence of this notion may be traced back to a period which pre-dates even the earliest autosegmental models of the 1970s — to the work of J.R. Firth and others associated with the London School of Linguistics. Firth's theory of Prosodic Analysis³⁰ developed in resistance to the prevailing

³⁰See Firth (1948) for an insight into the motivation behind this theoretical stance. The reader is also referred to S.R. Anderson (1985) for a short introduction to Prosodic Analysis, while a more detailed discussion is found in Palmer (1970).

view that it was the phoneme which occupied centre stage in phonological analysis. In reaction, Firth suggested that some melodic properties were distributed in a way that indicated their association not to individual segments, but to larger units of structure such as syllables. Such properties would then manifest themselves across these larger structures via some mechanism of multiple association such as 'spreading'. Given that a similar approach had already been established with regard to features of tone and stress, the developments undertaken by the London School during the 1940s and 1950s consisted largely of transferring this idea of suprasegmental representations to the domain of what is now termed melodic organisation.

A similar view has also been adopted in van der Hulst and Smith (1982a), where it is shown how autosegmental rules of association (which link autosegmentalized features to positions on the skeleton) must refer to various prosodic domains in their description. Their proposals allow for the possibility of a given binary feature being simultaneously represented at more than one prosodic level. For example, a spreading feature [+F] may be specified as a word-level autosegment, in which case its properties will be observed in all the relevant segmental positions within that domain. In order to allow for the presence of neutral or opaque segments, however, the opposing value of the same feature [-F] may also be specified at the segmental level; this has the effect of blocking the association between [+F] and particular segments in the string.

Returning to the present discussion, I shall claim that the general principle of prosodic domains (though not the mechanism of spreading, by which multiple association is achieved) employed by van der Hulst and Smith may be successfully incorporated into a representational model which relies on the idea of element activation as the basis for phonological contrast. By developing the relationship between melodic properties and the various units of the prosodic structure, we may capture the effects of harmonic agreement without having to make any reference to the operation of autosegmental spreading which characterizes the majority of current representational models. I shall propose that the absence of any 'action-at-a-distance' mechanism affords a rather more unified approach to the representation of melodic material, in that the single lexical instruction **ACTIVATE** [α] may prove sufficient on its own to encode a range of oppositions and melodic events which the phonological literature has generally deemed necessary to sub-divide into

broad categories such as *segmental*, *harmonic* and *autosegmental*.

Under these proposals, the notion of an autosegmental representation is only partially retained; while we may still refer to the autonomous behaviour shown by individual elements (illustrated by the fact that each may reside on its own melodic tier, and may be accessed independently by phonological processes), we can also observe something of a shift in approach that may be most appropriately described as a revival of the spirit of 'segmentalism'. While rejecting the traditional conception of a neatly defined, self-contained unit of melody such as 'segment' — and thus, avoiding a wholesale return to segmentalism — it is clear that the proposed view is sympathetic to the linearity that characterizes most segmental models. Underlying the idea of element activation is the assumption that every layer of the melodic structure consists of a linear string of phonological slots (in which active elements may or may not be specified), and that the linear ordering of activation instructions anchored to such slots is of central importance to phonological processing.

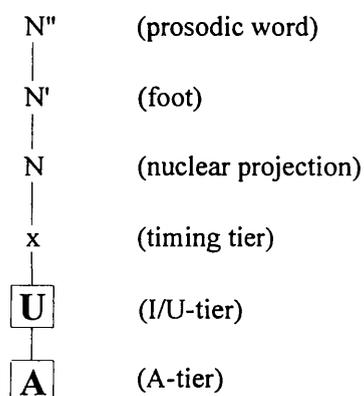
The analyses to be offered in later chapters will provide an insight into the way that lexical activation may be developed to a point where it can effectively replace the notion of autosegmental spreading. Before moving on to the analysis of specific language data, however, I demonstrate how the notion of element activation interacts with very general principles of licensing. I show how this offers an explanatory basis for some of the distributional patterns and alternation phenomena that we observe cross-linguistically.

3.3.2 Licensing Inheritance

I have claimed above that the vocalic contrasts observed in any one system may be accounted for, at least in part, by the controlled organisation of melodic tiers. In effect, a particular tier configuration encodes the melodic 'identity' of a language's vowel system, and hence, must be fixed for all nuclear expressions within the lexicon of that language. Let us now consider how a melodic template fits into the phonological structure as a whole. We may assume that, for every language we must recognize a phonological hierarchy of the following kind, where a timing tier mediates between the prosodic

structure and a fixed melodic structure. The geometry given in (36) is appropriate to a 5-vowel system such as Hawaiian or Spanish.

(36)



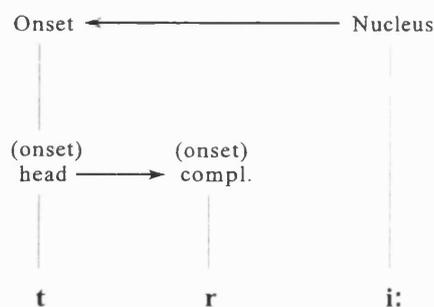
In general, I assume that prosodic units are characterized largely with reference to their relative position in the hierarchical structure, rather than by virtue of any intrinsic properties. This is emphasized by the X-bar labelling employed in (36), where a constituent is identified according to its proximity to the 'timing' tier. Here, I shall argue that, in a similar way, the behaviour of melodic units (specifically, the tiers on which those units reside) is also sensitive to the location of those units within the hierarchy. Furthermore, I wish to claim that it is the same structural property — that of phonological licensing — which is responsible for constituent organisation in both melodic and prosodic sub-structures. Here I shall show how the general notion of licensing, and more specifically, the concept of licensing paths (Harris 1992), may be employed as a means of uniting these two components of the representation into a single, coherent structure.

During the course of the present discussion there will emerge a structural condition which requires that a melodic tier must be licensed, before any of the elements it contains can be interpreted. Such a condition follows from the Phonological Licensing Principle (Kaye 1990a), which states that all units in a representation, with the exception of the ultimate domain head, must be licensed.³¹ I shall assume that this condition is

³¹It will become evident that the present model must recognize melodic tiers as true structural 'units' — on a par with prosodic constituents — rather than as a mere notational device.

fulfilled in accordance with the Licensing Inheritance Principle (LI), as formulated by Harris (1997). Briefly, the notion of LI rests on the claim that units in a representation enter into asymmetric licensing relations with each other, every licensee unit becoming licensed by receiving licensing 'potential' directly from its licensor. Furthermore, it is claimed that licensing potential is 'consumed' each time a unit becomes licensed in this way. To illustrate, consider the simple prosodic structure below, which gives a partial (and informal) representation of the word 'tree'.

(37)

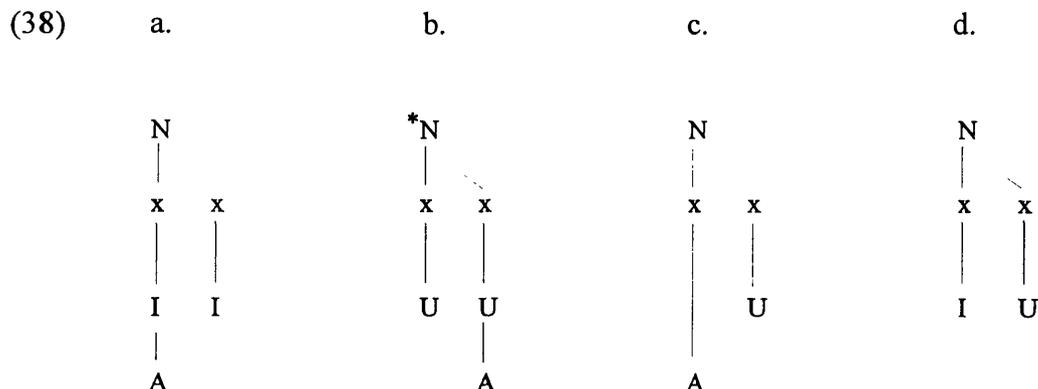


In (37), the prosodic constituent labelled Nucleus licenses another constituent Onset (shown by the left-headed arrow), allowing the latter to inherit from the Nucleus a certain amount of licensing potential. Although the head (i.e. dominant sub-constituent) of the Onset receives this potential as a licensee, the same unit also acts as a licensor (shown by the right-headed arrow) for its own complement constituent, which it dominates in the prosodic hierarchy; so the Onset head must then pass on some of its inherited licensing potential to the Onset complement. However, as the licensing of a unit involves the consumption of potential, it follows that the amount of licensing potential donated by a unit must be smaller than the amount which that unit has inherited.

Within a representation we can identify licensing paths, which may be seen as unbroken chains of successive binary, asymmetric licensing relations of the sort just described. A prediction made by LI is that the stock of licensing potential, which originates from the ultimate licensor of the domain, will become increasingly depleted as it percolates down through the different levels of the phonological hierarchy. So, the

greater the distance (in terms of the number of licensing 'steps' required) between a phonological unit *p* and the ultimate licenser, the smaller the amount of potential (in relative terms) received by *p*. How, then, does licensing potential manifest itself in *p*? In general, the greater the amount of potential a unit inherits, the greater its scope for acting as a licenser itself. In the case of units on the timing tier, the amount of potential available to a timing position may be reflected in the number of melodic contrasts that may be supported or licensed by that position.

The effects of LI can be observed in a variety of different phonological domains, from branching syllabic constituents to prosodic words, and beyond. To illustrate, let us begin by looking at melodic distribution within the set of possible English diphthongs. What we typically find is an asymmetry with respect to the number of oppositions (gauged in terms of the number of elements employed) that can be supported in the two positions of the branching nucleus. Specifically, the left hand position is able to license a complex melodic expression, while only a single element is possible in the position to the right. The well-formedness of such a configuration is illustrated in (38a). This may be compared with (38b), where it is shown how a reversal of this asymmetric relation yields an ungrammatical structure.



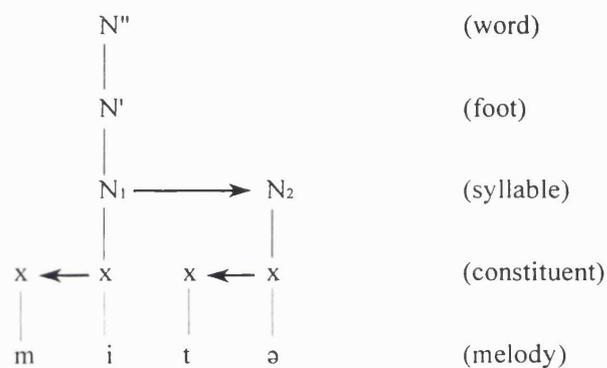
The ill-formedness of (38b) finds a straightforward explanation in the fact that it is inconsistent with the predictions made by LI. Following the established convention in the Government-based literature that intra-constituent licensing relations are universally left-headed, we infer that the right-hand position of a branching nucleus inherits its licensing potential from its licensor, the position to its left. In this way, LI dictates that the left-hand position possesses a greater amount of potential than its neighbour, an asymmetry which is reflected in the ability of the former to support a more complex melodic expression than its licensee position. In (38b), however, it is the prosodically weaker position, the licensee, which has the task of licensing more than one melodic unit. The ill-formed status of this structure then results from the mismatch between the licensing burden borne by the weak position and the relatively small amount of licensing potential available to it.³² Turning briefly to the remaining structures in (38), we find that some instances of equal complexity in licensor and licensee positions may be tolerated. While the *iu* diphthong in (38d) represents a marginal case which is permitted only in some dialects of English,³³ *a*-initial patterns such as *ai* and *au* are widespread. The grammaticality of cases represented by (38c) will be considered in §3.3.3 below.

³²The ill-formed status of the structure in (39b) is illustrated in the phonology of Italian, where the orthographic sequence *uo* is systematically interpreted as an onset glide *w* followed by a monophthong: e.g. *uovo* [wovo] 'egg'.

³³In Welsh English, for example, this sound appears in words such as *blew* [bliu], to contrast with *blue* [blu:]. The well-formedness of *iu* in this dialect is, presumably, influenced by the presence of the same diphthong in Welsh, where the sound behaves as a contrastive unit.

At a higher prosodic level, the effects of LI can be observed in the way licensing potential is distributed in unequal proportions between the syllable heads within a word domain. In English, this manifests itself in terms of stress placement, and also melodic weakening in prosodically recessive positions. To illustrate, let us consider (a non-rhotic interpretation of) the word *meter* ['mitə], represented as in (39). Here, the sub-segmental melodic structure has been omitted, as it is not directly relevant to the point at issue.

(39)



The only unlicensed unit in this structure is the 'strong' nuclear position N₁, which is ultimately projected to the word level as the head of that domain. As the domain head, the projected nucleus N'' acts as the source of licensing potential for all the units it dominates. Following LI, we assume that licensing potential is consumed each time a licensing relation is contracted. Hence, the longer the licensing path that separates a timing position from the ultimate licenser N'' (where the length of the path is measured in terms of the number of licensing steps it involves — represented here by emboldened arrows), the less potential will be available to that position. As a consequence, a prosodically recessive position will demonstrate a diminished capacity for supporting melodic contrast.

In (39), the prosodic position which licenses the melodic expression **i** is projected as the head of the word domain. The absence of any asymmetric licensing relations entails that the position to which **i** is linked receives an undiminished amount of licensing

potential (in fact, more than any other position), which is reflected in the fact that it carries word stress.³⁴ The licensing path to the other nuclear expression is longer, however, since it does include an asymmetric licensing relation (as indicated by the right-headed arrow between the two nuclear constituents); accordingly, its ability to support melodic contrast is affected. In English, a prosodically weak nucleus is typically marked by vowel 'reduction', which may be captured in terms of the failure to support the interpretation of elemental material; that is, melodic complexity is seen to reduce, in response to the limited amount of licensing potential available as a trigger for element interpretation (see Harris (1994a) for arguments in favour of treating melodic reduction as element loss). Finally, let us turn to the longest licensing path in (39), which places the position dominating *t* as the furthest removed from the ultimate licensor. As a direct consequence of this 'distance' (evaluated in terms of the two asymmetric licensing relations involved), the relevant melodic material is, again, subject to a weakening or *lenition* effect, which manifests itself in a number of different ways, according to dialect. For instance, the loss of supralaryngeal material gives us the glottal articulation [miʔə] that is typical of London English, while the interpretation of *t* as a coronal tap [mirə] is found in varieties of English spoken in, for example, Australia and North America. The motivation behind such cases of consonant lenition is fully discussed in Harris and Kaye (1990).

Although brief, this overview of LI will prove sufficient for the purposes of the present discussion, where I shall argue in the following section that the notion of licensing path be extended to incorporate sub-segmental, as well as prosodic structure. In this way, we are able to account for some of the idiosyncrasies that we observe in the behaviour of different elements across a variety of languages, in terms of both static distribution patterns and also dynamic phenomena such as harmony.

³⁴The capacity for supporting lexical contrasts is also a characteristic of the prosodic strength of this position: minimal oppositions include *matter*, *motor*, *martyr*, *mitre*, etc. Compare this with the rightmost nucleus of *meter*, where no change of vowel can bring about lexical contrast within a single morpheme. (NB: forms such as *meaty* cannot be used to create a minimal opposition, owing to their internal morphology).

3.3.3 Tier licensing

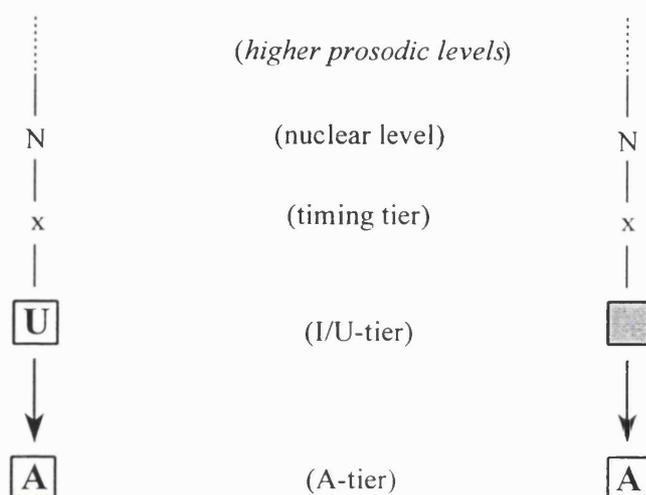
Recall the generalisations that we were able to establish on the basis of the examples in (38). What we typically find is an asymmetry in the complexity of the melodic material contained within the two timing units present in the representation of English diphthongs, such that the (left-hand) licensor position is able to support a wider variety of melodic oppositions (including compound expressions) than its complement. In the latter position we see the range of melodic possibilities restricted to simplex (i.e. single element) expressions. Thus, *ɔi* and *ei* are well-formed, whereas **uo* and **ue* are deemed impossible as branching constituents. When we consider well-formed diphthongs such as *au* and *ai*, however, this complexity generalisation is challenged: in these cases, both portions of the diphthong consist of only a single element, and consequently, the desired asymmetry between licensor and licensee is lost.

Evidently, the low vowel *a* displays behaviour which has more in common with compound expressions than simplex ones; this is apparent from the way in which it is seen to pattern with mid vowels in the strong position of a branching nucleus. This observation finds further support in the distribution of elements in the licensed position of the examples in (38), where simplex *i* and *u* are permitted but *e*, *o*, and *a* are banned. An attempt to account for these facts had been made in the early Government Phonology literature (Kaye *et al.* 1985), where it was proposed that every melodic element possessed a fixed 'charm' value — taken from the set comprising E^+ (plus), E^- (minus), and E^0 (neutral) — which restricted the ways that particular elements could be organised in relation to each other. So, on the basis of the $A^+ I^0 U^0$ values assigned to the three vocalic elements, together with the stipulation that any positively charmed expression could license any neutrally charmed expression but not *vice versa*, it became possible to formalize the regularities just outlined. Yet, for some time it has been recognized that the arbitrary values assigned to elements by Charm Theory could offer little towards an explanation for the distributional asymmetry observed between the three primes. In contrast, the model of tier geometry proposed in §3.2 can provide a clearer insight into these distributional patterns by exploiting the requirement, already alluded to in §3.3.2, that a tier must be licensed in order to act as a licensor for the tier immediately below it

on the licensing path.

(40) a. mid vowel **o**

b. low vowel **a**



Here I shall claim that licensing paths, which have been shown to reflect the characterisation of licensing relations between prosodic constituents (as in the example in (39), following Harris (1992)), may be usefully extended beyond the prosodic hierarchy, to incorporate the various sub-segmental configurations of melodic geometry already proposed. This is illustrated in (40), where downward arrows represent steps on the licensing path. For both (40a) and (40b) let us assume that the x-slot on the timing tier possesses a certain amount of licensing potential, by virtue of its participation in prosodic relations with other constituents. But the same position may also be viewed as a projection of the highest level of the melodic hierarchy — in this case, the I/U-tier; accordingly, this colour tier has at its disposal the same stock of licensing potential as its projected nuclear position. Here I shall claim that the I/U-tier itself takes on the role of a licenser, when another licensing relation is contracted between it and the A-tier which it dominates in the structural hierarchy. Following the predictions made by LI, we expect the aperture tier to inherit an amount of licensing potential which is smaller than that possessed by its licenser, the colour tier. This asymmetric licensing relation between the two melodic tiers allows us to identify an independent domain of licensing, in the same way that a licensing domain is recognized on the basis of relations contracted between

prosodic constituents. And just as the head of any prosodic domain can be singled out as the only unlicensed unit within that domain, similarly the head of this melodic domain (here, the colour tier) remains unlicensed at this level of structure. As a result, the same unit is projected up through the different levels of the prosodic hierarchy until a point at which it becomes licensed in the usual way.

Although we do need to refer to head-dependent relations holding between different tiers of the melodic hierarchy, it should be noted that this amounts to no more than a *structural* dependency (see Ewen (1995)) or dependency of *occurrence* (see §3.2.4 above), where the presence of a dependent tier entails the presence of its dominant tier. Significantly, the mechanism proposed here stops somewhere short of the *inherent* dependency view adopted in standard Dependency Phonology and in frameworks based on Element Theory, where the asymmetric head-dependent relations holding between different melodic primes are seen to have a direct influence on the interpretation of those primes, or at least, on the way each prime contributes to the overall interpretation of the resulting expression; the U-headed expression (U,A) in Element Theory will typically have an interpretation that is different from the A-headed object (U,A), for example, despite the fact that the same set of primes is involved in each. In the case of the model being developed here, however, it is assumed that the precise interpretation of a melodic element will be unaffected by the status of its tier as either licensor or licensee; this is reinforced by the possibility of a single tier simultaneously taking up both roles within two different licensing domains (as in the 'middle' A-tier of the three-tiered melodic structure proposed in (13) for languages such as Turkish). Instead, element interpretation must be established on the basis of system-internal oppositions and language-specific acoustic targets (see §3.2.3 above).

By allowing licensing paths to infiltrate the melodic structure in this way, we can make a number of predictions regarding the individual characteristics of the different tiers within the melodic geometry. In (40) the [A]-tier is located at the bottom of the structural hierarchy, and hence, occupies the most distant point from the ultimate licensor of the domain. Accordingly, the amount of licensing potential inherited by this unit is rather small in relation to that possessed by the colour tier dominating it. As a consequence, we would expect only a relatively strong source of licensing potential — a prosodically

prominent x-slot, such as the N_1 position in (39), for example — to display the capacity necessary for the interpretation of an element on this tier. This correspondence between prosodic strength (i.e. an ample stock of licensing potential) and the interpretation of material situated towards the bottom of the hierarchy follows directly from the assumptions that are fundamental to LI. We established above that a unit inherits its licensing potential from its licensor, and that a certain amount of this potential is consumed whenever a unit becomes licensed. Logically, then, the greater the number of licensing steps referred to in the licensing of a particular unit, the more the stock of potential will have been subject to depletion. Thus, the licensing of terminal units on the licensing path must require a significant amount of licensing potential at its source, in order to avoid a total exhaustion of the supply.

Let us consider the structural templates used in the examples in (40). To interpret a high vowel **i** or **u** we require an active colour (that is, I/U-) tier. In these cases we make no reference to the aperture (A-) tier, because its resident element [A] plays no part in the representation — either as an active unit itself or as a licensor for anything else. In the interpretation of the vowels **i** and **u**, then, we must identify a licensing path along which a stock of licensing potential percolates down through the prosodic hierarchy and terminates at the level of the colour tier. Since this path exploits fewer licensing steps than are potentially available to it (the final step of licensing the aperture tier is not lexically invoked), we predict that such a configuration should be relatively 'easy' to license (where an 'easily' licensed expression is one that is characterized by a relatively small amount of licensing potential required to license the relevant tiers). In contrast, a mid vowel such as **o** — the representation of which is shown in (40a) — requires the involvement of two melodic tiers in order to be interpreted. A licensing domain is established on the basis of the dependency relation contracted between the two melodic tiers, where the colour tier acts as the head of that domain. I propose that a unit's status as a domain head must grant that unit two specific privileges: first, it may act as a licensor for the tier that it dominates; and second, it may itself interpret melodic material. In the case of (40a) the colour tier takes up both of these options — the [U] element is interpreted, and additionally, it sanctions the presence of the aperture tier below it. Having become licensed in this way, the [A]-tier may now interpret its own melodic

material (the [A] element), thus yielding a compound expression comprising both active [U] and active [A].

Clearly, the licensing path required for mid vowels must be longer than that proposed for the high vowels *i* and *u* since, in the former case, an additional step is needed to incorporate the participating aperture tier. We have already identified a correlation between the (relative) length of a path and the (relative) prosodic strength of its source. Specifically, we predict that the terminal unit of a hierarchical structure (in the present case, the aperture tier) will be successfully licensed only if it receives a sufficient amount of potential; and in order to meet this condition, the distance from the ultimate licenser (e.g. of the word domain) must be a relatively short one. From this, we are now able to forge a direct link between the prosodic strength of a position and the capacity of that position to support compound melodic expressions: via the notion of LI, we predict that a recessive position will be capable of supporting only a short sub-segmental licensing path, while a stronger, or more prominent position will pass on sufficient potential to license a longer path. As (40a) demonstrates, compound expressions can be interpreted only if we identify a longer melodic licensing path.

Having established a non-arbitrary association between complex melody units and prosodically prominent positions, let us return to the English phonotactic constraints shown in (38), and in particular, to the sequences such as **au** and **ai**, represented by (38c). Our challenge remains one of finding an explanation as to why the low vowel **a** tends to pattern with complex mid vowels in such diphthongs, rather than with the other simplex vowels **i** and **u**. In view of the representations in (40), however, we are now in a position to offer a straightforward solution, given that the two vowels **o** and **a** both involve an active [A] element, and furthermore, both require an identical licensing path. The mid vowel **o** in (40a) must refer to a sub-segmental licensing domain, since each tier contains melodic material that is active. But crucially, the low vowel also demands that a similar licensing domain be established — although inactive, the colour tier must act as a domain head to act as a licenser for the aperture tier. The licensing of the latter is a necessary requirement if the lexical instruction **ACTIVATE [A]** is to be successfully carried out.

On the assumption that both mid and low vowels employ an identical licensing path in their respective representations, we predict that each will need to be supported by

a similar degree of licensing potential. Consequently, we expect the two categories to share similar patterns of occurrence, in that their interpretation will be largely restricted to prosodically strong nuclear positions. This result corresponds closely to the distribution facts outlined in (38) above. Here we found that, in the head slot of a branching nucleus, it is complex expressions (i.e. those involving two licensed tiers) which abound. This may be compared with the range of contrasts supported by nuclear complement positions, which are located further down the licensing path where proportionately less licensing potential is available. In these positions, only the simplex expressions **i** and **u** (i.e. those in which no licensing relation between melodic tiers need be recognized) are permitted. So, by analysing the low vowel as a melodically complex expression in this way, we account for the above distributional data wholly in structural terms.

This line of argument emphasizes the need to recognize that the licensing of a structural unit (usually a melodic tier) should be viewed as something quite different from the activation of an element. In order to group together low and mid vowels as complex expressions, we must refer to the licensing of particular tiers as the shared characteristic — in other words, complexity is gauged not according to melodic specification (i.e. element composition), but to structural configuration. We have just observed that it is the complexity of the participating tier structure, rather than straightforward element counting, which corresponds directly to the prosodic strength of different nuclear slots. On this basis, then, what is the status of lexical activation? I shall suggest that, unlike tier licensing, element activation has no effect on the depletion of licensing potential along a given path — that is, the lexical instruction to activate an element comes essentially 'for free'. In the case of (40), this means that the two licensing paths shown as (40a) and (40b) consume an identical amount of potential, irrespective of the fact that the former contains a greater number of active elements than the latter.

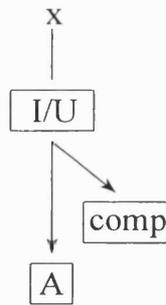
Although there are clear advantages in making a distinction between activation on the one hand, and tier licensing on the other, it is equally apparent that the two notions are inextricably interwoven. Indeed, we have already observed a case illustrated in (40) where they are both indispensable in the attainment of a common goal — the interpretation of a melodic prime. Once a tier is licensed, then it may act as a licensor for another tier (assuming enough potential is available), and it may also become active itself

(and interpret melodic material). I have assumed the latter to be largely a matter of lexical stipulation. Yet the successful interpretation of an element which is lexically activated must remain at the mercy of its tier and the licensed/unlicensed status of that tier. In short, for a melodic unit to be interpreted, there are both lexical conditions (i.e. activate [α]) and phonological conditions (i.e. a licensed tier) which need to be satisfied. The failure of only one of these must result in a failure to interpret the relevant melodic material.³⁵ In this way we achieve a straightforward characterisation of melodic weakening, such that lexically activated melodic material fails to be interpreted in a prosodically weak position whenever the relatively small amount of licensing potential available in such a position proves insufficient to license the relevant melodic tier.

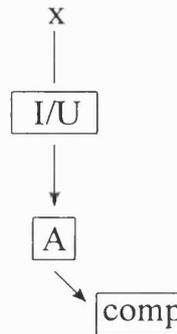
While the present discussion has focused particularly on the licensing of a colour tier complement, it will be recalled that, in §3.2.3 above, I pointed out the necessity of recognizing the possibility of an aperture complement too (e.g. in the vocalic system of Cham). It was also noted that the latter seems to occur far less frequently than the widespread [I/U]-comp. Having established the role of Licensing Inheritance in melodic structure, we are now in a position to express this unequal distribution not as a stipulation, but as a prediction of the model. (41) illustrates the relevant structures.

³⁵On the basis of the present discussion, it appears that vocalic expressions referring exclusively to the highest tier of the melodic hierarchy can support element activation without that tier itself becoming licensed. However, as this tier is taken to represent an 'interface' between melodic and prosodic structure (i.e. the skeletal tier is to be viewed as a projection of the tier in question), we may assume that the established conventions of licensing are followed — namely, that any unlicensed units are projected up through the prosodic hierarchy until a point where they do become licensed.

(41) a. colour tier complement



b. aperture tier complement



I have been assuming that the shorter a licensing path between a timing position and a melodic tier, the greater the relative amount of licensing potential inherited by that tier (i.e. the fewer licensing steps involved, the fewer opportunities for depleting the stock of potential). I have also assumed that the licensing of a complement consumes potential (in effect, the licensing of a structural object 'costs', whereas element activation comes 'for free'). So, in a configuration consisting of a colour tier dominating an aperture tier, the former is expected to be in possession of a greater amount of licensing potential than the latter, as the [A]-tier inherits its potential from the colour tier. It follows, then, that the colour tier has more potential available to license its complement than does the aperture tier. The latter, which is located at the bottom of the phonological hierarchy, possesses only a relatively small amount of potential, and consequently, will have less at its disposal for the licensing of its complement. Accordingly, [comp]-licensing should prove a more onerous task for the [A]-tier, as in (41b), than for the colour tier, as in (41a). Thus, although we have no grounds for ruling out the licensing of an aperture [comp] altogether, we predict that a structure such as (41b) should be much less likely to occur. This position is more fully motivated in chapter 5, where an analysis of some RTR harmony systems is offered.

3.4 Summary of theoretical proposals

In this chapter I have presented a model of intra-segmental melodic structure which attempts to portray, in a restrictive manner, the kinds of variation we observe in vowel systems across many different languages. I have attempted to outline some of the facts concerning both static vowel distribution and dynamic phenomena (i.e. vowel harmony); each of these areas will be considered in greater detail in the remaining chapters. The measures introduced here contribute to an overall enrichment of the melodic representation — but crucially, without relying on any additional melodic primes, and without employing the intrinsic headship properties conventionally used in Element Theory and elsewhere. The results of this enrichment are such that the predictive power of the structural model is more greatly restricted, and we are able to optimize the use of very general conditions on well-formedness, thus minimizing our reliance on language-specific properties.

I began by postulating a structural configuration, or melodic template, which is fixed for all the nuclear expressions of a language. The specific characteristics of a template are defined according to a small parameter set of configurational choices made by the infant language learner. Such options are defined along only two structural dimensions — the geometric arrangement of tiers housing the three resonance elements, and the possibility of licensing a complement tier. Once established for a given language, the template serves to delimit the range of vowel contrasts which may be supported in that language. This delimiting function can be carried out only if we assume the melodic template to be present under each nuclear position in the phonological string, in the form of a full set of elements. The encoding of lexical oppositions is then achieved by individual elements being interpreted only if they are activated via lexical instruction. Inactive primes lie dormant in the melodic structure.

Having motivated the notions of melodic template and element activation, I have gone on to show how the resulting configurations are seen to interact with general principles of licensing, such as Licensing Inheritance. If we extend the idea of licensing paths to encompass melodic, as well as prosodic structure, then we can successfully bring together these two components into a single, unified phonological hierarchy. By doing

so, we gain a valuable insight into some widespread patterns of vowel distribution that are otherwise left unaccounted for. Throughout the remainder of this work, I offer a number of re-analyses of tongue root phenomena taken from a variety of different languages. These analyses will serve to illustrate the highly restrictive nature of the model's generative potential, as referred to above.

4 *A tier-geometric analysis of ATR harmony*

4.1 Introduction

In this chapter I focus on the representation of ATR as a harmonically active property. I examine the nature of several tongue root harmony systems, and attempt to show how their particular characteristics may be most appropriately captured by adopting the proposals for melodic structure set out in the preceding chapter. I begin by considering some earlier approaches to ATR harmony — the standard autosegmental mechanism of feature spreading (§4.2) and an Element Theory account in terms of headship agreement (§4.3) — and identify a number of potential difficulties associated with each. In response to such problems, I offer a tier-geometric analysis of Turkana vowel harmony in §4.4, which demonstrates how the postulation of a language-specific melodic template, coupled with the notion of lexical activation, can overcome some of the shortcomings inherent in earlier harmonic treatments. Finally, §4.5 highlights some of the ways in which the cross-linguistic variation observed between different ATR harmony systems may be fully incorporated into the structural model; this is achieved by introducing a localised form of principle ranking — a theoretical tool that has already been shown to benefit a number of analyses within the Government-based literature.

