CONDITIONS ON NUCLEAR EXPRESSIONS IN PHONOLOGY

by

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ABSTRACT

This thesis aims to provide a principled account of the distribution of 'tense'/'lax', and 'high'/'low' vowels in vowel harmony systems. It is based on the principles and parameters of Government Phonology in which variation is accounted for by possible combinations of parameter settings. To explain variation in 'tense'/lax' and 'high'/'low' distribution, I exploit the interaction of the parametric aspects of three universal mechanisms: Licensing Constraints, Head-licensing (both Kaye (1993b)), and the Complexity Condition (Harris (1990a)).

The type of language data this thesis seeks to account for has received some attention in the phonological literature, in terms of other frameworks as well as Government Phonology. These treatments are evaluated here.

Two of the three main tools employed are recent inclusions in Government Phonology. The role of Licensing Constraints as parameters on element distribution is explored in the context of the principles and parameters drawn on in this thesis. Licensing Constraints have certain repercussions for other aspects of the theory. These are explored in detail.

Licensing Constraints interact with Head-Licensing, a principle explaining 'ATR' distribution. Additionally, I claim that some aspects of Head-Licensing are subject to parametric variation. The possible combinations of parameter settings are presented, illustrated with a variety of language data.

The Complexity Condition is claimed to apply parametrically in processes taking place at the level of nuclear projection. As Head-Licensing occurs at this level, some languages are expected to enforce the Complexity Condition. I examine cases where this takes place, and the variety of strategies employed by languages for its maintenance.

Finally, I explore how the interaction of Licensing Constraints, Head-Licensing and the Complexity Condition might provide a unified account of harmony processes traditionally described in terms of 'raising', 'lowering', '+ATR' and '-ATR'. I evaluate, and propose analyses of some cases from the literature.

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ABBREVIATIONS

abs.	absolutive
C	consonant
ECP	Empty Category Principle
fem.	feminine
fut.	future
GP	Government Phonology
imperf.	imperfect
inf.	infinitive
KLV	Kaye, Lowenstamm and Vergnaud
masc.	masculine
N	nucleus
O	onset
OCP	Obligatory Contour Principle
pers	person
pl.	plural
R	rhyme
rad.	radical
sing./sg.	singular
tns	tense
UG	Universal grammar
V	vowel

CHAPTER 1

INTRODUCTION

1.1 Overview

The central claim of this thesis is the proposal of the interaction of some specific principles and parameters of a theory[1] in an attempt to explain seemingly unconnected varieties of vowel harmony data. The purpose of this introductory chapter is to provide the context for this proposal in two ways: by defining the phenomena to be addressed by this thesis, and by examining the theoretical environment of the proposal. In this way, this chapter serves as both an explanation of the topic to be addressed by the thesis and its relevance to the field of phonology, as well as an introduction to theoretical framework on which this thesis rests.

First, the type of phonological phenomena that the claims of this thesis seek to explain, specifically what may be informally termed 'height' and 'ATR' harmony processes is presented (1.2). Before exploring ways of capturing this type of data, I turn to the issue of the expressive power of phonological theories (taken up with respect to Government Phonology in a later section), and discuss the relationship of theoretical claims to our expectations of the type of phenomena manifested by the world's languages. This discussion includes the issues of language data sources, and the notion of 'markedness' in phonological theory (1.3).

In 1.4, I evaluate some approaches to the type of data presented in 1.2 in the phonological literature. The ability of Government Phonology to explain the data in 1.2 is also considered (1.5). Government Phonology (henceforth GP) is discussed in terms of what theoretical machinery exists to explain the type of phonological

[1] Specifically, licensing constraints, head-licensing (Kaye (1993b)) and the Complexity Condition (Harris (1990a)) in Government Phonology.

phenomena to be captured. Until 1993, GP was defined by a body of literature, including a 'core' of fundamental works: Kaye Lowenstamm and Vergnaud (henceforth KLV, 1985), KLV (1990), Harris (1990a), and Charette (1991)[2]. GP as it is defined by the literature prior to 1993, is referred to in this thesis as 'Standard GP'. With respect to its ability to explain vowel systems and processes, Standard GP is critically evaluated, and some problems highlighted.

Since 1993, GP has undergone some revisions, the nature of which has been discussed and defined in the literature[3]. The 'Revised Theory of Government Phonology' (referred to as 'Revised GP') is explained (section 1.6), making explicit reference to its attempt to address and answer the problems of Standard GP. For the purpose of explaining 'ATR'/'Height' harmony processes, two important aspects of the theory are introduced: headedness, and licensing constraints (1.6). The chapter is summarised in 1.7

1.2 Vowel Harmony Phenomena

This thesis seeks to contribute to an explanation of some aspects of what is traditionally termed vowel harmony phenomena.[4] The term 'vowel harmony' covers a wide variety of phonological processes in which the vowels of a word agree with respect to a particular characteristic. Explorations into pinpointing the precise nature of a harmonic characteristic has been significant in shaping the make-up of the set of primes from which phonological representations are constructed.

Harmony types include what are traditionally termed 'palatal' and 'rounding' (such as in Turkish and Uyghur (see chapter 2)), 'pharyngeal' (e.g. Goad's (1993) approach to Turkana, discussed in chapter 4 here), and 'nasal' (such as Desano (Kaye (1971), Guarani (Ploch, (in preparation)). Although I include a discussion of 'palatal'

[2] The body of literature referred to here includes papers included in conference proceedings, journals and books, as well as both published and unpublished doctoral dissertations. There are too many works to be individually referred to here, but a variety of topics explored using the tools of GP as it was understood up until 1993 can be found in two volumes of working papers: *SOAS Working Papers in Linguistics and Phonetics*, volumes 1 and 2 (1990, and 1991-1992 respectively).

[3] See *SOAS Working Papers in Linguistics* volumes 3 (1993), 4 (1994), and 5 (1995).

and 'rounding' harmony in Uyghur in order to illustrate a theoretical tool (licensing constraints, chapter 2), an investigation into these types of harmonies is not part of the aim of this thesis. Rather, this thesis is concerned with the types of vowel harmony processes described below.

The type of harmony addressed in this thesis is summarised in the table (1) on page 18. First, I describe the harmony types, followed by a summary of the characteristics proposed in the literature. One type of harmony is traditionally termed 'ATR' ('Advanced Tongue Root') harmony. The literature more or less agrees that with respect to the way 'ATR' type harmony is manifested. Vowels of words are harmonic in that they draw from one of two harmonic sets: either 'ATR' {i, u, e, o, (ɜ/ʌ)[5]}, or 'non-ATR' {ɪ, ʊ, ɛ, ɔ, a}. Harmony is also manifested in affix selection processes, in which affixes are obliged to 'agree' in the harmonic characteristic with the root.

With respect to the formal characteristic (feature or element) which effects the harmony, a variety have been proposed. Feature theories have employed [(+)ATR] and [-open], element-based theories have employed the elements *I* (van der Hulst (1988) and Ɨ[+] (KLV (1985)), and the characteristic of *headedness* (Kaye (1993b), Walker (1995)). In this thesis I follow Kaye and Walker in analysing data of this type in terms of the characteristic of *headedness*.

'-ATR', or 'RTR' ('Retracted Tongue Root') harmonies as they are sometimes called, are also considered by this thesis. These terms cover a variety of processes. In one type, the harmonic process is where the 'non-ATR' set of vowels shown above behave as the active set in the harmony process (for example in Vago and Leder's (1987) analysis of Turkana). In another type, it is claimed that the vowels *i* and *u* alternate with the mid vowels *ɛ* and *ɔ*, conditioned by the presence of *ɛ*, *ɔ* and *a* (as in Chukchee (see Calabrese (1988)). In a third type of process, *e* and *o* are claimed to alternate with *ɛ* and *ɔ*, conditioned by the presence of *ɛ*, *ɔ*, and *a* (for example, Archangeli and Pulleyblank's (1989) treatment of Yoruba).

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[4] See van der Hulst and van der Weijer (1995) for an overview of vowel harmony phenomena.

[5] These vowels are bracketed because not all 'ATR' harmony languages are claimed to have an 'ATR' counterpart for 'non-ATR' *a*.

Various formal characteristics have been proposed to explain these processes. Feature theories have employed [-ATR], [-tense] or [RTR]. Element based theories have opted for spreading or alignment processes utilising the elements *A* (van der Hulst (1988)), or the neutral element @ (Harris (1990b)).

'Height' harmonies are also considered by this thesis. In the literature, 'height' harmony is often subdivided into three different harmony types: 'high', 'mid' and 'low'. These terms do not appear to be used consistently, and what may be considered 'high' harmony in one analysis may be termed 'mid' in another. Generally speaking, 'high' harmony is where the high vowels, *i* and *u*, condition the 'raising' of the mid vowels (*ε*, *ɔ*) to high vowels (*i* and *u*), as in Brazilian Portuguese (Segundo (1993)). Sometimes the 'low' vowel *a* is included as a harmony target (such as in Lena Bable (see Hualde (1989)). Sometimes only *a* is targeted, as in Basque (Hualde (1992)).

'Mid' vowel harmony is variously described as either 'raising' or 'lowering'. The 'raising' process targets the mid vowels *ε* and *ɔ*. These are 'raised' to *e* and *o* respectively, in the company of *i* and *u* (and sometimes *e* and *o* as well). An example language would be Zulu (Khumalo (1987)). The 'lowering' process is where the high vowels *i* and *u* are claimed to be 'lowered' to *ε* and *ɔ*, in the company of *ε*, *ɔ* (and sometimes *a*). Languages claimed to manifest this type of 'height' harmony are Chichewa (Harris (1994b)) and Yaka (Goldsmith (1985)).

Finally, 'Low' harmony is claimed to be where *e* and *o* become *ε* and *ɔ*, in the environment of *ε*, *ɔ* and *a*. Yoruba is claimed to manifest this process (van der Hulst (1988), Goad (1993)).

As for the formal characterisation of 'height' harmony, the variety of harmony types covered by the term 'height' harmony, is reflected in the differences in analyses even within the same framework. For example, 'high' harmony refers to the *spreading* of a 'height' feature such as [+high] or [-low] in one approach (see Hualde (1989) on Lena Bable, and (1992) on Basque), but the *delinking* of a feature such as [open] (Goad, (1993)) or the element *A* (Harris (1990b)) in others. 'Mid' vowel harmony appears to refer to the same characteristics, [open], and *A*. However, in 'mid' vowel lowering harmony, [open] and *A* are *spread*. Although in the cases of [open] and *A* just discussed, it seems that 'high' and 'mid' harmonies can be treated with the same characteristic (a feature or an element), the processes result from an entirely different set of conditions. 'Low' harmony is treated in feature theory terms as the spreading of the feature [low] (Goad (1993)) and in an element based approach, as the spreading of the element *A* (van der Hulst (1988)). This thesis pursues the idea that all these 'height' harmony processes can be treated in terms of the characteristic *headedness*.

The discussion of harmony types and their formal characterisation above is summarised in the table below. Here I show an informal label for the type of vowel harmony processes which have been discussed in the phonological literature, together with a description of alternations and conditions involved (column one). The brackets indicate vowels which are involved in the process in some languages, but not others. The formal characteristics which are claimed to be involved in the process are in column two. The characteristics proposed in feature theories appear, by convention, between square brackets, and, depending on the framework, may be unary or bivalent. Characteristics proposed in frameworks employing elements or atoms (such as Dependency Phonology, or Government Phonology) are represented as they conventionally appear in Government Phonology (for clarity), in capitals: *I*, *U* and *A*. This is followed, in column three, by some examples of languages which are claimed to manifest the type of harmony. I have included one or two references here. This is not meant to be an exhaustive list. Previous treatments from a wider range of sources are discussed when the harmony processes of these languages are taken up elsewhere in this thesis.

(1)

HARMONY TYPE[6]	**CHARACTERISTIC**	**EXAMPLE LANGUAGE**
'ATR' ɪ, ʊ, ɛ, ɔ, a → i, u, e, o, (ʌ)(ɜ)(a).	[(+)ATR], I, headedness, [-open], Ɨ$^+$.	Vata (Kaye (1982), Walker (1995)), Akan (Clements (1981)), Turkana (Noske (1996)), Pulaar (Dunn (1989)), Yoruba (Ola (1992)).
'-ATR'/'RTR' i, u, (e), (o)→ (ɪ), (ʊ), ɛ, ɔ / (ɪ), (ʊ), ɛ, ɔ, a	[-ATR], [RTR], A, headedness, [-tense], @	Yoruba (Archangeli and Pulleyblank (1989)), Turkana, (Vago and Leder (1987)), Chukchee (Calabrese (1988), van der Hulst (1988)), Pasiego (Harris (1990b), McCarthy (1984)).
HEIGHT: **'HIGH'** e/ɛ, o/ɔ → i, u / i, u a → e / i, u	[+high], [(-)open], A, headedness, [-low], Ɨ$^+$	Lena Bable (Hualde (1989)), Pasiego (Hualde (1989)), Basque (Cobb (1995a, 1996)), Brazilian Portuguese (Segundo (1993)).
'MID' ɛ, ɔ → e, o / i, u (e, o) i, u → ɛ, ɔ / ɛ, ɔ (a)	A, headedness, [(-)open], [raised], [expanded], [-low], [tense], [-low]	Zulu (Khumalo (1987), Harris (1987)), Sesotho (Clements (1991) Khabanyane (1991)), Chichewa (Harris (1994b), Mtenje (1985)), Yaka (Goldsmith (1985)), Herero (Marten (1996)).
'LOW' e, o → ɛ, ɔ / ɛ, ɔ, a	A, [low], [+open], headedness	Tunica (Goad (1993), Haas (1940))[7], Yoruba (Goad (1993), van der Hulst (1988)).

[6] A note warning should be added here. The symbols and letters used in this column have no theoretical status, and transcription practices vary from phonologist to phonologist. The theoretical objects for which these letters are shorthand are revealed as this thesis proceeds.

[7] All the languages in this column are discussed in this thesis with the exception of Basque, which I discuss elsewhere (see references), and Tunica, because of the extremely limited data available. Haas' (1940) work contains examples which appear to show harmony of the type addressed by this thesis. It is based on forms elicited from the (then) only 'speaker' (born in (1870), who never spoke Tunica, and had not heard it spoken since his mother died in 1915). The Tunica forms come from some childhood

The table above illustrates a great deal of overlap in terms of the characteristic manifested by the process and the language which is claimed to exemplify it. The characteristics of [open] and *headedness* are common to all the harmony types listed here. This is because [open] is a particular feature proposed by Clements (1991, 1996) to contribute a uniform dimension of 'height', which he suggests extending to include the salient characteristic of 'ATR' harmony. This approach is discussed further in section 1.4. Likewise, *headedness* is the characteristic discussed in this thesis as being involved in the explanation of harmony in all these harmony types. The languages in the table are among those discussed in chapters 4, 5, and 6.

As for the example languages in the table, again some overlap is apparent. Yoruba appears as an example of 'low' harmony, 'ATR' harmony and as an example of '-ATR' harmony, its diagnosis depending on the analyses of particular frameworks.

The table then illustrates that this kind of 'harmony type' categorisation is not especially insightful. I have simply included it to illustrate the extent of the vowel harmony debate in matters of 'ATRness' and 'height', and as a reference point for the discussion in this chapter about the various approaches to vowel harmony in the literature.