4.2 Autosegmental spreading

Since the late 1970s it has been recognized that the standard linear model of phonology cannot be maintained as an adequate means of representing the kinds of phenomena that have been subsumed under the general label 'suprasegmental'. This description may be taken to involve properties such as, for example, stress patterning. In response, the idea of multi-linear structure has since dominated the theoretical arena, having developed

initially from early autosegmental models presented by, amongst others, Goldsmith (1976) and Clements (1977). It has been noticed, however, that we encounter problems if we attempt to draw any absolute distinction between suprasegmental processes of the type envisaged by Goldsmith, and purely melodic patterns formerly referred to as 'segmental'. Certain assimilatory phenomena such as vowel harmony, for example, apparently have recourse to both melodic and prosodic information in their description.

The analysis of Akan vowel harmony proposed in Clements (1981) was built around this very observation, where harmonic agreement is described as 'a phenomenon located at midpoint between true prosodic characteristics such as stress and tone, and purely local phenomena such as the assimilation of one segment to a neighbour' (1981:55). This amalgamation of melodic and prosodic characteristics is employed by Clements as a means of highlighting the appropriateness of a non-linear mode of representation, his departure from the linear tradition being motivated in the following way. Vowel harmony may be seen to operate by isolating the kinds of phonological properties (specifically, melodic primitives) normally used to define segments, and then giving them a prosodic, or suprasegmental role. So, a feature such as [-back], which is conventionally specified in the melodic make up of the front vowels *e*, *æ*, *i*, *ø*, etc., may alternatively be abstracted from this segmental level and elevated to a higher position in the phonological structure, where it becomes the property of a larger prosodic domain, typically the word. In the case of [-back] specified as a suprasegmental unit, we observe the palatality effects of this feature across (the vowels of) entire morphemes, rather than individual melodic expressions. Harmonic agreement with respect to palatality is characteristic of a number of Altaic systems, such as Mongolian and Turkish.

If the feature [-back] can be treated in this way, then we expect other melodic primes to be accessed in a similar fashion, creating a range of VH systems observable across different languages. In the paper cited above, Clements focuses his attention on the tongue root harmony system of Akan. Leaving aside some of the rather complex details regarding the distribution of vowels in this language, we may generalize by saying that the vowels within a prosodic word domain all agree with respect to ATRness. According to Clements, then, the feature value [+ATR] is associated either to all of the vowels in the domain, or to none of them; in the latter case, the default value [-ATR] is

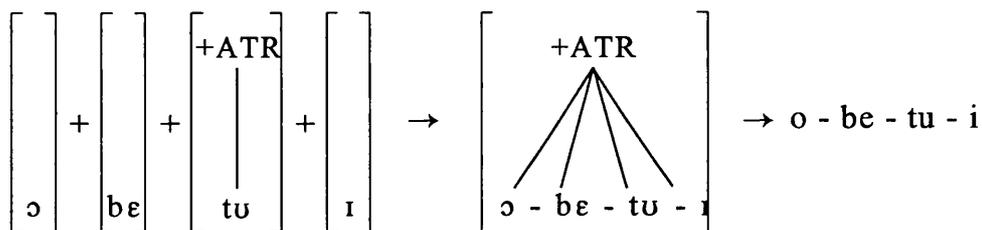
supplied. Clements proposes that this pattern is encoded in Akan via a lexical marking which specifies each noun and verb root as either an ATR or a non-ATR morpheme. Then, following affixation, the vowels of affixes reflect this marking. The effects of harmonic agreement are demonstrated in (1).

- (1) a. tu 'throw'
 b. tu 'dig'
 c. ɔ-be-tu-i 'he came and threw'
 d. o-be-tu-i 'he came and dug'

Examples (1a) and (1b) show two verb roots that are minimally distinct — they differ only in terms of the presence/absence of morpheme-level ATR. The fact that this [+ATR] feature is specified as a property of the word domain, rather than of an individual vowel, is illustrated by the morphologically complex form given in (1d), where the scope of ATRness is extended beyond the root vowel to all other vowels within the expanded domain. We may assume that the lexicon does not support any tongue root distinction in affixes, and therefore, that affixal vowels are subject to [±ATR] alternation, according to the lexical marking of the root to which they are attached.

In order to capture the suprasegmental behaviour of [+ATR] in this system, Clements (1981) adopts the kind of autosegmental structure first presented in Goldsmith (1976), in which the harmonizing feature is isolated from the remaining melodic material and represented on a separate autosegmental tier. The derivation of an ATR form is shown in (2), where the addition of association lines is typically achieved via a spreading operation.

- (2) o-be-tu-i 'he came and dug'



The widespread acceptance of this nonlinear model has led to the same process of feature spreading being applied in countless other autosegmental analyses of harmonic phenomena. Indeed, it offers a substantial degree of versatility since, we may assume, any unit belonging to the set of distinctive features may potentially be autosegmentalized in the way just outlined. Familiar harmonic processes may thus be characterized in a straightforward manner: labial harmony (e.g. Turkish) identifies [+round] as a prosodic feature, while height harmony (e.g. Chicheŵa) corresponds to the selection of either [+low] or [-high]¹ as the relevant autosegment. In the context of a restrictive generative model, however, this versatility cannot be viewed favourably, since we predict that all available features are equally likely to be accessed as a harmonic property within one language or another. Yet, in the absence of any serious empirical backing, such a prediction cannot be maintained. For example, while nasal harmony systems involving [+nasal] are widespread (e.g. Orejon, Gokana), the complement process of oralisation, which would target the feature [-nasal], is unattested. This issue of predicting the possibility of non-occurring patterns has already been addressed in §2.2 above, where the discussion argued for the postulation of a reduced set of monovalent primes — specifically, the [I], [U] and [A] primes associated with a triangular vowel space — as an alternative to the kind of binary-valued distinctive features employed in earlier autosegmental treatments.

By recognizing the validity of a diminished set of melodic primes — specifically, the set consisting of the three resonance elements [A], [I] and [U] — we immediately reduce the potential for autosegmentalisation, the central assumption being that the range of harmonic processes exclusively involving vowels (i.e. excluding nasal harmony) should only correspond to the members of this set. However, we need look no further than the data in (1) above to see that such a claim cannot be upheld. The harmonic pattern observed in Akan is representative of the kind of assimilation phenomenon which involves an active tongue root property, rather than any of the vocalic properties corresponding to A, I or U.² Assuming the validity of an ATR-harmony analysis for

¹See Mtenje (1986) for discussion.

²Here I follow the position adopted in Harris and Lindsey (1995) with regard to elemental representations. Other triangular approaches to melodic structure do involve one or more of the

systems such as Akan, a potential problem immediately arises: within the version of Element Theory (see references cited in chapter 2 above) adopted throughout this discussion, no melodic prime akin to the [+ATR] unit, as exploited in (2), is currently established as an independent object. The absence of a tongue root element is sufficiently well motivated (at least, theory-internally) to rule out a spreading account of the data in (1). The challenge for Element Theorists, then, has been one of finding an alternative means of representing the ATR distinction, together with an alternative mechanism for capturing its harmonic properties.

4.3 ATR harmony as head agreement

4.3.1 Head alignment

As described briefly in §2.2.4, the most widely accepted solution to the problem of representing ATRness within Element Theory opts for the exploitation of melodic headship properties. The asymmetric dependency relation assumed to hold between different primes within the same expression allows one element to be identified as the head of that expression, where this status as a phonological head results in relative phonetic salience or prominence. For example, the vocalic properties of lowness, present in [A], and labiality, present in [U], may fuse in unequal proportions, yielding either the [A]-headed expression (A,U) or the [U]-headed expression (A,U). In each case, the relative salience of the head element is reflected in the interpretation of these expressions as **ɒ** and **o** respectively. However, for the purposes of capturing the ATR distinction (particularly in the case of high vowels), this notion of headship is harnessed not as a relational property, as in the way just described, but as an intrinsic property of individual elements. Thus, a headed [U], for example, may potentially contrast with a non-headed [U], the general assumption being that headed expressions (whether single elements or

resonance elements in tongue root contrasts. See, for example, van der Hulst (1989), where it is proposed that a particular manifestation of the [I] prime contributes ATRness to an expression, while [A] is responsible for RTRness.

compounds) correspond to peripheral or advanced vowels, while non-headed structures represent non-ATR vowels. Returning to the illustration of compounds involving [A] and [U], we may now introduce a third combinatory possibility — a headless expression — representing the non-ATR vowel ə. The three-way distinction shown in (3) is assumed within the version of Element Theory supported in, for example, Harris and Lindsey (1995).

(3) (A,U) = ɒ (A,U) = ɔ (A,U) = ə

The view that ATR distinctions are encoded via headship properties is appealing in a number of ways. Most significantly, we do not need to refer to any independent ATR prime, which is clearly beneficial in terms of generative restrictiveness. Furthermore, we need not posit any additional structure in order to capture ATRness; instead, we simply exploit what is already present as an established representational property.

Extending this idea to cases of ATR harmony, we may infer that harmony arises from an agreement with respect to headship across a given domain. Let us illustrate this by returning to the examples from Akan, repeated here in (4).

(4) a. tu 'throw'
 b. tu 'dig'
 c. ə-bɛ-tu-i 'he came and threw'
 d. o-be-tu-i 'he came and dug'

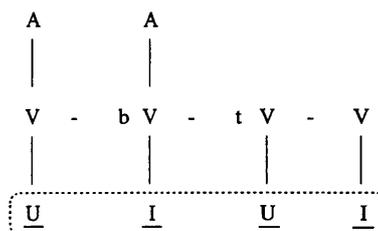
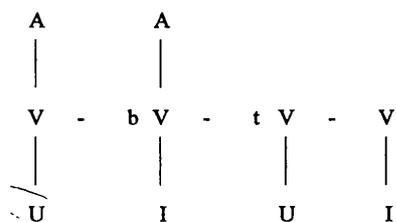
The verb root in (4a) contains a non-ATR vowel, which is represented as a non-headed vocalic expression. In contrast, the ATR root vowel in (4b) suggests that this morpheme is lexically marked as a headed object. In (4d), the headedness properties of the root are seen to 'associate' to the vowels of neighbouring morphemes following affixation. Predictably, these harmonic effects fail to be observed in (4c), since the concatenated string in question lacks a suitable ATR trigger.

A mechanism of head alignment (Lowenstamm & Prunet 1988; Harris & Lindsey 1995) has been put forward as a means of formalising the way in which headship harmony of this kind may be achieved. As an alternative to feature spreading, Harris and

Lindsey (1995) claim that harmonic effects arise from changes in the internal representation of harmonizing vowels, such effects being triggered by particular characteristics of a dominant vowel present in the relevant domain. Given the means by which the tongue root distinction is captured in (3), it follows that these changes should typically involve a switch in the headship status of nuclear expressions. For instance, within the set of non-low vowels, an expression which is lexically non-ATR (such as the 3rd person prefix marker \mathfrak{c} - in (4d) above) may acquire full-headedness in the environment of a dominant ATR root vowel. It is in this way that head agreement is achieved, where the head elements of all vowels within the relevant span are aligned on the same melodic tier. As the examples in (5) demonstrate, harmony is captured by means of headship agreement, where headedness may be most appropriately viewed as a property belonging to a melodic tier, rather than to individual elements. In representational terms, then, the effects of harmony are such that all elements on the designated harmony tier are uniformly either headed or headless (where headed status is indicated by underlining).

(5) a. \mathfrak{c} -*bε-tu-i* 'he came and threw'

b. *o-be-tu-i* 'he came and dug'



The vowels in (5a) are all lexically headless. The absence of any (dominant) headed expression in the word allows each vowel to remain structurally unaltered, thus yielding the non-ATR interpretation \mathfrak{c} -*bε-tu-i*. The representation in (5b), on the other hand, is characterised by the presence of a lexically headed expression in the verb root *tu*, which has a harmonizing effect on affix vowels. We arrive at the aligned configuration in (5b) by allowing the headship status of recessive vowels to be manipulated via an ON/OFF setting. So, for example, an operation of head switching permits a lexical \mathfrak{c} (U,A) to be

interpreted as \mathbf{o} (\underline{U},A) under harmony conditions.

4.3.2 H-licensing

The same basic notion of headship harmony is given a more formalized treatment in terms of a mechanism known as H(ead)-licensing. Since the precise details of this operation are not central to the present discussion, I shall avoid any unnecessary restatement of the facts here, which are presented fully in, for example, Walker (1995) and Denwood (1995). The main proponents of H-licensing view the mechanism essentially as a 'lexical function' which maps headless expressions on to headed ones, although it may also apply in a derivational capacity (where harmony is found to occur in morphologically complex forms, for example). In either case, the melodic configurations which come about via H-licensing must interact with a number of language-specific licensing constraints, the latter serving to restrict the way that elements are permitted to combine within any one system.³

Given that both of these devices — H-licensing and licensing constraints — are involved in the manipulation of the same phonological property, that of headship, it is inevitable that a certain degree of conflict will arise with regard to their respective predictions. In some instances of clashing, licensing constraints are overridden, in order that the output of the H-licensing function can remain intact (and thus, be interpreted successfully). In other instances, however, constraints behave as inviolable requirements on structural grammaticality and, as such, force the breakdown of the H-licensing process. In view of this dynamic behaviour shown by H-licensing, its status within the grammar appears somewhat indeterminate. The possibility of resolving grammar-internal conflict on a language-specific basis suggests an approach which is reminiscent of the constraint ranking found within Optimality-Theoretic (OT) models (Prince and Smolensky 1993); in OT, the violation of a constraint is sanctioned only in order to ensure that the conditions prescribed by a more highly ranked constraint (located in a

³Licensing constraints are central to the theoretical context in which H-licensing has been conceived. They typically take the form of generalisations regarding the headship of particular elements: for example, the constraints *[U] must be a head* and *[A] is not a licenser* are argued for in the description of the Turkish vowel inventory (Charette and Göksel 1996).

language-particular hierarchy) are met. However, if H-licensing is to be most appropriately seen as a well-formedness constraint on output representations, on a par with the other grammaticality constraints with which it interacts, then its defining characteristic as a *lexical* function is somewhat undermined.

The recent literature has seen a number of attempts to extend the application of H-licensing to a wider range of languages exhibiting tongue root harmony. Although the outlook is not altogether discouraging, the results seem to indicate that the H-licensing mechanism cannot be subject to the kind of rigid definition that had originally been proposed. Instead, the focus of its development appears to be centred on the incorporation of parametrically controlled properties, in place of absolute requirements. For example, Cobb (1995) suggests that the domain of H-licensing in Zulu need not correspond directly with either morphological or prosodic categories,⁴ while it is proposed in Denwood (1995) that the directionality of H-licensing be specified on a language-particular basis. In the same paper, Denwood also raises a number of theory-internal matters, such as the predicted incompatibility between the mechanism of H-licensing and the presence of phonologically empty nuclei. The references given above provide discussions of these, and other recent developments in the formulation of H-licensing, which will not, however, be pursued here.

Of greater significance to the present argument is the question of the appropriateness of headship harmony to a restrictive theory of well-formedness — whether harmonic agreement is achieved by referring to melodic tiers, following Harris and Lindsey (1995), or to H-licensing, as in Walker (1995) and elsewhere. In other words, how successfully may this approach be incorporated into our overall view of phonological structure? I shall argue below that harmonic agreement in terms of headedness may be considered problematic in two particular respects. First, it is a structure-altering mechanism, and, as such, is incompatible with a generally established principle of grammar. Second, if we choose to sanction structural (i.e. headship) agreement as a manifestation of vowel harmony, then it must exist in addition to, rather than in place of, the established analysis of vowel assimilation as feature/element spreading. Under the

⁴In effect, this analysis allows a harmonic domain to be described independently of the harmonic mechanism employed. This view has much in common with the Optimal Domains approach to harmony, as presented in Cole and Kisseberth (1994).

assumption that a spreading mechanism is still required in the description of, for example, rounding or palatal harmony, we are then forced to recognize two independent ways — spreading and head agreement — of representing what is (at least, intuitively) the same harmonic effect. I shall consider each of these issues in turn, beginning with the question of head agreement as a structure-altering mechanism.

4.3.3 Headship harmony: some potential problems

4.3.3.1 Structure Preservation. The question of the structure-changing nature of head agreement has been addressed briefly in §2.2.4 above, where it was observed how the lexically headless vowel *ə* in Tigré alternates with its headed counterpart *a* under harmony conditions. As we have seen in §4.3.1, it is also via headship properties that Element Theory captures tongue root distinctions; and consequently, it is proposed that head-dependent relations can be manipulated, or 'switched', in order to account for harmonic alternations involving ATR.⁵ The same mechanism of switching is also exploited in other triangular models of representation, notably Dependency Phonology. To illustrate, consider the diachronic vowel changes collectively referred to as Old English *i*-umlaut (Anderson & Jones 1977), which include a vowel raising process /*æ*/→/*e*/. From a Dependency perspective, such a change is analysed as involving a switch in the dependency relation holding between the two components contained within both expressions — specifically, from {*a*; *i*} to {*i*; *a*} (where the head appears to the left).⁶ Following the arguments put forward in Backley and Takahashi (1996), however, I claim that a mechanism which allows head status to be created or dropped (due to affixation) poses a potential obstacle to the established idea of Structure Preservation.

⁵According to Charette and Göksel (1994, 1996), for example, head switching is central to the analysis of vowel harmony in several Turkic languages such as Kazak.

⁶Interestingly, this switching analysis survives in the Dependency Phonology literature alongside an apparent commitment to the Dependency Preservation Condition (Anderson 1986), which states that 'dependency relations are preserved, where possible, throughout a derivation (and in diachronic changes)' (1986:84). In its original formulation, this condition refers to headship stability in processes such as monophthongization.

Although the notion of Structure Preservation (SP) has been employed in the phonological literature for some considerable time, theorists have been less than consistent with regard to a precise definition of its status and function. The earliest reference to SP is found in Selkirk (1982), where 'structure' specifically relates to syllable structure. Here, the central claim is that syllabic configurations produced during derivation (via resyllabification rules) must conform to the syllable template of the language in question. What is preserved, then, is the set of lexically possible syllable types. Some time later, Kiparsky (1985) transfers a similar conception of SP to melodic structure, where he proposes a ban on the creation of segments which are unable to contrast lexically. That is, a melodic expression produced during the course of derivation must already be a member of the language's segment inventory. Once again, therefore, it is a particular set of lexical possibilities which must remain intact. I shall employ the cover term 'Templatic SP' to refer collectively to these formulations; this will allow a straightforward comparison between these and a revised interpretation of the notion SP to be introduced below.

In some representational models, the emphasis on preserving phonological structure has been extended to include not only the individual units referred to at the lexical level, but also the particular relations holding between those units. This position is perhaps most strictly maintained in the Government-based literature⁷ where, following the view currently established within syntax, it is assumed that the licensing relations present at derived levels of representation are necessarily the same as those given lexically. Harris (1994a) offers a phonological instantiation of Structure Preservation which requires that licensing conditions holding of lexical forms also hold of derived representations. As with earlier formulations of SP, this has the effect of preventing a phonological process from adding to a language's inventory of prosodic templates or patterns of melodic association defined in the lexicon.

On the other hand, Kaye *et al.* (1990) choose to develop the issue of SP primarily in relation to prosodic structure — that is, in relation to those lexical categories that are (potentially) projected. This is achieved by making a direct appeal to the representation of syntactic structure, and specifically, to the Projection Principle (see Chomsky 1981,

⁷See, for example, Charette (1991), Harris (1994a), Brockhaus (1995), and references therein.

1986). The latter requires that relational properties (e.g. subcategorization) be 'projected' from the lexicon on to the derived structure, thus ensuring that lexical structure is fully represented at every syntactic level. The effects of this projection may be observed in a number of ways. For instance, head-complement relations established in the lexicon must be preserved throughout derivation — the head/complement status of an object is immutable with respect to all dynamic structural operations. From this, it follows that the categorial status of lexically specified constituents must similarly remain fixed. So, if a position is projected from the lexicon as a verb phrase, then it cannot lose this identity during the course of derivation.

As Kaye *et al.* (1990) demonstrate, there are clear advantages to be gained from transferring the syntactic notion of lexical projection to the phonology. In a Government-based approach, it is assumed that all prosodic units must participate in licensing relations with each other,⁸ and that such relations contribute to the well-formedness of lexical objects. By allowing the Projection Principle to constrain phonological derivation (thus ensuring that the licensing relations present in the lexicon are maintained at all levels), it becomes possible to make the (desirable) prediction that no resyllabification operations of any kind will be permitted. This result follows from the assumption that, if a timing unit were to be resyllabified, then it would either have to undergo some change in its categorial status, or otherwise, would be involved in a change affecting prosodic licensing relations.

Whether or not melodic structure should be similarly controlled by constraints such as SP or the Projection Principle is clearly a matter for debate. It may be argued that the behaviour of melodic elements ought not to be expected to mirror that of prosodic constituents, given the fundamental differences existing between the two planes involved — for example, all units of prosodic structure must be lexically identified as either a head or a complement, whereas the elemental expressions of melodic structure may stand as 'headless' objects. However, within the context of a Government-based phonological framework it is evident that, like prosodic units, the melodic elements, together with the relations holding between them, are also subject to certain licensing conditions (see

⁸This requirement results from the Phonological Licensing Principle (Kaye 1990a) — see §2.4 above — which demands that all phonological units, with the exception of the ultimate domain head, must be licensed.

§3.3.2 and §3.3.3 above); this much is clear from the way in which (melodic) licensing constraints are formulated and expressed within the model.⁹ If we consider the notion of licensing to be responsible for the well-formedness of both melodic and prosodic structure, then it is reasonable to make the further assumption that the nature of licensing relations ought to be determined, in both cases, by the same set of principles (some of which are universal generalisations, others system-specific). In other words, the principles of licensing should determine the grammaticality of structure *in general* — an assumption that highlights the way in which the notion of licensing may be seen to unify the different components of a phonological representation into a single, coherent structure. On this basis, we can assume that, for instance, the Phonological Licensing Principle (see footnote 8) refers to melodic elements as well as prosodic constituents, since both are to be seen as phonological units that must be licensed within their respective domains.

Having established this theoretical stance, I return to the question of head switching, by which tongue root harmony is achieved within the standard Element-based model. Recall that a lexically headless object such as \mathfrak{c} [A,U] may be interpreted as its headed counterpart \mathfrak{o} [A,U] in the appropriate harmonic environment. Here, I claim that a mechanism of the sort which can convert [α] into [$\underline{\alpha}$] must constitute a violation of SP, in the sense that the lexically assigned head-dependent relations of melodic categories — and consequently, the licensing relations responsible for determining headship status — are overridden during the course of derivation. What justification, then, do we have for endorsing such a switching operation (whether lexical or phonological), when this move apparently reflects a change in the categorial status of lexically specified constituents, and consequently, stands in violation of the Projection Principle? After all, from the fact that head switching is unconditionally ruled out in the case of prosodic units (e.g. a nuclear complement cannot be recast as a nuclear head), we might reasonably expect a similar restriction to hold at the melodic level too.

For some Element theorists, it is maintained that the Projection Principle involves only the projection of *prosodic* categories from the lexicon, thus placing melodic structure outside the scope of its influence. I shall argue, however, that this interpretation

⁹Proposed constraints on element licensing include *Nothing can license [I]* (for English), *Operators cannot be licensed* (for Zulu) and *[A] cannot be a head* (cross-linguistic).

is not sufficiently restrictive. An obvious inconsistency arises from the assumption that, while the notion of licensing is equally applicable to both melodic and prosodic units, the preservation of licensing relations is restricted exclusively to the prosodic structure. In response, I follow Backley & Takahashi (in press) in adopting an alternative — a stronger, and more highly restrictive — instantiation of SP which extends Kaye's implementation of the Projection Principle to incorporate the entire phonological structure.

(6) **Inherent Structure Preservation (ISP)**

Lexical head-complement relations must be retained throughout derivation

The condition in (6) effectively places a ban on any move which results in a change in the relation between phonological units — where a relation may be one of government, or dependency, or licensing, for example. ISP also entails a ban on any categorial change, whether 'category' refers to a syllabic constituent or to a melodic prime. Hence, this immediately rules out any operation of head switching as a grammatical possibility. Thus, in the same way that, for example, a lexically specified onset head position cannot be re-defined as an onset complement, I shall claim that a melodic object such as [$\underline{\alpha}$] cannot be interpreted as another object [α], without falling foul of this very general constraint on phonological derivation. The motivation for preserving lexically established relations (and consequently, the head or dependent status of melodic primes) appears particularly compelling from the point of view of restrictiveness.

4.3.3.2 A non-uniform analysis of harmonic agreement. Leaving aside the issue of SP violation, we encounter a further difficulty with respect to head alignment and H-licensing when we consider the analysis of vowel harmony from a rather more general perspective. In broad terms, harmony may be viewed as some kind of agreement with respect to a melodic property across a wide domain. I shall claim, therefore, that it is not unreasonable to expect all instances of harmony to be explained in the same way, regardless of which particular melodic property happens to be active in any given case. Such an outcome is especially appealing within the context of a restrictive theory of

representation, where the desire to minimize the number of possible process types is given high priority. Ideally, then, cases of rounding or palatal harmony should be captured in the same way as, for example, ATR or height harmony. By adopting a head agreement analysis, however, difficulties arise with regard to certain instances of harmonic alternation, as demonstrated by the Chamorro data given below.

The Philippine language Chamorro has a vowel fronting system (i.e. palatal harmony) in which the following melodic changes occur in the first syllable of a root, when that root is preceded by a front vowel.

- (7)
- | | | |
|----------|---|----------|
| u | → | i |
| o | → | e |
| a | → | æ |

The examples in (8) illustrate these vowel alternations (data is taken from Kenstowicz and Kisseberth 1979). The nominal roots in (8a) are interpreted as the 'palatalized' forms in (8b) when they follow the *i* vowel of the definite article.

- | | | | | |
|-----|----|--------------|--|--------------------|
| (8) | a. | gumə 'house' | | i gimə 'the house' |
| | | tomu 'knee' | | i temu 'the knee' |
| | | lahɪ 'male' | | i læhɪ 'the male' |

Recall that, under a head alignment analysis, vowels are either headless, or they are all headed by an element on the same tier (see the example shown in (5) above). But under the assumption that the elements [I] and [U] reside on the same tier in this language (thereby preventing them from combining), we are unable to derive the desired output form in any straightforward manner. Regardless of whether we consider the alternating vowel of *gumə* to be represented lexically as [U] or as [̥U], we would most likely be forced to describe the effects of palatal harmony in terms of a sequence of phonological events, where the delinking of [U] is followed by the spreading of the [I] element. An analysis of the same facts involving a mechanism akin to H-licensing proves equally inappropriate. The latter appears to have been formulated solely as a means of describing the kind of headship agreement found in ATR harmony systems. While nothing prevents us from introducing an operation such as I-licensing for describing palatal harmony, I

suggest that this would be appropriate only in addition to, rather than in place of, a more conventional I-spreading account.

In the light of harmony systems such as Chamorro, we may recall the problem alluded to above — namely, that there are two independent ways of representing the propagation of a melodic property beyond its lexically given domain. On the one hand, it seems appropriate to recognize the validity of a spreading account in the context of palatal harmony cases,¹⁰ and on the other, we must rely on some kind of alignment or head licensing for tongue root systems. Yet the end result of these two mechanisms is essentially identical, to the extent that a melodic property is uniformly present, or active, throughout a given domain. I suggest that this 'functional overlap' — whereby the same phonological effect may be subject to more than one structural analysis — is undesirable from the point of view of generative restrictiveness.

My primary aim in the following section is to demonstrate how the alternative approach to the description of tongue root harmony outlined in chapter 3 can be seen to overcome the problems just outlined with respect to head alignment and H-licensing.

4.4 A tier-geometric account of harmony in Turkana

4.4.1 Patterns of distribution

As van der Hulst & Smith (1986) have remarked, the Nilotic languages in general seem to provide a fruitful testing ground for theories concerned with the formalisation of vowel harmony phenomena. Here I consider one such system, Turkana,¹¹ which has been the focus of a number of different analyses in the recent literature — see Dimmendaal (1983), van der Hulst and Smith (1986), Noske (1990) and Vago and Leder (1987), from which my examples have been taken. The aims of the present discussion are to provide only the broadest outline of the vowel harmony patterns observed in Turkana, while demonstrating

¹⁰Presumably, this may be extended to include other harmony types, involving *rounding*, *height* and *nasal*, for instance.

¹¹An Eastern Nilotic language, spoken primarily in Kenya.

how the structural model motivated in chapter 3 may be appropriately applied to the description of a 'typical' tongue root harmony language. For a more detailed presentation of the facts relating to the phonology of Turkana, the reader is referred to the works cited above.

The nine vowel system of Turkana may be divided into two harmonic sets, distinguished on the basis of ATR.

(9) a. *Turkana vowel inventory*

i	u
ɪ	ʊ
e	o
ɛ	ɔ
a	

b. *harmonic groupings*

ATR:	i, u, e, o
non-ATR:	ɪ, ʊ, ɛ, ɔ, a

In keeping with the expected distributional characteristics of an ATR harmony language, it is generally the case that all vowels within any given word domain must be taken exclusively from one of the harmonic sets in (9b). The choice between the ATR and the non-ATR set in Turkana is determined by the lexical marking on either the root portion or the suffix portion of each concatenated form. To illustrate the operation of root-controlled harmony, consider the following:

- (10) a. ε-εm-ɪ 3rd person-'fear'-aspectual '(s)he will fear'
 b. e-los-ɪ 3rd person-'go'-aspectual '(s)he will go'

Here, an alternation is observed with respect to both affixes, such that the vowel of each is interpreted as ATR when attached to an ATR verb root, but is otherwise interpreted as the corresponding non-ATR vowel. For example, the aspectual suffix *-ɪ* manifests itself as ATR *i* under the influence of the ATR root *los* 'go'.

As I have already indicated, a system of dominant harmony also exists in the language, where morphological categories other than roots are capable of acting as harmonic triggers. Consider the concatenated forms in (11):

(11)	a.	ak-ɪs-ɪmuj	infinitive-causative-'eat'	'to feed'
	b. ¹²	a-ɪmuj-ɪ	1st person-'eat'-aspectual	'I ate'
	c.	ak-ɪmuj-eeɪni	infinitive-'eat'-habitual	'to eat regularly'

(11a) and (11b) establish the verb root *ɪmuj* 'eat' as lexically non-ATR, as highlighted by the non-ATR status of affix vowels (if this root were lexically marked for ATR, then we would expect it to pattern with the form in (10b), and trigger ATR harmony throughout the word domain). However, the presence of the dominant ATR suffix *-eeɪni* in (11c) causes all the vowels within the domain to be interpreted as ATR, with the result that the verb root is itself subject to alternation — **ɪmuj** and **imuj** are both possible interpretations, the choice depending on the ATR/non-ATR status of the domain in which the root occurs.

4.4.2 Harmonic alternations: an activation account

Although the surface inventory of Turkana comprises the nine vowels shown in (9a), the phonological behaviour of those vowels — in terms of their distribution and harmonic patterning — suggests an analysis based on a smaller system of contrasts, which is then enriched by the addition of a tongue root distinction in non-low vowels. The fact that symmetrical harmonic alternations are observed between non-low vowels that differ only with respect to ATRness (i.e. the members of each alternating pair are otherwise identical) lends support to the postulation of a canonical five-vowel system of oppositions as illustrated in (12), where the choice between the ATR and non-ATR member of each pair is determined on the basis of word-level melodic properties.

¹²This form is regularly interpreted as *ɛmuj-ɪ*, owing to a vowel contraction operation observed in Turkana.

(12) 5-vowel system with additional ATR dimension

i/ɪ	u/u
e/ɛ	ɔ/o
a	

I suggest that the way in which the Turkana vowel inventory is organized in (12) gives a rather closer indication of the corresponding phonological description than is provided by the more conventional arrangement shown in (9a). This preference follows from the clear parallel in (12) between, on the one hand, the Turkana system, and on the other, a symmetrical, three-height system of the kind found in, for example, Spanish and Swahili. So, how should the system of vowel contrasts in Turkana be captured by the grammar?

It will be recalled from the previous chapter that the notion of a sub-segmental melodic geometry is central to the representational model being developed here — where this configuration is established on the basis of a limited number of parametric choices, and predicts the range of vowel contrasts that may be exploited within any one system. In the case of Turkana, the appropriate melodic template should ideally encode two quite different sets of characteristics relating to the phonological properties of the system: first, it should capture the essence of a canonical 5-vowel system, as indicated by (12); and second, it should be able to accommodate the ATR/non-ATR alternations affecting non-low vowels. On this basis, I suggest a melodic template for Turkana which is identical to that proposed in chapter 3 for the vowel system of Maasai. The relevant phonological oppositions are set out in (13) below, arranged according to their harmonic groupings. The geometric configuration given here involves the addition of a colour tier complement — as a means of encoding tongue root distinctions — to a two-tier structure of the sort employed in five-vowel systems such as Spanish, which is built around the colour versus aperture split.

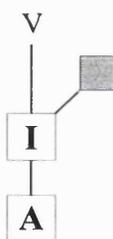
terms of a single unit of the 'core' or 'skeletal' tier, which I assume defines the scope of most instances of lexical contrast — but instead, at the level of the prosodic word.¹³ Indeed, I suggest that it is this word-level activation of [comp] which gives Turkana its particular harmonic properties.¹⁴

To illustrate how an account of ATR agreement as [comp] harmony might proceed within the present model, let us consider the example of root-controlled harmony given in (10), which is repeated here:

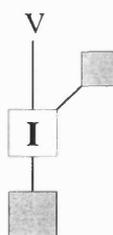
- (14) a. ϵ - ϵ m-i 3rd person-'fear'-aspectual '(s)he will fear'
 b. e-lo*s*-i 3rd person-'go'-aspectual '(s)he will go'

The structures employed in the phonological representation of the affixes *E*- (3rd person) and *-I* (aspectual marker) contain a colour tier complement, by virtue of this [comp] unit being included in the melodic template for the language as a whole. As shown in (15), the complement tier is inactive in the respective lexical forms of these affixes. This is encoded in terms of the absence of any **ACTIVATE [COMP]** instruction.

- (15) a. *E*- (3rd person)



- b. *-I* (aspectual)

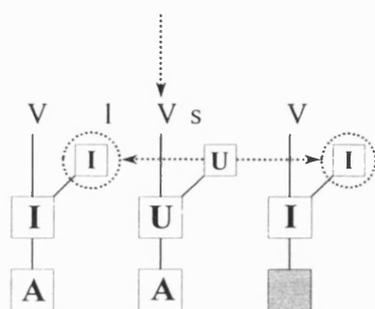


¹³The motivation behind the specification of melodic properties at higher levels of the prosodic hierarchy is formalized in Cole and Kisseberth (1994) as the Principle of Extension. This is discussed in §4.5.2 below.

¹⁴While there are strong arguments in favour of a direct connection between activation instructions and particular units of the prosodic hierarchy, it is rather less clear how this association should be expressed notationally. Such difficulties are not new to the phonology literature, however: consider, for example, the problems encountered by the Firthian analysts in their attempt to depict representationally the distinction between 'placed' and 'unplaced' prosodies. For the purposes of this discussion, domains of activation are to be identified solely with reference to the melodic string.

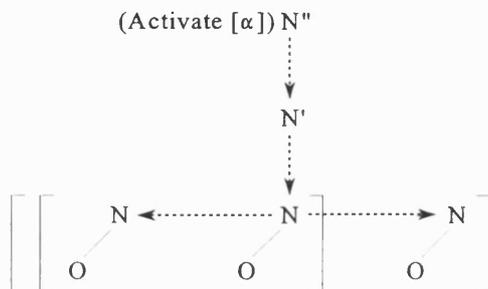
However, when these forms are attached to an ATR root in the formation of a prosodic word, as in (14b), the complement tier in the affix vowels is activated, due to the presence of an active [comp] in the verb root. Specifically, it is the *word-level* instruction to activate the complement tier which brings about the harmonic agreement observed. The harmonic effects resulting from **ACTIVATE [COMP]** in Turkana are demonstrated in (16), where dotted arrows indicate the transfer of the word-level activation instruction.

(16) e-los-i '(s)he will go'



The representation in (16) illustrates how wide-scope activation — that is, activation affecting a domain larger than that defined by a single nucleus — gives rise to the kind of melodic agreement which has already been characterised in §4.3.1 as alignment. But rather than opting for the alignment of headship status, which was argued for in Harris and Lindsey (1995), I propose to view this form of structural agreement as one which requires all (or otherwise, none) of the elements on a particular tier to be active throughout a given domain. I assume that the word-level activation instruction is borne initially by the nucleus which acts as the head of the word domain, specified lexically as a property of the N⁰ constituent. At the lowest level of nuclear projection, the instruction is then transmitted (bi-directionally, in the default case) via a chain of local inter-nuclear relations throughout the extent of the harmonic span, as depicted in (17).

(17) 'horizontal' transmission of word-level activation instruction



The word-level ATR harmony of Turkana, then, may be captured in representational terms by identifying an extended span of activation along the complement tier, the scope of this span being defined with reference to the prosodic word domain. In other words, the lexical instruction **ACTIVATE [COMP]** is characterized as a word-level (N'') specification in Turkana, and manifests itself melodically throughout the phonological string contained within that domain.

It will be recalled that the examples of harmonic alternation shown in (11) above indicate a pattern of dominant ATR harmony existing in Turkana, alongside the system of root-controlled harmony already illustrated. These forms are repeated here.

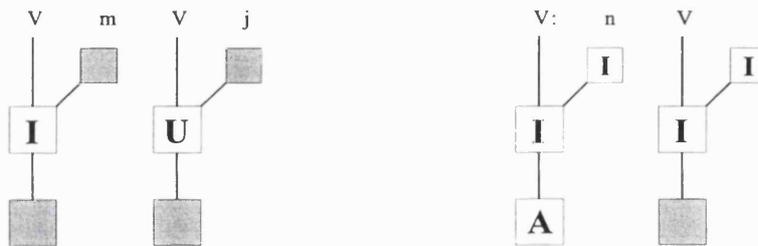
- | | | | | |
|------|----|------------------|----------------------------|--------------------|
| (18) | a. | ak-ɪs-ɪmɔj | infinitive-causative-'eat' | 'to feed' |
| | b. | a-ɪmɔj-ɪ (ɛmɔjɪ) | 1st person-'eat'-aspectual | 'I ate' |
| | c. | ak-ɪmɔj-ɛeni | infinitive-'eat'-habitual | 'to eat regularly' |

In terms of the way that harmonic agreement is achieved, (18c) can be analysed in the same manner as (14b). The form in (18a) establishes the verb root *ɪmɔj* 'eat' as a non-ATR object, on the basis of the non-ATR vowels it contains and its failure to trigger ATR harmony on affixes. However, when the dominant habitual suffix *-ɛeni* — which is lexically specified as an ATR morpheme — is attached to this non-ATR root in (18c), the complement tier (regardless of its lexical specification in individual positions) is activated throughout the extended prosodic word domain. This effect comes about as a result of the same mechanism already stated with respect to root-to-suffix harmony — namely, that the instruction **ACTIVATE [COMP]** is specified as a property of the head

namely, that the instruction **ACTIVATE [COMP]** is specified as a property of the head nucleus of the concatenated domain (in this case, the head position of the dominant suffix *-eeni*). From this position it then emanates along the [comp] plane to affect all the nuclear expressions occurring within the scope of the word domain. If no dominant (i.e. inherently ATR) suffixes follow a root such as *imuj* 'eat', then the complement tier remains inactive throughout, as in (18b).

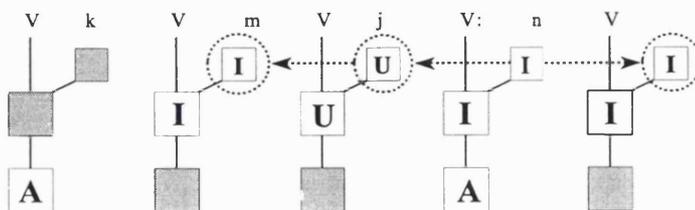
In (19), the lexical form of this non-ATR root may be compared with that of the dominant suffix *-eeni*.

(19) a. *imuj* 'eat' b. *-eeni* (habitual)



Harmonic effects within the prosodic word domain are illustrated in the following structure, where alignment along the complement tier results from the word-level activation of [comp], yielding ATR agreement.

(20) *ak-imuj-eeni* 'to eat regularly'



It may be noted that, in this description of harmony in Turkana, the alternation facts have been accounted for without referring to any head switching operation of the kind that is

since the flipping of head/complement status is never observed in prosodic structure, it should similarly be ruled out at the melodic level too. This led to a revised formulation of the notion of Structure Preservation in (6), which posited that lexical head-complement relations should be retained throughout derivation. In the illustrations of harmonic alternation given in (16) and (20), the restrictive ISP has been successfully adhered to, given that no new structures — and crucially, no new licensing relations — have been introduced, which were not already present in the lexicon. In the case of the verb root *imuj* 'eat', the fixed head-complement relation holding between the colour tier and [comp] is established as a necessary part of Turkana's melodic template, and accordingly, is present in all lexical forms. So, the derived activation of [comp] in the root vowels of the form *ak-imuj-eeeni* 'to eat regularly' does not entail any modification of the structural relations established lexically, and in this way, gains an advantage over other Element Theory analyses in maintaining the effects of ISP at all levels of the representation.

4.4.3 The behaviour of low vowels

A particular characteristic of the low vowel **a** is its failure to participate in regular harmonic alternations. Indeed, this neutral behaviour is evident from the harmonic groupings shown in (9b), where **a** is unique among the members of the retracted harmony set in not having an ATR counterpart with which to alternate. In §4.4.2 I have already suggested a structural explanation for this asymmetry: in the case of the low vowel, the potential for making a tongue root distinction (by means of an active or inactive [comp]) is denied, by virtue of the colour tier — the only possible licenser for [comp] — being necessarily inactive itself. The inability of the low vowel to license an active complement tier is consistent with its uniform phonetic interpretation within both ATR and non-ATR domains alike. The following pairs of examples demonstrate how **a** can appear in either an ATR or a non-ATR span:

- (21) a. makuk 'chair'
 pɔran 'Boran (person)'
- b. a-gol-un infinitive-'close'-motion towards 'to close in'
 a-dɔk-un infinitive-'climb'-motion towards 'to climb down'

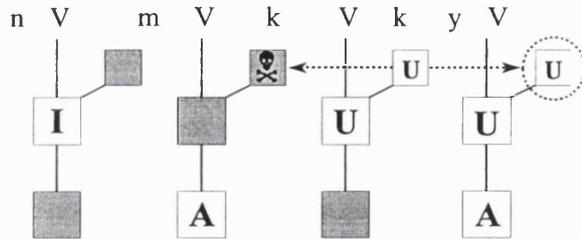
The infinitive prefix in (21b) displays an invariant phonological shape, thus highlighting the low vowel's neutrality with respect to regular ATR harmony.

In addition, the vowel **a** exhibits a blocking effect on the propagation of harmony across a word domain; this opacity is illustrated in the following examples:

- (22) a. ε-makuk (*e-makuk) 'chair' (singular)
 b. ŋɪ-makuk-yo (*ŋɪ-makuk-yo) 'chair' (plural)
 c. ŋɪ-kiŋɪm-aan-ot-in (*ŋɪ-kiŋɪm-aan-ot-in) masc-'deaf'-hab-
 deverb-pl.

We can assume that the noun root in (22a) is lexically ATR, in view of the advanced high vowel **u** which it contains. However, this ATR specification is unable to trigger harmony on the prefix vowel, owing to the presence of the opaque low vowel in the leftmost nucleus of the root. The form in (22b) confirms the status of **a** as a harmonic blocker: the prefix vowel is, once again, prevented from harmonizing to the ATR root, whereas the suffix vowel *can* undergo harmony, since there is no low vowel in the rightmost nucleus to block the rightward propagation of ATR agreement. Besides highlighting the opaque properties of **a**, this example also demonstrates the way in which the effects of an active complement are (at least, potentially) able to radiate *bidirectionally* from the ATR root — unless a low vowel interrupts this progress of harmony. The following structure illustrates the blocking effect of **a** in (22b).

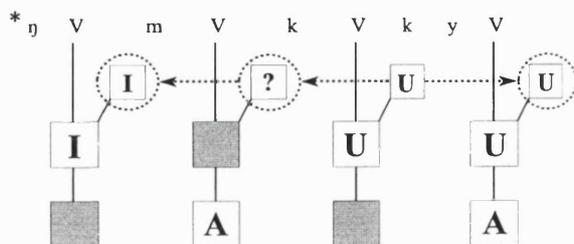
(23) ŋɪ-makuk-yo 'chair' (pl.)



In (23), the noun root *makuk* 'chair' is lexically defined as an ATR morpheme — its phonological description includes the word-level lexical instruction **ACTIVATE [COMP]**. Given the status of this instruction as a word-level specification, we expect alignment in terms of an active [comp] throughout the relevant domain, resulting in ATR agreement. For the reasons already given, however, the low vowel is unable to comply with this melodic requirement, and therefore fails to alternate. In addition, this failure has repercussions for other vowels within the same word domain, owing to the way in which [comp] activation is transmitted from one position to the next (see (17) above). At the particular point (marked by ☠ above) in the phonological string where [comp] cannot be interpreted, the chain of local inter-nuclear relations is effectively broken, thereby interrupting the span of activation and halting the further progress of the activation instruction. On this basis, we can express harmonic alignment in terms of an *unbroken* span of activation along a given melodic plane.

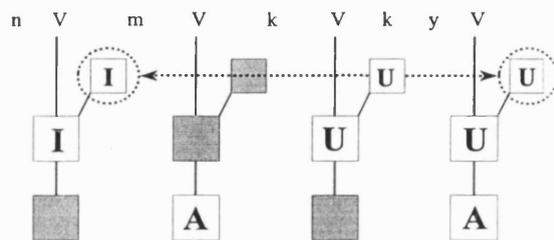
The ill-formed configurations in (24) and (25) demonstrate how low vowel opacity remains the expected outcome in the present example.

(24) *ŋɪ-makuk-yo (*ACTIVATE [COMP] without active head element)



While (24) depicts an illegal configuration that allows an active [comp] with an inactive head element, the structure in (25) highlights the necessity of recognizing a local trigger for the activation of [comp]. This violation of locality corresponds to a breakdown in the transfer of the lexical activation instruction between adjacent nuclear positions.

(25) **ŋi-makuk-yo* (*Interruption of activation span)



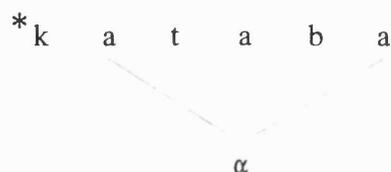
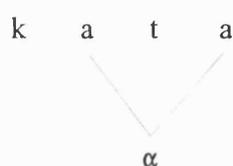
It seems, then, that (23) must be regarded as the only possible, well-formed representation of the form in (22b), despite its incomplete alignment. Thus, the string *ŋi-makuk-yo* remains the only attested interpretation of the nominal phrase in question.

The opaque behaviour of the low vowel — as portrayed in (23) by an interrupted span of [comp] activation — clearly raises questions concerning the issue of locality, which has been treated in a number of different ways in the recent literature on vowel harmony. In Archangeli and Pulleyblank (1994), henceforth A&P, it is proposed that relations within representations are governed by a general Locality Condition, subsuming an adjacency requirement which holds of all tier-internal phenomena. The effects of this requirement are such that the structure in (26b) below is rendered ungrammatical; while the two associated vowels in (26a) are adjacent on their respective tier, the corresponding vowels in (26b) are separated by intervening material, thereby creating a gap (and consequently, a violation of locality) in the multiple association of α .¹⁵

¹⁵Here, I assume the relevant tier to be the moraic tier, which will allow adjacency between vowels, irrespective of intervening consonantal material.

(26) a. multiple linkage

b. 'gapped' configuration



Although the present model does not make use of association lines or multiply linked melodic features as they are employed in standard autosegmental theory, the ungrammatical structure in (26b) does have much in common with the configuration in (25): in both cases, ill-formedness derives from the presence of non-harmonizing material within the melodic span affected by the phonological process in question. Specifically, the present approach shares with A&P the assumption that this interruption in the chain of local (and in the case of the activation account, essentially segmental) harmonic relations should be deemed fatal to the further progress of harmony, by virtue of a very general (or possibly universal) grammatical constraint. This is formalized by A&P as the 'No Gapping Constraint' which, I suggest, may also be appropriate to the case of incomplete alignment described in (25) above. Within A&P's autosegmental approach, this constraint states that a harmonizing property cannot skip over a potential target, while in the context of the activation model motivated above, it ensures that harmony is identified on the basis of an *unbroken* span of activation along a single melodic tier.¹⁶

In contrast, a rather different view of locality is adopted in Optimal Domains Theory (Cole and Kisseberth 1994), henceforth ODT, which encodes the effects of harmony by appealing to the notion of harmonic domains constructed within the constraint-based grammars of Optimality Theory (Prince and Smolensky 1993). Despite the theoretical differences separating OT from the activation model assumed here, it is nevertheless possible to draw a parallel between the two approaches, in terms of the way that the realisation of melody is assumed to refer directly to the scope of prosodic

¹⁶In §4.5.2 I shall address the question of transparent vowels, and reconsider A&P's approach to harmony.

categories in the description of harmony. While element activation may be specified as applying at the level of the foot or the prosodic word, for example, a similar claim is maintained in ODT, such that

a feature F is realized within a phonological constituent, termed an F-domain...In cases of F-harmony the domain has wide scope, defined in terms of prosodic or morphological constituents.

(Cole and Kisseberth 1994:12).

So, the construction of wide-scope harmony domains in ODT serves a purpose that is similar to the role performed by autosegmental spreading in the A&P approach to harmony. And it is precisely this denial of multiple association by the proponents of ODT which motivates their claim that the No Gapping Constraint has no place in their model:¹⁷ they propose that this constraint is '...really only meaningful under the assumption that harmony involves association of a single token of the harmony feature to multiple anchors' (Cole and Kisseberth 1994:8). However, in view of the way that locality is significant to the well-formedness of activation spans (see (25) above), I remain unconvinced of the motives underlying the ODT rejection of locality as a fundamental grammatical notion; instead, I follow A&P in assuming the validity of an adjacency condition on phonological representations in general, and on spans of harmonic agreement in particular. In this way, I shall maintain that harmony may be expressed representationally in terms of a continuous activation span along any given melodic plane.

While the characteristics of vowel harmony in Turkana involve a number of additional complexities not dealt with in this short overview,¹⁸ the preceding discussion should suffice in providing a general illustration of the way the structural proposals set out in chapter 3 may be utilized in the description of a tongue root harmony system such as this. Yet, as revealed by the extensive body of literature covering this area of investigation, we find a certain amount of cross-linguistic variation in the way that the

¹⁷The effects of transparency and opacity are achieved in ODT as a result of language-specific constraint rankings.

¹⁸See references already given for an insight into, for example, the process of low vowel rounding in Turkana and the influence of glides on ATR alternation.

basic harmonic patterns resulting from the word-level instruction **ACTIVATE [COMP]** can differ from one language to another. In view of this apparent diversity, I shall now consider a number of other ATR harmony systems, and attempt to show how the various idiosyncratic properties they display can be incorporated into the theoretical position motivated above.

4.5 Variations on a theme: accounting for systemic diversity

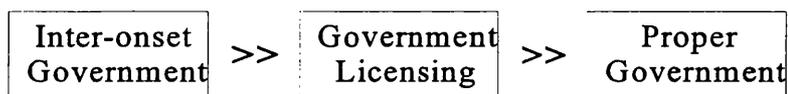
4.5.1 Introduction

As Clements points out, the study of related languages can offer 'interesting possibilities for observing minimal patterns of variation across the same or very similar structural conditions' (1991b:37). In the case of the ATR-harmony systems to be described here we can identify a number of shared structural conditions, such as (i) the use of a melodic template identical to that proposed for Turkana, and (ii) the assumption that the lexical instruction **ACTIVATE [COMP]** is specified as a word-level property. Despite these structural similarities, however, we must also allow for some degree of typological variation within the group of languages displaying tongue root harmony. Here, I focus on two particular areas of variation that are among the most frequently observed: first, I consider the option of recognizing low vowel transparency, as opposed to the opacity observed in Turkana; and second, I explore the possibility of making an apparent tongue root distinction in low vowels. The analysis of Kinande in §4.5.3 will provide an illustration of the proposed grammatical distinction between transparency and opacity, while systems featuring an alternating low vowel are discussed with reference to the Eastern Nilotic language Bari in §4.5.4. It is inevitable that the harmonic systems of these ATR languages will each involve additional complexities and idiosyncrasies which are not immediately relevant to the present discussion; the fact that such details are omitted here does not affect the validity of the points being made.

The analyses to be offered in this section represent something of a departure from the overall theoretical position maintained up to this point. While I continue to assume

that phonological structure is controlled by a set of very general principles of well-formedness,¹⁹ and that cross-linguistic variation is typically captured by means of language-specific parameter settings, I also explore the possibility of allowing such principles to be violated, specifically in order that other, more influential principles may be satisfied.

This kind of approach is by no means unprecedented in the Government-based literature; indeed, several analyses of observed phonological behaviour that essentially adopt a principles-and-parameters view of grammar have relied on a localised form of principle ranking in order to match the empirical facts. In Cyran (1996), for example, it is claimed that the interaction of licensing principles and governing relations is conditioned by the following language-specific hierarchy of principles.

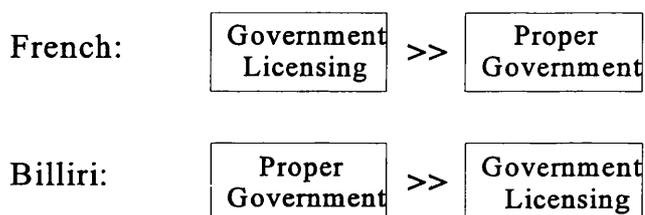


Specifically, it is this ranking that allows a unified description of vowel lengthening and ə~zero alternation in Munster Irish. Briefly, a conflict of principles results in a situation where Government Licensing overrides Proper Government, leading to an instance of 'government (or ECP) failure' (Charette 1990, 1991). This occurs when a melodically unspecified nucleus that is licensed to remain empty (i.e. uninterpreted) via Proper Government is nevertheless realized phonetically. Additionally, we find cases in the same system where ECP failure does not arise when expected to do so, owing to an independent mechanism of Inter-Onset Government also observable in the phonology of Munster Irish. To make the correct grammaticality predictions, governing relations between onsets must be allowed to override the effects of both Government Licensing and Proper Government.

The question of conflicting principles within a Government-based framework was first addressed by Charette (1990, 1991), who also proposes to account for cross-

¹⁹See Kaye (1989) for an overview of the principles/parameters approach to grammatical organisation. For a more detailed treatment, the reader is referred to Kaye *et al.* (1990) and Harris (1994a).

linguistic differences in the behaviour of word-internal empty nuclei in terms of the relative influence of one principle of licensing over another. Drawing on data from French and Tangale, Charette similarly highlights a clash between Proper Government and Government Licensing, forcing an empty (and properly governable) word-medial nucleus to be interpreted whenever it must fulfil the role of government licenser for a preceding governing head. She concludes by proposing the following language-specific rankings:



More recently, Polgárdi (1996) has adopted a parallel approach to the issue of the licensing of domain-final empty nuclei, where she incorporates the notion of ranking into an otherwise principle-driven account as an alternative to the established idea of parametric control.

In these languages where principle ranking is employed, I shall maintain that the fundamental nature of grammaticality — derived from the collective predictions made by very general statements controlling representational well-formedness — remains unaltered with respect to the standard principles-based model. That is, ranking is viewed not as a central feature of the framework, but rather, as a strategy for handling a small number of isolated cases in which two general principles make opposing predictions within a single grammar. In the majority of languages, however, we may assume that every structural principle is permitted to operate freely and without hindrance from any other principle belonging to the universal set. I shall adopt a similar stance in the analyses of ATR harmony to follow, where the basic assumption of a principle-based grammar is preserved, despite the necessary move of allowing principle violations under certain conditions.

As shown by the examples referred to above, it is not clear how these cases of principle clash could be resolved without appealing to the relative weakness of one of the

generalisations involved. That is to say, something must 'give' whenever a direct conflict arises — assuming, of course, that the principles in question can all be independently established as legitimate members of the universal set. In the discussion that follows, for instance, I shall demonstrate how the vowel distribution facts of a small number of languages may be accounted for by allowing Structure Preservation (SP) to be overridden by an Economy Principle that eliminates redundant units of structure from a representation. Given the way that these two notions have been widely exploited in the phonological literature and beyond, there appears to be little problem in motivating the status of both as generalisations expressed within UG. Furthermore, I propose that this universal status is not undermined by the conclusion that SP may be violated in cases where its predictions are rivalled by those of another, equally well established principle of well-formedness. Indeed, we can assume that the effects of SP can still be observed elsewhere in the grammar of those systems which allow a necessary violation of this principle, thereby ruling out structure-changing moves such as resyllabification. To this end, I maintain that my argument in §4.3.3.1 for avoiding any systematic violation of SP (i.e. head switching) across the range of ATR harmony languages is justified, in view of SP's universal presence. Structure Preservation remains an integral component of UG, and must be upheld wherever possible. Instances of grammar-internal conflict, on the other hand, represent infrequent cases that must be resolved on a language-by-language basis; these inevitably call upon a strategy of localised principle violation.

By permitting the introduction of a principle hierarchy, we arrive at a view of grammar that accommodates a significant degree of theoretical overlap between, on the one hand, a representationally-oriented model based on principles and parameters, and on the other hand, a derivationally motivated (although non-serial) approach such as Optimality Theory (Prince and Smolensky 1993) built around the notions of constraint ranking and constraint interaction. As Polgárdi (1996) points out, both are concerned with the formulation of a constraint/principle-based grammar, and differ only with respect to the role that such generalisations are thought to play in determining well-formedness:

GP [Government Phonology] concentrates on issues of representation, while OT on issues concerning derivation. Or in other words, GP deals with the nature of constraints, while OT with their ranking. Since these issues are inter-connected, paying attention to both can only be to one's advantage.

(1996: 596)

In view of this common ground shared by the two approaches, I shall offer analyses of low vowel transparency in Kinande and the *a~ə* alternation in Bari which incorporate aspects of both theoretical viewpoints: while the principles themselves are identified primarily on the basis of representational well-formedness, I propose that the interaction of different principles — and in particular, the conflicting grammaticality predictions that arise from instances of principle clash — provides evidence to support the postulation of dominance relations between principles, determined on a system-specific basis. I begin by motivating the relevant principles.

4.5.2 *Dramatis personae*

To account for the two areas of variation under analysis, it will be necessary to refer to three principles relating to structural well-formedness. These are given in (27):

- (27)
- a. INHERENT STRUCTURE PRESERVATION (ISP)
 - b. PRINCIPLE OF STRUCTURAL ECONOMY (PSE)
 - c. PRINCIPLE OF EXTENSION (PE_x)

The first of these has already been motivated in §4.3.3.1 above, where I proposed a restrictive interpretation of SP as a means of undermining the notion of head agreement as a mechanism for describing ATR harmony. Following the claim that the constraining effects of SP should be observed at all levels of structure, I offered the following generalized formulation:

- (28) **Inherent Structure Preservation**
Lexical head-complement relations must be retained throughout derivation

The 'relations' referred to in (28) — which are established in the lexicon, typically via licensing or government — may hold between any phonological units, whether prosodic (e.g. syllabic positions, projected nuclear heads) or melodic (e.g. element tiers, complement tiers). While nothing appears to prevent us from creating additional head-complement relations during the course of a derivation, there is ample evidence²⁰ for the need to control the ways in which existing asymmetric relations can be manipulated within a structure. I maintain that the responsibility for this control rests with the principle ISP, although it will become evident that in some languages the ideal of preserving lexical structure may be overridden in certain circumstances.

A particular case in point is the interaction of ISP with another principle, the PSE, which I introduce here. PSE amounts to the formal instantiation of a very general criterion of representational simplicity, which I express as follows:

(29) **Principle of Structural Economy**

All structural units must be independently motivated

The PSE effectively acts as a guard against representational redundancy, ensuring that the presence of every structural object in a representation is appropriately sanctioned.²¹ This is usually achieved in one of two ways: either the object is identified by the phonology as a target for lexical activation or for some particular dynamic process, or it plays an active role in maintaining the well-formedness of the structure as a whole (e.g. by acting as a licenser for another unit). At the level of melodic organisation, which is the focus of the analyses below, we observe both of these possibilities for motivating individual units: the appearance of a melodic tier or complement tier in a structure may be justified either on the strength of its lexical specification (i.e. **ACTIVATE** [α]) or otherwise on the grounds that it dominates another (independently sanctioned) tier positioned immediately below it on the sub-segmental hierarchy.

²⁰See Harris (1994a) and Kaye (1995).

²¹The sanctioning of phonological units is, of course, carried out initially by the Principles of Licensing. What the PSE performs is essentially a 'checking' and 'streamlining' operation whereby output structures (resulting from the potential effects of dynamic phonological phenomena) are monitored for redundant properties.

In (30a), for example, both the [A]-tier and the [comp] fail to conform to PSE — neither is lexically active, and neither serves as a licenser for anything else; consequently, these units lack the required functional status prescribed by PSE, and we expect the simplification of structure illustrated. In (30b), on the other hand, the inactive colour tier is present as a functional unit in the structure — it passes on licensing potential to the active [A]-tier — and must therefore be retained. In this case, economy of structure is achieved by the elimination of [comp] alone.



I assume the notion of structural economy to play an essential role in the construction of all restrictive representational models of phonology — if not overtly, then at least implicitly. What PSE amounts to is no more than a formal expression of this general maxim, to the effect that structural simplicity be expressed as a universal constraint on representational well-formedness. My claim, then, is that the influence of PSE may potentially motivate a simplification of structure, thereby dispensing with those parts of a representation deemed superfluous. Clearly, some degree of incompatibility is evident between the two principles motivated here — while ISP is hell-bent on preserving lexical structure, the PSE strives to eliminate it. I will argue in §4.5.3 that the two possible solutions to this conflict of interests will define the typological difference between an ATR harmony system with low vowel opacity (Turkana) and one exhibiting low vowel transparency (Kinande).

Besides the question of opacity versus transparency, however, this discussion also aims to account for another form of typological variation within ATR harmony languages — namely, the grammatical distinction between 9-vowel and 10-vowel systems. To this end, I introduce a third principle, the Principle of Extension (henceforth PEx), which is presented in Cole & Kisseberth (1994) as the motivation behind the specification of

melodic properties at higher levels of the prosodic hierarchy. Within the context of their Optimal Domains Theory (ODT), the authors assume that the key role of melodic primes is to mark contrast, and that primes should therefore be perceptible in order to fulfil that function. They then argue that many properties of phonology, including harmonic agreement, may be viewed as contributing to the enhancement of perceptibility. Specifically, they claim that an individual melodic property should be interpreted over a relatively long span if the criterion of perceptibility is to be satisfied.²²

In an ODT grammar, the Principle of Extension is realized by the family of ALIGN constraints termed Wide Scope Alignment (WSA), which match the interpretation span of a melodic property with a morphologically or prosodically defined domain. Harmony then arises from the interaction of WSA with an independent constraint termed Expression, which ensures that the harmonic feature in question is associated to every potential target within the domain. In the spirit of this ODT view, I acknowledge the validity of a Principle of Extension, which I formulate as (31):

(31) **Principle of Extension**

Extend the domain of **ACTIVATE** [α] to enhance element interpretability

The function of PEx broadly corresponds to WSA, to the extent that PEx and WSA are both responsible for the interpretation of melodic units across domains larger than the segment. A potential drawback of the WSA approach stems from the need to refer to two separate alignment statements (controlling the left and right edges of the relevant span, respectively) in the construction of a harmonic domain. In contrast, under the present proposal a single specification of the relevant prosodic category (e.g. prosodic word) is sufficient to isolate the target string. This results from the unified nature of the melodic-prosodic hierarchy, which ensures that all and only those target positions dominated by — that is, located further down the same licensing path than — the specified prosodic unit can interpret the active harmonic property. On the basis of (31), we may assume that languages exhibiting vowel harmony possess their harmonic characteristics by virtue of

²²Cole and Kisseberth (1994) argue that the notion of articulator stability is also an influential factor in the construction of harmonic domains; however, the presence of intervening consonantal material between harmonizing vowels would seem to invalidate this suggestion.

the dominant influence of PEx in their respective grammars: in order to achieve an extended span of [α]-activation in the phonological string, the relevant lexical activation instruction must be specified at a higher prosodic level such as the *foot* or *word*. In §4.5.4 I shall demonstrate how PEx interacts with ISP to create a formal distinction between the 9-vowel system of Turkana and a corresponding 10-vowel system (Bari) containing an advanced low vowel. A conflict of interests arises once again, which can only be resolved in one of two ways, thus defining the observed typological variation.