1.3 Theoretical Claims and Empirical Fit: language variation and the notion of 'markedness'

In this section I discuss the relationship of the symbols in the first column of (1) to the phonological characteristics (in the second column). The distributional restrictions on vowels manifested by the harmony processes form a part of the generalisations which can be made about which vowels pattern together as vowel systems. Phonological theory attempts to explain not only what is possible, but also what is common, by embracing the notion of 'markedness'. Consideration of how phonologists know what is common or rare leads us to a discussion of sources.

First, the summary of vowel harmony types, mechanisms, and example languages in (1) immediately raises the issue of the relationship of theoretical claims

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stories remembered by the consultant, recounted to Haas. However, the data are limited, and a detailed analysis is not really feasible.

to the empirical record. The symbols in the leftmost column used to describe the vowel alternations and their distributional relationships do not have any kind of theoretical status in themselves. Rather, they are a shorthand (as is the term 'vowel'[8]). As such, wherever possible, I have tried to use the symbols consistently throughout this thesis. The representations for which the symbols are shorthand are revealed as this thesis proceeds.

As GP is a phonological theory which aims to represent all and only what is attested, theoretical expressions and language data are expected to match exactly. This type of approach therefore makes strong predictions not only about what we expect to find in the phonological world, but also what we expect not to find.

This relationship of theoretical claim to empirical fit is an aspect of the notion of markedness which is used in a variety of senses. The discussion below aims to illustrate some of the ways the notion of markedness is used in the literature, showing the sense in which markedness is employed here.

First, it is possible to make some generalisations about the way vowels pattern together, of the following type: the occurrence of some vowels in a language depends on the existence of other vowels, and this dependency is not mutual. For example, *ü* is only found in languages which also have *i* (e.g. Turkish and French), but not all languages which have *i* also have *ü* (for example English and Zulu).

The type of observation can be extended. It has been claimed (by Crothers (1978)), for example that all languages have the vowels *a, i, u*. It follows from this that languages with mid vowels, also have *a, i,* and *u* in their inventories (for example, the Basque system *i u ε ɔ a*). Furthermore, the presence of *e* and *o* in a language is claimed (again, by Crothers (1978)) to imply the presence of *ε* and *ɔ* (e.g. the Italian system *i, u, e, o, ε, ɔ, a*)[9]; the presence of *ɪ* and *ʊ* is claimed to imply the presence of *i* and *u* (e.g. Dida, *i, ɪ, u, ʊ, ε, ɔ, e, o, a*).

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[8] In GP, the term 'vowel' is shorthand for a phonological expression associated to a nuclear skeletal point.

[9] This generalisation depends on whether one considers only lexical objects, or phonological ones as well, and then ultimately depends on one's theoretical tools. Crothers' own work lists Nama (Khoisan) as /i e æ u o/. In this case *e* and *o* do not seem to imply *ε* and *ɔ*. It has also been pointed out to me (by Jonathan Kaye) that Spanish has *e* and *o* without having *ε* and *ɔ*, lexically. This, of course, depends on one's analysis of the distribution of these mid vowels. See Chapter 6 for a discussion.

What is more, phonologists who consider these kinds of generalisations valid, seek to formally evaluate them by invoking the notion of *markedness* with respect to what is *possible* in terms of (1) vowels and vowel systems, and (2) vocalic processes. On this view, with respect to the generalisations made above, it is assumed that *a*, *i* and *u* are the *least marked* vowels as every language has them. Apart from this sense of markedness in terms of simple occurrence, vowels are also subjected to a sense of markedness when they are involved in phonological *processes*. For example, in most languages with ATR-harmony such as Vata (see Kaye (1982) and Walker (1995)), the process is analysed as transforming 'lax' vowels to 'tense'. Therefore the 'lax' vowels are unmarked, as the 'tense' ones are found only under certain conditions.

The notion of markedness is extended in that not only is the *possible* versus the *impossible*, but also by using surveys such as Crothers (1978)[10], and Maddieson (1984)[11], phonologists have generalised that certain vowels and vowel systems are relatively more *common*, or 'natural', than others. Regarding markedness in this sense, although *a*, *i*, and *u* are the most common *vowels*, as a *vowel system*, *a i u* is not the most common pattern. Crothers indicates that a five-vowel system (*a*, *i*, *and u* plus the two mid-vowels) is the norm. With respect to vocalic processes, '+ATR-harmony' ('lax' → 'tense') is traditionally considered more commonplace than '-ATR-harmony' ('tense' → 'lax'), therefore 'tense' vowels are considered more marked than 'lax' in systems with these harmonies.

Distinguishing between the commonplace from the rare in terms of the occurrence of *vowels*, *vowel systems*, and *vocalic processes*, is traditionally assumed to be a desirable feature of the formalism of any phonological theory. Chomsky and Halle (1968) (Markedness Conventions), KLV (1985) (Elements and Charm), Calabrese (1988) (Constraints and Filters) are united in attempting to build into their theoretical frameworks a way of evaluating both the possible (versus the impossible) and the commonplace/'natural' (versus the rare/'unnatural').

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[10] Crothers' (1978: 114) generalisations about vowel systems are based on the Stanford Phonology Archiving Project which contains 'phonetic-phonemic' descriptions of 209 languages.

[11] Maddieson's (1984) book reports on the UCLA Phonological Segment Inventory Database (UPSID) project which contains 317 languages.

A question to be addressed is how do we know what is possible (and what is not), what is common (and what is not)? Some phonologists make explicit that in addition to analyses made of individual languages, they depend on language surveys for this knowledge. For example Calabrese (1994), in proposing two types of constraints[12] on feature combinations to explain the structure of phonological systems, uses generalisations based on Maddieson (1984); Backley (1995) puts forward a tier geometry for vowel systems which incorporates the findings of Crothers (1978). Clements (1996) uses Crothers as support in generalising "all languages have low vowels, but not all have high vowels".

Taking works such as those of Crothers and Maddieson as being representative of the world's languages in the sense that they proportionately represent the world's vowel systems presents a number of drawbacks, as pointed out in Maddieson (1984: 157): "The ideal sample for the purposes of statistical evaluation is a random sample, drawn from the total population under study. In the case of language data, the 'population' is all the world's extant languages. It is impossible to draw a random sample from this population for two reasons. First, there are areas of the world about whose languages we have no data or wholly inadequate data. Second, a 'language' is not a clearly demarcated object".

Another serious drawback is that one would have to assume that letters are constant theoretical objects. Both Maddieson (1984) and Crothers (1978) use secondary sources (i.e. published works), which must of course vary in transcription practices. Also, it is possible that a single 'sound' might have more than one theoretical identity. For example in Brazilian Portuguese, *ɛ* and *ɔ* is shorthand for the theoretical objects (A.I) and (A.U) in the Natal dialect, and (I.<u>A</u>) and (U.<u>A</u>) in Mineiro (see Kaye (in preparation)).

In addition, a look at some of the literature on particular languages in for example, Crothers (1978) reveals some discrepancy with respect to exactly what the vowel system is. For example, Crothers lists Sinhalese as having four high vowels contained in its inventory: *i, ɪ, u, ʊ*. Karunatillake (1992) concurs with this diagnosis,

[12] The two constraint types are: (1) 'prohibitions' which absolutely exclude certain feature combinations, and (2) 'marking statements' on the 'phonetics', which are marked feature specifications.

also analysing four high vowels. However, Reynolds (1980) indicates that Sinhalese has only two high vowels, *i, u*. A similar discrepancy can be found with respect to the vowel system of Malayalam, with Crothers (1978) and Mohanan (1982) indicating four high vowels, but Kumari (1972) giving only two. The literature abounds with such inconsistencies.

Finally, the set of vowels phonologists propose that a given language possesses, is ultimately determined by the theoretical framework or assumptions used in the analysis of that set.[13] This is as true of the proposed vowel systems appearing in this thesis, as it is of the proposals of any other. However, by using at 'face value' the generalisations based on large surveys in the foundations of the construction of phonological theory, phonologists seem to be implying that either (1) there exists meaningful phonological data independent of phonological theory, and that this is indeed represented in the phonological literature; or (2) that they accept that the way the data is presented in such surveys is influenced by theoretical assumptions, but that this influence is trivial. I do not debate these conclusions here. However, as the authors of such surveys make explicit the theoretical underpinnings of their works, phonologists should not underestimate their influence on the representation of data.

To provide a specific example, Crothers (1978: 102) points out that " the vowel system of each language in the sample is analysed along the lines of the classical phonemic method". This phonemic approach means that English, for example, is classified as language having six vowels, because although there exists more than six vowel 'contrasts', these additional contrasts also involve vowel length, and are not included as phonemes. Therefore, although ɪ and *i* distinguish *bit* from *beat*, only ɪ is included in the basic six-vowel classification, as *i* is 'long'. On the other hand, Akan is classified as having a nine-vowel system with both ɪ and *i* included in the set of phonemes as length is not a factor. The theoretical assumptions behind phonological surveys cannot be separated from the way language data is represented, and influence, in turn, claims about phonological phenomena in works which heavily rely on data from language surveys.

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[13] For example, Clements (1991) points out that disagreement over how best to characterise Bantu vowel systems and harmonies is reflected in the widespread use of two different transcription systems.

The theoretical claims made by this thesis are supported by specific, detailed phonological analyses, largely based on data (1) personally elicited from native speaker consultants, and (2) on phonological analyses employing GP in the literature.[14] The theoretical claims make strong predictions about our phonological expectations of the world's languages, not only of what we expect to find, but also of what we expect not to find. The phonological literature is simply used as a starting point in order to test those predictions.[15]

As expected, the claims made in this thesis often predict that data is misrepresented in other frameworks, and that certain types of harmonic patterns and vowel systems cannot exist. This point is made explicit, for example, in the discussions in chapter 4 of Sesotho and Turkana

This thesis aims in the direction of the development of the interaction of theoretical mechanisms which can contribute to the explanation of a range of 'ATR'/'Height' processes from which phonological representation is recovered. I therefore refer to the notion of markedness in the sense that it is desirable to explain only what is possible. As for the notion of markedness in terms of the evaluation of 'naturalness' on a scale from the commonplace to the rare, apart from the difficulty of assessing which harmony patterns are more common than others (given the reservations expressed above of language sources), I assume that considering markedness in this sense involves the question of why some languages employ 'unnatural' or uneconomic processes. Addressing this question is beyond the scope of this thesis. The Revised GP analysis presented here does not aim to evaluate and rank language variation with respect to 'ATR'/'Height' harmony processes.

To summarise so far, phonological theory aims to express all and only possible phonological phenomena. However, phonological analysis often attempts to explain not only the possible from the impossible, but also the commonplace from the rare. In deciding what is possible and commonplace, phonologists augment their experience

[14] I do, however, discuss some cases from the published literature. The specific limitations are made explicit in the discussion.

[15] In this respect, I have used Crothers (1978) and Maddieson (1984) as the beginning of a search for specific phonological inventories. Their findings are never taken at 'face value' without further investigation to substantiate the claims made here.

of the world's languages by employing sources which include a wide variety of data such as language surveys. This thesis attempts to contribute to the explanation of the possible and does not evaluate the aspect of markedness with respect to relative naturalness.

1.4 Other Treatments of 'Height'/'ATR' Harmonies

The table presented in (1), with its overlaps in harmonic characteristics from one type of harmony to another, reflects that there appears to be evidence to suggest that there is a formal relationship between what are informally described as 'ATR' and 'height'. This thesis aims to explicitly define the connection in the context of GP. As a preliminary, I examine some other recent approaches which also aim to express a connection.

Relationships between harmony types has been the subject of various works employing different approaches in the literature, and researchers investigating the problem have proposed a variety of tools for expressing the relationship between 'height' and 'ATR'. Although the work of other researchers into issues of vowel harmony is also relevant to this thesis (for example that of van der Hulst (1988, 1990), and Harris (1990, 1992, 1994), in this section I discuss only those frameworks which explicitly attempt to unify the two. The contributions of van der Hulst and Harris are discussed in the context of analyses of specific harmony processes elsewhere in this dissertation.

In many frameworks 'vowel height' is considered a property which needs to be formally implemented. In frameworks where this is performed by the binary features [high] and [low], in order to distinguish more than three 'vowel heights', as exhibited by many west African languages (e.g. Vata), or Romance (e.g. Italian, Brazilian Portuguese), another feature needs to be used[16]. The feature [ATR] was introduced by Stewart (1967) to describe the vowel system and harmony processes of Akan. [ATR] was also incorporated to privative feature theories to describe 'cross height vowel harmony' of other west African languages (see Kaye (1982) for an analysis of Vata). Using [ATR] as a way of creating more distinct objects with respect to 'height' establishes a sense of the relationship of 'height' to 'ATR', without, however, formally expressing it as such.

In feature theories which have features as primes (either binary or unary), organised under nodes which themselves are organised into structures (feature geometries), are able to express some relationship between the notions of 'height' and 'ATR' by organising the two features under the same organisational node. Using binary features, Odden (1991), for example has the node 'height' dominating the features [ATR] and [high]. In a privative feature approach, Goad (1993) organises [open] and [ATR] hierarchically, under the node Vocalic. These are illustrated below:

(2) (a) Odden (1991)

```
                vowel place
               /
        Height
       /   |   \
([low]) [ATR] [high]
```

(b) Goad (1993)

```
  vocalic
     |
  [open]
     |
[low]/[atr]
```

Both approaches reflect traditional assumptions about the correlation of phonological representation to some kind of articulatory/acoustic property. For example, Goad (1993: 8) points out that the features [low] and [ATR] are in complementary distribution in that low vowels never possess the characteristic [ATR]: "From an acoustic point of view, a vowel cannot be simultaneously [low] and [ATR]". However, she nonetheless retains both features, even though they theoretically function in the same way.

The motivation for organising 'height' and 'ATR' features together in this way comes from phonetic observations (Clements (1996): " The most readily definable physical correlate of 'high', 'low' and 'ATR' is F1."), and data such as that presented by Odden of Kimatuumbi a Bantu language spoken in Tanzania. The vowels of Kimatuumbi are specified as follows:

[16] See Kenstowicz (1994) for a discussion of the vowel height debate in feature theories.

(3)

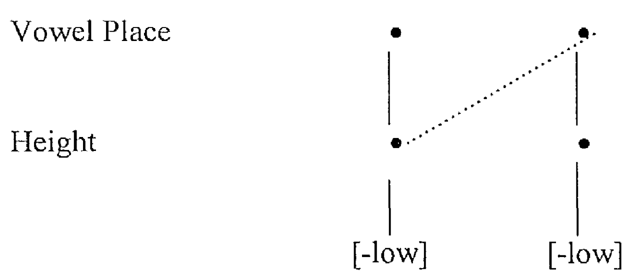
	high	low	ATR	back
i	+	-	+	-
u	+	-	+	+
ɪ	+	-	-	-
ʊ	+	-	-	+
ɛ	-	-	-	-
ɔ	-	-	-	+
a	-	+	-	+

Vowel harmony is manifested when the causative suffix *-iy-* appears as *-iy-*, *-ɪy-*, or -*ɛy-* (Oddens's transcription is preserved).

(4) ut-iy-a *to make pull*
yib-iy-a *to make steal*
yʊyʊʊt-ɪy a *to make whisper*
bɪɪk-ɪy-a *to make put*
gɔɔnj-ɛy-a *to make sleep*
chɛɛng-ɛy-a *to make build*
kaat-iy-a *to make cut*

In the examples above, the causative suffix *-iy-* alternates in terms of assimilating the value of both [high] and [ATR] from the preceding non-low vowel. Odden explains this alternation by a rule which spreads the height node, with the context for the application of the rule as [-low], the only feature which is common to all the vowels except *a* (which is not involved in the harmony process).

(5) Kimatuumbi Height Harmony (Odden 1991)

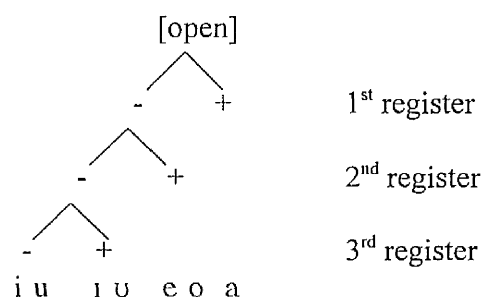


The strategy of employing a feature in the rule which is not the feature or features to which the suffix assimilates is vital to Odden's analysis. Given the feature chart in (3), referencing the rule to [-low] is crucial to stopping it from applying to *a*, and thus accounting for the data. Harris (1994b) in a discussion of height harmony, provides a useful evaluation of approaches of this type. Supplementing the conditions of the rule application so that its application is more precisely defined certainly achieves the right results. However, the rule is essentially arbitrary in that it fails to provide a principled formal explanation for why a process takes place where it does: "...in principle, any harmony process is potentially conditioned by any feature. As a result, it is a matter of accident that the rules...happen to be conditional on the presence of [-low]" (Harris (1994b: 522)). Goad (1993) recognises this problem in her analysis of Chichewa, but can offer no alternative other than an ad hoc condition on the rule application to effect that it cannot apply to a low vowel.

Clements (1991, 1996) goes further in tying 'ATR' phenomena to 'height' phenomena by scrapping the features [high], [low] and [ATR] and proposing the binary feature [open] for the purpose of capturing 'ATR' and 'height' harmonies.

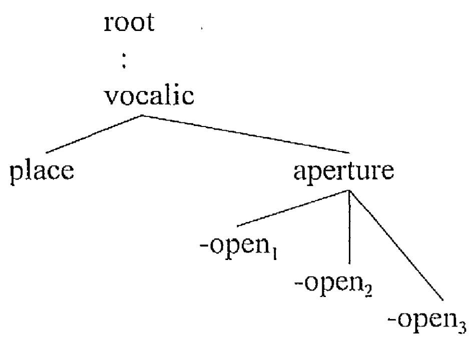
Clements motivates a hierarchical model of vowel height, in which 'height' is a uniform phonological dimension, indicated by the feature [open], and can be divided into a series of registers. The first division of [open] (plus and minus) partitions the register into two. These two, or just one, may then both be divided into secondary registers, which can then in turn be sub-divided. On this view, the vowels of Kimatuumbi are specified for [open] as below:

(6)



The binary feature [open] appears, and may be manipulated, on several autosegmental tiers. Each occurrence of the feature [open] links directly to an aperture node, as illustrated for the vowel *i* below.

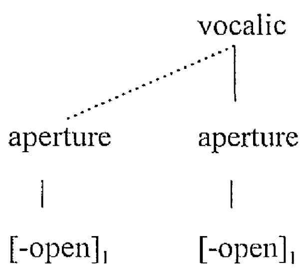
(7)



The feature [open] is organised this way because the spreading of a higher level feature such as [open$_1$] does not entail the spreading of lower ranked features.

The harmony process is effected by rule:

(8)



Although the approach attempts to provide a unified account of 'height' and 'ATR' harmony processes, by collapsing three features into one, unfortunately, it falls short of its goal. By utilising a binary feature, effectively two features are employed. The features are binary so that lowering ([+open] spread) can be characterised, as well as raising (spreading [-open]). In addition, the rules have to be context feature sensitive so that they apply in the right places. In the process formalised in (8) above, the context [-open$_1$] has to be made explicit, so that the spreading of the 'vocalic' node does not occur from *a*, which is specified as [+open] on the first register. I follow Harris (1994b) who notes (with respect to Bantu lowering exemplified by Chichewa) that the approach then suffers from the same kind of arbitrariness as the previous rules we discussed for Kimatuumbi: it fails to provide a principled formal explanation for why a process takes place where it does.

The model is also over-generative in that in principle, any number of heights can be created. For example, the following vowel system could be generated, because at each level, the register may subdivide again. Although Clements claims that vowel systems with five heights are the *de facto* upper limit, there appears to be no principled way of defining terminal nodes. In the Kimatuumbi example in (6), only the minus branch subdivides again at level 2. However, there is no principled reason to rule out the theoretical system below:

(9)

	(i u)	(ɪ ʊ)	(e o)	(ɛ ɔ)	(??)	(??)	ʌ	a
open 1	-	-	-	-	+	+	+	+
open 2	-	-	+	+	-	-	+	+
open 3	-	+	-	+	-	+	-	+

The model of vowel height cannot explain why no language appears to have such as vowel system. Another problem, which Clements (1991) points out, is that [open] is the only feature in this model allowed to subdivide in this way.

To summarise so far, the attempts of theories of feature geometry to formally capture the relationship between 'ATR' and 'height' cannot explain harmony data such as that manifested by Kimatuumbi, in a principled way, as they depend on arbitrary feature specifications built into the contexts of the rule application.

1.5 Standard Government Phonology

Standard Government Phonology does not express a formal connection between the types of harmonies which typify 'ATR' harmony, and the types of harmony which manifest 'height' harmony. This thesis then uses tools which are not available in Standard GP. In this section, I present a brief overview of the tools of Standard GP, together with a discussion of some of the recognised challenges it faces, for two purposes: (1) to show how Standard GP is unable to capture some of the harmony data discussed in 1.2, and (2) as a backdrop to the presentation of the revisions to the theory, on which this thesis draws, which appear in the following section.

1.5.1 Elements

In GP, phonological expressions consist of independently pronounceable elements either alone or fused in combination. They are associated to skeletal points which project the constituents Onset, Nucleus and Rhyme (discussed in more detail in chapter 2). The set of elements assumed by Standard GP are set out below.[17]

(10) A^{+} $ɪ^{+}$ N^{+} I^{0} U^{0} R^{0} h^{0} $ʔ^{0}$ L^{-} H^{-} v^{0}

A^{+}, $ɪ^{+}$ (the ATR element), N^{+} (nasal), I^{0}, U^{0}, L^{-} (low tone), H^{-} (high tone), and v^{0} (the cold vowel) are employed in vocalic expressions. As the Revised GP in this thesis addresses the properties of only A^{+}, $ɪ^{+}$, I^{0}, U^{0}, and v^{0}, the remaining elements, N^{+}, L^{-} and H^{-} are omitted from this discussion of Standard GP. In Standard GP, the fusion of elements in a phonological expression involves one element being the head, the other(s) as operator(s). Expressions may be (a) simplex: $(\underline{A^{+}})^{+}$ head only; (b) complex: $(A^{+}.\underline{I^{0}})^{0}$, head and operator(s). The head of the expression is, by convention, underlined, and on the right: (operator.<u>head</u>). The '.' indicates the fusion operator. v^{0}, the identity element, is included in the set of elements which may occupy the head position of a phonological expression. The special status of v^{0} and the relevance of the head-operator roles in the fusion operation to the ability of GP to capture phonological generalisations is elaborated in detail in chapter 3.

The relationship of the phonological expressions of Standard GP to expectations about phonological processes is as follows. Phonological processes involving phonological expressions are explained in terms of (1) the presence of an element, irrespective of whether it is a head or an operator (e.g. *I* spreading in Turkish, Charette and Göksel (1994)[18]); (2) the behaviour of an element as a head (e.g.

[17] These elements are motivated and defined in KLV (1985 and 1990) and Harris (1990a).

[18] As Charette and Göksel's paper appears after 1993, it does not form part of the body of literature defining Standard GP. However, with respect to *I*-spreading, they propose it takes place whenever *I* is present in an expression, regardless of whether it occupies the head position or the operator position. This particular aspect of their analysis does not rest on any formalism exclusive to Revised GP. (Although they make crucial use of the tools of Revised GP in many other aspects of their analysis).

palatalisation in Japanese, Maeda (1994)); (3) the behaviour of an element as an operator (e.g. *I*-spreading in Finnish, Gibb (1992)).

Given that expressions can be either simplex or complex, it is reasonable to expect that phonological processes might make reference to these characteristics. Complexity is indeed referred to in phonological events in the sense of point (3) above: if an expression has an operator, it is also complex, and vice versa. Complexity is expressed in another sense. Phonological processes may be sensitive to the relative complexity of phonological expressions. i.e. if two constituents are involved in a phonological event, the relative complexity of the expressions they dominate is taken into consideration in some cases. Harris (1990a) develops the notion of relative complexity, and proposes a general principle called the Complexity Condition. This thesis draws heavily on Harris' work on complexity, and this issue is discussed further in chapters 3 and 5. The notion of simplexity is less straightforward in Standard GP. This is an issue taken up again in 1.5.3.

1.5.2 Markedness and Charm Theory[19]

With respect to the notion of markedness, KLV (1985) incorporate the two notions of markedness exemplified in section 1.2: that languages exhibit regularities ranging from the norm to the rare with respect to vowels, vowel systems and processes, and that only the *possible* should be expressible.

Markedness in the standard GP story, with respect to possible *vowels*, is directly built into phonological representation in the following way. Phonological expressions are constructed of elements. As all languages have *a*, *i* and *u*, these should form the basic building blocks of all vowel systems. Thus A^{+}, I^{0} and U^{0} are primitives.

With respect to possible *vowel systems*, the implications in section 1.3, where the presence of a vowel, for example, a mid-vowel, implies the presence of *i*, *u* and *a* is an artefact of having elements as primes. For instance, $(A^{+}.\underline{I}^{0})^{0}$ in a vowel system implies the presence of both $(\underline{A}^{+})^{+}$ and $(\underline{I}^{0})^{0}$.

Considering the 'ATR' harmony processes mentioned in section 1.3, recall that in an ATR -harmony system, ATR vowels behave as marked vowels. To capture this marked distribution, ATR is an element $Ɨ^{+}$, but with limited fusion capabilities: it can only fuse as an operator with a well-formed phonological expression. The higher the number of elements in an expression, the more marked (less formally simple) it is. For example, as a *vowel* $(Ɨ^{+}.(\underline{I}^{0}))^{+}$ *i* is more marked (less natural) than $(\underline{I}^{0})^{0}$ *ɪ*.

As well as elements, Charm theory also contributes to the evaluation of 'naturalness' with respect to vowels in terms of what is possible and what is not. The superscripts in (10) indicate the charm value of an element. $^{+}$ is positive charm, $^{-}$ is negative charm, and ^{0} is charmless. Charm affects the combinations of elements in a phonological expression. Charmed elements of like value may not fuse in an expression, restricting the number of possible phonological expressions.[20] For example, the elements $Ɨ^{+}$ and A^{+} may not fuse to form a complex expression (an 'ATR' *a*), as both are charmed elements, with the same charm value. $Ɨ^{+}$, however, may fuse with the charmless phonological expression $(A^{+}.\underline{I}^{0})^{0}$ [21], the result of the fusion operation being the charmed expression $(Ɨ^{+}.(A^{+}.\underline{I}^{0})^{0})^{+}$ *e*.

'Naturalness' in terms of distinguishing the commonplace from the rare in vowel systems is also evaluated by Charm Theory, with ATR playing a more fundamental role. KLV observe that in a three-vowel system, we find *i u a* rather than *ɪ ʊ a*, and go on to note that "...in five-vowel systems we typically find the vowels /i u e o a/, but not /ɛ ɔ/. In general the appearance of a non-low [-ATR] vowel implies the presence of its [+ATR] counterpart. Systems such as /ɪ ʊ ɛ ɔ a/ do not appear to exist. By these criteria, and following the normal assumptions of markedness theory, [+ATR] would appear to be the unmarked value for this feature at least for non-low vowels" (KLV 1985: 312). KLV therefore acknowledge this notion of *systemic markedness* and posit that the most natural (unmarked) vowel system contains only positively charmed expressions. On this view, an unmarked vowel system would be $(\underline{A}^{+})^{+}$, $(Ɨ^{+}.(\underline{I}^{0}))^{+}$, $(Ɨ^{+}.(\underline{U}^{0}))^{+}$ (*a i u*), or $(\underline{A}^{+})^{+}$, $(Ɨ^{+}.(\underline{I}^{0}))^{+}$, $(Ɨ^{+}.(\underline{U}^{0}))^{+}$, $(Ɨ^{+}.(A^{+}.\underline{I}^{0})^{0})^{+}$, $(Ɨ^{+}.(A^{+}.\underline{U}^{0})^{0})^{+}$ (*a i u e o*). A more marked system would be that of say Italian, with $(\underline{A}^{+})^{+}$, $(Ɨ^{+}.(\underline{I}^{0})^{0})^{+}$, $(Ɨ^{+}.(\underline{U}^{0})^{0})^{+}$, $(Ɨ^{+}.(A^{+}.\underline{I}^{0})^{0})^{+}$, $(Ɨ^{+}.(A^{+}.U^{0})^{0})^{+}$ $(A^{+}.\underline{I}^{0})^{0}$, $(A^{+}.\underline{U}^{0})^{0}$ (a i u e o ɛ ɔ).

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[19] Charm theory is fully described in KLV (1985).

[20] With respect to the association of expressions to skeletal points, charm is also involved in the way skeletal points govern each other. This involvement is not addressed in this thesis.

[21] The charm value of the expression is the contribution of the head (except in the case of $Ɨ^{+}$).

In this last system, although some of the expressions are of neutral charm, they all contain a charmed element. This system is in turn more 'natural' than one which allows expressions without charmed elements, $(\underline{I}^0)^0$ and $(\underline{U}^0)^0$, such as Vata.

KLV also value the generalisation mentioned in section 1.2 of this thesis that the presence of *ɪ* and *ʊ* in a vowel system implies the presence of *i* and *u*. They extend this type of generalisation to mid vowels (1985: 313): "systems of the form /i u ɛ ɔ a/, if they exist at all, are rare and accordingly highly marked. In general the presence of /ɛ/ and /ɔ/ in a system implies the presence of /e/ and /o/". KLV then propose a system of Charm Markedness to capture these implications.

(11) Charm Markedness
The presence of a charmless segment in a vowel system implies the presence of its positively charmed counterpart. (adapted from KLV 1985: 314)[22]

Charm markedness ensures that the highly marked expressions, $(\underline{I}^0)^0$ and $(\underline{U}^0)^0$, only occur in systems which also contain their 'ATR' counterparts such as the nine/ten-vowel 'ATR-harmony' systems such as Vata. Note that *a* $(\underline{A}^{+})^{+}$is not targeted by the principle of Charm Markedness, and in any case, cannot fuse with the positively charmed ATR element. KLV note that this is empirically borne out: *a* frequently does not have an 'ATR' counterpart in 'ATR' harmony systems.

To summarise so far, the formalism of Standard GP (the elements and Charm Theory) captures certain generalisations about vowels and vowel systems and processes, in terms of what is possible: all vowel systems have *a i u*; the presence of 'lax' non-low vowels implies the presence of their 'tense' counterparts. The theory also values some vowels and vowel systems as more 'natural' than others: the five-vowel system where all non-low vowels are 'tense', is more 'natural' than a seven-vowel system which has some charmless expressions. This is in turn more 'natural' than systems which allow charmless expressions which do not contain charmed elements. With respect to the phonological processes implied by Standard GP, processes can be explained by the presence of an element, its behaviour as a head, it's behaviour as an operator, and by complexity.

[22] I have adapted the exact wording of the principle of charm markedness for simplicity. In the original paper, KLV used the following charm notation: $^{+}$ = positively charmed, $^{-}$ = neutral/charmless.