Finally, while the principles PSE and PEx are both seen to interact independently with ISP, the ATR harmony systems considered here provide no evidence to indicate any direct involvement between the two principles themselves.²³ The lack of antagonism between PSE and PEx makes their relative rankings inconsequential, with the result that the following 4-way typology is expected on the basis of the three principles in question:

(32)

	<i>neutral a</i>	<i>a~ə alternation</i>	<i>language</i>
ISP > PSE, PEx	opaque	NO: 9-vowel system	Turkana
PEx > ISP > PSE	opaque	YES: 10-vowel system	Bari
PSE > ISP > PEx	transparent	NO: 9-vowel system	Kinande
PEx, PSE > ISP	transparent	YES: 10-vowel system	?

I complete the discussion in §4.5.5 by providing empirical backing for the final principle ranking shown in (32), where low vowel transparency derives from the dominance of PSE over ISP (as in Kinande) and the ranking of PEx over ISP is responsible for the same *a~ə* alternation found in Bari.

²³However, see §5.3 and §5.4 below for instances of principle conflict involving PSE and PEX.

4.5.3 Kinande

The Kinande language²⁴ of Zaire displays a system of tongue root harmony which has much in common with that of Turkana, already described in §4.4 above. The same 9-vowel inventory is exploited, and the same harmonic groupings prevail. However, when we consider the behaviour of the low vowel, we find that the two languages do not always behave in a parallel fashion. In both systems, **a** is neutral with respect to harmony — it fails to participate in harmonic alternations, either as a trigger or a target. Nevertheless, we can still observe a clear difference between the two languages, in terms of the way this vowel affects the propagation of harmony across the word domain: while **a** halts the further progress of harmony in Turkana (i.e. it acts as an opaque vowel), no such blocking effect is found in Kinande (i.e. the low vowel is transparent). (33) illustrates this difference in the behaviour of **a**, where the examples of opacity in Turkana, given in (22) above and repeated here as (33a), are compared with cases of low vowel transparency in Kinande.²⁵ In both languages, roots containing only a low vowel are consistently non-ATR, and therefore take affixes with non-advanced vowels. The Kinande forms are taken from Archangeli and Pulleyblank 1994 (A&P).

(33) a. *low vowel opacity (Turkana)*

ɲi-makuk-yo	(*ɲi-makuk-yo)	'chair' (plural)
ɲi-kiɲim-aan-ot-in	(*ɲi-kiɲim-aan-ot-in)	masc-'deaf'-hab-deverb-pl.
ɛ-maɲ		'liver'

b. *low vowel transparency (Kinande)*

tu-ka-ki-lim-a	(*tu-ka-ki-lim-a)	'we exterminate it'
tu-ka-ki-huk-a	(*tu-ka-ki-huk-a)	'we cook it'
ɛ-mi-hamba		'knives'

²⁴See Hyman (1989), Valinande (1984), Mutaka (1991), and references therein.

²⁵In the absence of any information to the contrary, I shall assume that the vowel **a** retains its 'lowness' in ATR spans, rather than alternating with (a non-contrastive) **ə**.

In (33a) the low vowel has the effect of bringing to an end the span of ATR harmony. The noun root in *ɲɪ-makuk-yo* is lexically ATR, and we expect its tongue root properties to associate to all of the vowels within the word domain. However, the presence of *a* in the leftmost nucleus of the root causes a break in the chain of local harmonic relations along the complement tier and prevents ATRness from progressing further leftwards to the prefix, thus demonstrating the opaque behaviour of the low vowel in this language (see (23) above). Similarly, in *ɲɪ-kɪɲɪm-aan-ot-in* a dominant ATR suffix has no harmonizing effect on the portion of the string to the left of the habitual suffix *-aan*, which contains a low vowel and consequently acts as a harmonic blocker.

The situation in Turkana may be directly compared with that in Kinande, where the low vowel in (33b) has the opposite effect with regard to the progress of harmony across the domain. In the Kinande forms, the verb roots *lim* 'exterminate' and *huk* 'cook' are both ATR, and trigger harmony on other vowels sharing the same domain. In these cases, however, tongue root agreement is observed on *all* potentially alternating vowels, despite the presence of a word-medial low vowel in the prefix *ka-*. In this language, then, ATR harmony is permitted to radiate from the root throughout the entire word domain, effectively 'passing through' the non-harmonizing low vowels *en route*. So, how should this difference between opacity and transparency be treated in the phonology?

There is an extensive body of literature which addresses this question, offering a broad range of solutions conceived from both melodic and prosodic angles. In Hyman (1989) it is claimed that the transparency displayed in Kinande is only apparent, and that low vowels in fact do undergo harmony in an ATR environment. In keeping with the observed data, a late phonetic rule is then assumed to operate, which reassigns the original melodic characteristics to the vowel *a*, thereby giving the appearance of a non-alternating expression. A&P follow a similar line of argument, in which it is proposed that the harmonizing property [+ATR] spreads on to a segment already specified as [+low]. The resulting feature combination of [+ATR] and [+low] is then deemed 'antagonistic'. In response to featural incompatibility of this sort, it is suggested that a neutralization process comes into play:

...the [+ATR] instruction of an advanced low vowel may be neutralized phonetically by the [+low] instruction of such a vowel. In Kinande, it would appear that such neutralization takes place...perhaps by causing an additional expansion of the pharynx by larynx lowering (A&P 1994: 211).

This approach allows A&P to avoid any violation of the No Gapping (i.e. locality) Constraint in the analysis of 'transparent' vowels. So, what appear to be instances of transparency are, according to the Grounded Phonology standpoint taken up by Archangeli and Pulleyblank, the results of an interaction between regular harmonic spreading and so-called 'grounded' conditions (on feature combination) that influence the phonetic output.

In contrast, a parametric approach to the analysis of opacity versus transparency is developed in Odden (1994), where a distinction is drawn between Locality, which applies universally, and Adjacency, which is defined on a language-particular basis. To work in conjunction with the No Crossing Constraint, Odden proposes a universal Locality Condition which ensures that nothing can intervene between two relevant units (e.g. a harmonic trigger and its target) *on the same structural plane*. This interpretation of locality permits a straightforward treatment of transparent segments, on the assumption that such segments are unspecified for the harmonizing property. In the Kinande example *tu-ka-ki-huk-a* 'we cook it', for instance, neither segment of the prefix *ka-* is specified lexically for ATR;²⁶ consequently, the entire morpheme may stand between the harmonic trigger to its right and the harmonizing vowel to its left, without resulting in any violation of locality.

In the theoretical context assumed by Odden, the Locality Condition effectively places no limit on the amount of melodic material that may potentially intervene between a harmonic trigger and its target. While this situation accords with the transparent behaviour of neutral vowels in languages such as Kinande, it fails to accommodate the cases of opacity found in, for example, Akan and Turkana. In these systems, the presence of a non-harmonizing (low) vowel prevents harmonic relations from holding between units either side of it, despite the locality requirement (according to Odden's interpretation

²⁶In a melodic representation based on binary features, the low vowel would presumably be assigned the default [-ATR] value via a redundancy rule.

of Locality) having been met. In response, Odden (1994) proposes a set of Adjacency Parameters which impose further conditions on the separation between trigger and target:

- (34) **Syllable adjacency:**
trigger and target must occupy adjacent syllables (ON/OFF)

Root adjacency:
the root nodes of the trigger and target must be adjacent (ON/OFF)

In instances of low vowel opacity, the syllable adjacency parameter is assumed to apply alongside the Locality Condition, resulting in a breakdown of harmony whenever a neutral vowel (occupying a separate syllable) is present between a potential trigger and target. The grammatical distinction between transparency and opacity in harmony systems is thus captured by Odden in parametric terms, where the parameters determine the relations between harmonizing units, rather than the characteristics of the neutral segments themselves.

A rather different kind of approach is adopted in Cole and Kisseberth (1994). As mentioned briefly in §4.4.3 above, this work attempts to characterize vowel harmony patterns in terms of a theory of harmonic domains (Optimal Domains Theory, or ODT) constructed within an Optimality-based framework of constraint ranking. In ODT it is proposed that different rankings of the same set of constraints will predict both opacity and transparency of the low vowel in different tongue root harmony systems. Specifically, the following hierarchies are given:

- (35) Transparency: CLASH *[Low, ATR], WSA >> EXPRESSION
Opacity: CLASH *[Low, ATR], EXPRESSION >> WSA

In both cases, the feature occurrence (CLASH) constraint marks the combination of [low] and [ATR] as ill-formed; this effectively prevents the harmonic feature [+ATR] from associating to an expression already specified as [+low] (i.e. it renders the low vowel neutral with respect to harmony).

In languages with low vowel transparency, such as Kinande, the constraint WIDE SCOPE ALIGN — which extends a harmonic domain to the edge of a prosodic or

morphological constituent — dominates EXPRESSION, which forces the interpretation of the harmonic feature on every anchor in the domain. This particular ranking creates a situation in which priority is given to the construction of a harmonic domain corresponding to an entire prosodic word, resulting in some vowels within that domain — namely, the transparent low vowels — failing to be affected by harmony. In contrast, instances of opacity are characterized by a reversal of this dominance relation, one in which WIDE SCOPE ALIGN lies below EXPRESSION in the constraint ranking. Accordingly, the optimal configuration in this instance must be a harmonic domain (although not necessarily one corresponding to a prosodic word) where [ATR] is interpreted throughout, thereby conforming to the undominated constraint EXPRESSION. Given the neutrality of *a*, this vowel stands in violation of EXPRESSION, and is therefore assumed to be located outside the domain of harmony; in other words, the presence of a low vowel necessarily marks the extent of an ATR domain, its opaque behaviour effectively blocking the progress of harmonic agreement beyond it. So, the behaviour of neutral vowels in ODT is determined by the parametric rankings of (presumably universal) constraints, rather than by the effects of specific structural parameters of the kind proposed by Odden.

For an Element Theory view of the distinction between low vowel transparency and opacity, I refer to the typological survey of ATR harmony languages offered in Cobb (1997). Using the languages Akan and Vata as examples of opacity and transparency respectively, Cobb claims that both systems are subject to the parametrically controlled licensing constraint *A cannot be a head*, which entails that the low vowel, represented as a headless [A] element, cannot show up as a headed [A] even in a headed (i.e. ATR) domain. For both systems she then follows the analysis of Vata proposed in Walker (1995) and assumes that the [A] element of the low vowel delinks in response to its inability to become a headed expression, thereby leaving a melodically unspecified nucleus. This is interpreted as \mathfrak{z} [] in Akan and as Λ [] in Vata.

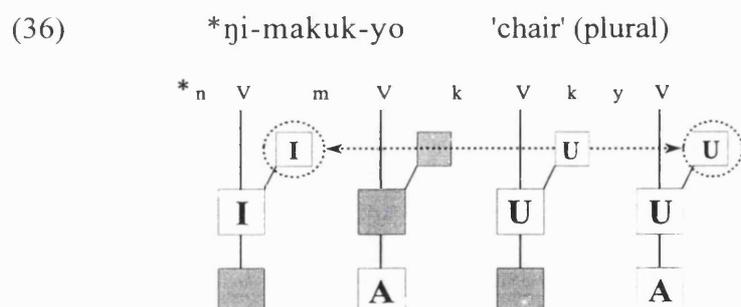
In order to distinguish between opacity and transparency in these two systems, Cobb makes appeal to the particular way in which the mechanism of h-licensing interacts with the established licensing constraint *A cannot be a head*. Briefly, h-licensing (see Walker 1995) is initiated by a headed expression occupying the domain-final nuclear

position of an h-marked domain. Identified as a suitable h-licensor, this domain-final headed expression can then proceed to license headedness in an adjacent nucleus which it h-governs; this process is iterative, thereby creating a chain of successive h-governing relations throughout the designated ATR harmony domain. The relevant issue here concerns the way the unspecified nucleus [] behaves with respect to h-licensing. Given that this expression is melodically empty — that is, it contains neither a head element nor any dependent elements — we might expect it to pattern with the headless vowels of an ATR harmony language in a systematic way. However, this is apparently not always the case. Specifically, an empty nucleus acts as a headless expression (i.e. as a non-h-licensor) only in languages such as Akan, that exhibit low vowel opacity. In contrast, it is claimed by Cobb that the same unspecified nucleus can also behave as though it were a headed expression (and therefore, a good h-licensor); this is the case in low vowel transparency systems such as Vata.

The actual distinction between opacity and transparency is derived as follows. Being identified as a headed expression, the empty vowel in Vata acts as an appropriate h-licensor for the nucleus it h-governs; it can therefore license a headed expression in the neighbouring nucleus and maintain an unbroken chain of h-governing relations across the harmony domain. Since the empty nucleus can both receive and pass on headedness properties via h-licensing, it may be treated as transparent. In comparison, the empty vowel in Akan is (somewhat arbitrarily) not identified as an h-licensor and, as an unlicensed unit, is projected up to the next level of structure where it "intervenes between the h-governor and other potential h-governees in the string" (1997:104). Consequently, the h-licensing chain is broken and the low vowel manifests its opaque properties. While this description deals adequately with the facts, there appears to be no formal means of capturing this opacity~transparency distinction in the grammar. Both system types exploit the same licensing constraints and both make use of an unspecified nucleus as the 'ATR' counterpart of the low vowel [A]. Whether or not the empty vowel is assigned h-licensing properties appears no more than a matter of stipulation — something that could be described equally well using, for example, a YES/NO parameter controlling opacity.

In response to this solution proposed in Cobb (1997), which cannot, it appears, be explicitly encoded in the standard Element Theory grammar, I now motivate an

alternative account of a similar set of facts based around the model of tier geometry employed in the analysis of Turkana above. Despite the apparent theoretical differences separating the constraint-based OT view from the representation-based model motivated in the previous chapter, I shall argue that their respective approaches to the question of neutral **a** are founded on the same fundamental notion — namely, the relative dominance and influence of one general principle over another. In §4.4.3 above I argued that harmonic agreement could be achieved via a series of harmonic relations, each holding between adjacent units along a given melodic plane. As already noted, this requirement amounts to a specific instantiation of a more general condition on locality, the violation of which proves sufficient to render the configuration in (36) ungrammatical in the grammar of Turkana. The ill-formed status of **ŋi-makuk-yo* (grammatical form *ŋi-makuk-yo*) manifests itself as an interruption in the span of activation along the [comp] tier, as illustrated:



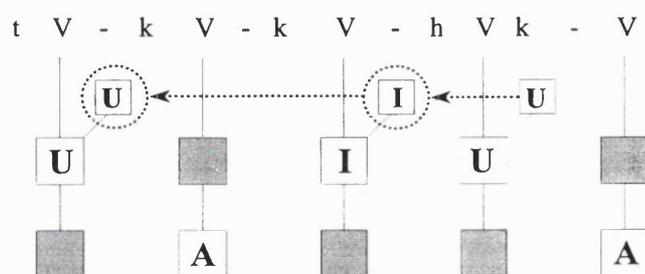
Here, this violation of locality corresponds to a breakdown in the transmission of the lexical activation instruction, the absence of an active [comp] in the low vowel being responsible for such a breakdown. And yet, it seems that the ungrammatical structure in (36) is exactly the kind of representation which is required for the well-formed strings involving transparent **a** in Kinande: recall the grammatical status of attested forms such as *tu-ka-ki-huk-a* 'we cook it'. So, how should we best approach the apparently paradoxical nature of structures such as (36)?

Perhaps the simplest solution would be to assume that the condition on locality can be relaxed in particular systems — that a locality violation is fatal to the

grammaticality of word-level activation in some languages (i.e. those with low vowel opacity, such as Turkana) but not in others (i.e. those exhibiting transparency, such as Kinande). I argue, however, that the integral and fundamental nature of the notion of locality prevents us from adopting such a view. The phonological literature provides a substantial amount of evidence in favour of a locality condition as a general constraint on structural well-formedness, this support coming from a variety of different theoretical traditions. Furthermore, the idea of locality is well motivated in other parts of the grammar too.²⁷ It seems unlikely, therefore, that a condition requiring grammatical relations to be necessarily local could be 'switched off' in a language such as Kinande (or manipulated on a language-by-language basis, as proposed in Odden's Locality Theory), merely in order to allow for [comp] activation to bypass a neutral vowel. Even less likely would be a situation in which locality were selective in its domain of application — where the constraint could contribute to the grammaticality of licensing relations between prosodic constituents, for instance, but at the same time could be suppressed with respect to the construction of harmonic activation spans.

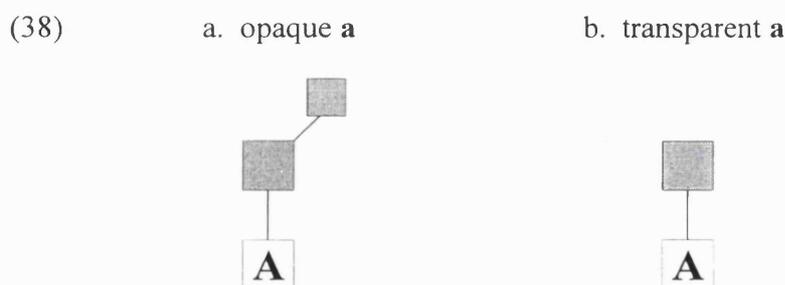
So, in view of the integral nature of the locality requirement, I suggest that an alternative approach to low vowel transparency must be sought, one in which locality is preserved, and yet, one in which the span of [comp] activation can still effectively 'skip over' the harmonically neutral low vowel **a**. I suggest that this may be achieved by assuming the structure in (37). In the spirit of Odden's parametric adjacency, the burden of explanation is borne by (the relations holding between) the harmonizing units, rather than by any of the properties of the intervening neutral **a** segment.

(37) *tu-ka-ki-huk-a* 'we cook it'



²⁷See Manzini (1992) for a discussion of the role of locality in syntactic structure.

In this configuration, the active [U]-comp and active [I]-comp of the two high vowel prefixes are adjacent on their melodic tier. The absence of any [comp] slot in the melodic template of the intervening low vowel **a** allows the lexical activation instruction to construct a harmonic span right up to the left edge of the word domain; crucially, this is achieved without any violation of the condition on locality. However, assuming that the configuration in (37) constitutes a well-formed structure in Kinande, the following question must be addressed: how does the grammar of this language generate a melodic template for low vowels which differs from the template which has been established for other vocalic expressions?



I propose that the structure in (38b) — the representation of the transparent low vowel in Kinande — demonstrates the effects of the PSE given in (29) above, such that any structural unit which fails to be phonologically motivated, is eliminated. The PSE may be viewed as the formal instantiation of a very general criterion of representational simplicity. In the case of the colour complement belonging to the structure in (38b), the 'independent motivation' prescribed by the PSE fails to be observed; the [comp] of a low vowel does not license anything else, and furthermore, it can never be activated, since its licenser (the colour tier) is necessarily inactive itself. I shall claim that, in Kinande, the selection of the structure in (38b) over that in (38a) as the appropriate representation of the low vowel is determined on the basis of the dominant behaviour of the PSE in that language. So, the difference between the behaviour of the low vowel in Turkana and the behaviour of the same vowel in Kinande reflects the choice between a full melodic template and a truncated one, respectively. I shall claim that a grammar in which the latter is permitted (e.g. Kinande) must be more strongly influenced by the PSE than an

otherwise similar grammar in which the full melodic template is maintained throughout.

In terms of its theoretical significance, the PSE may be placed alongside other influential principles such as, for example, Licensing Inheritance (LI) and Inherent Structure Preservation (ISP). A distinguishing characteristic of principles such as PSE, LI, and ISP is that they are seldom violated — in other words, a strict adherence to these requirements is typically regarded as an absolute grammatical necessity. From the present study of ATR harmony systems, however, it emerges that this state of affairs does not always hold. Specifically, I claim that, in the grammar of Kinande, the pressure to conform to the PSE — which is achieved by eradicating the redundant complement tier from the representation of low vowels, resulting in the configuration in (38b) — leads directly to a violation of ISP, brought about by the destruction of a lexically established licensing relation between the colour tier and its [comp]. In contrast, a language such as Turkana, which features low vowel opacity, employs the structure in (38a) to represent the low vowel. While successfully conforming to ISP — since all relations holding lexically are retained at all levels — this is achieved at the expense of a PSE violation, where the structural unit [comp] is preserved in the representation.

It might be assumed that the truncated configuration in (38b) should be regarded as the only structural option permitted to appear in these circumstances. That is, we might expect the superfluous licensing relation between the inactive colour tier and its inactive dependent [comp] to be eliminated simply as a matter of course. I shall argue, however, that such a move cannot be taken for granted, owing to the universal applicability of ISP and the command that this fundamental principle exerts over the way representations may be manipulated in general. Indeed, it is the influence of ISP which motivates the claim in §3.2.3 that a full melodic template is present under every nuclear position (thereby delimiting the range of contrasts that the position can potentially support).

As mentioned in §4.5.1, the option of allowing ISP to become violated in the description of harmonic transparency does not necessarily compromise the universal status of this principle. The preservation of licensing relations in Kinande will presumably still be enforced with respect to other parts of the structure (thus leaving syllable structure intact, for example). In other words, the violation of ISP amounts to a localised effect, permitted solely as a strategy for handling the direct conflict between it

and the PSE, which arises exclusively in relation to the progress of word-level [comp] harmony. I maintain, therefore, that the force of ISP allows the configuration in (38a), with its empty [comp] slot, to exist as a well-formed structural unit and potentially halt the progress of local licensing relations across the harmonic domain. This state of affairs will persist unless ISP is specifically overridden in such a way as to force representational streamlining (and the elimination of the [comp] unit), as occurs in the grammar of Kinande.

So, the relevant distinction between the grammars of Kinande and Turkana may be formalized in terms of the following principle rankings:

- (39) Kinande (transparent **a**): PSE >> ISP
 Turkana (opaque **a**): ISP >> PSE

It seems entirely appropriate to recognize this comparison between the two systems as an essentially Optimality Theoretic (OT) approach to the facts, in view of its focus on the postulation of a hierarchy of general constraints, which are subject to different (language-particular) rankings that account for cross-linguistic variation. More specifically, the analysis reflects the fundamental nature of OT as a theory of constraint *interaction*, by highlighting the antagonistic nature of the relationship between the two principles under scrutiny, ISP and the PSE. While the majority of the well-formedness principles — such as the OCP, Licensing Inheritance, and other principles controlling phonological licensing — are free to operate independently of each other (i.e. the effects of one principle do not interfere with the effects of another), the same cannot be said of ISP and the PSE. What we observe is a tension between the two, which stems from the opposing predictions each one makes as to the overall grammaticality of a given structure. Pulling in one direction is the influence of ISP, which disallows any modification of the lexically established melodic template, while pulling in the opposite direction we find the effects of the PSE, which induces structure simplification.

I assume that both principles have universal application — i.e. that they are necessarily present in the grammars of all languages — and that, in the majority of cases, their respective predictions do not create any observable conflict. In some systems, however, we encounter instances where ISP and the PSE do interact, each generating a

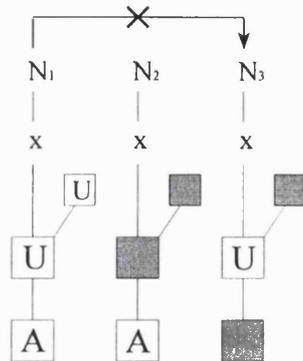
different grammatical outcome. In these cases, the tension between the two principles must be somehow resolved: one must be relaxed (i.e. become subject to violation) in order that the other may be allowed to make its contribution to overall well-formedness, since only one of the potentially generated structures will match the attested facts. I claim that, in languages exhibiting low vowel opacity (e.g. Turkana), the conflict between ISP and the PSE is resolved by allowing the former to dominate, thereby suppressing the effects of the PSE. If the PSE is prevented from exerting any influence on the shape of the generated structure in this way, then no simplification procedure will operate, even on those units deemed representationally redundant. As a direct result, low vowel structures such as that in (38a) are created, which act as harmonic blockers. Conversely, in systems such as Kinande, it is the PSE which is favoured over ISP;²⁸ this allows the elimination of redundant material, causing all low vowels to be represented as in (38b), and thereby assigning them their transparent properties.

It has been suggested by van der Hulst (p.c.) that an alternative account of the distinction between low vowel opacity and transparency — crucially, one which does not rely on the incorporation of principle ranking — is also conceivable in this theoretical context. Such an approach makes appeal to the difference between minimal and maximal scansion, as explored by Archangeli & Pulleyblank (1992). As in the case of Odden (1994) discussed above, this line of argument maintains that the success of a harmonic relation is bound by a criterion of locality existing between trigger and target *at some level of projection*, and attempts to account for differences in harmonic behaviour by identifying which part(s) of the phonological representation are accessible or visible to the harmonic mechanism in different systems.

If the harmony process applies to a string that includes information on its prosodic structure — and in particular, one in which syllable heads are identified — then the locality requirement prevents non-adjacent nuclei from supporting a harmonic relation between them. This position is illustrated as follows:

²⁸To reiterate, the effects of the dominated ISP will, of course, be observable whenever this principle is not in conflict with a higher-ranked principle; this ensures a ban against non-structure-preserving events such as resyllabification.

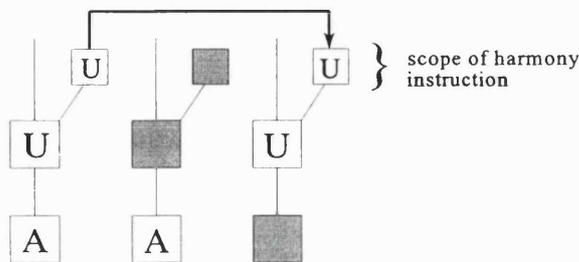
(40) *maximal scansion (opacity effects)*



Since the nuclear positions N_1 and N_3 in (40) are not prosodically adjacent, they are unable to contract a harmonic relation. At the point in the string marked by N_2 therefore, the harmonic span is halted and this intervening vowel N_2 may be analysed as an opaque segment. So, from maximal scansion of the representation we derive the opacity effects observed in languages such as Turkana.

In contrast, a case of minimal scansion may be seen as involving adjacency at the melodic, rather than the prosodic level. Essentially, two autosegments (here, two lexically activated elements) are deemed to be adjacent if (i) they occupy the same tier and (ii) no other autosegment intervenes. So harmony, together with the locality restriction that controls harmonic relations, refer only to a single melodic tier — in the present case, to the complement tier.

(41) *minimal scansion (transparency effects)*



Given that no lexically specified active element intervenes between the harmonic trigger in (41) and its potential target, the two nuclear positions are taken to be melodically

adjacent, and therefore able to contract a harmonic relation. This analysis in terms of minimal scansion gives rise to harmonic transparency effects of the kind observed in Kinande.

For the moment, it must remain a matter for debate as to whether the minimal versus maximal scansion approach to neutral vowels can be successfully incorporated into a principles-driven model of vowel structure such as the one developed here. Clearly, however, its formal simplicity makes for an appealing alternative to the notion of principle ranking which provides the main thrust of this discussion of typological variation. To summarize the theoretical position presented so far, I maintain an assumption which is widely supported in the contemporary literature, that phonological representations across different languages are controlled by a set of very general, universally applicable principles on structural well-formedness. Members of this set include the Locality Condition, the OCP, Structure Preservation, the PSE, and those principles determining licensing relations between constituents. Although these principles are not generally subject to violation, an exception is brought to light in cases where two principles make conflicting predictions, as observed in the interaction between ISP and the PSE in some ATR harmony systems. The 'antagonism' existing between these two principles — which are both independently motivated in the grammar — must be resolved on a language-by-language basis, ruling in favour of one principle over the other as the dominant criterion in any given system. So, the choice between low vowel transparency and low vowel opacity in harmony systems is ultimately as random as the choice between, for example, left-headedness and right-headedness in sentence structure, where it is not possible for both — or neither — to hold within any one language. A system conforming to both ISP and the PSE must select one or the other as the favoured characteristic in determining overall well-formedness: because their respective grammaticality predictions inevitably conflict, the effects of one principle must override the effects of the other.

4.5.4 Bari

While the previous section has highlighted the kind of cross-linguistic variation we can expect to find with regard to the behaviour of neutral vowels, this subsection aims to account for another area of divergence observed between (otherwise very similar) tongue root harmony systems. I refer to the option of recognizing an ATR counterpart of the low vowel, thereby creating a symmetrical 10-vowel system. Given the incompatibility between an active [comp] and an inactive colour tier, I shall argue below for the analysis of this apparently ATR low vowel as the manifestation of a melodically empty nuclear position. A 10-vowel system characterizes a number of languages, including Vata (Kaye 1982), Okpe (Pulleyblank 1986) and Akan (Clements 1981). The Eastern Nilotic language Bari — a close relation of Turkana — is also a member of this set, and will be used here to exemplify the structural differences under investigation.

The vowel harmony system of Bari is described in Steinberger and Vago (1987), from which my data has been taken.²⁹ The issues I address here arise from the division of the Bari vowel inventory into the following harmonic groupings, where each member of the non-ATR group recognizes an ATR counterpart with which it alternates:

(42)	<i>ATR set</i>	<i>non-ATR set</i>
	i u	ɪ ʊ
	e o	ɛ ɔ
	ə	a

In terms of vocalic distribution, Bari is distinguished from Turkana by the presence of an additional (tenth) vowel — the ATR correlate of **a** — which I represent as **ə**.³⁰ The harmonic behaviour of the vowel pair **a/ə** parallels that of other alternating pairs, where **ə** occurs in ATR domains while **a** appears in non-ATR environments. Below, I examine

²⁹Particular aspects of this language's harmonic properties are also considered in van der Hulst & Smith (1986).

³⁰Steinberger and Vago (1987) describe this sound as a centralized low vowel, for which they use the Bari orthographic symbol **ö**. In an effort to mirror the phonological properties of this vowel, I shall employ the symbol **ə** here, although **ä** may be equally appropriate.

the relation between **a** and **ə** in this language, and attempt to account for the phonological properties of these vowels within the context of the model assumed here.

Harmonic patterning in Bari closely resembles that observed in Turkana, to the extent that the language exhibits both root controlled harmony and dominant harmony. In the majority of cases, the ATR value of the root or dominant suffix is transferred to all vowels within the word domain, as the following examples illustrate. (43a) shows the alternating behaviour of a prefix vowel within the context of a verb root which is lexically ATR, while (43b) highlights the effects of a dominant ATR suffix on a lexically non-ATR noun root:

- (43) a. **Root-controlled harmony**
 tɔ-mɔk 'embrace'
 to-muk 'cover each other'
- b. **Dominant harmony**
 kɔrɔdɔʔ 'rubbish'
 korodo-ti 'a piece of rubbish'

On the basis of these examples, it appears that harmony in Bari follows a pattern which is comparable to the one already established for Turkana.

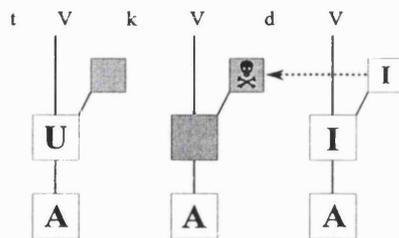
A further similarity between the two systems is observed in the behaviour of the low vowel. The following forms suggest that **a** in Bari shows opaque properties: the low vowel in (44) does not alternate (i.e. it can co-occur with ATR vowels in the same morpheme); furthermore, it blocks the advancement of ATR harmony across the domain.

- (44) a. kade 'different' lele 'bald'
 b. kadel-ək 'different' (pl.) lely-ak 'bald' (pl.)
 c. tɔ-kade 'difference' tɔ-lele 'baldness'

(44a) compares an inherently non-ATR morpheme *lele* 'bald' with a root which is lexically ATR (the presence of an ATR mid vowel in *kade* 'different' is indicative of ATR status). This difference is confirmed by (44b), in which the ATR alternant of the plural suffix is selected by the ATR form, to give *kadel-ək* 'different (pl.)', whereas the

non-ATR alternant is chosen by $l\epsilon l\epsilon$, resulting in the form $l\epsilon ly-ak$ 'bald (pl.)'. I shall discuss below the nature of the $a\sim\text{ə}$ alternation which is highlighted by this plural suffix. In (44c), however, we find that both adjectives take the non-ATR form of the alternating prefix $t\text{ɔ}-$. In the case of $t\text{ɔ}-kade$ 'difference', we may assume that this results from the opaque behaviour of **a** in this language, which blocks the leftward propagation of ATR harmony. This is captured in (45):

(45) $t\text{ɔ}-kade$ (* $t\text{ɔ}-kade$) 'difference'



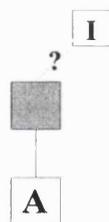
Low vowel opacity is also evident in examples containing a dominant ATR suffix. In the form $biran-ti$ 'a type of shrub' the medial vowel **a** is responsible for the failure of ATR harmony to reach the first vowel of the root; accordingly, the string * $biran-ti$ is ill-formed.