1.5.3 Some Problems with Standard GP

The problems that arise in Standard GP are discussed below. The way Standard GP incorporates markedness has a direct impact on our expectations of phonology in the world's languages. Problems relating to markedness, are highlighted below. Other problems are also briefly mentioned, so that the features of the Revised GP provided in section 1.6 can be more fully appreciated.

With respect to the elements and charm theory, a number of problems arise. First of all, with respect to markedness, we have seen that standard GP can differentiate not only between the possible and impossible, but also values some vowels and vowel systems as more natural than others. With respect to *vowel systems*, considerations of charm with respect to markedness means that a five vowel system, where all expressions are positively charmed (*i u e o a*) is considered unmarked and more natural than either a seven vowel system where expressions all contain positively charmed elements, (*i u e ε a ɔ o*), or a five vowel system, *i u ε ɔ a* (ruled out by the principle of charm markedness). This returns us to the question of whether anything can be gained by this ranking of 'naturalness'. Furthermore, it is possible to challenge some generalisations. Five-vowel systems with 'lax' mid vowels (*i u ε ɔ a*) appear to exist in the world's languages. This thesis considers languages which appear to have this system, Chichewa, Herero, and Lena Bable.[23]

Standard GP seems to be over-restrictive, not only in the vowel-systems it captures, but also in the vowels. Some phonological expressions are predicted never to be found. An example of this over-restriction is provided from French. Charm theory predicts that nasal *a* (*ã*) will not be found, if we assume the expression to contain the fusion of two positively charmed elements, A^+ and N^+. However, this expression apparently occurs[24]:

(12) (a) bã (banc) *bench* (b) ãfã (enfant) *child*

[23] Basque also appears to have this system. See Cobb (1995a).

[24] Notice that charm theory also predicts no 'tense'/'lax' contrast between nasal vowels, as this would involve the fusion of N^+ and I^+. Consideration of this issue is beyond the scope of this thesis.

The expression for *ã* would be the illegal $^*(N^+.(\underline{A}^+))^+$, involving the fusion of two positively charmed elements. Charm theory also predicts that A^+ and Ɨ^+ cannot be found fused in the same expression i.e. that $(\underline{A}^+)^+$ has no ATR counterpart. The validity of this prediction is discussed in chapter 4, as this example has direct relevance for this thesis which considers a revised inventory of phonological elements without the ATR element and charm theory.

Another problem is that in Standard GP, simplexity cannot really be effectively expressed. Charm Markedness considerations mean that the only expression which is basically simplex in a vowel system is $(\underline{A}^+)^+$; $(\underline{I}^0)^0$ and $(\underline{U}^0)^0$ only occur in vowel systems which also have the positively charmed counterpart i.e. $(\text{Ɨ}^+.(\underline{I}^0))^+$ and $(\text{Ɨ}^+.(\underline{U}^0))^+$. Thus *a*, and 'ATR' *i* and *u* are not a natural class in Standard GP. Or rather they could only be so in a language which has 'tense'/'lax' contrasts *i*-*ɪ*, and *u*-*ʊ*. This does not seem to fit the empirical record very well. *a*, *i* and *u* form a 'natural class' in Khalkha Mongolian which does not also have 'lax' counterparts, *ɪ* and *ʊ*. Non-initial nuclei in this language can only contain *a*, *i* and *u*, and so it would be useful to be able to express this as a 'natural class' of simplex expressions.[25] Again, simplexity is referred to by the harmony process in Ogori: the recessive nuclei in a harmony process may only be simplex (see chapter 5 for details).

There is also the problem of over-generation. Even with the restrictions through charm or additional stipulations (e.g. H^-, L^- and Ɨ^+ may not be heads), the number[26] of possible phonological expressions predicted is just over 2300. This includes expressions apparently not attested in the world's languages.[27]

In Standard GP, the elements are not treated equally. Charm, of course, is a property which is shared by some elements, and serves to define natural classes of elements. It has an impact on element combinations in complex expressions. However, further to this, some arbitrary properties are assigned to some elements, but not others. For instance, I^0, U^0, N^+, L^- and H^- may be associated to skeletal points

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[25] This was pointed out to me by Monik Charette.

[26] This figure was worked out and communicated to me by Jonathan Kaye.

[27] In spite of its over-generation, the Standard GP is an improvement on any theory employing binary features. Calabrese (1994) points out that in principle such a theory obtains 2^{20} possible combinations of features.

dominated by either onset or nucleus constituents. R^0, h^0 and $ʔ^0$ are not associated to nuclear positions. L^-, H^- and I^+ are never heads. A^+ and I^+ are restricted to expressions associated to nuclear points. The cold vowel v^0 is an element in that it may fuse and contribute its properties to expressions as a head, however, it does not share other properties of elements in that it cannot be involved in phonological events such as spreading.[28]

A major drawback is that Standard GP cannot express any correlation between 'ATRness' and 'height', of the type exemplified by the discussion of the Kimatuumbi data in section 1.4. 'ATR' is represented by the element I^+, and 'height' might be a characteristic corresponding to the element A^+. Segundo's (1993) treatment of 'ATR'/'height' harmony in Natal Portuguese attempts to tie the distribution of I^+ to the distribution of A^+, by proposing that I^+-spreading takes place across an A^+-bridge. An A^+-bridge may be described as a relationship contracted between adjacent nuclei which dominate A^+ elements. As a result of this relationship, other elements, i.e. I^+, may spread. Ola (1992) proposes a similar type of relationship in order to link I^+ distribution to A^+ distribution in Yoruba. Although both approaches are able to account for the data, they both suffer from the problem inherent in the feature theory approach. They fail to explain why it is A^+ that is building bridges in phonological processes, and I^+ which likes to spread across them. Both these analyses are discussed in detail in chapter 5.[29]

As has already been mentioned, height harmony in Standard GP cannot be expressed by a specific element or process. Rather, it is expressed in terms of various different processes involving the element *A*. Height harmony in Pasiego and Kera is analysed by Harris (1990b, 1994c) in terms of A-delinking. On this approach, the distribution of *A* element is subject to special licensing conditions. If these are not met, *A* delinks. In other height harmonies such as Chichewa and Herero (Harris

[28] Some of the 'arbitrary' properties mentioned in this paragraph are captured in KLV (1985) in the relationship of elements to tiers. For example, v^0 and I^+ did not have tiers to reside on, unlike A^+, I^0 and U^0. By 1993, many Government Phonologists no longer used tier notation, although others continue to do so.

[29] Monik Charette (personal communication) points out that Mongolian labial harmony may be analysed as having an A-bridge, but this time with *U* spreading across it.

(1994b), Marten (1996)), the harmony is expressed in terms of A-spreading.[30] By focusing on the role of *A* in these harmonies, these approaches fail to capture the generalisation that the 'ATRness' of the triggers and targets forms a crucial part of the conditions for the harmony process. These cases are discussed in chapter 6.

A revised theory of elements should then try to address these problems: the strength of markedness with respect to what is possible and what is not, and in evaluating relative naturalness in both vowels and vowel systems, the over-generation of phonological expressions, the special treatment of some elements, and the inability to capture generalisations with respect to the distribution of I^+ and A^+.

1.6 An Approach to Problem Solving -A Revised GP

A Revised GP came about in response to those problems outlined in the preceding section. This section is a brief overview of the nature of the revisions to Standard GP, serving the purpose of providing the immediate context for the main proposal of this thesis: the interaction of *licensing constraints* (introduced below and chapter 2), *headedness* (introduced below and fully discussed in chapters 3 and 4), and *complexity* (fully discussed in chapter 5).

First let us take up the problem of over-generation. Revising the theory to reduce the number of possible phonological expressions could be achieved through two means: by reducing the number of elements, and by revising the restrictions on the way elements combine (performed by Charm theory in Standard GP)[31]. These two strategies could also have an impact on the problems of the unequal treatment of elements, the over-restrictive role of charm in preventing certain elements from combining, in predicting the non-existence of vowel systems apparently attested, and in ranking vowel systems with respect to 'naturalness'. The first strategy is to reduce the number of elements - the most radical way to reduce the number of possible expressions. In Revised GP a model of six is adopted:

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[30] Both Harris and Marten employ elements, but not charm theory. *A* therefore appears without a charm superscript in this discussion.

[31] These strategies were first suggested by Jonathan Kaye in a course of lectures at SOAS entitled *Current Issues in Phonology*, January-March 1993.

(13) A I U H L ʔ[32]

The three core elements of Standard GP (those whose fusion properties are alike) *A*, *I* and *U* are preserved. *H* is basically the high tone element of Standard GP without its charm, and *L* a combination of N^+ and L^-.[33] Absent from the revised inventory in (13) are those remaining elements which receive special treatment. R^0, $ɨ^+$, h^0 and the cold vowel v^0.[34]

The second strategy, to revise the component of the theory which restricts the way elements may fuse and the way expressions may pattern together in vowel systems, implies either radical revision, or the abolition of Charm Theory. This is of necessity as the element inventory has been so radically reduced, with only one of the originally charmed elements remaining (the *A* element). Furthermore, this strategy must contribute to resolving the other problems: the unequal treatment of elements and the restrictions on fusions and vowel systems predicted by Charm Theory. These problems could in principle be solved by retaining Charm Theory but radically modifying it. However, given these problems, and since Charm Theory ultimately ranks the relative 'naturalness' of vowel systems, a characteristic assumed to be impossible to estimate in section 1.2 of this chapter, it is completely abandoned in Revised GP.

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[32] Jensen (1994) argues for the abolition of glottal as an element and proposes characterising what has been traditionally thought of as 'glottal' phenomena by way of constituent structure. Incorporating Jensen's proposals here would be inappropriate as this would unnecessarily complicate the thesis proposed here.

[33] The motivation of these mergers is beyond the scope of this thesis. Nasukawa (1995) offers evidence from Japanese in support of the *L/N* merger, proposing L = slack vocal chords and L̲ (headed L) = nasality. See also Ploch (1995) on issues relating to the relationship of *N* and *L*.

[34] Motivating the abandonment of these last three elements is discussed elsewhere. See Backley (1993) and Broadbent (1991) on issues relating to R^0, Charette (1994) and Walker (1995) on $ɨ^+$ and the cold vowel. In particular, the empirical evidence for the loss of the cold vowel is evaluated in Chapter 3 of this thesis. Cyran (1994) argues for the abolition of h^0 proposing instead that phenomena which depended on it can be captured in terms of the headedness of the resonance element in consonants in some languages. He also suggests that *H* might be sufficient to represent friction, in, for example, Irish *x*.

The revised element inventory, and new characteristics of expressions enriches the expressive power of the theory in the following way. The important impact of the loss of Charm Theory is theoretical ‘equality’ amongst elements. Leaving aside the issue of glottal, it is assumed that the elements in (13) may in principle fuse as heads and operators in phonological expressions which are dominated by any constituent.

The loss of the cold vowel (motivated in chapter 3) has particular repercussions for the characteristics that phonological expressions may now display. Expressions cannot be ‘cold-headed’, and ‘cold-headed’ effects are captured by the absence of any head in a phonological expression. i.e. it is headless. With no identity element, phonological expressions and generalisations about them can be characterised in the following way: (i) simplex, e.g. (A), ($\underline{\text{A}}$); (ii) complex, e.g. (A.I.U), (A.I.$\underline{\text{U}}$); (iii) headed, e.g. ($\underline{\text{A}}$), (A.$\underline{\text{I}}$); and (iv) headless, e.g. (A), (A.I), (A.I.U). Here the head of the expression, if there is one, is underlined, and in complex expressions, ‘.’ is the fusion operator.[35] The expectation is that phonological processes make reference to these characteristics.

1.6.1 Headedness

This thesis builds on the claim that headedness and headlessness are indeed characteristics to which phonological processes make reference. Together with other principles of the theory, this characteristic can explain ‘ATR’ and ‘height’ harmony, and can capture the markedness of ‘ATR’ distribution in terms of expressing ‘ATR’ but not ‘-ATR’ as a possible process, and the pairing of ‘lax’ with ‘tense’ counterparts in vowel systems.

‘Headedness’ (discussed in chapter 3) is the characteristic employed by Revised GP in the explanation of the distribution of the characteristic ‘ATR’ (Kaye 1993b). In this thesis, I propose that headedness, exploited in essentially the same way as it is in explaining ‘ATR’ distribution, is the appropriate characteristic with which to capture the other types of harmony in the table. In harmony systems of ‘headedness’, headed phonological expressions (generated with licensing constraints

[35] KLV (1985: 309) define fusion “as involving two elements: a head and an operator”. In the revised model, fusion must be redefined as involving two or more elements drawn from the set of elements in (1). See chapter 3 for an in-depth discussion of the notions of *head* and *fusion*.

(see 1.6.2 and chapter 2)) are distributed according to the inter-nuclear governing relationships contracted by the nuclei to which they are associated (developed in chapter 4). These governing relationships are an aspect of *head-licensing* (Kaye (1993b)), in which headless expressions are mapped to headed expressions under specifically defined conditions. One condition may be a condition on complexity (Harris (1990a), discussed in chapter 5), yielding further patterns of distributional restrictions correlating to the informal term 'height' harmony.

As head-licensing is restrictive in that it can map only headless ('lax') expressions to headed ('tense') ones, *not* headed to headless, a type of harmony process such as '-ATR' harmony cannot be expressed, and is predicted not to occur. In addition, head-licensing can capture the generalisation that the occurrence of 'lax' vowels implies the presence of the 'tense' counterparts in vowel systems.[36]

In explaining vowel harmony in these terms, it makes no sense to refer to harmony processes using the harmony-type categories of the first column in (1). Indeed, the harmony discussed in chapters 4 and 5 includes language data from all of the categories in the table above. Chapter 6 shows how the 'headedness' analysis can contribute to debates about the nature of harmonies in particular languages which have not been discussed in earlier chapters because of limiting factors to do with data availability.

1.6.2 Licensing Constraints

Although this chapter has questioned the validity of some aspects of the notion of 'markedness' and has also questioned some of the generalisations claimed about the phonological phenomena of the world's languages, this thesis still acknowledges that there are generalisations to be made. In fact, this view is implicit in any theory which uses elements as primitives. By retaining the elements *A*, *I*, and *U*, Revised GP embraces the generalisation that some kind of *a*, *i*, and *u* are the most unmarked

[36] However, recall that I also claimed that systems such as *i, u, ɛ, ɔ, a* indeed exist. This is not predicted in Standard GP because of the effect of charm markedness. However, it is predicted to occur in Revised GP as head-licensing may be further restricted by the conditions imposed by the licensing constraints, and the Complexity Condition, as will be discussed in chapter 5. In addition, it is important to remember that *ɛ* and *ɔ* could also be shorthand for (I.<u>A</u>) and (U.<u>A</u>) in Revised GP.

vowels (every language must have them). Since some elements and Charm Theory have been abandoned, we have gained the ability to express such things as nasal low vowels, and can no longer evaluate some kinds of 'naturalness'. However, we have no way of explaining why a particular language has a certain set of phonological expressions and why the elements of these expressions behave as they do in phonological events. The mechanism proposed by Kaye (1993b) to perform this function is called *licensing constraints*, which is introduced below.

First, it should be noted that this thesis focuses on vowel phenomena, and with respect to expressions in nuclei, the elements concerned remain the domain of current research.[37] Of the inventory in (13), only *A*, *I* and *U* are discussed regarding Licensing Constraints here.

Individual languages have certain sets of phonological expressions. However, it is assumed that in principle, any combination of the three elements is possible. Given the characterisation of well-formed phonological expressions in Revised GP in this section, a total of twenty expressions is then yielded.[38] The possibilities are illustrated below:

(14)	$(\underline{A})$	$(I.\underline{A})$	$(U.\underline{A})$	$(U.I.\underline{A})$	(A)	(I.A)	(U.I.A)
	$(\underline{I})$	$(A.\underline{I})$	$(U.\underline{I})$	$(U.A.\underline{I})$	(I)	(U.I)	( )[39]
	$(\underline{U})$	$(A.\underline{U})$	$(I.\underline{U})$	$(A.I.\underline{U})$	(U)	(A.U)	

Assuming that any of these can be in principle associated to a skeletal point dominated by a nucleus, one may expect to find a language employing twenty vocalic 'contrasts' (without taking into consideration tone and/or nasality). This does not appear to be generally the case.[40] An example of a language which does not employ the vocalic inventory of (14) is the Altaic language Uyghur. I propose it employs the following phonological expressions:

[37] See Ploch (1995) on Nasal and Tone elements and Walker (in preparation) on Tone.

[38] Whether or not the identity element is admitted is irrelevant at this point of the discussion, as the same number of phonological expressions are generated.

[39] ( ) = the empty expression.

[40] It seems unlikely that there is a language with these twenty expressions. I assume, therefore, that all languages have at least some licensing constraint active. However, I assume, until it is demonstrated otherwise, that all the expressions in (14) exist.

(15) ( ) $(\underline{A})$ $(\underline{I})$ $(\underline{U})$ $(I.\underline{A})$ $(I.\underline{U})$ $(A.I.\underline{U})$ $(A.\underline{U})$

In Revised GP the particular configuration of (fused) elements in the expressions in (15) are no longer explained by Charm Theory. It is explained by licensing constraints.

The generation of phonological expressions, and the behaviour of elements and expressions in the phonological processes in which they are involved, are constrained by a set of parameters, licensing constraints. Instead of the Charm mechanism, head-operator relations can be more fully exploited to restrict the way elements combine. This takes the form of constraints on which elements may be heads, and on whether the heads can support, or 'license' operators. Constraining the way a phonological expression exhibits its characteristics with respect to its head and operator(s), a well-formed licensing constraint takes a single element as its subject, and makes a statement with respect to its potential to express the characteristics mentioned above. The licensing constraints for Uyghur are below:

(16) (a) U must be a head
(b) I licences no operators
(c) Operators must be licensed

The licensing constraints constrain the generation of phonological expressions as follows. (16a) ensures that when *U* is present in a phonological expression, then it can only be a head. This has the effect of outlawing the following expressions from the set in (14): (U), $(U.\underline{A})$, (A.U), $(U.I.\underline{A})$, (U.I.A), $(U.\underline{I})$, $(U.A.\underline{I})$, (U.I). (16b) ensures than when the *I* element is present in an expression as a head, it cannot license operators, ridding the inventory of $(A.\underline{I})$, $(U.\underline{I})$, $(U.A.\underline{I})$[41]. The final licensing constraint in (16c) ensures that all expressions generated are headed. As the elements which are not heads must be licensed in an expression by a head, the headless expressions are not generated. The result is the inventory in (15).

[41] These last two expressions are already excluded by (16a) in any case.

The licensing constraints then explain the inventory of Uyghur, yielding expressions which are subject to phonological processes. Indeed, it is through such processes as the distribution of expressions in the phonological string which allow us to know the characteristics of the expressions of a language: whether they are headed or headless, which elements may or must be heads, and which cannot, which elements when they are heads have the potential to license operators. The processes which reveal the characteristics of the Uyghur phonological expressions are analysed in chapter 2. With respect to the 'ATR' harmony characterised by headedness, licensing constraints generate the headed and headless expressions involved in the head-licensing process.

Collectively, licensing constraints form a specific set of parameters on the licensing properties of elements. As such, in addition to the elements, they can capture some generalisations about the behaviour of elements across vowel systems. For example, it is noted (e.g. Goad (1993)) that in 'ATR' harmony systems, the 'non-ATR' vowel *a* often patterns strangely: it may have no 'ATR' counterpart and at the same time, it may behave opaquely (i.e. neither undergo, nor allow harmony to spread past it). As licensing constraints generate expressions, and the harmony process is where headless expressions are mapped to headed ones, this generalisation is then captured by a parameter on the licensing properties of *A* (not *I* or *U*): *A cannot be a head* (Kaye (1993b)).

To summarise so far, in this section a number of features of Revised GP have been introduced: a reduced inventory of elements, the abandonment of charm, and most importantly, the notions of licensing constraints and headedness. The retention of elements still allows GP to express the notion of markedness in terms of possible processes, and some aspects of vowel systems. The introduction of the licensing constraints and headedness, and their interaction with other principles of the theory, particularly the Complexity Condition, will allow us to capture some aspects of 'ATR' and 'height' distribution in a non-arbitrary way.

1.7 Summary

This chapter has discussed the domain of inquiry of this thesis: the question of explaining in principled way the existence of a vowel harmony phenomena variously described in terms of 'ATR' and 'height'. In presenting this objective, I have addressed the issue of the expressive power of phonological theories, and the relation of theoretical claims to empirical fit. I have presented some alternative accounts from the phonological literature to demonstrate that a principled and unified explanation for 'ATR'/'height' harmony has so far eluded phonologists. I have presented a discussion of the existing machinery of Standard GP to show that a standard GP account cannot provide a unified explanation of the types of harmony processes in (1), and also to highlight some of the drawbacks of the theory which motivated its revision. Finally, I introduced the revisions to GP which will allow a unified and principled account of 'ATR'/'height' harmony to be presented in the subsequent chapters. In the following chapter I, begin this endeavour by illustrating the role of licensing constraints.

CHAPTER 2

LICENSING CONSTRAINTS

2.1 Overview

In chapter 1, the type of phonological phenomena this thesis seeks to contribute in explaining, specifically some aspects of vowel distribution, has been discussed. Additionally, it is observed that the elements as primitives in Standard GP in well-formed phonological expressions, together with the Charm Theory constraints on element fusion and Charm Theory's role as the evaluator of 'naturalness', makes a substantial contribution to the explanation of how vowels pattern together to form vowel systems. In Revised GP, as elements in some form are retained, some of the generalisations about vowel systems that are explained in Standard GP are also retained. However, some central aspects of the ability of GP to capture other generalisations are lost. Most importantly, the ATR element, with its special fusion properties and as a positively charmed element, plays a vital role in Charm Theory with respect to markedness both in the vowel system of positively charmed expressions being the most 'natural' (unmarked), and in Charm Markedness. Standard GP is then able to describe and explain generalisations about the distribution of 'tense' vowels in vowel systems. With the loss of both the ATR element and Charm theory, Revised GP is then denied the tools of explaining ATR distribution. How Revised GP describes and explains what has been traditionally termed ATR phenomena, and the relationship of licensing constraints to this, is addressed in chapter 4.

Licensing constraints play an important role, interacting with h-licensing, the mechanism introduced in chapter 4 to explain 'ATR' distribution in harmony systems. This chapter aims to make explicit the properties of licensing constraints on phonological expressions in GP, at the same time as presenting the theoretical tools of GP which are relevant to this thesis. Generally speaking, GP is a constraint-based framework of Principles and Parameters. Licensing constraints function as parameters in GP, and must conform to the general architectural underpinnings of the theory. The role of licensing constraints within a constraint-based theory is then explored in section 2.2.

In GP, variation between the different phonological systems of languages is captured in a particular way: through the various possible combinations of parameter settings. As we have seen, licensing constraints, as constraints on the language particular aspects of well-formedness of phonological expressions, can explain why a language (in the example, Uyghur) has a certain set of expressions as its vowel system. However, the question of *how* we know the way that elements are organised within the expressions has yet to be addressed. Phonological processes reveal element distribution. Constraints on element distribution (formalised by the licensing constraints), together with the question of how the data supplying this information relates to the proposal of particular licensing constraints for a language, is explored for Uyghur in section 2.3.

Having explored how licensing constraints fit into a constraint-based theory, and how they are recovered for a language, this chapter goes on to explore issues relating to the architecture of the licensing constraint component itself (section 2.4), discussing possible well-formed licensing constraints and issues relating to these theoretical possibilities, such as structure preservation.

The properties of licensing constraints established in this chapter are summarised in section 2.5.

2.2 The role of constraints in Government Phonology

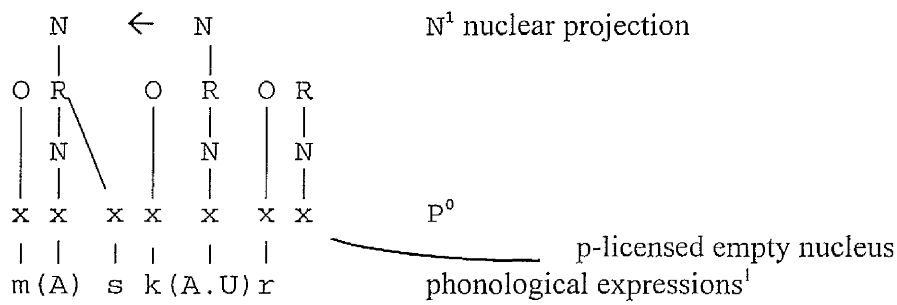
GP is a constraint based framework in the sense that the Principles and Parameters syntactic framework is constraint based. GP is defined by a set of principles and parameters which constrain phonological structural representations built of universal primitives. The basic architecture of GP with respect to the way constraints operate in the theory in general, raises specific expectations of the role of licensing constraints.

This section examines the role of constraints in GP and establishes the properties of licensing constraints in this context.

2.2.1 How Phonological Processes Occur

First, let us consider how phonological structure is recovered. In GP a well-formed structure is defined by a principled configuration of licensed phonological primes. The job of phonological parsing is to recover the structure by revealing the configuration of licensing which defines it. The mechanics are as follows. The Licensing Principle (Kaye 1990c) defines a phonological domain: all positions in a phonological domain must be licensed save one (the head of the domain). The example below from Basque illustrates a phonological domain.

(1)



mask'ɔr *shell*

The Licensing Principle unpacks as a set of ways constituents are licensed. This set conforms to a principled syntax for the organisation of the Government Phonology primitives: phonological expressions composed of privative elements associated to a skeleton mapped to the constituents Onset, Rhyme, Nucleus which are organised according to various licensing principles and strict relations of government, preserved throughout the course of a derivation.

In the example above, phonological expressions are associated to skeletal points. All the skeletal points are licensed except the second nuclear point. Onsets are licensed by following nuclei via a principle of onset licensing (Harris (1992)). The rhymal complement of the nucleus is licensed by the following onset point (via a

[1] Only the phonological expressions for expressions associated to nuclei are shown here

principle of 'coda' licensing (Kaye (1990c))). The first nucleus is licensed at the level of nuclear projection (to which all unlicensed (nuclear) points are projected) by the second nucleus. This is manifested by stress assignment. The second nucleus, the head of the domain, bears stress.

The final empty nucleus is licensed by a parameter active in Basque: domain final empty nuclei are licensed. As empty categories, lexically empty nuclei are subject to the Phonological Empty Category Principle[2]:

(2) The Phonological ECP: A-p-licensed (empty) category receives no phonetic interpretation.

The p-licensing required by the ECP can be achieved in the following ways:

(3) P-licensing:
1. Domain-final (empty) categories are p-licensed (parameter).
2. Properly governed (empty) nuclei are p-licensed
3. A nucleus within an inter-onset domain is p-licensed.
4. Magically licensed nuclei are p-licensed.

The domain final empty nucleus in Basque is then licensed by the parameter in (3(1)) above.

All kinds of phonological phenomena such as vowel harmony, palatalisation, the distribution of p-licensed empty nuclei and so on, serve to provide cues to the recovery of the configuration. For example, in Basque, as is illustrated in the example above, the parametrically licensed domain final empty nucleus provides an important cue to the domain. Other phonological processes are sensitive to the context of p-licensed domain final empty nuclei.[3] As p-licensed empty nuclei are distributionally highly restricted to domain final position in Basque, their presence in the structure revealed by phonological processes serves to cue the domain edge.

A licensing constraint is a constraint on phonological structure in the same way as the other principles and parameters are in the theory, contributing to the definition of the structure in (1) with respect to the composition of the phonological

[2] For a discussion of empty categories see Kaye (1990), KLV (1990), Charette (1991). For details with respect to (3(3)) see Kaye (1993a), and for (3(4)) see Kaye (1991/2).

[3] See Cobb (1996) for details of these processes.

expressions associated to the skeletal points. Just as the domain final empty nucleus in the structure above is licensed by an active parameter, the distribution of elements in the phonological expressions in terms of their roles as heads and operators is also licensed by parameters: the licensing constraints.

To summarise so far, phonological structure is a configuration of licensed primes driven by the Licensing Principle, constrained by universal principles and a set of parameters to which licensing constraints have been recently added.

2.2.2 The relationship of phonological domain to phonological domain.

As explored in the previous section, unlicensed nuclear points, and the configuration of licensing they dominate define phonological domains. These domains may be themselves organised with respect to other domains. This section explores the relationship of phonological domain to phonological domain, which Government Phonologists call 'morphological structure'.

With respect to 'morphological' complexity defined by phonological structure in GP, Kaye's (1992) Minimalist Hypothesis ('Phonological processes take place whenever the conditions that trigger them occur') and a principle of strict cyclicity (in the sense of Kean (1974)) interact to reveal the three possible phonological structures below.

(4) (a) Analytic Structure:
Domains: A, AB
structure: [[A]B]
interpretation: $\phi(\text{concat}(\phi(A),B))$
examples: *-ed*, *-ness*, *-ment*.

(b) Analytic Structure:
Domains: A, B, AB
structure: [[A][B]]
interpretation: $\phi(\text{concat}(\phi(A), \phi(B)))$
examples: *kilometre*, *superman* (cf. *postman*)

(c) Non-analytic Structure:
Domains: AB
structure: [AB]
interpretation: $\phi(\text{concat}(A,B))$
examples: *modernity*, *kept*

The phonological processes which combine to reveal the licensing configurations are represented as the function ϕ ('do phonology'). *Concat* is the single function defining how phonological domains are combined (string concatenation). The brackets represent instructions as to how the phonological string is to be processed, delimiting the phonological domains which are arguments to the functions *concat* and ϕ. Of course, these structures would be unrecoverable without some notion of cyclicity. The Principle of Strict Cyclicity (PSC) ensures that the phonological licensing in the inner domain cannot be undone in an outer one.[4]

2.2.3 Levels of Representation

In GP a derivation simply consists of a lexical structure input, and the simultaneous application of phonological processes yielding a result. Harris (1994a:271) points out that in a principle-based model (such as GP), derivation takes place in response to universal constraints, and is " the inevitable consequence of some combination of conditions obtaining within a representation." These conditions are the constraints on phonological structure.

The derivation is constrained by the same principles that constrain the lexical structure. This view is expressed by Harris (1994a: 271): "Within an authentic generative model of grammar, phonological derivation does no more than define the distributional and alternation regularities that hold over phonological representations...". Thus, there is no formal distinction between 'static' phonological phenomena (the composition of, for example, vowel systems or inventories discussed in chapter 1) and 'dynamic' phonological processes (for example systematic alternations of vowel quality in derived contexts, such as in affixation (as in section 2.2.2 above)). This view is explicit in the aforementioned Minimalist Hypothesis (Kaye 1992): 'processes apply whenever the conditions that trigger them apply'. Given this view of derivation, licensing constraints must be assumed then to hold of

[4] The version of the Principle of Strict Cyclicity usually cited in the GP literature is that of Kean (1974: 179): "...On any cycle A no cyclic rule may apply to material within a previous cycle B without making crucial use of material uniquely in A." Of course, GP does not have cyclic rules, and the PSC must be interpreted in the context of the principles and parameters (including the Projection Principle) which define GP. See Kaye (1992, 1993a) for a detailed discussion of the interaction of the PSC with the principles and parameters of GP.

both lexical structure and derivational output as part of the package of principles and parameters which define phonological structure.