On the strength of the examples considered so far, it might seem appropriate to analyse vowel harmony in Bari using grammatical and structural conditions identical to those assumed in the case of Turkana above. Yet clearly, the alternating suffix in (44b) fails to support this approach; instead, the $a\sim\text{ə}$ alternation highlights an additional complexity in the phonology of Bari — namely, the frequent (though not entirely systematic) interpretation as ə in exclusively ATR contexts. While unobserved in prefixes, this centralized vowel is widespread in suffixes:

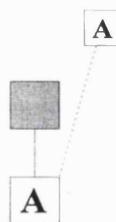
(46) <i>ATR domain</i>		<i>non-ATR domain</i>	
mug-gə	'cover' (indef.)	mug-ga	'store' (indef.)
muk-ə	'be covered'	muk-a	'be stored'
kadɛl-ək	'different' (pl.)	lɛly-ak	'bald' (pl.)

As (46) shows, the alternation between **a** and **ǣ** operates on the same basis as any alternating pair of non-low vowels: the central vowel belonging to the ATR harmonic set appears in an ATR domain, while its non-ATR counterpart **a** appears elsewhere.³¹ The inclusion of an ATR low vowel in the phonological system of a language such as Bari presents immediate problems for an analysis based on the fixed melodic template assumed throughout this discussion. As a result of the way in which the template is configured, the possibility of licensing an active complement tier (i.e. the phonological manifestation of ATRness in this system) in an expression involving only an active [A] element is categorically ruled out, since no potential licenser (in the form of an active colour tier) is available. The ill-formed status of such a configuration is illustrated in (47a), where an inactive head tier sanctions an active complement tier.

(47) a. *constituent licensing fails



b. *ISP violated



This structure fails to maintain the general pattern established for constituent licensing, which requires a head to be non-empty (see §3.2.3 above) in order to license its complement (e.g. within a branching onset or nucleus). As already discussed, the alternative in (47b) must also be rejected, on the grounds that it constitutes a violation of ISP.

So, how should the ATR low vowel of Bari be incorporated into the grammar? One potential solution may derive from the possibility that the melodic template proposed for this language is *not* identical to that assumed for Turkana — but rather, that the vowel

³¹Although the **a**~**ǣ** alternation operates systematically in suffixes, there are several examples of disharmonic roots in Bari where **a** is interpreted within a form lexically specified as ATR: e.g. *kade* 'different'.

system of Bari is generated by an altogether different configuration which *can* represent the alternation involving **a** and **ə**. I suggest that, on the whole, the evidence does not weigh in its favour. Setting aside the question of the central vowel **ə**, the two systems appear to have much in common phonologically: they exploit a similar set of vowel contrasts and adopt the same basic pattern of harmonic distribution; historically, they are closely related languages, and there is no indication of one system being any more marked or less marked than the other. All in all, there seems ample justification in assuming that both are appropriately described by referring to the same melodic template.

This being the case, I shall claim that there remains only one feasible approach to the analysis of the **a~ə** alternation in Bari — which is to assume that the central vowel **ə** is not, in terms of its melodic composition, the ATR counterpart of **a**. Instead, I propose that **ə** may be treated as the phonetic manifestation of a phonologically 'empty' nuclear position (i.e. one in which all lexically specified activation instructions fail to be interpreted) — a situation arising, once again, from a conflict between the well-formedness predictions made by two very general structural principles.³² In this instance, the principles in question are ISP — which, I have already argued, plays a crucial role in the distinction between low vowel transparency and opacity — and the Principle of Extension (PEX), motivated in §4.5.2 in connection with element activation in larger prosodic domains. Recall that the PEX, which is fundamental to the ODT (Cole & Kisseberth 1994) account of harmony, acts as the driving force behind the construction of harmonic domains extending beyond the scope of a minimal prosodic unit (such as the word-level domains under scrutiny here), stating that a melodic property should be extended over longer strings of sound in order to enhance its interpretability. Here, I follow ODT in assuming that the harmonic characteristics of systems such as Bari stem from the overriding influence of PEX in the grammars of these languages.

In chapter 3 I argued that the successful interpretation of an element depends on both melodic and structural conditions being met: in order to interpret a low vowel **a**, for example, the lexical instruction **ACTIVATE [A]** must be specified, and additionally, the

³²A similar conclusion is reached in Backley & Takahashi (1996), where the ATR low vowel in Akan is also analysed as a melodically unspecified nucleus.

relevant tier in the melodic configuration must be licensed to be active. Accordingly, we can identify only an indirect relationship between the activation of [α] and the interpretation of [α] — while interpretation necessarily entails activation, the reverse does not hold (see §3.3.3 for a discussion of the structural conditions required for successful element interpretation). As a result of this partial independence between the activation of an element and its interpretation, there are no grounds for ruling out the possibility of an individual lexical entry such as that given in (48a), which contains an activation instruction which is not readily interpretable using the structure available:

- (48) a. ACTIVATE [A]
 ACTIVATE [COMP]
 ▽
 ▽
 kət 'clear away'
- b. ACTIVATE [A]
 ▽
 ▽
 ▽
 jam 'talk'

We must assume that the lexical specification for *kət* 'clear away' includes the instruction **ACTIVATE [COMP]**, since this root contains a vowel belonging to the ATR harmonic set, and furthermore, it triggers [comp] harmony on affixes (e.g. *kət-ə-ni?* 'be cleared away'). Yet, in the absence of any lexical instruction to activate either [I] or [U], the contrastive potential of **ACTIVATE [COMP]** is effectively lost, owing to the lack of a suitable licenser for [comp] (i.e. the necessary structural conditions for the activation of the complement tier fail to be met).³³ In the case of a system such as Bari, I claim that the melodic distinction between (48a) and (48b) may be accounted for in terms of the dominant influence of PEx.

Following Cole and Kisseberth (1994), I assume that the notion of interpretability is central to the formulation of PEx: given that the primary role of melodic properties is to create phonological contrast, we should expect those individual properties to be easily interpretable — and to that end, should be active over a sufficiently long span. However, looking at the two activation instructions specified in the lexical form of (48a), we predict that the active [comp] will have no contrastive effects at all, in view of the limitations on

³³In a 9-vowel system such as Turkana, we can predict that this situation would result in a neutralisation of the two lexical expressions given in (48a) and (48b), so that the vowels of the hypothetical forms *kat* (ATR) and *jam* (non-ATR) would be indistinguishable.

element combination imposed by the melodic template. I propose that this result must constitute a violation of PEx, since [comp] is uninterpretable even on the vowel of the verb root,³⁴ let alone across a larger domain. While it is clear that this situation can be tolerated in the grammar of a language such as Turkana (where the low vowel does not alternate), it is equally apparent that the same outcome is deemed ill-formed in Bari. The evidence comes in the form of an alternation between **a** and **ə**, where the latter identifies a lexically low vowel within an ATR domain.

I shall claim that it is the relative influence of PEx on overall well-formedness which is responsible for the typological difference between a 9-vowel system like Turkana and a 10-vowel system such as Bari. In Turkana it appears that PEx is relatively weak, and its violation is permitted under certain circumstances (to be defined below); hence, the low vowel **a** is not compelled to alternate, simply in order to register the presence of an ATR domain. In contrast, the influence of PEx in Bari is rather stronger, as illustrated by the way in which the low vowel can encode the difference between active [comp] and inactive [comp], thus ensuring that a potential opposition is not neutralized.

Without allowing for the possibility of a localised form of principle ranking, it is far from obvious how this distinction between an alternating (**a**~**ə**) and a non-alternating low vowel can be formalised within an Element Theory approach. Cobb (1997) compares the alternating low vowel of Akan with the non-alternating **a** of Pulaar (which is uniformly interpreted as **a** in both ATR and non-ATR contexts). Her claim is that both systems are subject to the parametrically controlled licensing constraint *A cannot be a head*, which entails that the low vowel, represented as a headless [A] element, cannot show up as a headed [A] even in a headed (i.e. ATR) domain. To reiterate, in the case of Akan, Cobb follows the analysis of Vata given in Walker (1995) and assumes that the [A] element of the low vowel delinks in response to its inability to become a headed expression, thereby leaving a melodically unspecified nucleus: hence, non-ATR **a** [A] alternates with 'ATR' **ə** []. In contrast, Pulaar handles the ill-formed status of [A] in a different way — specifically, by allowing the representation of the low vowel to remain as [A]. This option leads to a uniform interpretation **a** in both harmonising and non-ATR

³⁴While it may be argued that the contrastive properties of [comp] will be observed in affix vowels, this cannot be guaranteed — affixes are equally likely to contain only a low vowel.

domains.

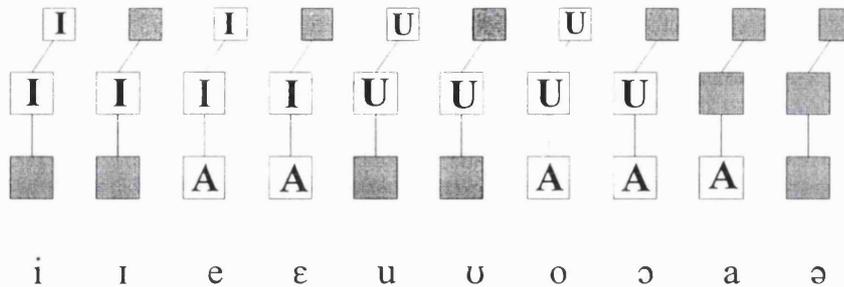
So in Cobb (1997) Akan eliminates the element [A] because it cannot become headed, while Pulaar leaves [A] intact for the same reason. Furthermore, there seems to be no explicit way of formalising this difference in the grammar — something that Cobb acknowledges by describing the comparison as an "example of variation with respect to the outcome of identical derivations" (1997:177). However, we might expect the choice between the delinking of A and the preservation of A in the melodic structure to be something encoded grammatically, in the way that other instances of element loss have been treated in the literature (by making appeal to Licensing Inheritance, for example). Instead, a formalised account of this difference — and hence, the distinction between the 9-vowel system Turkana and the 10-vowel system Bari — would seem problematic for the standard Element Theory model.

Returning to the proposed tier-geometric account which incorporates principle ranking, there are two questions that remain unanswered. First, if the vowel ə is not a genuine ATR counterpart of a, then how is it to be represented phonologically? And second, what motivates the claim that PEx has a stronger or a weaker influence in one grammar than it does in another? I address both of these issues below.

Given that PEx enjoys a relatively high profile in the grammar of Bari (in OT terms, it occupies a highly ranked position in the constraint hierarchy), it seems important that we identify a melodic configuration for ə which does not bring about the neutralization of any existing lexical vowel contrasts.³⁵ If the representation of ə must correspond to a melodic structure not exploited elsewhere in the phonological system of this language, then it seems that only one possibility presents itself: in the context of the proposed melodic template, the vowel transcribed as ə must be the interpretation of a phonologically empty position, since all other melodic configurations define lexically contrastive vowels. The 10-vowel system of Bari is therefore represented as follows, where all possible permutations of active elements are exploited:

³⁵If it were claimed that ə consisted of, for example, active [I] and active [A] — which already describes the non-ATR mid vowel ɛ — then the analysis would be of little explanatory value, since this would constitute a violation of PEx in much the same way as a non-alternating low vowel would.

(49)



Evidence to support this analysis of ə comes from the fact that the phonetic quality of the 'tenth vowel' (i.e. the 'ATR' counterpart of **a**) in other 10-vowel ATR harmony languages is subject to a significant degree of cross-linguistic variation. While a centralized low vowel ä is observed in Bari, a phonologically empty nucleus in Maasai suffixes is interpreted as **o**.³⁶ In Akan, on the other hand, we find a range of different interpretations according to dialect, including æ, ɛ, e and ɜ.³⁷ I suggest that the absence of stable or uniform phonetic properties in the ATR low vowel of these systems is indicative of this vowel's true phonological identity as a melodically unspecified expression. This argument builds on the assumption established in the Element Theory literature, that the precise phonetic manifestation of a phonologically empty nucleus is determined on a language-particular basis.

In melodic terms, then, the distribution of **a** and ə in Bari involves the alternation of an active [A] element with zero. But what is the grammatical mechanism underlying this alternation? How, for example, can the suffix form in (50b) be derived from its non-ATR counterpart in (50a)?

- (48) a. mug-ga 'store' (indef.)
 b. mug-gə 'cover' (indef.)

³⁶See Wallace-Gadsden (1983) for discussion.

³⁷See Stewart (1967) and Clements (1981).

alternation, it is not clear where the de-activation instruction would originate, since the interpretation ə comes about as a result of *any* active complement (i.e. an ATR harmony domain) being present in the structure, and not from the presence of particular lexical information. In short, a de-activation instruction would be as arbitrary as anything else specified in the lexicon, whereas the alternation in question captures a generalisation evident throughout the system as a whole.

The structure in (51b) offers an alternative approach to the representation of ə in Bari. Here, the lexical instruction to activate [A] remains intact, but the licensing relation between the colour tier and its dependent aperture tier is severed.³⁸ It will be recalled from chapter 3 that both melodic and prosodic conditions must be satisfied before an element can be interpreted: while the lexicon may make the necessary melodic contribution (i.e. **ACTIVATE** [α]), the element in question is required to reside on a licensed tier (its licensed status being dependent on sufficient licensing potential having been received from its licensing tier, in accordance with Licensing Inheritance). Residing on an unlicensed tier, the [A] element in (51b) cannot be interpreted. From this failure of [A]-interpretation, coupled with the fact that no other melodic material has been lexically activated, it follows that the resulting structure must be phonologically 'empty' (i.e. melodically unspecified), and that any interpretation of the low vowel within an ATR context must amount to the phonetic manifestation of an empty position.³⁹ My claim is that the central vowel of Bari does correspond to the melodically empty structure given in (51b). But how does this structure come about? What theoretical motivation is there for the removal of the licensing relation between the two tiers?

Recall that, in order to satisfy PEx, the two vowels **a** and ə must be distinguished

³⁸Following the removal of this inter-tier licensing relation, I assume that the unlicensed [A]-tier is subsequently deleted from the structure in accordance with the general notion of Stray Erasure. See Itô (1986) for a discussion of this operation in relation to unsyllabified melodic material.

³⁹John Harris (p.c.) has suggested a third possibility, which treats the instruction **ACTIVATE** [A] as a ranked constraint, on a par with principles relating to structural well-formedness. The suppression of [A] then results from the activation instruction being overridden by a higher ranked principle such as PEx.

phonologically⁴⁰ — in other words, we must be able to differentiate between their respective representations. While it remains clear that the representation of **a** corresponds to the expected structure of a low vowel (see (49) above), it is perhaps less evident why the precise phonological identity of the central vowel should match the structure in (51b). Given the fact that the two sounds in question are seen to alternate, we anticipate that one should be derived phonologically from the other. However, the scope for deriving the representation of **ə** from the low vowel configuration, for example, is clearly limited: [comp] cannot become active, as no suitable licenser is available; the colour tier may not become active either, since there is no legitimate source — either lexical or phonological — for the activation of [I] or [U];⁴¹ and the licensed aperture tier cannot act as a licenser for [comp], as this does not square with the melodic template established for the language. Ultimately, it seems that only one possible option will create the required alternation effect, a move which interferes with the lexically established licensing relations holding within the structure of **a**. More specifically, this option involves the loss of the only significant licensing relation in the structure, that holding between the [I/U]-tier and the [A]-tier. By severing this asymmetric relation, the (dependent) aperture tier effectively becomes an unlicensed unit. As a result, the licensing path is broken, and the licensing potential required for successful element interpretation fails to reach this point in the melodic structure. While the outcome may be described as a suppression of the [A] element, this is achieved via phonological means, rather than via lexical stipulation (such as **DE-ACTIVATE [A]**, for example).

As illustrated in the case of Kinande transparency, the destruction of a licensing relation established in the lexicon must be treated as a violation of ISP. Yet it appears that the grammar of Bari will tolerate such a violation, in case this ensures that another structural principle, PEx, will be satisfied. Once again, I propose that the dominance of

⁴⁰Specifically, a neutralization of the ATR opposition on low vowels would be inconsistent with the predictions of PEx, in that an active [comp] would no longer be perceived as a potentially contrastive property in this environment.

⁴¹Element epenthesis, by which an expression gains additional melodic material originating from a non-local source, may be suggested as a means of accounting for the phonetic variety observed cross-linguistically in the interpretation of empty positions: *ɛ* in Akan may involve epenthetic-[I], for example, whereas *o* in Maasai may result from epenthetic-[U]. As a *deus ex machina* device, epenthesis of this sort will inevitably have negative implications for generative restrictiveness.

one principle over another emerges as the result of a grammaticality conflict. On the one hand, ISP requires that a full melodic template be retained under every position, leading to the successful interpretation of [A] whenever it is lexically specified (i.e. no change in the interpretation of the low vowel in ATR domains); and on the other hand, PEx forces an ATR versus non-ATR distinction on low vowels, in order to indicate the presence of an ATR harmony span. As already encountered in the analysis of Kinande, an antagonistic relationship of this kind created by the conflicting predictions of two independent well-formedness principles must be settled in favour of one generalisation or the other — both cannot be satisfied by the same representation. The alternation facts suggest that, in the grammar of Bari, the conflict is resolved by allowing PEx to override ISP in terms of its influence on the grammatical outcome.⁴² I propose that this ordering must amount to a reversal of the principle ranking found in the grammar of Turkana. ISP is undominated in the latter system, ensuring the preservation of all licensing relations — including the relation holding between the colour tier and the aperture tier — which results in the ability of LI to supply the necessary licensing potential to the [A]-tier in low vowels, allowing the [A] element to be interpreted whenever lexically specified. Without any suppression of the [A] element, no *a~ə* alternation is predicted, and we observe the expected 9-vowel system of contrast.

4.5.5 Typological predictions

These dominance relations summarize the typological variations considered so far:

- (52) Turkana: ISP > PSE, PEX
 Kinande: PSE > ISP > PEX
 Bari: PEX > ISP > PSE

⁴²In view of the opaque behaviour of low vowels in Bari, it may be assumed that this language follows Turkana in allowing ISP to dominate the PSE. Recall from §4.5.3 that an undominated PSE will cause an inactive [comp] to be dropped from the melodic structure, resulting in transparency with respect to [comp] harmony. In Turkana and Bari, on the other hand, any tendency towards structural simplification appears to be overridden (giving low vowel opacity), presumably by the need to retain lexically established structural relations (i.e. ISP) at all levels.

As the table in (32) shows, however, the expected typology also includes a fourth possibility, in which both PEX and PSE are positioned higher than ISP in the principle ranking. Accordingly, we should ideally be able to identify a tongue root harmony language consisting of a symmetrical 10-vowel system (predicted by the hierarchical relation $PEX > ISP$) which also exhibits low vowel transparency (owing to the ranking $PSE > ISP$). Here, I shall show how the Eastern Kru language Vata (Kaye 1982) satisfies these criteria, thus fulfilling the predictions of the proposed principles and, in turn, lending support to the notion of principle ranking as a credible means of accounting for this range of cross-linguistic variation.

The 'tenth' vowel of Vata — the advanced counterpart of **a** — is typically transcribed as Λ , and appears exclusively in ATR environments. The expected $a \sim \Lambda$ alternation is observed in the interrogative suffix *-aa/- $\Lambda\Lambda$* :

- (53) a. n ka η akpɪ-aa (* η akpɪ- $\Lambda\Lambda$) 'Do you have some medicine?'
 b. n ka η lu- $\Lambda\Lambda$ (* η lu-aa) 'Do you have a chicken?'

This low vowel alternation may be treated in a way which parallels the analysis proposed for Bari (see §4.5.4 above). Specifically, I assume that the well-formed status of the phrase *η lu- $\Lambda\Lambda$* in (53b) results from the dominance of PEX over ISP, where the pressure from PEX to extend the ATR domain to the suffix vowel overrides the non-structure-preserving effects (i.e. the destruction of lexically established inter-tier licensing relations) that this move entails.⁴³

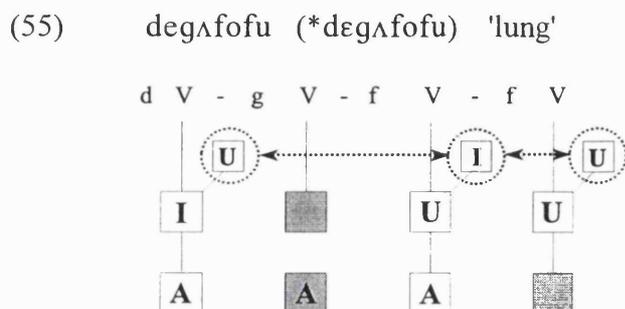
Turning to the question of low vowel transparency, the following forms confirm that the advanced low vowel Λ is indeed transparent to ATR agreement in Vata:

- (54) a. k^wl Λ g Λ su 'tree bush' (compound noun: k^wla + g Λ su)
 b. de Λ fofu 'lung' (*de Λ fofu)
 c. o k Λ z Λ pi 'he will cook food' (lexical form: o ka za pi)

This transparent behaviour follows the pattern observed in Kinande (see §4.5.3), which

⁴³As with ə in Bari, I assume that Λ in Vata indicates the absence of active melodic material.

was analysed in terms of the principle ranking PSE > ISP. Again, the need to preserve lexical structure is overridden by the influence of another (conflicting) principle — in this case the PSE, which eliminates all redundant units of structure from the representation.



Having removed the (potentially opaque) [comp] from the structure of the low vowel in (55), the PSE allows the harmonically active property to extend across the entire word domain. I shall argue that this transparent behaviour exhibited by the low vowel, together with the $a\sim\wedge$ alternation illustrated in (53), provides adequate motivation for the proposed principle hierarchy. Moreover, by matching this particular principle ranking with the empirical facts of melodic distribution in Vata, I have shown that the typological predictions made by the proposed principles (as set out in (32) above) are indeed borne out.

To summarize, the description of Turkana in §4.4 has demonstrated how the model of melodic organisation motivated in chapter 3 is appropriate for capturing both the distributional facts and the alternation properties of a 'typical' ATR harmony system involving an active [comp]. Using data from the example languages analysed in §4.5, I have then proceeded to show how some degree of variation in the precise nature of harmonic patterning may be incorporated into the model. The kinds of typological variation highlighted by Kinande, Bari and Vata represent perhaps the most frequently observed ways in which the grammar of an ATR harmony language may depart from the system established for Turkana. In the following chapter I turn to the question of harmony involving retracted tongue root — a problematic area for most theories of melodic structure recognizing only monovalent primes.

5 *Monovalency and the status of RTR*

5.1 Introduction

Having motivated the colour tier complement as a means of encoding ATR properties, I now generalize the discussion of tongue root phenomena by considering the case of vowel harmony in languages such as Wolof and Yoruba, for which the most appropriate analysis appears to be one involving RTR (tongue root retraction), rather than ATR, as the active property. I begin in §5.2 by evaluating the various proposals which have been put forward in the literature for the representation of tongue root oppositions; in particular, the discussion focuses on the potential of each for encoding typological markedness properties. I demonstrate how the most widely accepted view — one which recognizes the binary-valued distinctive feature $[\pm\text{ATR}]$ as the phonological instantiation of ATRness — must rely on an extrinsic, and essentially arbitrary mechanism for describing relative markedness. On the other hand, within a monovalent approach such as Element Theory — which employs melodic headship as the basis of tongue root distinctions — the question of markedness is of little relevance, since the typological distinction between an ATR harmony language and a system exhibiting RTR harmony can be expressed only in a way which compromises privativeness.

Despite the apparent difficulties encountered by Element Theory in explicitly referring to tongue root retraction, however, I shall argue in §5.2.3 that a tier geometry account of the relevant facts does permit RTR to be treated as a legitimate phonological property within the context of a set of monovalent primes. Specifically, I develop a tier-geometric analysis which makes appeal to an aperture tier complement as the harmonically active unit. This approach, which I have already alluded to in §3.3.3 above, succeeds in capturing the relevant alternation facts, and furthermore, allows the markedness characteristics of these uncommon RTR systems to be captured as an intrinsic property of the structures employed.

We may identify two theoretical implications of the proposed analysis which it shares with a number of other tri-directional approaches:

- (1) a. neither ATR nor RTR need be specified as a member of the inventory of melodic primitives
- b. the dimensions relating to vowel height and tongue root properties are encoded using the same basic units of melody.

With regard to (1a), the notion of complement tier was originally motivated in §3.2.3 as a means of overcoming the problem of under-generation inherent in those melodic templates which referred only to the three resonance elements; recall that an upper limit of eight contrastive vowels could be generated from the unrestricted combination of [A], [I] and [U], as illustrated by the vocalic system of Turkish. In response, I argued for the introduction of a complement tier to boost the generative capacity of the TG model, where the presence of this additional structure was seen to increase the saliency of the head tier. In keeping with the overall aim of minimizing the number of structural units available to the phonology, the option of licensing [comp] was proposed as the sole means of expanding any basic tier configuration. So, in the hypothetical case where an unmarked 2-tier structure (i.e. with a colour vs. aperture split) is established as a necessary component of the phonological system being acquired, the infant language learner may take up one of only two possibilities for increasing the number of potential contrasts generated: either the colour tier may license the complement tier, or the aperture may do so.

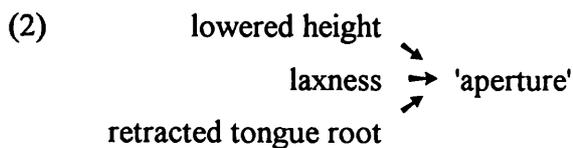
Although the complement tier can only be described in purely structural terms — it is, after all, unspecified for any intrinsic acoustic (i.e. interpretation) properties — it nevertheless corresponds to a recognized melodic characteristic in each of the observed cases: in the previous chapter it has been shown how, as a dependent of the colour tier, [comp] translates into ATR; in the following analyses, on the other hand, RTR will be seen to result from the complementization of the aperture tier. However, it is precisely this structural (as opposed to elemental) description of tongue root advancement/retraction which underlies the TG assumption that ATR/RTR exists not as a fundamental melodic

property specified in UG (in which case, it would correspond to a designated ATR or RTR prime), but rather as the typical interpretation of a particular tier configuration. So, ATR and RTR are treated not as atomic phonological categories in themselves, but as particular interpretative effects deriving from the permitted expansion (that is, the complementization) of the truly atomic units of melody such as the colour tier and the [A]-tier. The complementization of tonality (i.e. colour) properties results in the set of effects standardly referred to as tongue root advancement, while an expansion of the aperture dimension delivers a different set of effects corresponding to the standard label RTR.

Turning to the second implication given in (1b), I suggest that this means of representing tongue root retraction in terms of an increase in the salience of [A] implies a direct association between RTRness and vowel 'openness'. This assumption stems from the observation that the same basic melodic property of [A]-ness is involved in the description of each. For example, I will argue that the activation of [A]-comp is responsible for both vowel lowering in Wolof (see §5.3.1 for a comparison between the respective representations of ə and a) and tongue root retraction or 'laxing' in Yoruba (compare the melodic structures used to represent o and ɔ in §5.4.1). Crucially, however, the grammar makes no distinction between these two effects, treating both as expressions of a single structural configuration. The link between (low) vowel height, or aperture, and tongue root retraction has been noted several times in the recent literature. To account for the behaviour of vowel height properties in Bantu languages, Clements (1991) proposes to represent the height dimension in terms of a single binary feature [\pm open], which may simultaneously occupy a series of different registers within the same structure. His analysis serves as a useful illustration of how the introduction of a single 'height' unit may effectively dispense with the need to refer separately to height features (e.g. [high], [low]) and tongue root features (e.g. [ATR], [RTR]) as independent properties. In a similar vein, but within the context of Dependency Phonology, van der Hulst (1990) makes a direct connection between lowness and RTR in the description of VH systems such as Nez Perce. As an alternative to the traditional [-ATR] spreading account, he identifies the aperture component |a| as the harmonically active unit. Coupled with his treatment of [+ATR] harmony as the spreading of |i|, van der Hulst's approach supports

the conclusion already outlined above, that no phonological unit ATR (or RTR) need be referred to as an independent melodic prime.

In a more detailed investigation, Schane (1990) argues that the three parameters of lowered height, laxness and RTR be viewed as different manifestations of a shared attribute labelled 'aperture'.



As pointed out by the author, the phonological literature has played host to a lengthy period of disagreement regarding the precise definition of these properties¹ — a situation which he claims is indicative of their common identity. In the Particle Phonology model advocated by Schane it is the particle *a* which is chosen to represent the 'aperture' property in its various instantiations. This move clearly parallels van der Hulst's choice of the component |a|, and indeed (though less obviously) the selection of [±open] by Clements, to the extent that [+open] corresponds to the representation of the low vowel *a* in the absence of any other positive feature values. Furthermore, the proposed TG analysis follows along similar lines too: an enhancement of the [A]-tier by a complement may be viewed as a means of either creating a preponderant [A] element — thereby increasing the salience of its inherent low-vowel characteristics — or otherwise encoding RTRness, as observed in the analyses of Wolof and Yoruba to be offered below. What unifies these four different perspectives — the Dependency approach of van der Hulst, Schane's Particle approach, the feature-based approach of Clements, and the TG approach assumed here — is a commitment to the assumptions in (1), that UG makes no direct reference to tongue root properties in terms of its inventory of melodic primes, and that no absolute division need be made between the descriptions of vowel height and tongue root properties — each may be encoded using the same basic units of melody.

¹See Backley (1997) for a brief discussion of the apparent overlap between these various terms.

5.2 Competing representations of tongue root contrasts

5.2.1 ATR~RTR as a bivalent feature

While an array of different labels has been variously employed in the description of ATRness, the majority of analyses are agreed on the status of the tongue root opposition as a single binary-valued feature such as $[\pm\text{ATR}]$.² This bivalent approach is exemplified in A&P 1994, where the mechanism of ATR harmony in languages such as Akan and Maasai is described in terms of the spreading of the feature value $[\text{+ATR}]$. Additionally, the acceptance of a bivalent feature $[\pm\text{ATR}]$ permits a straightforward analysis of harmony in systems where RTR participates as the active harmonic property. In these latter cases, the spreading of a $[-\text{ATR}]$ autosegment is proposed — as illustrated by the account of Yoruba vowel harmony offered in Archangeli & Pulleyblank (1989).

A&P also consider the question of typological markedness, and note the following tendencies with regard to the involvement of $[\pm\text{ATR}]$ in the phonological systems of individual languages:

- (3) *[ATR] Markedness Statement* (A&P 1994:184)
- a. $[\text{ATR}]$ tends *not* to be used actively
 - b. If used actively, the active value of $[\text{ATR}]$ tends to be $[\text{+ATR}]$; the passive value of $[\text{ATR}]$ tends to be $[-\text{ATR}]$.

In the tradition of generative phonology, we might expect such tendencies to be explicitly encoded in individual grammars, perhaps as a reflection of descriptive or representational simplicity. In the feature-based model assumed by A&P, however, it is unclear how naturalness relations of this sort can be expressed in a non-arbitrary manner.

With respect to tongue root properties, the statement in (3) identifies three clearly defined markedness levels:

²The use of binary features has been central to the analysis of phonological contrast throughout the history of generative phonology (Chomsky & Halle 1968) and before (Jakobson, Fant & Halle 1952). It might be suggested that their continued presence in many contemporary models of melodic structure perhaps owes as much to theoretical tradition as to empirical argument.

correlation between naturalness and representational simplicity. The generalisations are presented as a set of implicational statements which express the unmarked values of individual features (e.g. [u nasal] \rightarrow [-nasal], where u represents the unmarked value). In Optimality Theory (OT), on the other hand, relative markedness is expressed as a ranked dominance relation (the following example is taken from Prince & Smolensky (1993:181)):

(6) **Coronal unmarkedness**
 *PL/Lab >> *PL/Cor

The ranking in (6) states that to parse a configuration in which a place node (PL) dominates the feature [labial] amounts to a structural violation that is more serious (by virtue of its more highly ranked position) than the parsing of an otherwise similar melodic structure where PL dominates [coronal]; in short, [coronal] as a place of articulation is less marked than [labial].

Common to both SPE and OT is the essentially extrinsic, peripheral nature of the markedness mechanism in each, constructed and described in a way that is largely independent of the representations to which it applies. A similar criticism may also be levelled at the A&P approach, where relative markedness is determined according to the number of grounding conditions violated by the [\pm ATR] specifications of any one system — the greater the number of violations, the more marked the system. The grounding conditions appear to function as little more than a repair strategy to control generative output, as if to acknowledge the problem of overgeneration as an inherent feature of the model.