The licensing constraints in GP both form part of the collection of the Principles and Parameters which govern lexical structure, and are constraints on element behaviour and serve to explain it. As explained in chapter 1, under the current assumptions of Revised GP, all elements are assumed equal with respect to their fusion properties, and can all, in principle, spread/delink in phonological processes. Licensing constraints contribute to the conditions under which spreading and delinking take place.

The role of licensing constraints in defining well-formed phonological structure, constraining derivational output, and contributing to the conditions which trigger derivation, is then an artefact of the general architecture of GP. This is in marked contrast with other types of theories which appear to attempt to explain the same phenomena i.e. both the structure of phonological inventories and phonological derivation. The type of theory I refer to is one which formally separates the notions of *static* and *dynamic* phonological processes. For example, Calabrese (1994) employs negative constraints on feature combinations in the definition of, for example, vowel inventories. However, rules are still admitted to account for 'language specific' phonological alternations.

Like the other constraints in GP, licensing constraints are monostratal, i.e. the order in which the constraints apply is irrelevant. In addition, the constraints are assumed to be hard (non-violable) as they are part of the package of constraints on lexical structure and derivational output in defining element behaviour. If they could be overridden they could not be recovered. This is also consistent with other constraints in GP.

2.2.4 Language Variation in a Constraint-based Model

Given this basic architecture of a constraint based theory of principles and parameters, how languages vary with respect to their phonology can be described and explained by reference to the various possible combinations of parameter settings.[5] For

[5] Harris (1994a: 271) points out that to some extent languages may also vary with respect to the outcome of identical phonological derivations, although the number of possible variations is limited.

example, Charette's (1991/1992) analysis of the government-licensing properties of licensed domain final empty nuclei in terms of a parameter predicts two possible outcomes: domain final licensed empty nuclei which are government-licensors, and those which are not. Briefly, an onset point which has governing work to do requires a government license, provided by the following nucleus. The status of p-licensed empty nuclei as government licensors is determined by the parameter setting *domain final licensed empty nuclei are government licensors*. Charette provides French as an example of a language in which the parameter above is *on*, and Wolof as representative of languages in which the parameter is not active. In the same way, the various settings of the licensing constraint parameters both give us the possible vowel systems of the languages of the world, and raise specific expectations about element behaviour.

2.2.5 Structure Preservation

In GP 'structure preservation' is, generally speaking, a term used in the same way as it is in the Principles and Parameters syntactic framework. Structure Preservation in a GP framework is discussed in KLV (1990), Kaye (1993a), Harris (1994a) and Brockhaus (1994). These discussions are summarised here.

Basically, Structure Preservation embodies the notion that the licensing relations of the lexical structure are preserved throughout the course of a derivation. In syntax this means that all instances of the derivational operation *move* α respect lexical categorial status. In GP it ensures, for example, that the constituent categories of skeletal points cannot be altered. As in Principles and Parameters syntax, structure preservation is effected in GP by a Projection Principle, defined below:

He provides the example of *t*-lenition in English. In response to an identical derivation, different dialects of English opt for different weakened reflexes. Another example would be Charette's (1990) discussion of two dialects of Tangale with respect to their responses to identical licensing conditions. These conditions are (1) the proper-government of empty nuclei, and (2) the government-licensing requirement of an onset. These two conditions cannot both be satisfied, and the two dialects differ with respect to the response to these conditions.

(5) The Projection Principle (KLV 1990: 221)
Governing relations are defined at the level of lexical representation and remain constant throughout a phonological derivation.

All 'movement operations' in phonology (such as the spreading and delinking of elements) must then respect the basic licensing conditions established by the principles and parameters of the theory.

Harris (1994a: 190) provides an alternative Structure Preservation Principle as follows: Licensing Conditions holding of lexical representations hold also of derived representations. Harris states that this is interpreted as meaning that general conditions on licensing remain in force throughout derivation. This is essentially the way KLV's (1990) Projection Principle is generally interpreted (see Brockhaus (1994) for further discussion), even though its wording might imply that only the licensing structure of governing relations, and not licensing conditions in general, apply.

Kaye (1993a) points that some latitude is involved in the interpretation of the Projection Principle. Indeed, lexical governing relations must be projected throughout a derivation. However, not all governing relations are defined at the level of representation. Kaye has in mind those governing relations contracted at the level of nuclear projection, manifested by stress, tonal phenomena and harmonic effects. Brockhaus (1995) takes up this point. She points out that the Projection Principle allows for governing relations to be added in the course of a derivation, whereas changing or deleting existing governing relations is prohibited. This interpretation of the Projection Principle is evident in cases involving analytic morphology in (4) above. In the inner domain, governing relations hold. In an outer domain, additional points are available and new governing relations are established. Brockhaus provides the example of stress assignment, which entails the building of governing relations at various levels of nuclear projection.

As for the relation between elements in expressions, and whether these are also subject to the Projection Principle, is an issue to which I return later in section 2.4, following the discussion of the licensing constraints for Uyghur vowel harmony.

To summarise so far, in examining the basic architecture of GP, and the role of constraints in general, the following properties are demanded of licensing constraints: they hold of lexical structure and of phonological derivation; they are inviolable; they are monostratal. How licensing constraints are recovered for a language is expanded in the following section.

2.3 Explaining Element Behaviour in Phonological Processes

In chapter 1, we saw how the licensing constraints function in terms of determining the particular set of expressions a language has as its vocalic inventory. This was illustrated for Uyghur. The licensing constraints present in that language are repeated below:

(6) U must be a head
I licenses no operators
Operators must be licensed

The licensing constraints above generate the vocalic expressions for Uyghur which are repeated below:

(7) ( )[6] $(\underline{A})$ $(\underline{I})$ $(\underline{U})$ $(I.\underline{A})$ $(I.\underline{U})$ $(A.I.\underline{U})$ $(A.\underline{U})$

The elements in the expressions above have certain properties, formally determined by the licensing constraints. Yet to be addressed is how we know which elements are heads, and which are operators, and whether or not expressions are headed or

---

[6] The empty expression is a member of the set of vocalic expressions for Uyghur, and its interpretation in a nuclear position is subject to the Empty Category Principle (Kaye (1990a)). It must be P-licensed if it is to remain uninterpreted. By convention, empty expressions are not shown to be associated to a skeletal point in this dissertation, to reflect that there is no distinction between ( ) and nothing. With respect to how Uyghur interprets its non-p-licensed empty nuclei, Uyghur adopts the strategy of utilising the *I* element for the interpretation of its empty nuclei when these fail to be p-licensed. The *i* yielded from the interpretation of an empty nucleus behaves, phonologically, as a lexical *i*.

However, in the relevant vowel harmony context, an unlicensed empty nucleus may be interpreted as *u/ü*. In addition, see example (8b) and the associated footnote for details of the interpretation of the empty expression as schwa. It seems that if elements are available locally to interpret non-p-licensed empty nuclei, then they are employed for this purpose. When local elements are not available for the interpretation of non-p-licensed empty nuclei, *I* is used.

headless. The expressions reveal their characteristics by their behaviour in phonological processes. In this way, licensing constraints are recovered from phonological processes. In this section, the phonological processes of Uyghur are examined, in order to show how the behaviour of elements and expressions relates to the licensing constraints.

2.3.1 Phonological Processes in Uyghur[7]

Uyghur exhibits vowel harmony processes which are traditionally described as palatal-velar harmony and rounding harmony. The licensing constraints *I licenses no operators* and *U must be a head* are motivated by constraints on element distribution in Uyghur expressions and in Uyghur words, observable in vowel harmony phenomena. The licensing constraint *operators must be licensed* ensures all expressions in Uyghur are headed expressions. The motivation for this constraint is that the expressions in Uyghur do not exhibit any characteristic which would distinguish them as headless expressions.[8] The issue of the well-formedness of phonological expressions in Revised GP with respect to heads and operators in the fusion operation is taken up in chapter 3. Regarding vowel harmony phenomena and its relationship to licensing constraints, we begin with 'palatal-velar' harmony below.

2.3.1.1 *I*-harmony

When the plural suffix *-lar* is affixed, *a* alternates with *e*:

(8)		stem	stem + plural *-lar*	
	(a)	til	tiller/tillar[9]	*language*
		göʃ	göʃler	*meat*
		gül	güller	*flower*
		er	erler	*male*

[7] The data was elicited from an Uyghur native speaker. I thank Chuguluk for all her help.

[8] The behavioural characteristics of headless expressions is discussed extensively in chapters 4, 5 and 6. I therefore postpone the discussion here. Informally, the characteristics of headless expressions are the auditory impression of 'laxness', and alternation in the some contexts with 'tense' counterparts.

[9] stems containing *i* in the initial nucleus optionally harmonise. *tillar* was also elicited from the same speaker.

(b)	qəz	qəzlar[10]	*girl*
	pul	pullar	*currency*
	ot	otlar	*grass*
	at	atlar	*horse*

The alternation between *-lar* and *-ler* can be explained in the following way. The noun stems in (8a) which affix *-ler* contain vowels of the set {i, ö, ü, e}. Those to which *-lar* affixes in (8b) contain vowels of the set {ə, o, u, a}. I propose the *-ler* set of stems are characterised by having the *I* element in their expressions.

(9) Active set: {*i* (<u>I</u>), *ü* (I.<u>U</u>), *ö* (I.A.<u>U</u>), *e* (I.<u>A</u>)}
Complement set: {*ə* (A), *u* (<u>U</u>), *o* (A.<u>U</u>), *a* (<u>A</u>)}

The licensing constraints allow this active set to be characterised by the presence of *I*. The vowel harmony is explained in terms of the spreading of *I* from the nucleus in the stem to the nucleus of the suffix, from left to right.[11]

(10) (a) <u>A</u>rl<u>A</u>r → <u>A</u>rl<u>A</u>r (b) g<u>U</u>ll<u>A</u>r → g<u>U</u>ll<u>A</u>r
• • • • • •
I→ I I I→ I I
erler *males* güller *flowers*

In the examples above *I* element spreads from the stem, into the *a* of the *-lar* resulting in the fusion of *A* and *I*.

I-spreading not only explains vowel alternations in affixation, but is also manifest in morphologically simplex words. As can be seen in (11) any expression from the vocalic inventory may occupy the initial nuclear position. However as expected, left to right *I*-spreading from the initial nucleus affects what vowel may

[10]In this illustration of vowel harmony I have included *ə* which is only found in the context of either preceding or following *q*. I propose that this schwa is the interpretation of an empty expression. In this context an unlicensed empty nucleus is not interpreted as *i*. Rather the *A* element in the onset expression (H.A) is employed to interpret the adjacent empty expression, yielding a schwa object.

(H.A) ( ) z
|__↑ qəz *girl*

The vowel is traditionally transcribed as *i* (*qiz*), but as expected, is never involved in *I*-harmony.

[11] In this example I have represented the expressions in a vertical fashion, so as to facilitate the illustration of spreading. Brackets are not included here. • indicates fusion; heads are underlined.

occupy a non-initial position in native Uyghur words. The distribution pattern is given below.[12]

(11)

initial nucleus	following nucleus	examples
e		
ü	{ü, e}	kümüs *silver,* güzel *beauty*
ö	({ü, e})	(höner *skill*, bölüm *department*)
a	{a}	tamaq *food*
u	{u, a}	burun *nose*, qulaq *ear*
o	({u, a})	(orun *place*, yogan *big*)
i	{i, e, a}	bilim *knowledge*, bilek *arm* yiza *countryside*

The table above shows that when harmonising vowels of the set {i, e, ö, ü} occur in the initial nucleus, the following vowels are restricted to {i, e, ü}. In native words there are no examples in which a member of this latter set occurring in a non-initial nucleus is preceded by one of the complement set {o, u, a}.

i is distributionally neutral, occurring in both 'front' and 'back' words (b), and optionally harmonising suffixes (a):

(12) (a) tiller/tillar *languages*
(b) bilek *arm*, yiza *countryside*[13]

---

[12]The distribution pattern is complicated here by the interaction of *U*-harmony (see section 2.3.1.2) and another phonological event regarding the licensing of *A* element. See Denwood (1993) for details. Generally speaking, in words of two or more metrical beats, *a* may be followed only by *a*, with the additional condition that this following *a* is stressed (stress is 'final' in Uyghur). When these conditions are not met, the *A* element in the left of this pair of nuclei is not licensed. The resulting empty expression is interpreted as *i* (I). *e* is further restricted. In native words which are morphologically simplex it is found only in stressed positions. The example in (8a) *erler* exhibits analytic morphology.

The parentheses indicate a dialect difference. For some speakers *e*, *o*, and *ö* are only found in native words of one metrical beat. For a speaker of such a dialect, *hüner*, *bülüm*, *urun*, and *yugan* would replace *höner*, *bölüm*, *orun*, and *yogan* in (11).

[13] Due to the conditioned distribution of *A* element and the application of *U*-harmony, it is not possible to illustrate *i* occurring in 'back' words in a non-initial nucleus. *a* followed by an unlicensed empty nucleus would in fact yield *i* followed by *i*. *u/o* followed by an unlicensed empty nucleus would result in the interpretation of that empty nucleus as *u* (U).

i is unique in this respect. *e*, *ö*, and *ü* are obligatorily involved in harmony processes. The expressions allowed by the licensing constraints can characterise optional harmony (neutrality): *I*-harmony is obligatory when the *I* element is an operator, and optional when *I* is a head. The contribution of the licensing constraint *I licenses no operators* is to generate expressions such that when *I* is fused in complex expressions it is an operator. In the simplex expression *I* is a head.

(13) *til* ($\underline{\mathrm{I}}$) *göf* (I.A.$\underline{\mathrm{U}}$) *gül* (I.$\underline{\mathrm{U}}$) *er* (I.$\underline{\mathrm{A}}$)

Uyghur is not the only language where this asymmetry can be observed. Similar optional *I*-harmony is evident in Finnish. *i* and *e* behave neutrally with respect to harmony, whereas *ä*, *y*, and *ö* may only occur in 'front' words. The examples below are from Goldsmith (1985).

(14)

'front'	**'back'**
pöytä *table*	pouta *fair weather*
sävy *trait, character*	tuhma *naughty, stupid*
tyhmä *stupid*	
'back' and 'neutral'	**'front' and 'neutral'**
tuuli *wind, mood, temper*	pelästyä *to be frightened*
pelastua *to be saved*	

Gibb (1991) proposes that the distinguishing characteristic of the Finnish expressions of *i* and *e* is that they have an *I*-head:

(15)

($\underline{\mathrm{I}}$) *i*	(I.$\underline{\mathrm{U}}$) *y*	($\underline{\mathrm{U}}$) *u*
(A.$\underline{\mathrm{I}}$) *e*	(A.I.$\underline{\mathrm{U}}$) *ö*	(A.$\underline{\mathrm{U}}$) *o*
(I.$\underline{\mathrm{A}}$) *ä*		($\underline{\mathrm{A}}$) *a*

In Finnish, *I*-harmony may be characterised as the licensing of *I* as an operator through the domain. Taking part in harmony is optional for *I*-heads in Finnish.[14]

[14] The Licensing Constraints *U must be a head* and *operators must be licensed* allow for the expressions in (15).

2.3.1.2 U-Harmony

I propose that like *I*-spreading, *U*-spreading is also from left to right. *U* element harmonises its domain from the initial nucleus, but the landing site is restricted: *U* only spreads to empty nuclei.

(16)

Nominative	possessive-*m* (1st pers sing)	
pul	pulum	*money*
ot	otum	*grass*
göʃ	göʃüm	*meat*
gül	gülüm	*flower*

In (16) the first person singular agreement marker is *-m*. First person singular possessives do not always display an expression with *U* element before *-m*:

(17)

nominative	possessive	
pil	pilim	*elephant*
at	itim	*horse*

In the examples above, an *i* appears in the possessive forms. This is consistent with the hypothesis that this nuclear expression in which *i* appears is empty. The empty nucleus, not being p-licensed, is interpreted as *i*. In (16) it is interpreted as *u/ü*. Crucially, the examples in (16) have *U* element in the first nucleus. Labial harmony may then be interpreted as the spreading of *U* from left to right.

(18) (a) p u l _ m
$\underline{U} \rightarrow \underline{U}$
pulum *my money*

(b) k ö l _ m
$\underline{U} \rightarrow \underline{U}$
• •
A
•
$I \rightarrow I$
kölüm *my lake*

The *U* element in the initial nucleus in both examples spreads into the adjacent empty nuclear position. The expressions in the initial nuclei of (16) are characterised by the presence of *U* element.

(19) active set: {*u* ($\underline{U}$), *o* (A.$\underline{U}$), *ü* (I.$\underline{U}$), *ö* (A.I.$\underline{U}$)}
complement set: {*i* ($\underline{I}$), *a* ($\underline{A}$), *e* (I.$\underline{A}$), ( )}

The restrictions on *U*-spreading can be seen in the examples of the plural forms below:

(20)

	nominative	plural	plural/possessive
(a)	pul	pullar	pullurum
	ot	otlar	otlurum
	gös	göʃler	göʃlürüm
	gül	güller	güllürüm
(b)	pil	pillar	pillirim
	at	atlar	atlirim

In (20a), *U* element does not spread into an expression with *A* element: the plural marker in the second column.

(21) pul + lar
$\underline{U}\rightarrow/\underline{A}$ pullar/*pullor

The *A* element of the suffix inhibits the spread of *U*, and no complex expression results.[15] In (21) the spreading of *U* element is inhibited by the head in the expression of the plural. This behaviour is explained by claiming that *U* must be the head of an expression. The head position is filled by *A*, and *U* is prohibited by the licensing constraint *U must be a head*, to fuse with a lexical head as an operator.

Now consider the third column in (20), exemplified by the form *pullurum* in the example below. Here, the *A* element of *-lar* is not licensed, for the following reasons (see Denwood (1993) for details)[16]. Denwood analyses the conditions for A-licensing as follows. *A* is licensed in a nucleus that is a head (i.e. a stressed nucleus, or the head of a morphological domain, or of a P^0 governing relationship). The *A*

[15] See Cyran (1995) for an almost identical situation found in Munster Irish. There, the headed expression ($\underline{A}$) is immune to an *I*-spreading process in which *I* wants to be the head of the affected expression.

[16] I have applied Denwood's analysis here. She does not specifically discuss the form *pullurum*.

element in *-lar* is, on Denwood's view, the head of a morphological domain, as she would analyse the following relationships of phonological domains: $[_{C}[_{B}[_{A}\text{pul}]\text{lur}]\text{um}]$. In domain B, *-lar* is the morphological domain head. However, in domain C, *-um* is the morphological domain head, as well as the stressed nucleus.

In this 'absence' of *A* element (by delinking), the head position of the expression is available. *U* (and *I*) element may spread rightwards into this expression.

(22) pul + l_r_m
$\underline{U} \rightarrow \underline{U}$
$\rightarrow$ $\underline{U}$ pullurum/*pullirim

In the absence of *A* element, the *U* from the initial expression spreads not only to the plural suffix, but also to the non-p-licensed empty nucleus preceding *-m*.

Like *I*-harmony, the *U*-harmony facts established by an examination of affixation also hold for the distribution of vowels within stems. On the account given here, *o* and *ö* non-initially could only be derived from the harmonisation of *A* element by *U* and *I* elements. Lack of *o* and *ö* non-initially then falls out from the assumption that *U*-spreading is inhibited by headed expressions. The licensing constraint, *U must be a head* predicts the absence of *o/ö* in non-initial nuclei and at the same time allows for the possibility of *ü*, and *u*. This prediction is borne out.

Specifically, *ö* is never found in a non-initial nuclear position, with the exception of one item, *dasö-university*.[17] The same holds for *o*, with few exceptions, all of which are non-nativised loan words, such as:

(23) pjinor *pioneer* termoz *thermos* cirko *church*

As for *u* and *ü*, assuming that *U* spreads from the initial nucleus predicts that where *u/ü* is found in a non-initial position, that position is lexically empty, and should be preceded by a nucleus with an *U* element (and an *I* element in the case of *ü*). This is true: *u/ü* are almost exclusively preceded by *o/ö/u/ü*, the exceptions being limited to non-native items of the type below:

[17] This is a loan word from Chinese (*daxue*). See Hahn (1991: 82).

(24) kinu *movies* (European) yaŋyu *potato* (Chinese)

In this examination of element spreading in Uyghur we have seen that elements do not spread into expressions which have heads (specifically, (A̲)), to occupy the head position. *I* fuses as an operator in complex expressions where it is obligatorily involved in *I*-harmony. *I* fused as a head is optionally involved in vowel harmony. This behaviour of *I* is explained by the licensing constraint *I licenses no operators* which ensures that *I* is distributed in the expressions for Uyghur as a head in simplex expressions, and as an operator in complex expressions. The *U* element cannot fuse as an operator at all and is therefore highly constrained in its distribution in Uyghur words. This is explained by the licensing constraint *U must be a head.* Non-domain initial nuclei then contain only (A̲) and ( ) lexically.

2.4 Licensing Constraint Theory

As we have seen in the examination of Uyghur, licensing constraints can in principle take an element as the subject and make a statement about its potential licensing power, or licensing requirements. Licensing constraints can also take the set of elements as a whole and make statements about their collective licensing properties. In addition, in the absence of the cold vowel, expressions may be either headed or headless.[18] This characteristic can be captured in the following way. Either, we can single out a particular element, and make it the subject of a licensing constraint (*X must be a head* would yield a headed expression, *X cannot be a head* would yield a headless expression), or we can generalise about the set of elements and subject them to a licensing constraint (*Elements must be heads*, *elements cannot be heads*). In the example below, I provide the theoretical possibilities, with the licensing constraints which take a single element as its subject in (25a-f), and those which generalise all elements in (25a'-f').

[18] This issue is discussed further in chapter 3.

(25) **single element licensing constraints:**
- (a) *X* must be a head
- (b) *X* cannot be a head
- (c) *X* licenses no operators
- (d) *X* licenses operators
- (e) *X* cannot be licensed (cannot be an operator)
- (f) *X* must be licensed (must be an operator)

Generalised licensing constraints:
- (a') Elements must be heads
- (b') Elements cannot be heads
- (c') Heads license no operators
- (d') Heads license operators
- (e') Elements (operators) cannot be licensed
- (f') Operators (elements) must be licensed[19]

The constraints in (25) are theoretical possibilities, a kind of 'short-list' of possible candidates from which I assume the smaller final set of constraints to be drawn. (25a-f) are six possible constraints which could apply to the behaviour of the three specific elements. (25a'-f') are the same type of constraints as (25a-f) in terms of the characteristics of the expressions they entail. However, instead of a single particular element as the subject of the constraint, the constraints are generalised to include all elements.

Certain issues raise themselves immediately. First, if the full set of constraints in (25) is considered, there seems to be too many constraints with the effect that there are too may possible combinations of parameters. Additionally, the constraints overlap in their effects. If there is any evidence to support the inclusion in the final licensing constraint parameter set all or any of the constraints (25a'-f'), then it follows that the effects which would follow from corresponding constraint(s) from (25a-f) would be automatically included. For example, if the licensing constraint *elements must be heads* is active in a language the effect of the licensing constraint *X must be a head* is included. Determining the finite set of constraint parameters is beyond the scope of this thesis. However, at the end of the relevant chapters, I summarise the

[19] This constraint is proposed by Charette and Göksel (1994). Element licensors are elements which can be heads.

licensing constraints called on in this thesis, which contribute to the make-up of the licensing constraint pool.

Secondly, as any element (*A*, *I* or *U*) may be selected as the subject of the constraints (25a-f), one may expect to observe all elements in all kinds of constraints in analyses of the world's languages. If this is the case, then the constraints can be shown to be non-arbitrary, and the licensing constraint component could be generated from the interaction of a subset of the types of constraint in (25) and the three elements *A*, *I* and *U*.

However, it may be the case that certain elements favour certain constraints, for example *X must be a head* may often occur where *X* equals *U*, but never where *X* equals *A*. It is this consideration that determines the licensing constraints be specific parameters as opposed to universal principles with variable subjects. For example, it may be the case that *U* behaviour may be characterised by the parametric choice *U must be a head*. *A* element behaviour, on the other hand, may be explained solely by the activation or not of the licensing constraint parameter *A cannot be a head*. Indeed, in the language data analyses of chapters 4, 5, and 6, the only constraint involving the element *A* is *A cannot be a head*. If it can be shown that *I* and *U* are never the subjects of this type of constraint (specifically, no constraints *I cannot be a head*, or *U cannot be a head*), then the parameter *A cannot be a head* contributes to a principled explanation of the licensing requirements of the element *A*, and therefore towards an explanation of the distribution restrictions of nuclear expressions containing *A*.[20] As with the first issue, determining whether or not the only parameter on, for example, in terms of A behaviour, is the constraint *A cannot be a head*, is an issue beyond the scope of this thesis.

Thirdly, determining which constraints and constraint types should belong to the finite set of licensing constraints also rests on the question of whether or not phonological expressions may be both headed and headless, or only headed. This last question depends itself on whether or not there is an identity element in the set of elements. If all expressions are minimally composed of a head and an operator, then

[20] This might include for example a generalisation such as why in 'ATR' harmony systems, if there is an opaque vowel, it is typically *a*. In explaining this generalisation, it must also be assumed that there is a function HEAD(elements) operating in ATR systems.

the presence of an identity element such as the cold vowel is required to identify the head of the expression in the absence of any other possible element. If, however, expressions do not require both a head an operator to be well-formed, and may be headless, then no identity element is required.[21]

The repercussions this has for the licensing constraints are as follows. For instance, if there is a formal notion of headlessness, with no identity element, then (25b), *X cannot be a head*, is **not equal** to (25f) *X must be licensed*. The effect of (25b) is that the element *X* must be *either* an element fused in a headless expression, *or* an element fused as an operator. The effect of (25f) is that *X* can only be an operator (in a headed expression). However, if in the theory all well-formed expressions are headed (employing the identity element), then (25b) and (25f) are equivalent. Both would mean that *X* could only be fused as an operator in a headed expression. This is also true of (25b') and (25f').

2.4.1 Structure Preservation and Phonological Expressions

Finally, I return to the issue of structure preservation discussed in 2.2.5, and how the Projection Principle may be interpreted with respect to elements in expressions. The licensing constraints are parameters on the licensing potential/licensing requirements of the elements. Are these licensing conditions preserved through the course of a derivation? Can the status of an element as a head or an operator be altered during the course of a derivation? First, I summarise the relevant spreading events of Uyghur. Then I discuss some of the relevant views on this subject from the literature. Finally, I present my own interpretation of the Projection Principle.

In the discussion of element spreading in Uyghur presented in the last section, recall that *I* spreads from the head of an expression (I̲) to fuse as an operator in the expression (I.A̲). In the course of this derivation, this particular instance of *I* has changed its head-operator role. It is licensed as a head in the trigger, but as an operator in the target. However, in Uyghur, *I* is effectively generally licensed as both a head and an operator, as there are no licensing constraints to the contrary. (I̲), (I.U̲), (A.I.U̲), and (I.A̲) are all lexical expressions in Uyghur.

[21] This issue is discussed in detail in chapter 3.

Although in the I-spreading process, *I* spreads from a head position, and fuses as an operator, *U* is prevented from engaging in this sort of activity by the licensing constraint *U must be a head.* This explains why the headed recessive expressions cannot be harmonised.

The issue of structure preservation with respect to the licensing conditions on elements in expressions has been discussed in the literature. I summarise the main points made here. Generally speaking, a hard line is taken with respect to the preservation of structure within phonological expressions. Cyran (1995) assumes that KLV's (1990) Projection Principle ensures that phonological derivation cannot create new governing relations. Consequently, if licensing constraints are to define the correct lexical expressions, these should remain constant throughout a derivation. This means that licensing constraints may not be overridden in any sense. On this view, the harmony derivations in Uyghur would then be considered structure preserving.[22]

Harris (1994b) is particularly important to include here, as he discusses structure preservation with particular reference to an element spreading process, an A-spreading process, analysed in Chichewa. Harris claims that lexically established dependency relations remain stable under spreading. The claim is that in a spreading operation (such as that as illustrated for Uyghur), a spreading element cannot change its category from a head to a dependant, or vice versa. This strictly enforced in Harris' analysis.

In order to illustrate Harris' interpretation of structure preservation, I provide a brief summary of his analysis. According to Harris, the Chichewa vowel system is as follows: *i* ($\underline{\text{I}}$), *u* ($\underline{\text{U}}$), *e* (A.$\underline{\text{I}}$), *o* (A.$\underline{\text{U}}$), and *a* ($\underline{\text{A}}$). In the vowel harmony spreading process, the active set (triggers) are those complex expressions containing *A*: *e* (A.$\underline{\text{I}}$), *o* (A.$\underline{\text{U}}$). The complement set (targets) are those expressions without *A*: *i* ($\underline{\text{I}}$), *u* ($\underline{\text{U}}$). *A* spreads from the compound expressions as a *dependant*, to fuse with the headed expressions in the complement set as a *dependant.* In order to explain why *a* ($\underline{\text{A}}$) is not a member of the active set (i.e. *A* cannot spread from the A-headed expression),

[22] Backley and Takahashi (1995) take a similar line to Cyran with their definition of structure preservation: Categorial distinctions and lexical head-complement relations must be retained throughout derivation, regardless of levels of phonological structure.

Harris has to call on the strict interpretation given above (lexically established dependency relations remain stable under spreading) of his Structure Preservation Principle (Licensing Conditions holding of lexical representations also hold of derived representations). *A* cannot spread from the head of the expression, to fuse as a dependant, for reasons of structure preservation. On this view, the Uyghur U-spreading is structure preserving: *U* cannot spread as a head to fuse as an operator. However, the I-spreading process would be an illegal violation of structure preservation. Harris' interpretation of structure preservation would predict that I-spreading would only occur with the triggers (I.$\underline{\text{A}}$), (A.I.$\underline{\text{U}}$), (I.$\underline{\text{U}}$), with *I* spreading as an operator to fuse as an operator (non-head), yielding (I.$\underline{\text{A}}$), and potentially (I) as outputs of the process.[23] I-spreading would be predicted to take place from ($\underline{\text{I}}$), if the target were an empty expression, but would never take place when the target is ($\underline{\text{A}}$).

In the element spreading processes of Uyghur, such a strict interpretation of structure preservation has not been assumed. Assuming that the Projection Principle is interpreted in the sense that general conditions on licensing remain in force throughout derivation, (Harris' interpretation of his own Structure Preservation Principle), the derivations described for Uyghur are structure preserving. I suggest that the additional structure preserving statement Harris employs for Chichewa is unnecessary here.[24] Uyghur element spreading is structure preserving in that no 'new' (non-lexical) general licensing conditions on elements are created during the course of a derivation.