Along with this peripheral status of the markedness conventions comes a certain degree of arbitrariness in the markedness statements themselves. In the case of OT, the ranking in (6) could quite easily be reversed; the resulting hierarchy would still accord with the established formalism, yet would encode a markedness relation that has little empirical support.³ Similarly, the universal marking conventions presented in SPE remain largely unexplained; to conceive of an alternative set of markedness statements with very

³For a summary of the problems stemming from OT's apparent arbitrariness and lack of generative restrictiveness, see Davenport & Hannahs (1996).

different predictions — such as [u nasal] → [+nasal], for example — presents no real challenge to the model. And again, the suitability of A&P's approach may also be challenged on similar grounds. What, for instance, motivates the grounding condition ATR/HI given in (5)? The abundance of vowel systems containing ATR mid vowels renders this particular statement a rather weak generalization — in turn, opening the way for other conditions that are similarly lacking in independent motivation (either phonetic or phonological).

In sum, the binary feature analysis of tongue root contrasts employed by A&P can provide an adequate description of the different roles ATRness plays in a range of languages (see (4) above), yet proves less than ideal in the way it encodes the markedness characteristics of the languages that highlight those differing roles. If the grounding conventions cannot be adequately justified, then any theory of markedness based on the violation of such conditions must be considered, at best, unreliable.

5.2.2 Monovalency: a headship approach

Within a contrastive system built around single-valued melodic units, the option of recognizing the *absence* of ATR (that is, [-ATR] or [RTR]) as an active phonological property is categorically denied.⁴ This leaves only the possibility of a privative opposition [ATR]~zero. However, since the primary motivation for abandoning equipollence has typically been a reduction in the scope for generating unobserved facts, it is entirely in keeping with the 'restrictivist' stance adopted by some models employing unary features that they have also opted to reject the [ATR]~zero contrast as a means of representing tongue root properties.⁵ In the version of Element Theory assumed in Walker (1995) and elsewhere, nothing akin to the feature [±ATR] is recognized. Instead, the difference between ATR and non-ATR is represented structurally as a distinction in headship: an

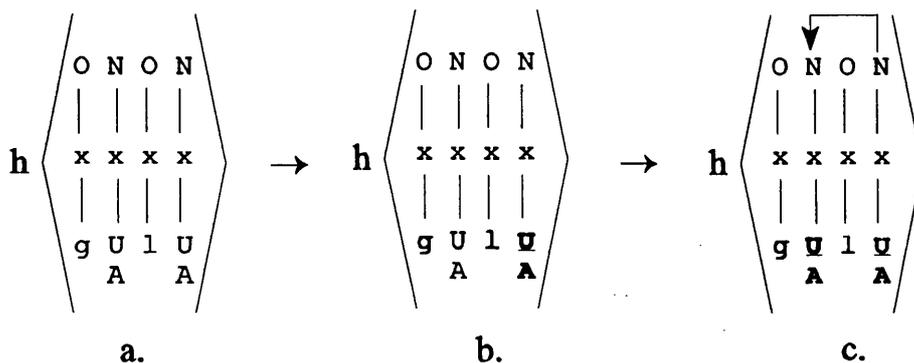
⁴The question of postulating two monovalent features [ATR] and [RTR] is addressed by Pulleyblank (1995), Steriade (1995) and Rose (1996).

⁵The general reluctance among triangular models of segmental structure to accept ATR as a legitimate melodic unit stems from its anomalous behaviour within the established set of vocalic primes. For arguments against recognizing an independent ATR prime, see Harris & Lindsey (1995).

ATR vowel corresponds to a headed expression such as \circ [U,A], whereas headless expressions like \circ [U,A] denote non-ATR vowels (see §2.2.4 and §4.3.1 above). As for harmonic alternation, this is achieved via a lexical function termed H-licensing, which maps headless expressions on to their headed counterparts.

Walker demonstrates the mechanism of H-licensing — which is discussed in §4.3.2 above and which may be viewed as a kind of 'headedness harmony' — with examples of ATR agreement in Vata. In essence, a harmonic span must contain a morpheme which is lexically marked as a headed domain $h < >$. This is illustrated in (7a).

(7) H-licensing in $h < g \circ l \circ >$ [golo]:



Unique to the domain-final position is the potential for supporting a headed melodic expression, as in (7b), which affords this nucleus the status of an H-licensor.⁶ As such, this position proceeds to license a headed expression in the remaining nuclei within the domain, as shown in (7c); this is achieved via prosodic licensing relations contracted at the level of nuclear projection.

While H-licensing admits a satisfactory analysis of ATR harmony in systems of the (4b) variety (e.g. Vata, Turkana), there appears no obvious way of adapting the mechanism so as to provide a natural account of vocalic agreement in type-(4c) languages such as Yoruba, where RTR behaves as the harmonically active property. In the latter

⁶In the derivational steps shown in (7b) and (7c), melodic heads are underlined. Examples are taken from Walker (1995:111).

case, the presence of a headless, non-ATR vowel would require other vowels within the harmonic domain to be similarly headless — presenting a potential challenge to the headship harmony approach, since it would require well-formedness to be conditioned by the absence of particular representational entities (i.e. headed expressions) rather than by their presence. While negative conditions are included in the characterization of some theoretical frameworks — such as OT, where the burden of explanation lies primarily with the interaction between constraints, rather than with the precise formulation of the constraints themselves — I argue that they find a rather less natural setting amongst the positive, structure-building conditions employed in Government-based models.

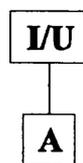
From the Element Theory point of view, then, it appears that a rejection of bivalency in favour of a unary system of contrast inevitably leads to the loss of the melodic property RTR as an independent phonological unit. In view of the highly marked status of those languages which exploit RTR as a linguistically significant property, this might well be considered a desirable outcome. On the other hand, we cannot afford to ignore the evidence provided by systems such as Yoruba and Wolof (to be analysed below), which strongly indicates the status of RTR harmony as a legitimate phonological phenomenon. In response to the inability of the H-licensing argument to adequately account for such cases, I shall consider next a tier-geometric approach to the relevant facts.

5.2.3 Monovalency: a tier-geometric approach

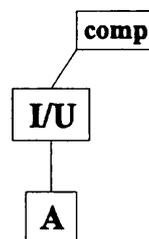
In terms of typological markedness, the distinction between a language such as Spanish or Hawaiian — where the ATR quality of any vowel is predictable on the basis of other (contrastive) melodic properties — and a system belonging to the (4b) category may be motivated by appealing to differences in structural complexity. Specifically, an ATR harmony language such as Turkana (see §4.4 above) must recognize a colour tier complement as part of its melodic template, whereas the 5-vowel system of Spanish is able to generate the required set of lexical contrasts without this additional structure. It is entirely in keeping with the markedness device inherent in the TG model that the

postulation of some additional structure should be necessary in order to capture an expanded set of melodic distinctions which includes advanced/retracted pairs. So the melodic template in (8b) is predicted to be more marked than the structure in (8a) — which is reflected in the capacity of (8b) to generate a larger inventory with contrastive ATRness.

(8) a. *Spanish*



b. *Turkana*

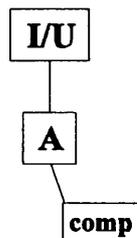


The relatively marked status of (8b) compared to (8a) is also reflected in the additional licensing burden that the configuration in (8b) involves: a greater number of units to be licensed in a structure should require a greater amount of licensing potential — generally, the more complex the structure, the more difficult it should be to license. Deriving the set of contrasts generated by the three melodic units in (8b) amounts to a licensing task which goes beyond that involving the licensing of the two units present in (8a). Thus, the structure in (8a), which typically generates the canonical five vowel system {i,u,e,o,a}, is expected to be easier to derive and inherently less marked than the (8b) configuration. This result is borne out by the comparatively widespread distribution of (8a) cross-linguistically.

Having highlighted the direct association between markedness and complexity of structure, I now turn to the second of A&P's markedness generalizations given in (3b). Within the set of languages analysed as displaying tongue root harmony, the literature is largely united in the opinion that it is considerably more common to find ATR (in binary feature terms, [+ATR]) as the active property, rather than its opposite value RTR (that is, [-ATR]). In other words, as a phonological phenomenon, RTR harmony appears to be considerably more marked than ATR harmony. In order to capture this difference in structural terms, I shall propose that the melodic template in (9) is appropriate for

representing the harmonic facts of those systems that have been most robustly shown to display active RTR.

(9) *tier geometry for Wolof and Yoruba*



The rarity of RTR harmony systems entails that (9) should be a more marked configuration than (8b), a result that may be derived via the Licensing Inheritance Principle in the following way. As already outlined in §3.3.2 above, I assume that the licensing of a complement tier cannot be achieved without cost, but rather, that it consumes licensing potential in the same way that the licensing of other units do. So, in order to successfully sanction a complement, a strong enough licenser must be available (where 'strength' may be defined in terms of the possession of sufficient potential to pass on to a licensee). Since the colour tier in (8) and (9) is situated at a point higher up the licensing path than the [A]-tier, it is the former which possesses a greater amount of potential, and therefore, is predicted to be a stronger licenser and thus license a complement tier more easily. Nevertheless, there is no apparent reason for ruling out the possibility of the [A]-tier licensing the complement tier instead, which I propose to be the case in RTR harmony languages like Wolof and Yoruba.

Of course, the [A]-tier must be considered a relatively weak licenser — given its position lower down the licensing path than its licenser, the colour tier — and as such, is expected to support a complement tier less easily. But the difficulty in licensing the structure in (9) compared to that in (8b) illustrates clearly the difference in markedness between the types of vowel system that each represents. To capture the characteristics of a language which displays either ATR harmony or an ATR/RTR contrast, we would posit a melodic template such as the one in (8b). To describe a much less common, more highly marked phenomenon like RTR harmony, however, it is necessary to refer to a more

marked structure such as (9), which is predicted by the TG model to be less easily derived.

The following section demonstrates how the configuration in (9) may be employed in the characterization of the relatively uncommon vowel system of Wolof. I shall argue that the harmonic properties of this language may be described in terms of the lexical instruction **ACTIVATE [A]-COMP** specified at the word level.

5.3 RTR harmony in Wolof

5.3.1 Introduction

Wolof⁷ is analysed by A&P as a system which exhibits vowel harmony involving the active participation of the property RTR. This approach contrasts with an alternative proposal by Ka (1994), who suggests that a [+ATR] autosegment is responsible for harmonic agreement in this language. I shall illustrate below, however, that this latter view is problematic with regard to the treatment of high vowels: specifically, **i** and **u** must be analysed as harmonic triggers in word-initial position, but as neutral vowels elsewhere. Accordingly, I develop an RTR account of the facts within a tier-geometric context, which demonstrates the capacity for capturing (i) the identity of the two harmonic vowel sets and (ii) the transparent behaviour of neutral vowels. Here I argue for the structure in (9) as the only melodic template which will accommodate all the harmonic facts of this language.

The inventory of Wolof contains the eight vowels given in (10), dividing into the two distinct harmonic groups shown. Vowels may be lexically either long or short — with the exception of **ə**, which always appears short.⁸ Unlike the ATR harmony systems reviewed in §4.4 and §4.5 above, the two high vowels in Wolof have no retracted counterparts. Besides being neutral to harmony (i.e. non-targets), both **i** and **u** are also transparent to harmony (i.e. non-blockers); this fact, I shall argue in §5.3.3 below, results

⁷A Niger-Congo language spoken primarily in the Gambia and Senegal.

⁸I shall discuss the significance of vowel length in §5.3.4 where, in defiance of expectations, I demonstrate how the analysis of **ə** as a melodically unspecified position proves inappropriate in this instance.

directly from the tier-geometric structure employed. The neutrality of the high vowels entails that they are accommodated within both the ATR and RTR vowel sets.

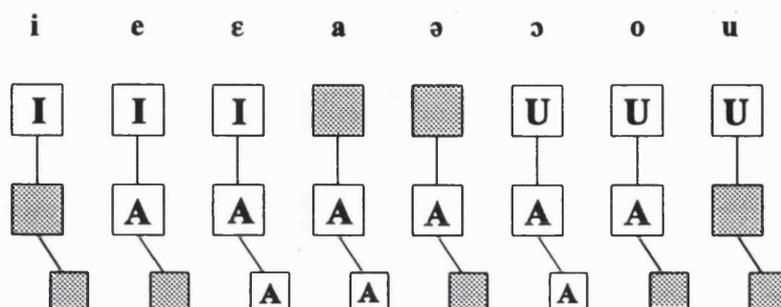
(10)	i	u	ATR vowels: {i,u,e,o,ə}
	e	o	RTR vowels: {i,u,ɛ,ɔ,a}
	ɛ	ə	
		ɔ	
		a	

On the face of things, an adequate description of the distributional sets in (10) may be obtained from either of two possible melodic structures. One analysis posits a configuration of the type in (8b), where the members of the ATR set are defined in terms of the presence of an active colour tier complement. This characterization immediately excludes the RTR vowels and yields the desired split within the inventory. Two potential problems arise from this proposal, however. First, there is no obvious explanation for the absence of the RTR high vowels **ɪ** and **ʊ**; given the melodic template in (8b), we might expect an active [U], for example, to contrast with an expression involving an additional active [comp]. Second, we would be forced to adopt a representation of **ə** that does not easily accommodate the characteristics displayed by this vowel. Under the 'active-ATR' view, the most likely analysis would take **ə** as the interpretation of an empty nuclear position,⁹ while the distribution of **ə** in Wolof, together with its behaviour in harmonic alternations, provide sufficient evidence to refute this view.

An alternative analysis of the Wolof vowel system employs the structure in (9), where the complement tier is licensed by the [A]-tier, rather than by the colour tier. This approach exploits the full set of contrasts supported by the melodic configuration, as illustrated in (11).

⁹See Backley & Takahashi (1996) for an analysis of the central vowel in Akan along these lines.

(11)



This representation of Wolof vowel contrasts allows us to identify the two harmonic sets in a straightforward manner — the members of the RTR set { $\epsilon, \text{ɔ}, \text{a}$ } all contain an active [A]-comp, whereas the same unit is inactive in the ATR set comprising { $\text{i}, \text{u}, \text{e}, \text{o}, \text{ə}$ }. By assigning this particular tier structure to Wolof and other typologically similar systems, we make the strong prediction that the non-advanced high vowels **I** and **U** (which this configuration is unable to generate) should be consistently absent from the vowel inventories of RTR harmony languages. Thusfar, I have found no compelling evidence to falsify this claim.¹⁰ While the Wolof high vowels **i** and **u** fail to participate in harmony, we do observe harmonic alternation in the non-high ATR~RTR pairs **e~ε**, **o~ɔ**, and **ə~a**. In the following sections I illustrate the distribution of these alternants using examples cited in Ka (1994).

A comparison between the [A]-comp configuration shown in (11) and the less marked (8b) structure employed in the case of Turkana exemplifies one of the basic characteristics of the TG model introduced in chapter 3. In keeping with the view of elements as cognitive categories (grounded in basic phonological notions such as contrast and alternation) — rather than purely phonetically-motivated interpretable units — we inevitably find some degree of inconsistency between the melodic representation of an expression and the precise interpretation of that expression. The fact that the vowel system of Spanish contains phonetically advanced high vowels does not motivate the inclusion of a colour complement in the melodic template of that system. Such a move

¹⁰Further support for the structural distinction made here between ATR and RTR harmony languages is found in Casali (1993). He notes that symmetrical 9-vowel systems (such as that of Turkana — see §4.4 above) undeniably involve ATR as a distinctive property but never refer to RTR as a harmonically active value, whereas RTR systems such as Yoruba never give rise to ATR harmony rules.

would fail to be supported by the phonological behaviour of the vowels in the language (e.g. no high vowel tongue root distinction is observed). A single vowel sound may therefore be identified by different phonological structures, according to the particular phonological characteristics of any given system: for example, the vowel *i* corresponds to active [I] in Spanish, but to active [I]-comp in Maasai. Similarly, the low vowel of Turkana is encoded as [A] in that system, whereas the phonetically similar vowel *a* in Wolof corresponds to the representation [A]-comp.

5.3.2 Cases of 'regular' harmony

In general, tongue root harmony in Wolof occurs in noun and verb roots, and also within morphologically complex words (typically root-plus-suffix(es)).

(12) a. *lexically ATR roots*

tilim	'to be dirty'
jigeen	'woman'
legum	'vegetable'
fitnə	'hardship'
bukki	'hyena'
yonni	'to send'
kəriŋ	'coal'
bəccəg	'daytime'

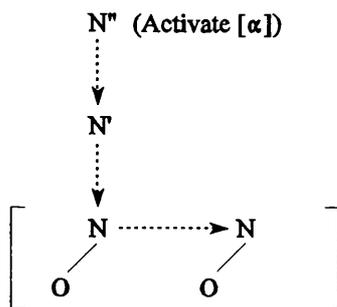
b. *lexically RTR roots*

cere	'couscous'
lɛmpɔ	'tax'
jafe	'to be expensive'
sɔxla	'need'
gannaay	'weapon'
nɛlaw	'to sleep'
mango	'mango'
bakkan	'nose'

These forms illustrate the 'regular' pattern of harmony in Wolof, where the vowels are taken exclusively from one of the harmonic groups in (10). On the strength of this data set we can assume that the mechanism by which the harmonic property in Wolof is distributed across the relevant span is similar to that observed in the case of the ATR systems considered in chapter 4. Once again, I claim that the activation of the complement tier is specified in the lexicon as a property of N" — a projection of the nucleus identified as the head of the word domain. From this domain-head position, the lexical instruction to activate [A]-comp is then transmitted to the remaining nuclei within the harmonic span via a series of local harmonic relations. I shall argue below that the role of domain head

is assumed by the leftmost nucleus in this language; left headedness is illustrated in the following example, which shows the linear (i.e. horizontal) transfer of the word-level activation instruction in a di-syllabic form such as *cεε* 'couscous'.

(13)



In the following examples, suffix vowels harmonize with the ATR/RTR category of the root (there are no prefixes in this language).

- (14) a. **-e ~ -ε** ('instrumental-locative' suffix)
- | | | | |
|--------|----------------|--------|-------------|
| door-e | 'hit with' | xaar-ε | 'wait in' |
| suul-e | 'bury with' | xɔɔl-ε | 'look with' |
| gən-e | 'be better in' | dəm-ε | 'go with' |
- b. **-oon ~ -ɔɔn** (past tense suffix)
- | | | | |
|----------|--------------|----------|--------------|
| reer-oon | 'was lost' | rɛɛr-ɔɔn | 'had dinner' |
| tiit-oon | 'was scared' | xaar-ɔɔn | 'waited' |
| bəgg-oon | 'wanted' | jɔɔx-ɔɔn | 'gave' |
- c. **-ənte ~ -ante** ('mutual' suffix)
- | | | | |
|-----------|-------------------|-----------|----------------------|
| sedd-ənte | 'share' | rɛy-ante | 'kill each other' |
| dugg-ənte | 'be friends' | baag-ante | 'go back and forth' |
| bəgg-ənte | 'love each other' | xɔɔl-ante | 'look at each other' |

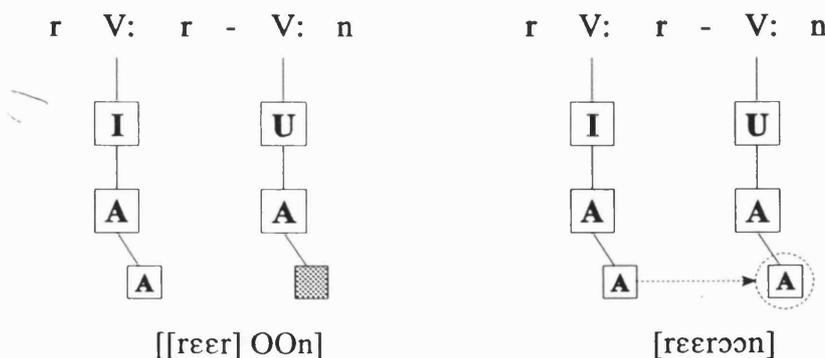
These examples demonstrate the co-occurrence restrictions on vowels in Wolof, such that the vowels within the word domain must agree in terms of tongue root quality — all must either be advanced or retracted. The structure proposed in (9) has already allowed us to identify the melodic property that distinguishes the two harmonic sets —

i.e. an active [A]-comp. We may argue, then, that a characterization of vocalic agreement in this system refers to the lexical instruction **ACTIVATE [A]-COMP** specified at the level of the prosodic word. To illustrate, consider the minimal pair in (15); these forms differ only with respect to the lexically active vs. inactive status of the aperture tier complement.

- (15) a. reer 'to be lost'
 b. rɛɛr 'to have dinner'

The form in (15b) contains an active [A]-comp, which manifests itself in the RTR quality of the vowel. I propose that the complement of [A] enjoys harmonic status in Wolof, such that it is activated at the word level whenever it is lexically specified; as with the set of ATR harmony systems considered in the previous chapter, it is in this way that the harmonic properties of this language are derived. So in cases of 'regular' harmony, [A]-comp activation originating in the leftmost (domain head) nucleus translates into its uniform activation throughout the entire word span. In (16) the addition of an alternating suffix to the form in (15b) demonstrates how the scope of complement tier activation expands throughout the extended domain.

- (16) a. lexically given b. extended [comp] activation



In the RTR context shown in (16), a suffix exhibiting the alternation $o \sim \text{ɔ}$ harmonizes with the RTR quality of its root by allowing the activation of the complement

tier in the root to expand throughout the newly extended word domain.¹¹ The same mechanism applies to the remaining examples in (14) — including the ə ~ a alternations in (14c), which receive a parallel treatment under the present analysis. From (11) it will be recalled that ə is identified phonologically as an active [A] in this system; following the effects of harmonization, the additional activation of the [A]-complement tier then results in the representation of a low vowel a.

In this section I have demonstrated the capacity of the proposed melodic structure for distinguishing the two harmonic groups of vowels and for characterizing the observed harmony in a straightforward manner. Below, I show how the harmonically neutral status of high vowels is derived as a direct result of the proposed melodic template.

5.3.3 Non-alternating vowels in Wolof

It has already been noted that either of the structures given in (8b) and (9) could serve as a possible candidate for the melodic template required in Wolof. That is, either configuration has the generating capacity to produce the set of vowel contrasts observed in this language. Importantly, however, the high vowels have no RTR counterpart (i.e. they are neutral to harmony) — which I shall claim provides motivation for the choice of the [A]-comp configuration over that in (8b).

(17)	<i>ATR roots</i>		<i>RTR roots</i>	
	gimm-i	'to open eyes'	sapp-i	'to lose taste'
	wedd-i	'to straighten up'	lemm-i	'to unfold'
	mən-in	'capacity'	dɔx-in	'way of walking'
	təgg-in	'rhythm'	defar-in	'way of making'
	lett-u	'to braid hair'	sɛɛt-u	'to look in the mirror'
	dindik-u	'to be taken off'	xappatik-u	'to be damaged'

¹¹The lexical form of each suffix vowel is shown with an upper case symbol, indicating that its precise interpretation as either ATR or RTR is determined only after affixation. All suffixes in Wolof appear to be lexically uninstructed for [comp] — that is, harmony is root controlled.

Although the [A]-complement tier is active (presumably at the word level, in line with all other cases in Wolof) in RTR forms such as *seetu* and *doxin*, this activation fails to manifest itself in the position occupied by the suffix vowel. Clearly, this contradicts the regular harmonic pattern we have established above, and ideally we should like to find some non-stipulative explanation for the apparent irregularity shown by the set of high vowels. Such an explanation is readily available if we opt for the configuration in (9), rather than that in (8b), as the melodic template for Wolof.

Fundamental to the TG model is the assumption that a structure such as (9) employs two different kinds of licensing relations, as motivated in §3.2.3. First, the licensing of the [A]-tier relies on the presence of its dominating tier to act as a licenser; this relation alone is sufficient to create a configuration such as that given in (8a). Second, in order to license a complement we require not only the presence of a licensing tier but also its active status. So in (8b), the complement tier cannot be licensed until either [I] or [U] is active; similarly in (9), [A] must be active before it can license its complement.¹² In the context of the Wolof harmony process, this condition on the licensing of [comp] proves crucial in excluding the high vowels as harmonic targets. Having characterized harmony as the expansion of [A]-comp activation, it is clear that only those expressions with a lexically active [A] (to support the licensing of the complement tier) are potential participants. Given that the high vowels form a set which is defined by the inactive status of [A], it is predicted that neither *i* nor *u* can display RTR properties, even within an RTR domain. In this way, the fact that high vowels are denied the ability to license [comp] entails that they should behave as neutral expressions.

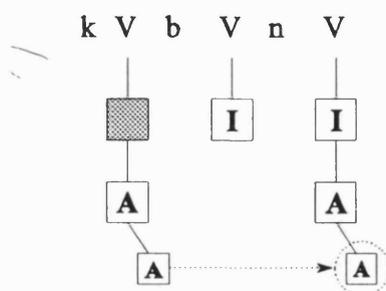
But besides the issue of non-alternation, the high vowels may also be described as transparent — that is, although they are never harmonic targets, *i* and *u* do not block the progress of harmony across a domain. This is illustrated in the following root forms (18a) and derived words (18b). The examples in (18c) are included in order to illustrate the alternating nature of the chosen suffixes.

¹²This distinction has a clear parallel in the licensing of prosodic positions, where a similar difference can be observed between constituent licensing (e.g. involving a nuclear head and its complement) and inter-constituent licensing (e.g. between a nucleus and its prehead or onset).

- (18) a. kabine (*kabine) 'toilet'
lantinɔɔr (*lantinoor) 'funnel'
- b. bɛy-u-lɔɔ (*bɛy-u-loo) 'you did not cultivate'
bɔkk-u-lɛɛn (*bɔkk-u-leen) 'you are not good'
- c. tox-u-loo 'you did not smoke'
tiit-u-leen 'you are not scared'

I shall claim that high vowel transparency derives from the absence of anything within the structure of such expressions that could impose any potential blocking effect on the span of [A]-comp activation. Having formulated harmonic agreement in terms of an unbroken chain of local harmonic relations along a particular tier, the description of a harmonic blocker must amount to the identification of a melodic position which cannot harmonize, and which therefore interrupts the transmission of the activation instruction along the harmonizing tier. This has already been observed in the case of Turkana — see §4.4.3 above. In direct contrast, to capture high vowel transparency we must show that the representation of high vowels makes no reference to the melodic unit [A]-comp, not even to the point of indicating an empty slot. So, for the word *kabine* 'toilet' we would have to posit the structure in (19).

- (19) kabine 'toilet'



In (19) the medial vowel *i* does not interrupt the transmission of the activation instruction along the complement tier, since it is unable to license the melodic unit [A]-comp. We may attribute this gap on the complement tier (and also on the aperture tier) to the influence of the PSE. Recall from §4.5.2 that this constraint brings about the elimination of all unnecessary structure from the representation, where a unit is deemed redundant unless

(i) it is identified as a target for lexical activation or (ii) it plays a role in maintaining overall structural well-formedness (e.g. by acting as a licenser for another unit). In the medial vowel of (19), the aperture and complement tiers fulfil neither of these functions, and accordingly, are removed from the structure. With a truncated melodic template in this nuclear position, locality is then preserved between the harmonizing units, allowing [comp] activation to progress unhindered throughout the domain. This parallels the analysis of low vowel transparency given in §4.5.3 for Kinande.

In previous analyses of the Wolof harmony system it has been proposed that high vowels behave differently according to their distribution within the word. Ka (1988) attempts to capture vocalic agreement in terms of [+ATR] harmony which, as the following examples show, forces the conclusion that *i* and *u* behave as triggers in word-initial position but as neutral vowels elsewhere.

- (20) a. *Word-initial high vowels*
- | | | |
|----------|-------------|----------------------------|
| suul-e | (*suul-ε) | 'to bury with' |
| yiw-ədi | (*yiw-adi) | 'to have a bad appearance' |
| tiit-oon | (*tiit-ɔɔn) | 'was scared' |
- b. *Word-medial high vowels*
- | | | |
|------------|---------------|-----------------------|
| warugar | (*warugər) | 'obligation' |
| sɔppi-leen | (*sɔppi-leen) | 'change!' |
| xɔɔl-ulɔɔ | (*xɔɔl-uloo) | 'you did not look at' |

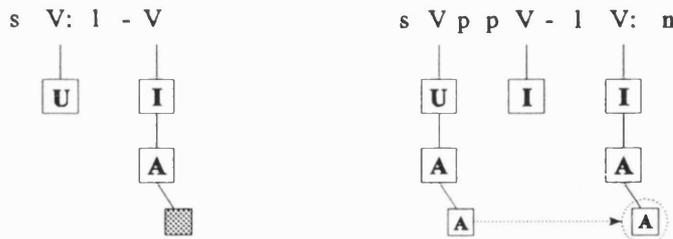
According to Ka's spreading analysis, ATR harmony is initiated by the word-initial high vowel in the examples in (20a), resulting in a ban on any subsequent RTR vowels. This is illustrated in (21a). In contrast, (20b) shows mixed forms consisting of a medial ATR vowel flanked by RTR expressions; and when the same autosegmental spreading operation is carried out, as given in (21b), an ill-formed sequence results.

- (21) a.
- | | | |
|-------------|--------|------------------|
| | [+ATR] | |
| | \ | |
| s u u l + E | | → suule (*suule) |

- b.
$$\begin{array}{c} [+ATR] \\ | \quad \backslash \\ s \text{ } \textcircled{\text{o}} \text{ } p \text{ } p \text{ } i \text{ } + \text{ } l \text{ } E \text{ } E \text{ } n \end{array} \quad \rightarrow \quad *s\textcircled{\text{o}}ppileen$$

Ka is therefore forced to analyse the (20b) forms as featuring a non-triggering high vowel within an RTR morpheme. In contrast, the TG approach achieves a more straightforward interpretation of the facts in (20). Since RTR harmony is described with reference to an active [A]-complement tier, it follows that high vowels cannot act as triggers under any circumstances, as illustrated by (19). So the forms in (20a) appear as exclusively ATR domains, owing to the absence of any harmonically active RTR. Those in (20b), however, may be treated as lexically specified RTR spans containing a transparent high vowel. An example from each is given in (22a) and (22b) respectively.

- (22) a. suul-e (*suul-e)¹³ b. soppil-leen (*soppi-leen)



While Ka's analysis proves awkward with regard to its treatment of high vowels, the author's observations nevertheless provide support for the assumption made above, and illustrated in (13), that the tongue root quality of a word is determined by the active or inactive status of the [A]-complement tier in the first vowel of the root (i.e. the head of the word domain). This point may be demonstrated in the following way. If we were to assume (incorrectly) that RTR is specified as the property of whole morphemes in Wolof, then we predict — given that high vowels are necessarily neutral — the possibility of finding a distinction based on tongue root quality in medial or final vowels, such as *gune* vs. *gunε*. Yet this kind of contrast is unattested in Wolof — only the pattern in

¹³The inactive [comp] of the suffix vowel — included here precisely in order to highlight its inactive status and the non-RTR quality of the expression — will, of course, be eliminated in accordance with PSE.

(20a) is observed. From this we may conclude that the non-RTR span which extends throughout forms such as *fidiwəl* 'string' and *dibeer* 'Sunday' is accounted for by the absence of a harmonic trigger in the domain head vowel. In this way, it is possible to view harmony as a manifestation of left-headedness in this language.

5.3.4 Low vowel stability

The final issue to be addressed here concerns the apparently anomalous behaviour displayed by the low vowel of Wolof with respect to harmonic alternation. Specifically, I consider the association which evidently holds between vowel length and participation in harmony: while short *a* alternates with its ATR counterpart *ə*, as observed in many of the examples above, long *aa* never undergoes any change, even within an ATR span. The forms in (23) demonstrate the point.

- (23) a. *ATR domains*
- | | |
|----------|-------------------------|
| ginnaaw | 'back' |
| xurfaan | 'to have a sore throat' |
| yeeg-aat | 'to climb again' |
| gudd-aay | 'length' |
- b. *RTR domains*
- | | |
|-----------|----------------------|
| pɔqtaan | 'underarm' |
| fanaan | 'to spend the night' |
| dɔg-aat | 'to cut again' |
| rafet-aay | 'beauty' |

In all contexts, then, the long low vowel retains its RTR quality. So, even when an ATR vowel occupies the position which regularly determines the tongue root quality of subsequent vowels (i.e. the leftmost vowel of the root), the complement tier which is active in the representation of the vowel *aa* remains active and creates a mixed form of

the kind shown in (23a).¹⁴ Furthermore, the long low vowel also behaves as a harmonic trigger, initiating a span of [A]-comp activation to its right. This is illustrated in the following derived forms.

(24)	yobbuw-aale	(*yobbuw-aale)	'to carry away also'
	genn-aale	(*genn-aale)	'to go out also'
	tiit-aange	(*tiit-aange)	'effect of fear'
	lor-aange		'loss'

In response to the examples in (24), we are forced to revise our hypothesis with regard to the way in which tongue root properties are specified. While it is still possible to maintain that word-level complement tier activation is initiated by the nucleus identified as the head of the word domain, we must also be able to accommodate the forms in (24), in which a word-medial aa can also begin a new RTR span. In fact, it appears that an active complement tier assumes the role of a harmonic trigger in any position, as the forms in (25) illustrate.

(25)	a.	<i>active [A]-comp in long low vowels</i>			
		yaakaar	'hope'	gaaw-leen	'hurry up!'
		paase	'to iron'	aawɔ	'first wife'
	b.	<i>active [A]-comp in short low vowels</i>			
		barigo	'barrel'	marineer	'blouse'
		xandoor	'to snore'	alluwa	'koranic board'
	c.	<i>active [A]-comp in mid vowels</i>			
		lempɔ	'tax'	wɔyɔf	'to be light'
		rɔbine	'tap'	golɔ bale	'that monkey'
	d.	<i>active [A]-comp word-medially</i>			
		seytaane	'devil'	kumaase	'to start'
		genn-aale	'to go out also'	gis-aan-ε	'to predict'

¹⁴In an analysis involving ATR spread, such as that offered in Ka (1994), the vowel aa must be treated as opaque, since it appears to halt the progress of ATR harmony. This is handled by means of an arbitrary filter.

In Wolof, then, we must recognize two different sources of the harmonic property [comp]. Whether the complement tier is activated in the leftmost nuclear position, as in (25a)-(25c), or in a word-internal nucleus, as in (25d), it initiates a span of activation to its right throughout the remainder of the domain (excluding transparent high vowels).

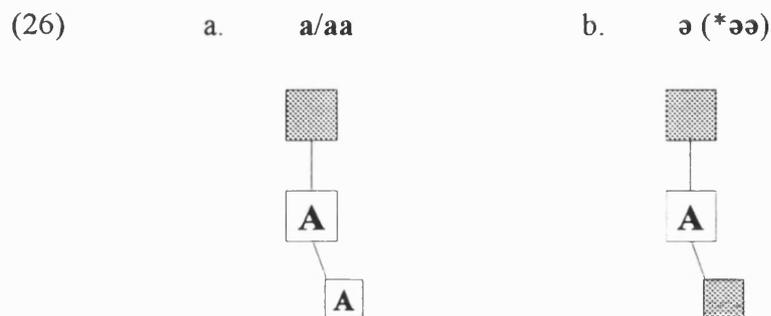
It remains an empirical issue as to whether these sources behave independently of each other, or whether they are in fact mutually 'visible'. If the two lexical instructions — both referring to **ACTIVATE [A]-COMP**, one specifying it as a word-level property, the other including it within the lexical representation of the long low vowel **aa** — are indeed independent of each other, then we might expect *seytaane* 'devil', for instance, to contrast with a form such as *seytaane*. From the limited amount of language data available, however, there is nothing to indicate that such a contrast can be maintained. This leads to the conclusion that the active/inactive status of the complement tier must be treated as the lexical property of an entire morpheme. Owing to the head-initial nature of Wolof, the span of harmonic activation is regularly initiated on the leftmost nucleus of the domain. In addition, however, the same property may manifest itself in any nuclear position where a long low vowel **aa** is lexically specified.

The non-alternating status of **aa** has already been noted with regard to the observation that the long central vowel **əə** is systematically ruled out as a member of the contrastive set in Wolof. Admittedly, the absence of **əə** makes for an appealing analysis of the short vowel **ə** as a phonologically empty nuclear position. Such an analysis would accord with the standard Government Phonology assumption that an empty position is incapable of acting as the head of an inter-constituent licensing domain.¹⁵ However, I do not consider there to be sufficient motivation for abandoning my original analysis of **ə** as a melodically specified vowel, since the unpredictable distribution of this vowel does not suggest the usual set of conditions under which empty slots are permitted. Many forms in Wolof appear not to comply with the condition of Proper Government (Kaye 1990b), which has been frequently referred to in the Government Phonology literature as a means of predicting the circumstances controlling the interpretation or non-interpretation of

¹⁵The question of whether phonetically long vowels in Wolof are represented as branching constituents or as nuclear sequences is largely irrelevant to the present discussion.

phonologically empty nuclei. For example, we would expect the form *yiwədi* 'to have a bad appearance' to be interpreted as the string *yiwdi* if the expression denoted by ə were truly an unspecified melodic unit and subject to proper government.

The question remains as to why the structure in (26a) is well-formed as either a short or a long vowel in this language, whereas (26b) may exist only within a minimal (that is, a non-branching) nuclear domain.



Although the motivation for this distributional asymmetry is far from clear, I shall suggest that the inability of a branching constituent to support the configuration in (26b) may ultimately be accounted for by appeal to the structural instability of the latter as a melodic unit. Recall that a licensing domain exists between two melodic tiers that are adjacent on the licensing path, where the role of domain head is assumed by the higher of these (i.e. by the tier located nearer to the ultimate source of licensing potential). In this way, a relation of structural dependency is established, which requires merely the presence of a head tier to sanction a dependent tier below it; accordingly, the aperture tier in (26b) is licensed, despite the inactive status of its licensing tier.

Nevertheless, we do find cross-linguistic evidence to support the idea that an active melodic tier may participate in licensing relations as a stronger, or more effective licensing unit than an inactive (but otherwise identical) tier. I shall refer to this generalisation as the Stable Licensor Condition (SLC), which I formulate as follows:

- (27) **Stable Licensor Condition**
 The head of a strong licensing domain must be non-empty

To illustrate how (27) manifests itself, let us briefly look beyond the patterns of tongue root phenomena discussed so far, and consider the height harmony found within the 5-vowel system of Chicheŵa.¹⁶ As alluded to in §3.3.1 above, alternations involving the height dimension may be captured in terms of a harmonically active [A] element. In the case of Chicheŵa, we can assume that the instruction **ACTIVATE [A]** is lexically specified as a word-level property in verb roots, with the result that the height properties of alternating suffix vowels are determined by those of the root vowel.

- | | | | |
|------|----|------------------------|--------------------------------|
| (28) | a. | kolez - ets - a | 'cause to blow air on to fire' |
| | | fotokoz - edw - a | 'to be explained' |
| | | lomb - ets - a | 'cause to write' |
| | b. | futukul - idw - a | 'to be unfolded' |
| | | budul - its - a | 'cause to remove branches' |
| | | put - idw - a | 'to be provoked' |
| | c. | bal - its - a | 'give birth' |
| | | kangaz - its - idw - a | 'be caused to hurry up' |

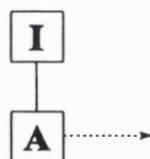
While verb roots are able to support a 3-way (high~mid~low) height contrast, the suffixes, on the other hand, can only contain either high or low vowels lexically. These high suffix vowels are then lowered whenever a mid vowel appears in the root, as in (28a). In terms of the present model, this effect may be viewed as the result of [A]-activation extending throughout the entire word domain. (Note that the verbal suffix *-a* is not influenced by the shape of preceding vowels, since it lies outside the harmonic domain in question). In contrast, the examples in (28b) display suffix vowels which are unaffected by the word-level activation of [A], since the relevant verb roots contain only high vowels, in which the aperture tier is inactive.

Turning to the low-vowel roots in (28c), we find suffix vowels which appear to contradict the description of harmonic behaviour established above. Given that the [A]-tier is lexically active in root forms such as *bal-* 'give birth', and that [A] is typically present as a word-level property in this language, we should expect the vowels of the causative

¹⁶A Bantu language of East-Central Africa, spoken predominantly in Malawi. For a more detailed analysis of its harmonic properties, see Harris (1994b), Mtenje (1985) and Scullen (1992).

suffix *-its-/-ets-* to be similarly interpreted with an active [A] (i.e. we predict the mid vowel alternant). Contrary to expectation, however, the low root vowel fails to initiate harmony, rendering the form **bal-ets-a* ungrammatical. But why should **ACTIVATE [A]** behave as a word-level property only when it is specified in the representation of mid vowels? I propose that the key to this anomalous behaviour lies in the SLC — that is, in the particular status (active versus inactive) of the [A]-tier's licenser, the colour tier. Specifically, I shall claim that a sufficiently strong licenser, in the form of an *active* colour tier, must be present in order to sanction [A] as a harmonic property in this language. This is exemplified in (29a).

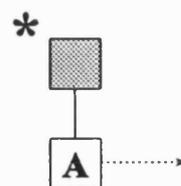
(29) a. word-level
[A]-activation



b. segment-level
[A]-activation



*c. word-level
[A]-activation



If the colour tier is *inactive*, then the aperture tier still becomes licensed in the usual way, as argued in §3.3.3 above and illustrated in (29b). In this latter case, however, the SLC identifies the colour tier as a relatively weak licenser (and consequently, the inter-tier relation as a relatively weak licensing domain) — only a non-empty (i.e. active) unit can stand as the head of a strong licensing domain. The status of the colour tier as a weak licenser is evident from the way it supports the activation of [A] only within a minimal prosodic (i.e. segmental) domain, thus ruling out (29c) as a well-formed configuration in this language. Note that we are able to identify some common ground between this approach and the notion of 'transmitting visibility' presented in Rennison (1990). In the latter, it is argued for Chicheŵa that a harmonizing [A] element is associated to a unit on the [I/U]-tier (rather than directly to the skeleton) and spreads to another element on the [I/U]-tier. Since the [A] of a low vowel *is* linked directly to the skeletal tier (rather than

via an intermediary colour tier), however, it fails to participate in harmony.

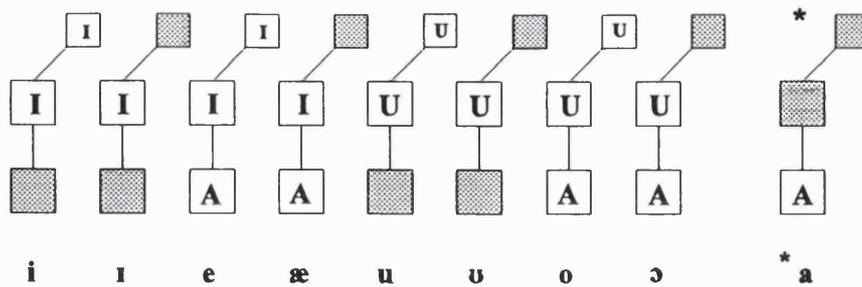
While the SLC — which highlights the correlation between the active status of a licensing tier and its relative licensing strength — must be regarded as a general tendency, rather than an absolute principle of phonological structure, we nonetheless find a number of other languages besides Chicheŵa which help to confirm its validity as an empirically motivated option. The vowel inventory of Igbo, for instance, is shaped according to this pattern:

(30)	<i>Vowel contrasts in Igbo</i>	<i>Advanced~retracted alternations</i>
	i u	i ~ ɪ
	ɪ ʊ	u ~ ʊ
	e ɔ	o ~ ɔ
	æ ɔ	e ~ æ

In view of its 'regular' harmonic alternation between ATR and non-ATR in high and mid vowels, we may assume that Igbo employs the same melodic template used in the case of the ATR harmony systems considered in the previous chapter. Once again, vowel harmony is formalised as the word-level instruction **ACTIVATE [COMP]** — an analysis which indicates that the vowel transcribed here as æ¹⁷ is to be treated as the non-advanced counterpart of e, as confirmed by the alternation pattern. What sets the Igbo system apart from other ATR harmony languages, however, is the absence of a low vowel a. Clearly, the [A] element has a role to play in the phonology of this system, given the contrastive status of vowel height. Yet the instruction to activate a lone [A] is never given, as the following set of structures shows:

¹⁷This vowel is described by Emenanjo (1978) as an 'open front unrounded vowel...fairly close to cardinal vowel no.4.'

(31)



To rule out the ill-formed configuration of *a* in (31) we may refer to its unique status as the only structure in the system without an active licenser for the aperture tier. For Igbo, then, we observe a more rigid enforcement of the SLC, which requires that a 'strong' licensing domain (i.e. one with a non-empty, or lexically active head) be established between the colour tier and its dependent [A]-tier. If the colour tier is inactive — in other words, if a strong domain fails to be established between the two melodic tiers — then [A] cannot be interpreted.

Clearly, there are similarities between the vowel system of Igbo and the case of harmonic distribution in Chicheŵa. In the latter, an active licensing tier is required in order to sanction the word-level activation of its dependent tier element [A], while Igbo requires the active status of the dominant [I/U]-tier before *any* instance of [A]-activation can take place. I assume that these two sets of circumstances may be viewed as different manifestations of the same structural tendency, formulated in (27) above as the SLC, in which an active melodic tier exhibits stronger licensing capabilities (i.e. may head a stronger domain of licensing) than an inactive, but otherwise identical tier. Furthermore, I shall argue that this same tendency provides an insight into the anomalous behaviour of the low vowel of Wolof, as illustrated in (26) above and repeated here as (32).

5.4 RTR harmony in Yoruba

5.4.1 Introduction

The harmonic patterns which characterize (standard) Yoruba, another language of the Niger-Congo group, further exemplify the advantages of a tier-geometric analysis based on the activation of a complement tier. Moreover, I shall show how this language fulfils one of the typological predictions made in §3.3.1, by supporting the lexical activation of the relevant harmonic property at the foot level.

Having received considerable attention in the phonology literature,¹⁸ this language has now become accepted as an established source of reference for investigations into the properties of [-ATR] harmony systems. In many respects, the behaviour of vowels in Yoruba has much in common with that already observed in the case of Wolof, and accordingly, an approach similar to the position argued for in §5.3 will be adopted here. In this way, I attempt to substantiate the claims made in the previous section concerning the formal nature of RTR harmony. The following discussion is based largely on the examples cited by A&P, who argue for a radical underspecification account where all predictable information is absent from lexical forms. I shall make occasional reference to the A&P analysis below, in order to highlight the advantages of the present proposal in terms of its simplicity and generality.

I begin by introducing the general pattern of Yoruba harmony as observed in di-syllabic words, where the close similarity between the harmonic systems of Yoruba and Wolof will become apparent. This is followed in §5.4.3 by a discussion of some of the less straightforward aspects of vowel alternation in Yoruba, which are uncovered by the distributional facts relating to tri-syllabic words. In the light of the harmonic behaviour of vowels in these latter forms, I conclude that the harmonically active unit — the [A]-tier complement — is associated not at the level of the prosodic word, as in Wolof, but at the foot level.

¹⁸See Archangeli and Pulleyblank (1989,1994), Meltzer (1991), Pulleyblank (1994) and Ola (1995).

The inventory of oral vowels in standard Yoruba¹⁹ is given in (33); these are distributed between the two harmonic sets as indicated.

(33)	i	u	ATR span: {i,u,e,o,a}
	e	o	RTR span: {i,u,ε,ɔ,a}
	ε	ɔ	
	a		

As indicated in §5.2.1 above, it is the bivalent feature [\pm ATR] which is crucial to the A&P account of vocalic phenomena in this language. In A&P (1989) the authors are obliged to stipulate specific conditions on the association of feature values, as given in (34). The formulation of these constraints is reminiscent of the grounding conditions illustrated in (5) above, from which they obtain the desired result that the feature value [-ATR] is contrastive only in mid vowels.

- (34)
- a. RTR/HI condition:
[-ATR] cannot co-occur with [+high], either lexically or via spreading
 - b. RTR/LO condition:
if [-ATR] then [+low]
 - c. ATR/HI condition:
[+high] vowels are *underlyingly* associated to [+ATR], to derive opacity

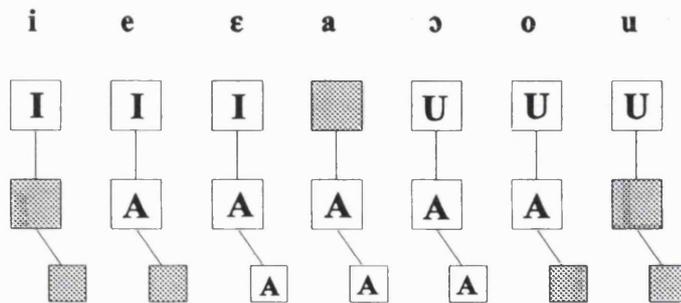
These distributional facts appear strikingly similar to those already encountered in the analysis of Wolof; yet in §5.3 we were able to derive at least the first (and trivially, the third) of these from the representation itself, rather than via any arbitrary condition. Recall that the absence of an ATR contrast in high vowels, as expressed by (34a), resulted from the lack of a colour tier complement in the melodic template of the language. Furthermore, the ability of the [A]-tier to license a complement entailed a contrast in tongue root quality amongst mid vowels, since a suitable licenser for the complement tier

¹⁹I postpone any discussion of nasal vowels until a suitable means of representing nasality has been incorporated into the tier-geometric model. In the meantime, I shall follow A&P (1989: fn.5) in assuming that, with respect to harmony, the analysis of nasal vowels can be accommodated within that of oral vowels.

(i.e. an active [A] element) was available in each case. Even (34b), which specifies a [-ATR] value on low vowels, was observed in the phonology of Wolof as a manifestation of the Stable Licensor Condition, determining the non-alternating characteristics of the long low vowel **aa**.²⁰ On the basis of the typological properties shared by the two systems Yoruba and Wolof, I shall assume a sub-segmental configuration for Yoruba which is identical to that proposed in the analysis of Wolof above.

This melodic template generates the full set of vocalic contrasts found in Yoruba, as illustrated below.

(35)



The phonological distinction between the two harmonic sets can be drawn by referring, once again, to an active [A]-complement tier as the defining characteristic of the RTR group. It may be noted how this approach to the analysis of Yoruba vowel harmony shows some degree of similarity with an account of the same phenomenon given in van der Hulst (1988b). The latter identifies the DP component |a| as the active harmonic property, the presence of which defines the natural class of harmonic triggers {ε ɔ a}. To exclude the upper mid vowels **e** and **o** from the harmonic set, however, van der Hulst is forced to represent these two expressions as the non-ATR high vowels **ɪ** and **ʊ** respectively (i.e. which make no reference to |a| in their melodic structure). Furthermore, a complexity condition is also required, in order to render the high vowels opaque to harmony (this condition disallows two dependents to co-exist within one expression, thereby ruling out the spreading of |a| to **i** and **u**: e.g. *|i → i,a|, *|u → u,a|).

²⁰See below for further discussion of the SLC, and its behaviour in the phonology of Yoruba.

5.4.2 Co-occurrence restrictions: di-syllabic forms

5.4.2.1 High/mid vowel distribution. The co-occurrence restrictions for vowels within a single morpheme or derived word are set out in the following table. These represent the vowel combinations in a typical two-syllable word of the form (C)V₁CV₂.

(36)

		(V ₂)						
		i	e	ɛ	a	ɔ	o	u
(V ₁)	i	✓	✓	✓	✓	✓	✓	✓
	e	✓	✓	✗	✗	✗	✓	✓
	ɛ	✓	✗	✓	✓	✓	✗	✓
	a	✓	✓	✓	✓	✓	✓	✓
	ɔ	✓	✗	✓	✓	✓	✗	✓
	o	✓	✓	✗	✗	✗	✓	✓

A number of generalisations can immediately be made on the basis of (36). First, high vowels are permitted to co-occur with any vowel, in either V₁ or V₂ position.²¹ Second, a sequence of mid vowels must agree in tongue root quality — so strings such as *CeCɔ and *CoCɛ are ill-formed. And third, the low vowel a displays some variation in its harmonic behaviour, depending on its position in the word; specifically, it may be followed by any vowel, but cannot be preceded by an ATR mid vowel. The following forms exemplify these patterns.²²

(37) a. *High vowels*

ilé	'house'	ilè	'land'
ebi	'hunger'	èwù	'clothing'
ìgò	'bottle'	òkín	'egret'
isu	'yam'	àrún	'five'

²¹The absence of the vowel u word-initially is acknowledged by A&P simply as an idiosyncratic property of Standard Yoruba.

²²Following the convention established in the literature on Yoruba, example words are given with tonal markings but without reference to vowel nasality (see footnote 19). Both properties are omitted from structural representations.

b. *Mid vowels*

ebè	'heap for yams'	esè	'foot'
epo	'oil'	èkò	'pap'
olè	'thief'	òbè	'soup'
owó	'money'	òkò	'vehicle'

c. *Low vowels*

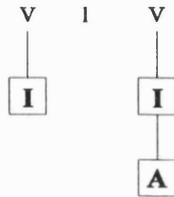
àdí	'palm nut oil'	ilá	'okra'
ate	'hat'	èpà	'groundnut'
àwo	'plate'	òjà	'market'
àjè	'paddle'	*epa	
aso	'cloth'	*oja	

The examples in (37a) illustrate the unrestricted distribution of high vowels in Yoruba. Regardless of whether a high vowel occupies the first or the second nuclear slot, it may occur with another high vowel (e.g. *isu* 'yam'), with a low vowel (e.g. *àrún* 'five'), with an ATR mid vowel (e.g. *ebi* 'hunger') or an RTR mid vowel (e.g. *èwù* 'clothing'). In all contexts, then, *i* and *u* fail to participate in harmony — their neutral status is verified by their membership of both the harmonic sets given in (33). As we have already observed in the case of Wolof, the neutrality of high vowels with respect to harmony is the predicted outcome in a system where the activation of the [A]-tier complement defines a harmonic span. This is a necessary consequence of the configuration used in (35), where *i* and *u* are the only vowels which do not contain an active aperture tier, and thus, the only ones which fail to provide a potential licenser for the harmonically active complement tier. The high vowels, then, must behave both as non-triggers and non-targets, which renders them compatible with members of either harmonic set within the same morpheme.

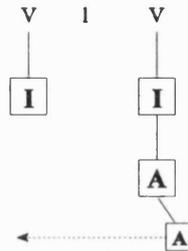
The representations in (38) demonstrate how the lexical instruction **ACTIVATE [A]-COMP** may apparently be specified as a word-level property without being affected in any way by the presence of high vowels. Following Ola (1995), I shall assume that domain heads in Yoruba occur at the right edge of the word, from where harmonic

activation originates.²³ The structures shown here have been stripped of all redundant material, in accordance with the PSE.

(38) a. *ilé* 'house'

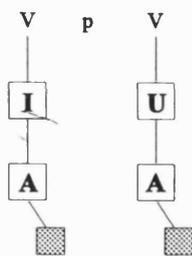


b. *ilè* 'land'

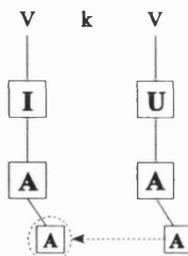


Turning to the forms in (37b), we find that the effects of harmony are most clearly visible when two mid vowels are involved: tongue root agreement must prevail, which I assume to be the result of the active/inactive status of the complement tier throughout the entire domain. So sequences such as *e...o* and *ɔ...ɛ* are well-formed, whereas **ɔ...o* and **o...ɛ* are deemed impossible.

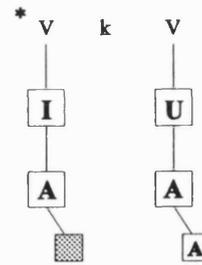
(39) a. *epo* 'oil'



b. *èkɔ* 'pap'



c. **ekɔ*



Clearly, the example in (39b) does not lend any real support to the right-headedness hypothesis just referred to; the same well-formed result would obtain, whichever one of the two nuclei in this di-syllabic form were to be identified as the origin of word-level

²³Below I return to the question of prosodic word structure in Yoruba and the head-final characteristics of this language.

harmony — in either case, nothing prevents a local harmonic relation from being created along the complement tier, since any mid vowel will provide a necessary licenser (an active [A] element) for the harmonically active unit [comp].

While the forms in (37b) are at least consistent with the assumption of right-headedness, the following examples appear, at first sight, to provide compelling counter-evidence against this viewpoint.

- | | | | | |
|------|----|----------------------|----|----------------------|
| (40) | a. | <i>lexically ATR</i> | b. | <i>lexically RTR</i> |
| | | ì gò 'bottle' | | ò kín 'egret' |
| | | e bi 'hunger' | | il è 'land' |

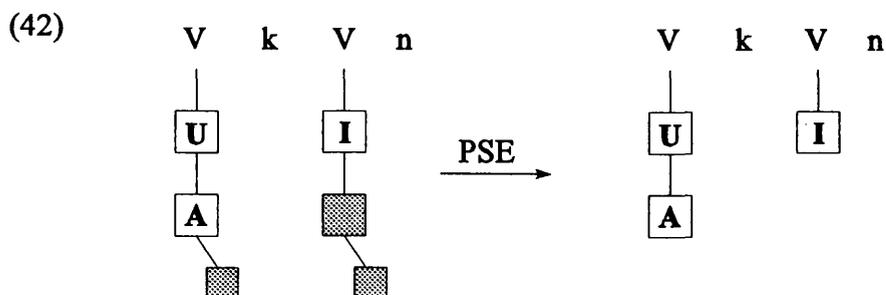
Each contains a high vowel which, for the reasons already indicated, cannot participate in harmony. But it is possible for a high vowel to co-occur with a mid vowel of either tongue root quality, irrespective of whether that mid vowel occupies the V_1 or the V_2 slot. On the strength of (40) we cannot predict the point at which activation of [A]-comp is initiated — in Firthian terms, the property is 'unplaced'; it seems equally likely to manifest itself in V_1 or V_2 , apparently leading to the conclusion that the activation of [comp] is not prosodically conditioned (i.e. it is not restricted to a 'strong' position or subject to any parametrically controlled constraint such as headedness). However, I shall argue in §5.4.3 that right-headedness properties are indeed crucial to an explanatory analysis of harmony in Yoruba, and accordingly, cannot be undermined even by a small number of apparently contradictory cases such as *ò kín*.

To accommodate (40), I propose that the following dominance relation be recognized in the phonology of Yoruba:

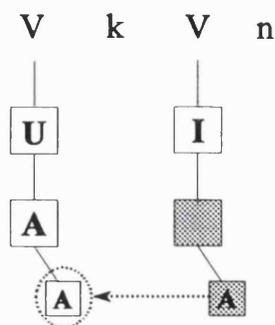
- (41) $PE_x \gg PSE$

While these two constraints have already been shown to play a decisive role in the description of the typological variation existing between ATR harmony languages (see §4.5), I now demonstrate how the same well-formedness generalisations come into direct conflict with each other in the RTR morpheme *ò kín* 'egret' given in (40b). This example clearly poses a problem for the right-headedness claim made above, since activation of the

complement tier is observed only in the prosodically weak nucleus (recall that this property is assumed to originate in the strongest position of the domain). Under normal circumstances, we expect the PSE to remove all unnecessary structural units from the representation of this word, as shown in the hypothetical configuration in (42):



(43)



Although this form is lexically RTR, the domain head nucleus is unable to interpret the instruction to activate the complement tier, owing to the absence of an active aperture tier to act as a suitable licenser. Nevertheless, the lexical instruction **ACTIVATE [A]-COMP** remains intact as a property of the domain head position — i.e. it is only the unsuitable *structural* conditions in the rightmost nucleus which lead to failure of interpretation — from which it initiates local harmonic relations along the complement tier and causes the activation of [comp] in the nucleus to its left. Of course, the representation in (43) may be constructed only by a grammar in which PEx dominates PSE: without any suppression of the PSE's reduction effects, no empty [comp] unit would be retained in the strong position, and the word-level harmonic instruction could not be transmitted by the head nucleus.

Wolof provides ample evidence for the existence of this latter state of affairs as a typological possibility, where a high vowel occupying the strong (leftmost) nucleus always heads an ATR domain.

- | | | | |
|------|----------|--------------|-------------|
| (44) | jigeen | 'woman' | (*jigeen) |
| | fitnə | 'hardship' | (*fitna) |
| | bəccəg | 'daytime' | (*bəccag) |
| | suul-e | 'bury with' | (*suul-ε) |
| | tiit-oon | 'was scared' | (*tiit-ɔɔn) |

As the forms in (44) demonstrate, the presence of **i** or **u** in the first nucleus has a neutralising effect on any contrast potentially generated by the word-level specification of complement tier activation. I propose that this neutralisation results from the following

constraint ranking in Wolof, a reversal of the dominance relation holding between the same two constraints in Yoruba.

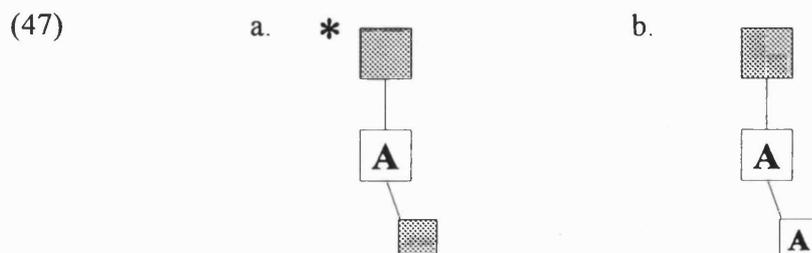
(45) PSE >> PEX

The dominant status of the PSE in Wolof predicts that the [comp] of a high vowel will be eliminated, thereby removing the one melodic unit necessary for the successful transmission of any harmonic instruction to remaining nuclei.

5.4.2.2 Low vowel behaviour. Consider now the distributional facts pertaining to two-syllable forms which contain a low vowel, such as those given in (37c) and repeated here as (46).

- | | | | | | | |
|------|----|-----|------------|----|------|-------------|
| (46) | a. | àdí | 'palm oil' | b. | ilá | 'okra' |
| | | ate | 'hat' | | èpà | 'groundnut' |
| | | àwo | 'plate' | | ɔjà | 'market' |
| | | àjè | 'paddle' | | *epa | |
| | | aso | 'cloth' | | *oja | |

Two clear patterns emerge from this set, the distinction corresponding to whether the low vowel **a** is located in the first nucleus (46a) or the second (46b). In either case, however, the low vowel itself fails to harmonize. Instead, it retains its RTRness — a characteristic which, I shall argue, may be attributed to the existence of a structural stability condition in Yoruba requiring that the complement tier must be active in a low vowel. This is shown in (47):



Recall from §5.3.4 that a similar condition — formalized in terms of the Stable Licensor Condition — is also observed in the phonology of Wolof, where the alternation between *aa* and **əə* is banned on the grounds that the [comp] of a low vowel must be active within a prosodic licensing domain. In the case of Yoruba (where vowel length is not contrastive), however, it would appear that the same constraint has a wider application and refers to *all* tokens of the low vowel *a*. In the analysis to follow, I shall treat this distributional characteristic as another instantiation of the SLC.

When *a* appears in word-initial position in Yoruba, it may be followed by a mid vowel of either ATR or RTR quality: so *aCe* and *aCε* are potentially contrastive forms. This pattern must be seen as the expected outcome in a system where the domain-head (rightmost) nucleus supports — whenever structural conditions allow — the opposition between an active and an inactive complement tier. In (46a), however, the identity of [comp] activation as an assumed word-level property is concealed by the non-alternating status of the low vowel in the preceding nucleus: in order to comply with (47), [comp] must be active in the structure of *a* — irrespective of whether the harmonic domain is lexically ATR or RTR. So, a word of the shape *aCo* or *aCe* does not contain any *word-level* ACTIVATE [A]-COMP instruction, since the mid vowel occupying the head position is interpreted as ATR. Instead, we can attribute its harmonically 'mixed' status — that is, the apparent co-existence of two distinct harmonic spans, one with active [comp], the other without — to the requirement that, even within an ATR root, the low vowel must license an active [A]-comp in order to be interpreted. This activation of the complement tier is confined to the single position containing the low vowel, since [comp] can be activated harmonically in this language only via an instruction originating in the strong (domain-head) position — see (43) above. Of course, there remains a potential contrast between *aCε* and *aCe*, which is encoded by the word-level specification of [comp], initiated on the final nucleus. This lexical property is, however, independent of the active status of [comp] in the initial vowel, the latter reflecting the low vowel stability condition (SLC) just outlined in (47).

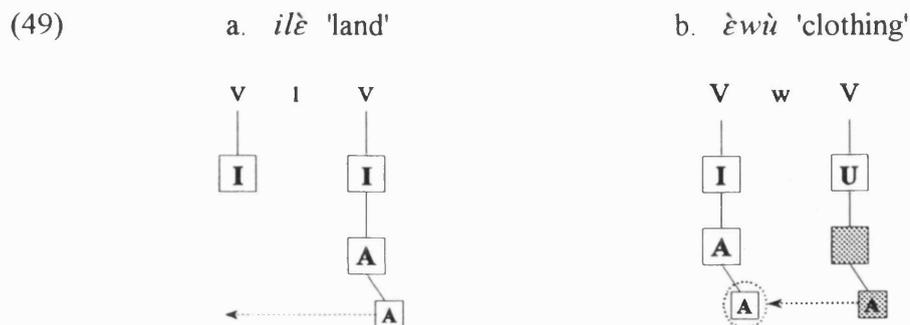
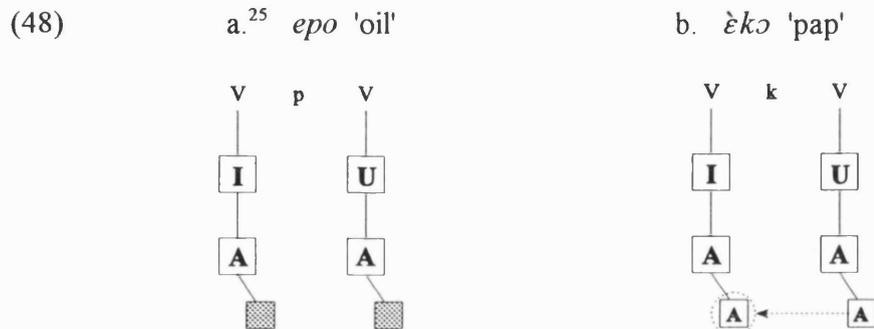
Turning to the pattern that emerges from the set of low vowel forms in (46b), it appears that no tongue root contrast can be supported by a V_1 position when followed by a nucleus containing *a*; thus *əCa* cannot contrast with *oCa*. In the analysis offered by

A&P, this fact prompts the authors to impose a directionality control on the association of the harmonic feature [-ATR], such that the harmonically active unit is first assigned to the rightmost vowel and then spreads only leftwards across the domain. In this way, the low vowel — which is redundantly RTR, in line with the condition in (34b) — begins an RTR span when in word-final position, causing the vowel to its left to agree in RTRness, thereby predicting the well-formedness of the examples in (46). On the other hand, a form which begins with a low vowel is able to support a tongue root contrast word-finally, since this latter position assumes the role of harmonic trigger, rather than target.

This directionality requirement proposed by A&P is consistent with the notion of right-headedness which, I have already suggested, exerts a significant influence over structural well-formedness and harmonic patterning in Yoruba.²⁴ Indeed, this characteristic of right-dominance may be exemplified by referring to the same sets of data used by A&P in their discussion of directionality. Consider, for example, forms such as *èpà* 'groundnut' and *ɔjà* 'market', where *a* in the prosodically strong (rightmost) position prevents any ATR mid vowel from occupying the preceding nucleus: hence, **èpà*, **ɔjà*, etc. To account for this distribution, I shall argue that the complement tier, which is active in a as a result of the low vowel stability condition SLC, demonstrates harmonic properties by virtue of its association with the domain-head nucleus — the position from which the harmonic activation of [comp] always originates in this language. In short, the activation of the complement tier in the prosodically strong nucleus consistently leads to its interpretation as a harmonic property of the word domain — regardless of whether or not this unit is lexically specified as such. We have observed, then, two apparently independent sources of complement tier activation in the examples considered so far. It may either contribute to the representation of a low vowel — in order to comply with the SLC depicted in (47) — in which case its location (in either V_1 or V_2) is unrestricted; or it may be activated in V_2 as a word-level property, in which case all potential targets undergo harmony.

²⁴In contrast, the propagation of harmony in Wolof was analysed as head-initial. I suggest that direction of harmony be treated as the manifestation of a more general property controlling headedness at other levels of structure too. We find a clear parallel between Wolof (head-initial) and its suffixation, on the one hand, and Yoruba (head-final) and its prefixation, on the other. Déchaine and Manfredi (1995) discuss the demarcation of vowel harmony domains in terms of the scope of particular syntactic governing relations.

5.4.2.3 Summary. I close the present discussion of di-syllabic forms by reviewing the various distributional patterns already observed. In words containing only mid vowels, full harmonic agreement is predicted to be always visible, since a potential trigger will occupy V_2 and a potential target will be present in V_1 . This is verified by (48).



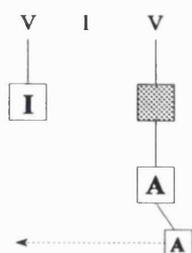
Again, (49) shows complement tier activation at the word level. In *ilè* 'land' the activation instruction is initially associated with the prosodic constituent N'' — a projection of the domain-head nucleus. From the latter we expect the instruction to be transferred to the remaining nuclei within the domain; in this instance, however, the truncated structure of the first vowel renders it neutral (and transparent) to harmony. On the other hand, when the neutral high vowel appears in the rightmost position, as illustrated in (49b), we observe the effects of the constraint ranking given in (41). In this case, V_2 cannot support any active complement tier, yet it still fulfils its expected role as the source of the

²⁵This structure is, of course, a target for structural streamlining, in accordance with the PSE.

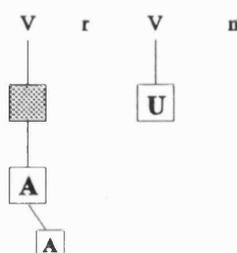
harmonic instruction, and transmits this to the harmonizing vowel to its left.

With regard to words containing **a**, we have already seen how this vowel is consistently RTR, regardless of its position in the word. The generalisation holds true, whether **a** is located in the strong nucleus (50a) or a prosodically weaker position (50b).

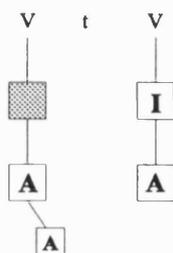
(50) a. *ilá* 'okra'



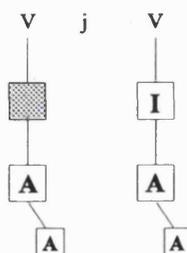
b. *àrún* 'five'



(51) a. *ate* 'hat'



b. *àjè* 'paddle'



When **a** occurs in V_1 position, the strong nucleus is able to support a word-level tongue root contrast — compare the ATR form in (51a) with the RTR morpheme in (51b). Note that, in the latter, the active [comp] belonging to the low vowel is specified independently of the word-level marking for the same property. That is, the two independent means of interpreting an active complement tier in Yoruba are observed in the same string: first, the noun itself is lexically RTR, allowing the strong position to activate [comp]; second, the SLC ensures that the low vowel in the initial nucleus also contain an active [comp]. So the leftmost instance of active [comp] does not derive from word-level harmonic activation (despite the fact that this vowel occupies the position where we would expect

In the first batch of examples, a medial high vowel is flanked by two mid vowels.

(53)	a.	èlùbó	'yam flour'	b.	*èlùbó
		òwùrò	'morning'		*òwùrò
		ewùré	'goat'		*ewùré
		odíde	'Grey Parrot'		*odíde.....etc.
		òkùró	'palm kernel'		*òkùró
		erùpè	'earth'		*erùpè
		okúro	'name'		*okúro.....etc.

In these cases the patterns of distribution are clear. First, the co-occurrence of two RTR mid vowels is ruled out, hence **odíde*, **èlùbó*, and so on. Second, whenever a form contains two mid vowels, one ATR and the other RTR, the latter must occupy the final nucleus: so *ewùré* is well-formed, since the ATR vowel occupies the V_1 position while the RTR vowel is word-final; in contrast, **ekuro* is impossible, given that V_3 contains the ATR expression and V_1 the RTR one. The remaining possibility with respect to mid vowel forms is the case in which two ATR vowels flank the medial *i* or *u*. The grammaticality of such forms is demonstrated here.

(54)	èsúró	'Redflanked Duiker'
	òyì bó	'any European'
	orúpò	'mudbench (serving as a) bed'

Two questions immediately arise. Firstly, why must an ATR mid vowel precede an RTR vowel in a harmonically mixed form? Secondly, and more fundamentally, why does [A]-comp activation systematically fail to be maintained throughout the entire word domain?

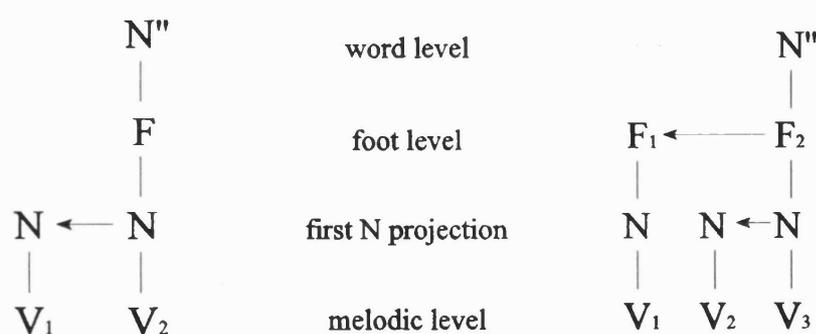
We have already observed that a di-syllabic word containing the lexical instruction **ACTIVATE [A]-COMP** always manifests its RTR properties on the strong domain-final vowel whenever that position can support the necessary melodic configuration. This generalisation may now be extended to include 3-syllable forms, since the same dominance relation correctly predicts both the well-formedness of *ekure* and the ungrammatical

status of **ekure*. §5.4.2 has shown how right-headedness properties are seen to prevail throughout the structure of Yoruba, dictating that, in an RTR form of the shape *vCV*, the nucleus 'V' must contain an active complement tier wherever possible. However, this seems equally applicable to longer strings such as *vCvCV*, where again the final nucleus 'V' must reflect any morpheme-level marking for RTRness.

To capture the characteristic of right-dominance observed in 3-syllable words, we must recognize a prosodic structure which, once more, identifies the rightmost nucleus as the head of the word domain. The figures in (55) show the proposed prosodic configurations for both di-syllabic and tri-syllabic words. I maintain the approach established in §3.3.2 and represent the traditional prosodic categories (*foot*, *word*, etc.) in terms of nuclear projections, under the assumption that any nucleus which fails to be licensed (via binary asymmetric licensing relations) at any given plane is projected up to the next prosodic level. This is repeated until only one nuclear position remains unlicensed, thus identifying the ultimate head of the domain. Each arrow marks the presence of an asymmetric licensing domain, indicating one 'step' along the licensing path.

(55) a. di-syllabic forms: e.g. *ilè*

b. tri-syllabic forms: e.g. *ewúré*



The structure in (55a) demonstrates how the tendency towards right-headedness manifests itself in 2-syllable forms: the right-hand position is prosodically the stronger of the two and, as such, must register lexical RTRness wherever possible. The larger structure in (55b) differs from the preceding one in that there are two constituents at the

level of the foot, and three nuclear positions to be interpreted. I shall assume that right-headedness still prevails, rendering the rightmost nucleus prosodically strong and identifying it as the head of the word domain. At the first level of nuclear projection this head position licenses V_2 to its left. This relation established, the two remaining unlicensed nuclei V_1 and V_3 are projected to the next level of structure, where a larger prosodic domain is circumscribed via a second asymmetric licensing relation. Again, the tendency in Yoruba towards right-headed structure is reflected at the foot level, the head position V_3 licensing the nucleus V_1 to its left and being projected to the next level as the only unlicensed position within the word domain. On the basis of the structure in (55b) we derive a scale of relative prosodic strength as shown in (56).

$$(56) \quad V_3 > V_1 > V_2$$

This hierarchy corresponds to the amount of licensing potential possessed by each position, where both V_1 and V_2 are licensees of the domain head. The difference in strength between the two licensed positions corresponds to the way in which the former is licensed at a higher prosodic level, where a greater amount of licensing potential is available. In the examples to be introduced below, the strength hierarchy in (56) will manifest itself as a particular set of vowel distribution patterns.²⁶

The proposed structure in (55b) contains two constituents at the foot level: the right-hand unit F_2 marks a right-dominant binary foot, while F_1 is identified as a degenerate (non-branching) foot. Although the recent literature²⁷ casts some degree of doubt over the acceptance of the latter as a legitimate unit of prosodic structure, I shall nevertheless follow Ola (1995) in treating degenerate feet as a necessary feature of Yoruba prosody. Ola provides evidence in favour of the degenerate foot by making appeal to the notion of minimal word domain. While the minimal word standardly corresponds to a bimoraic structure cross-linguistically (McCarthy & Prince 1993), it is demonstrated

²⁶See also the analysis of Neapolitan Italian offered in Bafle (1996) — cited in Harris (1997) — which provides further evidence of the direct correspondence between a position's status as a domain head (or non-head) and its capacity (i) to bear stress and (ii) to support a full (or reduced, as the case may be) range of vowel contrasts.

²⁷In particular, see Hayes (1995).

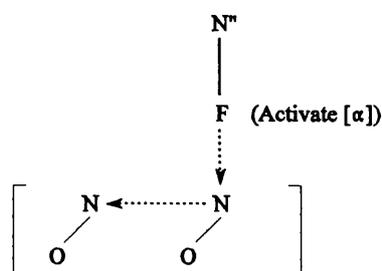
the harmonic instruction **ACTIVATE [A]-COMP** is specified as a property of the F constituent (as opposed to its association with N" in Wolof), thereby creating a foot-level domain of vowel harmony. As (55a) illustrates, the di-syllabic forms introduced above all consist of a single, binary branching foot — that is, the foot domain and the word domain each identify the same string of sounds. So, a re-consideration of these (C)VCV words in terms of a foot-level (rather than a word-level) harmony is expected to have no adverse effect on the descriptive accuracy of the analysis proposed thusfar. In accounting for vowel distribution in tri-syllabic words, however, the difference between a word-level and a foot level approach is inevitably a crucial one, since the harmonic domains circumscribed by each are no longer identical — see (55b) above. The fact that harmony regularly fails to extend across all three nuclei clearly weakens the case for word-level activation. Conversely, positive evidence to support a foot-level analysis comes from the fact that [A]-comp activation in a three-syllable word is typically observed in *either* the degenerate foot F_1 *or* the branching foot F_2 — but not in both.

This pattern is most clearly visible in words containing two mid vowels, such as those given in (53a), which systematically consist of two distinct harmonic domains — an ATR span followed by an RTR span. Significantly, we never encounter strings such as *èlùbɔ́, in which complement tier activation extends throughout the entire domain. On the grounds that activation of this sort *is* permitted in two-syllable words (e.g. èkɔ́ 'pap'), it is suggested by A&P that the presence of the medial high vowel in 3-syllable words has some bearing on the distributional differences observed. Specifically, they posit that **i** and **u** behave as opaque segments, underlyingly associated to the feature value [+ATR], which leads to their blocking effect on any leftward spreading of the harmonically active [−ATR]. This mechanism correctly predicts that an initial RTR mid-vowel cannot be interpreted when another RTR mid-vowel occupies the final position. However, an appeal to high vowel opacity presents an immediate challenge for the tier-geometric analysis of Yoruba proposed here. As demonstrated by the example in (49a) above, there is nothing contained within the structural representation of high vowels which can potentially act as a blocker to the transmission of complement tier activation: the model predicts that such expressions are unable to refer to any licensed complement, let alone allow its activation. Instead, it is high vowel transparency that must be the expected outcome if we are to rely

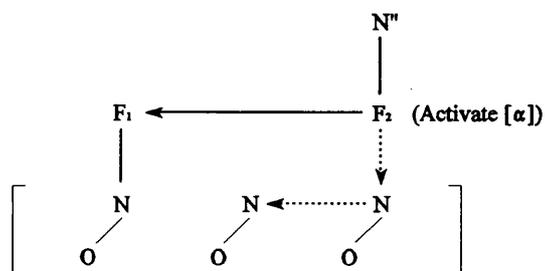
on the structure itself for determining the nature of harmonic behaviour. Recall that the same conclusion was reached in §5.3.3 above with regard to high vowel transparency in Wolof, where an identical melodic template was employed.

So, assuming that we cannot attribute the distribution of RTRness in (53) to any properties of the medial high vowel, then we are forced to examine other aspects of the structure in order to explain why a single domain of [A]-comp activation is never observed across an entire three-syllable morpheme.²⁹ As I have already suggested, the proposal that Yoruba RTR harmony be treated as a foot-level phenomenon will be shown to readily accommodate the attested facts. This approach is compatible with 2-syllable words such as *èkɔ* 'pap', which take the form of a single binary foot structure, as outlined in (59), and also with 3-syllable words based on the structure in (60), where the span of complement tier activation corresponds to the rightmost foot domain F_2 .

(59)



(60)

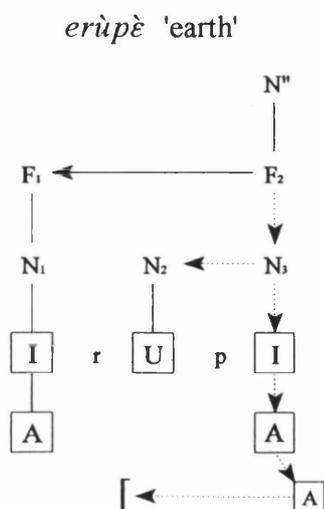


²⁹Forms involving the low vowel require separate discussion, which I turn to in §5.4.3.2 below.

In both figures, the transmission of the foot-level instruction **ACTIVATE [A]-COMP** is marked by dotted arrows. In (59) the single foot constituent is assigned the harmony instruction, which is initially interpreted on the rightmost nucleus and transmitted via a local harmonic relation to the remaining nuclear position within the foot domain. In the case of a form such as *èkɔ* 'pap' the necessary structural requirements (i.e. an active licenser for the complement tier) are met, with the result that [comp] is interpreted throughout.

A similar foot-level specification of the harmonic value may be assumed for the tri-syllabic structure in (60). In this instance, however, two foot-level constituents F_1 and F_2 are available as potential locations for complement tier activation, and the grammar must identify the preferred option. In view of the strong tendency towards right-dominant structure in Yoruba, the choice of F_2 over F_1 is the expected outcome; the status of the right-hand foot as (a projection of) the head of the word domain renders it the stronger of the two candidates, and therefore the 'first choice' for activation of the harmonic property. So, if a 3-syllable word is lexically RTR, then its representation must include a foot-level instruction to activate the complement tier. Given that the structure contains two feet, it is predicted that each will constitute a separate harmonic span. Consequently, a word-initial and a word-final mid vowel — although both potential licensers for [comp] — will necessarily differ in tongue root quality, as (61) illustrates. Again, the transmission of the harmonic instruction is indicated by dotted arrows.

(61)



Foot-level activation of the complement tier in (61) is specified in the rightmost foot constituent F_2 and interpreted in the nuclear position N_3 . As a foot-level property, [comp] activation then proceeds to extend its span of activation to incorporate any remaining positions within the designated (foot) domain. In this case, however, no potential target for harmony is available, with the result that the harmonic value is observed on only a single vowel. Note that the complement tier of N_1 is removed in accordance with the PSE, since it lies outside the specified domain of harmony and cannot therefore exist as a potential target for activation.

As observed in the preceding example, the prevailing tendency towards right-headedness in Yoruba manifests itself in the choice of the rightmost foot F_2 as the favoured location for harmonic activation. In some 3-syllable words, however, the melodic structure renders this impossible, as the examples in (62) testify. These forms end with a high vowel, which cannot support any tongue root distinction because no suitable licenser is available for [comp].

- (62) ègúsí 'food made from melon seeds'
 èbùrú 'shortcut'

Furthermore, the licensed position N_2 within the same foot domain also contains a high vowel, so complement tier activation cannot manifest itself in the weak nucleus either. In such cases we can expect one of two possible outcomes: either the foot-level instruction **ACTIVATE [A]-COMP** is interpreted elsewhere in the word (specifically, in the degenerate foot F_1), or otherwise it fails to be interpreted altogether (because it cannot be supported in the strong foot). The latter option would clearly amount to a violation of the PEX, a constraint (see §4.5.2) which ensures the interpretability of lexically given melody. However, we have already observed how the PEX exerts a strong influence over the harmonic distribution of vowels in Yoruba, as illustrated by its dominant behaviour in the constraint ranking in (41) above. The relatively high profile of this constraint therefore rules out this second option as a grammatical possibility, with the result that the burden of interpreting the activation instruction shifts to the other foot-level constituent within the word — the initial foot F_1 — which supports a melodic structure capable of providing the necessary conditions for successful interpretation. Hence, *ègúsí* constitutes a well-

formed string, despite the fact that the RTR harmony span corresponds to a weak foot domain.

So, if the strongest position N_3 in a tri-syllable word is unable to carry out the harmonic instruction to activate the complement tier, then the favoured alternative is consistently shown to be N_1 , an outcome which lends support to the fundamental claim of this work — that it is the *interaction* of lexical activation instructions with general principles of structure that determines the behaviour of melodic units in phonological phenomena. Further evidence in support of the present line of argument comes from the observation that the position predicted to be the least favoured as an initial point of [comp] activation — namely, the prosodically recessive nucleus N_2 — regularly fails to support any RTR vowel. Moreover, low and mid vowels appear to be excluded from this position, leaving *i* and *u* as the only potentially contrastive vowels.³⁰ Significantly, these are the only vocalic expressions in Yoruba which contain only a single licensed tier in their representation — which I suggest is a direct reflection of the depleted licensing potential inherited by the weakest nuclear position within the domain.

5.4.3.2 Low vowels revisited. To finish, I consider 3-syllable forms containing low vowels. Morphemes containing a fall into two distinct categories, according to vowel distribution: in one group the low vowel is word-initial, and in the other, word-final. In all cases the medial vowel must be high, either *i* or *u*, owing to the influence of Licensing Inheritance, as just noted. The first pattern to be considered involves words with a final low vowel; in all such examples, the leftmost (non-low) vowel must be ATR. It will be recalled from §5.4.2 that the complement tier must be active in the representation of a low vowel in Yoruba, owing to the influence of the structural stability condition (SLC) in the grammar of this language (see (47) above). As already observed for di-syllabic forms, this means that two sources of [comp] activation are potentially available, the first from the foot-level instruction **ACTIVATE [A]-COMP**, and the second as a result of the SLC.

On the basis of the pattern represented in (63), it would appear that any potential tongue root contrast is neutralised in N_1 : for example, *ojiya* cannot contrast with *ɔjiya*.

³⁰In fact, non-high vowels can occupy word-medial positions but, it seems, only as the result of vowel copying or reduplication: e.g. *kəkərɔ* 'key'. No height *contrast* is supported.

(63)	yorùbá	(*yɔ̀rùbá)	'Yoruba'
	ojiya	(*ɔ̀jiya)	'Daniellia Ogea'

To account for this restricted distribution, there are two conceivable analyses that present themselves. First, let us suppose that *ojiya* is an RTR form — i.e. that the foot-level instruction **ACTIVATE [A]-COMP** is included in its lexical representation. On the basis of the structure proposed in (60), we expect the branching foot F_2 to support this activation, since (i) its projected head (the rightmost vowel N_3) assumes the role of word-domain head, and (ii) it retains the necessary melodic configuration (i.e. a potential licenser for the complement tier) for successful interpretation. If this prediction is fulfilled and the harmonic span is interpreted on the stronger foot, then the preceding degenerate foot cannot also support the same foot-level activation instruction; consequently, an ATR vowel must be interpreted word-initially. Incorporation of the harmonic property into the string *ojiya* follows the pattern illustrated in (61) for *erùpè* 'earth'.

As an alternative, suppose this morpheme is lexically ATR, and therefore does not contain any harmonic instruction to activate the tier complement. This still leaves an active [comp] in the (dominant position within the) branching foot, by virtue of the generalisation that the low vowel specified in N_3 must conform to the SLC depicted in (47). Meanwhile, there is no possible source of complement tier activation in the initial foot, given that the word is assumed to be non-RTR. Under this second analysis, then, the same interpretation *ojiya* results. It appears that, in these examples, the proposed theoretical approach correctly predicts neutralisation (and the presence of an ATR expression) in mid vowels occupying N_1 , whether the active complement tier in N_3 is viewed as a language-specific characteristic of low vowel structure or as a lexical property of the morpheme as a whole. This result may be compared with A&P's explanation of this restricted distribution, which requires:

- the directionality of [-ATR] harmony to be specified as right-to-left
- the feature value [+ATR] to be linked to high vowels (thereby rendering them opaque to leftward harmony)
- the [+high]→[+ATR] association to be implemented before the [-ATR] spreading rule.

Finally, I examine the group of tri-syllabic forms with a low vowel in word-initial position. While (64a) gives forms containing a final ATR vowel, (64b) shows an RTR vowel in N_3 .

- | | | | |
|------|--------|----------------------|-------------------|
| (64) | a. | àbúrò | 'younger sibling' |
| | | àtíkè | 'make-up powder' |
| | | àdúgbò | 'neighbourhood' |
| b. | àkùrò | 'a type of farmland' | |
| | abíyá | 'armpit' | |
| | àgùtàn | 'sheep' | |

The forms in (64a) contain no morphemic (foot-level) RTR specification, as indicated by the ATR quality of the mid vowel in word-final position. Nevertheless, the complement tier is active in the first nucleus, which we may attribute to the now-familiar structural stability requirement on low vowels spelled out in (47). Turning to the pattern in (64b), the form *àkùrò* 'farmland' provides an example where both sources of [comp] activation are employed within the same word. First, the word is lexically RTR, resulting in an RTR mid vowel appearing in N_3 , the head of the word domain. Second, the complement tier is also active in the initial degenerate foot, by virtue of the fact that a low vowel is specified word-initially. So, although the resulting interpretation of this string shows [comp] to be active throughout the entire word, this is not achieved via any process of word-domain harmony. Instead, each foot refers to its own independent source of complement tier activation. The remaining examples in (64b) serve to demonstrate that the SLC on low vowels applies whenever and wherever a is lexically specified, and furthermore, that there is apparently no restriction on the number of low vowels that may occur within a single morpheme.³¹ So, two separate spans of [comp] activation can potentially result from the presence of two low vowels in a word, as illustrated by the forms *abíyá* 'armpit' and *àgùtàn* 'sheep'.

³¹Of course, in general the prosodically weak status of the medial nucleus in a three-syllable word prevents a non-high vowel from being supported in this position.

5.4.4 Summary of analysis

This discussion has shown how the melodic template employed in the treatment of Wolof proves equally appropriate for capturing the vowel distribution facts observed in Yoruba too. I have claimed that this language's harmonic characteristics may be attributed to (i) the instruction **ACTIVATE [A]-COMP** specified at the foot level, and (ii) the SLC, a condition which states that well-formedness in low vowels can be achieved only by the presence of a strong licensing domain (i.e. an active [A]-tier *and* tier complement) in the melodic structure.

At the outset I suggested that the postulation of an enriched representational structure, as characterized by the proposed tier-geometric approach, could go some way towards reducing the number of language-specific stipulations which the more conventional A&P (1989,1994) account relies on. The following points indicate those areas in which this has been achieved:

- A&P's RTR/HI condition (34a):
falls out from the proposed melodic template
- A&P's (leftward) directionality requirement on spreading:
results from the general properties of prosodic licensing relations
- A&P's claim that high vowels are opaque (underlyingly linked to [+ATR]):
foot-level activation results in two distinct spans, F_1 and F_2
- A&P rely on derivational ordering
([-ATR] association in low vowels precedes the spread rule)
([+ATR] association in high vowels also precedes [-ATR] spreading):
no serial derivation involved

So, foot-level activation and the low vowel structural condition SLC can jointly account for the range of distributional patterns observed in di-syllabic forms (constituting a single binary foot) and also three-syllable forms. In this latter group, each word has been analysed according to the prosodic structure given in (55b), consisting of two distinct feet capable of supporting two independent domains of harmony.

6 *Conclusion*

The objective of this thesis has been to develop a model of melodic structure that would offer an explanatory account of the nature of vowel systems, in terms of both typology and dynamic behaviour. The discussion has focused specifically on (i) the cross-linguistic variation observed in the characteristics of vowel inventories, and (ii) the patterns of harmonic agreement found in a variety of tongue root harmony languages of Africa. In addressing the question of vowel system typology, I have proposed that the vocalic contrasts of a language be generated from a melodic template — a sub-segmental geometry of melodic tiers, established on a language-particular basis according to a number of parametric choices controlling tier division and conflation. The template has been shown to have a delimiting effect on the generation of vocalic expressions, predicting the number and, to a large extent, the identity of the vowel oppositions potentially supported in a given language. Furthermore, the notion of melodic template is intended to reflect the facts of language acquisition, each parametric choice being directly motivated by the perception of a particular set of lexical contrasts in the input data received by the infant language learner.

In response to the problem of undergeneration inherent in the tier-geometric model, I have also introduced the option of licensing a complement tier as a controlled means of increasing the generative capacity of individual melodic templates. Again, the inclusion of this additional structure takes as its cue the identification of the relevant contrasts in the input language data. I have argued that the function of complement tiers may be distinguished from the role of melodic headship as it is already employed in standard versions of Element Theory and Dependency Phonology. In particular, the description of ATR harmony systems given in §4 has illustrated some of the advantages to be gained from recognizing the former option which, significantly, is able to encode the relative saliency of individual melodic properties in a structurally dynamic way. This allows a correlation between a given melodic template and the relative markedness of the vowel system it generates, where an increase in structural complexity (via

complementization) parallels an increase in the degree of markedness.

In the latter half of this work I have shown how the postulation of a complement tier also allows us to proceed with a unified treatment of various dynamic processes such as vowel harmony. Assuming that harmonic agreement may be captured in terms of the (prosodically defined) activation of a given melodic plane, we need not distinguish between instances of tongue root harmony — involving an active complement tier — and those in which a resonance element such as [U] is identified as the harmonic property. In every case the targeted melodic tier belongs to the structural template of the language in question, allowing all harmony types to be described in a uniform manner. This approach offers a solution to the potential difficulties arising from the standard Element Theory treatment of harmony, where two independent mechanisms — element spread and the alignment of heads — are required in vowel harmony descriptions.

Although the TG model is able to unite tongue root harmony and other types of element-based harmony as a single process type, it nevertheless maintains a fundamental distinction between the units involved in each: while the resonance properties represented by [A], [I] and [U] exist as atomic units of melodic structure, the tongue root properties indicated by the labels ATR and RTR do not share the same status — that is, they are not considered members of the UG vocabulary. This distinction is maintained by defining the complement tier in purely structural (rather than elemental) terms, with the result that it is never interpreted independently of its licensing tier (recall the criterion of autonomous interpretation described in §2.2.1, which asserts that all melodic primes are fully interpretable in isolation). Despite this conclusion, however, the TG approach does expose patterns of melodic behaviour that correspond directly to the informal categories ATR and RTR, these patterns emerging from particular tier configurations generated by the model as grammatical (and therefore, predicted) possibilities.

In the example languages analysed, ATR harmony has been consistently matched with a melodic template containing a colour tier complement. Within this typological set, however, a limited amount of cross-linguistic variation has been recorded, and I have proposed to account for these facts in a way which exploits the resources of the Government-based framework on which the present TG model is founded. While largely maintaining the position that representational well-formedness is defined according to a

small number of universal constraints or principles, I have attempted to show how a minimal degree of flexibility in the way such principles are applied can make useful typological predictions without necessarily compromising generative restrictiveness. Specifically, in those cases where the respective predictions of different general principles come into conflict, I have taken up the option of allowing one or more principles to be violated.

The notion of a language-particular constraint ranking (determining the precise way that constraint clashes are resolved) has been the focus of much research activity in recent years. However, it may be suggested that much of this work points to an overall view of grammar which is not sufficiently controlled in terms of its generative capacity. As long as the formulation of constraints is allowed to proceed in an essentially unrestricted manner (by permitting these 'generalisations' to refer specifically to individual units of structure such as *coda* or *[labial]*¹ or *trochee*, for example), the threat of a return to the overgeneration problems associated with extrinsically ordered re-write rules will continue to loom very large. In contrast, the use of a localised dominance hierarchy has been incorporated into the present work without losing sight of the restrictivist aims of the overall model. The constraints themselves have, as much as possible, been formulated independently of the languages they are used here to describe, so as to reflect the characteristics of phonological structure in general. Furthermore, I have attempted to account for the full set of typological predictions generated by the constraints proposed — a necessary outcome if we are to assume that the success of any model of phonological processing must be gauged by the extent to which its grammatical predictions are matched by the empirical facts.

The predictive capacity of the TG model has been further exemplified in the previous chapter by the identification of a relatively marked complement tier structure that squares with another attested language typology. As with the other analyses of natural language data presented in this work, the descriptions of Wolof and Yoruba have been developed according to the view that the majority of language-specific facts relating to distribution and alternation should be determined by the representation itself — if the melodic template is correctly identified, then the melodic patterns that characterise an

¹See Prince & Smolensky (1993) for the motivation behind constraints such as *PL/LAB.

individual language should follow directly.

Having considered some of the ways that a sub-segmental geometry of melodic tiers might benefit the description of tongue root harmony systems, I am now keen to investigate the model's predictions regarding the behaviour of other vowel properties, such as the harmonic activation of the resonance elements [A], [I] and [U]. Looking still further ahead, if Tier Geometry can be developed to a point where it may successfully account for a much broader survey of vowel systems and related phenomena, then the question of consonant representations must ultimately be addressed. Given that all current versions of Element Theory recognize individual melodic primes which contribute to both vowel and consonant melody — specifically, the resonance elements [A,I,U] and the laryngeal elements [H,L] are assumed to be shared between both categories — it is hoped that the tier-geometric approach to vowel structure established in this thesis will also prove beneficial to our understanding of melodic organisation in non-nuclear expressions too.

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