Under the assumption that licensing constraints hold of derived expressions as well as lexical, the behaviour of *U* is explained by the licensing constraint *U must be a head*. *U* element cannot fuse as an operator. *I*-spreading also yields expressions consistent with those allowed by the licensing constraints: ($\underline{\text{I}}$), (I.$\underline{\text{A}}$), (I.$\underline{\text{U}}$), (I.A.$\underline{\text{U}}$). The licensing constraints on elements apply at the level of lexical representation and also apparently hold through a phonological derivation to constrain output.

[23] However, in Revised GP terms, the expression (I) would be ruled out by the licensing constraint, *operators must be licensed.*

[24] I would also suggest that this strict interpretation of structure preservation is unwarranted for the Chichewa harmony case. See chapter 6 for suggestions for an alternative analysis.

2.5 Summary

In this chapter some of the formal properties of licensing constraints have been made explicit. Fitting in with the general architecture of GP and the role of constraints generally in the theory, licensing constraints are parameter constraints which form part of the package of principles and parameters holding of lexical structure and derivation. They are assumed to be non-violable, and form part of the conditions which trigger derivation. Like all parameters in the theory, it is through the various possible combinations of the licensing constraints that language variation with respect to phonological systems can be expressed. As expected, the 'on' setting for the licensing constraint parameters is recovered by relevant phonological phenomena. This chapter has illustrated the relevant phonological phenomena, specifically element distribution, in the switching 'on' of three licensing constraints in Uyghur. All possible theoretical types of constraint have been presented. The further issues of reducing the set of constraints, the relevance of the role of headedness in the well-formedness of phonological expressions, asymmetries in the distribution on elements as subjects of certain constraint types, and structure preservation have been highlighted.

CHAPTER 3

THE ROLE OF HEADSHIP

3.1 Overview

In chapter 1, section 1.3.3 it was noted that in Standard GP, some elements are given special treatment over and above the 'special treatment' defined by Charm Theory. Ɨ^{+} and v^{0} are two such elements. Eliminating the arbitrary treatment of elements combines with other advantages in reducing the number of elements. Revised GP proposes an element inventory which does not include *v* and *Ɨ*.[1] The non-inclusion of *v* and *Ɨ* warrants more detailed discussion because of its relevance to the explanation of vowel distribution, as outlined below. This chapter first deals with the motivation for the loss of v^{0}, and the consequences of its loss, and then with the element Ɨ^{+}.

The cold vowel v^{0} displays many various unique properties when compared with other elements, serving to motivate its not being included in the set of elements in Revised GP. These are discussed in 3.2. This section draws on the element framework of Harris (1994a), and Harris and Lindsey (1995), which includes a cold vowel type element, in illustrating some of the unusual properties of v^{0}. However, the non-inclusion of *v* has serious repercussions with respect to how phonological expressions may be defined, because of its function as the identity element in the fusion operation. v^{0}'s crucial role with respect to defining the well-formedness of phonological expressions is discussed in section 3.3.

Because of the role v^{0} plays as the identity element in Standard GP, the absence of *v* in Revised GP then entails the reformulation of how well-formed

[1] If v^{0} and Ɨ^{+} were to occur in Revised GP, they would in any case be without a charm superscript. I therefore show these two elements without charm values when discussing their hypothetical inclusion in the set of elements of Revised GP.

phonological expressions are defined. New definitions aimed at ensuring the well-formedness of phonological expressions in a Revised GP without *v*, are also presented in section 3.3.

In 3.4, arguments in favour of the phonological expressions as defined by Revised GP are provided, drawing on both theoretical and empirical considerations.

Also absent from Revised GP's set of elements is the 'ATR' element from Standard GP, Ɨ$^{+}$. Certain differences in the nature of constraints on element distribution in nuclei can be observed, depending on the element involved. When compared to the *I* and *U* spreading harmony of the type discussed in chapter 2, 'ATR' distribution appears to be constrained in a different way. These differences are made explicit in 3.5, and contribute to the arguments for eliminating the element Ɨ$^{+}$.

3.6 concerns the most impressive argument in favour of the abolition Ɨ$^{+}$, and in support of the removal of the cold vowel, and the adoption of the Revised notion of headship: Kaye's (1993b, 1994) proposal that 'ATR' distribution be captured by the headed-headless distinction available in Revised GP. This characteristic of expressions in Revised GP interacts with other aspects of the theory (some inherited from Standard GP, some which are new proposals), in explaining the distribution of 'ATRness' in vowel systems. There are various ways in which 'ATR' distribution is conditioned This thesis considers two of them. First, by combining with a restriction on the association of headless expressions to sites of constituent government, the correlation of 'ATRness' to 'length' may be explained (Kaye 1994). This is discussed in section 3.6. Secondly, by combining with a h(ead)-licensing mechanism. (Kaye (1993b), Walker (1995)), 'ATR-harmonies' can be explained. This last point is covered in detail in chapter 4, and so a discussion is not included in this chapter. The chapter is summarised in section 3.7.

3.2 The Cold Vowel

In this section the properties of v^0 are discussed. The cold vowel v^0 is an element, but does not share some of the formal properties enjoyed by other elements in Standard GP, as detailed below. In KLV (1985) v^0 differs from other elements in two main ways. First, elements are defined by feature matrices (whose features cannot be directly manipulated by phonology). One feature in the matrix is the salient or 'hot' feature. v^0 however, is unique in that it has no hot feature. This has the effect that in the fusion operation, when two matrices are combined, v^0 contributes to the computation only as a head element (discussed fully in 3.3). Secondly, generally speaking, elements reside on labelled tiers. For example, A^+ resides on the A (or 'high') tier. However, v^0 does not have its own tier but rather fills in empty positions on the tiers in the absence of any 'real element'.[2] These two characteristics of v^0 set it apart from other elements, and illustrate its identity element status.

However, including a cold vowel in the set of elements means that it has a number of unique characteristics. v^0 is special on the point of phonetic manifestation. In KLV (1985) it is claimed that elements are autonomous, independently pronounceable units. KLV do not go into details, however, in their analysis of Kpokolo, ($\underline{v}^0$) is pronounced ɨ .[3] The theory of elements proposed by Harris and Lindsey (1995) also includes a cold vowel type element @. They point out that @ is different from other elements in terms of phonetic interpretation. The elements *A*, *I* and *U* are identified by characteristic qualitative patterns in the signal, observable in spectra (Lindsey and Harris (1990), Williams and Brockhaus (1991/1992), Harris and Lindsey (1995)). The characteristic patterns of *A*, *I* and *U* are defined by relative spectral peaks and valleys. However, Harris and Lindsey (1995) observe that the cold vowel lacks the distinct peak-valley patterns of *A*, *I* and *U*.

Harris and Lindsey (1995) point out another unique property of the cold vowel, or neutral element. On their view, it is *latently* present in all segmental expressions. Specifically, @ is claimed to be latently present as a dependent (*operator*, in GP terms) in all vocalic expressions, and has the potential to become audible only when other elements in the compound are suppressed for some reason. No other element enjoys this status.

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[2] $ɨ^0$ does not have its own tier either, but does not fill in empty positions. As elements are theoretical primes, it is recognised in Standard GP that residing on tiers is not crucial to their ability to display autosegmental properties. The role of the tier as a crucial part of the phonological computational system is exploited in other related approaches. In particular see Rennison (1987), Harris (1994b) and Backley (1995)

[3] The feature matrix is provided for v^0 as follows (KLV (1985: 309)): [-round, +back, +high, -ATR, -low].

As a member of the set of elements, the cold vowel is also anomalous in its interaction with the theory of complexity as proposed by KLV (1985, 1990), and Harris (1990a, 1990b, 1992). As stated in chapter 1, the theory of representations in KLV (1985) allows for possibility of phonological processes to refer to the property of complexity. Harris (1990) develops the notion of complexity as a characteristic pertinent to all sites of government, proposing the Complexity Condition[4], repeated below.

(1) **The Complexity Condition** (Harris 1990a: 274):

> Let α and β be segments occupying the positions A and B respectively. Then, if A governs B, β must be no more complex than α.

The Complexity Condition is strictly enforced at P^0, and may be relaxed at the level of nuclear projection. For Harris, the complexity of phonological expressions is "straightforwardly calculated in terms of the elemental composition of a segment."[5] Given this calculation of complexity, and as the cold vowel element 'counts' only when it is head in phonological expressions, cold-headed compounds are expected to show complexity effects, in line with compounds headed by other elements. Harris (1990a, 1990b, 1992) illustrates a wide range of manifestations of the complexity condition in a variety of language data. However, in no example does the cold vowel v^0 play a role in complexity. In terms of calculating complexity by elemental composition, then, v^0 does not seem to count.

To summarise so far, v^0 functions as an identity element, identifying the absence of an element. However, v^0 is nonetheless an element, and as such, manifests a number of special properties: it has no characteristic spectral pattern, it is 'present' in some sense in all phonological expressions, and it doesn't count in complexity

[4] The Complexity Condition is discussed more fully in chapter 5.

[5] In KLV (1990) complexity is an issue in the operation of P^0 interconstituent government (onsets governing rhymal complements). In these instances, a neutrally charmed phonological expression can govern if it has greater complexity than its governee. KLV (1990) propose that complexity of a phonological expression can be calculated in terms of the number of *operators*. As the cold vowel is only 'visible' as a head, in KLV's terms it is not expected to manifest complexity effects.

evaluations. In short, in comparison with other elements, it behaves as if it is not one, and should be excluded from the set of elements in Revised GP.

3.3 Fusion and Headship[6]

The purpose of this section is to illustrate the role of v^0 as the identity element in fusion. I begin with the original fusion proposal of KLV (1985) and move on to how this proposal is understood in the Standard GP literature. The purpose of this illustration of the cold vowel with respect to fusion is to first highlight its crucial role in the fusion operation, and then to show that in the Standard GP interpretation of fusion, the role of the cold vowel is diminished. Finally, I present the notions of fusion and headship as they are understood in Revised GP, without the presence of the identity element.

3.3.1 Fusion and Headship in KLV (1985) and Standard GP

In KLV (1985), following the matrix analogy, fusion is the operation for combining two matrices into one. In this computation, one element is the head, the other is the operator. Fusion is performed by the giving of the value of the salient feature of the operator matrix to the same feature in the head matrix. The values of the remaining features in the matrix are those of the head, as illustrated below:

(2)

$$\begin{array}{cccc}
\begin{bmatrix} \text{-round} \\ \underline{\text{-back}} \\ \text{+high} \\ \text{-ATR} \\ \text{-low} \end{bmatrix} & \begin{bmatrix} \text{-round} \\ \text{+back} \\ \underline{\text{-high}} \\ \text{-ATR} \\ \text{-low} \end{bmatrix} & & \begin{bmatrix} \text{-round} \\ \text{-back} \\ \underline{\text{-high}} \\ \text{-ATR} \\ \text{-low} \end{bmatrix} \\
\text{operator} & \text{head} & & \\
\text{I} & \text{A} & \rightarrow & [\text{æ}]
\end{array}$$

The operation illustrated above is therefore asymmetrical. KLV (1985: 309) define fusion as follows: "We define fusion as involving two elements: a head and an

[6] The discussion of headship in this section greatly benefited from contributions made by participants in the phonology workshop group at SOAS during a session on the notion of headship. I am extremely grateful to all those concerned.

operator." In KLV (1985) fusion defines a well-formed phonological expression. The role of the cold vowel in this operation is highlighted below.

In general, in the Standard GP literature, it is recognised that the feature matrices of KLV (1985) are for illustrative purposes only. For clarity, the illustration of the fusion operation without the use of feature matrices is provided here using numbers and the mathematical operator 'minus'. Fusion is an asymmetrical operator which may be likened to mathematical 'minus' in the operation of subtraction[7]. A *head* and an *operator* are terms to identify the two elements which are inputs to the fusion operation, just as two numbers are the input to the subtraction operation. To continue this analogy, the head is then like the number we start from in subtraction, the operator is the number we take away. It is important to note that there can only be one head (just as we can only start subtraction from one number). As KLV (1990: 218) note: "Segments consist of a head and one or more operators."

In the Standard GP definition of fusion, the cold vowel plays a special role. *In principle*, it is free to fuse in either head or operator position in a phonological expression: fusion is defined in terms of an asymmetrical operation taking two elements (of which the cold vowel may be one). However, in terms of the computation of feature matrices, as it has no hot feature, the cold vowel cannot affect the output when it is the operator in the input. It can only affect the outcome of a fusion operation as the head element. This is illustrated below:[8]

(3) (a) v^0 fused as a head: $(A^+.\underline{v}^0)^0$ or $0 - 2 = -2$
(b) v^0 fused as an operator: $(v^0.\underline{A}^+)$ or $2 - 0 = 2$

Like zero in the minus operation v^0 is the identity of the fusion operation. The identity element is a member of the set of elements (just as zero is a number), but is assigned special properties. In a phonological expression the identity element is like any other element if we fuse it on the right (3a) (recall that in GP heads are by convention the right most element in phonological expressions), as the output is

[7] The utilisation of subtraction in illustrating the asymmetrical fusion operation was suggested to me by Sean Jensen.

[8] Notice that in this illustration, in the phonological expression, the head is the rightmost element (underlined). In the minus operation, the 'head' is (by convention), the leftmost number.

different from the input. If we fuse v^0 on the left (3b), the input and output of fusion remain the same.[9]

To summarise so far, v^0 plays a crucial role in the fusion operation in KLV (1985), as phonological expressions are defined by fusion, which demands (at least) two arguments.

3.3.2 Revised Fusion and Headship[10]

The numerous anomalous properties of the element *v* support the view that the identity element should not be assigned a symbol, and regarded as an element. However, given its role as identity element in the fusion operation, this revision entails the reformulation of the way phonological expressions are defined.

As has been illustrated above, fusion is defined as an asymmetrical operation, with a head and operator(s) as inputs to this operation. In Revised GP, the notion of the asymmetrical *relation* between heads and the operators they license is retained, but the fusion operation as it is understood in Standard GP is lost, as indeed it must be with the disappearance of the cold vowel. In Revised GP, a phonological expression is not defined in terms of fusion, but in the spirit of the KLV (1990) statement already mentioned:

(5) **A Phonological Expression in Revised GP (Kaye 1993b)**
A phonological expression has zero to 1 head, and *n* number of operators, where $0 \leq n \leq$ number of elements

This new definition above makes headship independent of fusion, which must now be viewed as simply indicating a relation between elements.[11] Notice that as a

[9] In order to reflect the identity property of v^0, in Standard GP, by convention, v^0 is only shown in a phonological expression representation in the head position. Thus, for example, $(v^0.\underline{A}^+)^+$ is given as $(\underline{A}^+)^+$.

[10] Thanks are again due to Sean Jensen for help with defining headship, fusion and phonological expressions in Revised GP.

[11] In a complex expression, the term *head* denotes the element which is the licensor of the other element(s) in the expression. This is made explicit in the language with licensing constraints such as *I licenses no operators*. In Revised GP, a simplex expression can also be headed, e.g. ($\underline{I}$). This indicates its potential as an element licensor.

phonological expression may have zero to 1 head, not all expressions have to have heads as in Standard GP. Given a universal set of elements, {α, β, γ,...}, a phonological expression is simply any subset of this. Without considering headship then, a phonological expression is essentially an unordered set {α, β}, {α}, {α, β, γ}, and so on. Where there is a headship relation within the phonological expression, headship is expressible as follows: {α, {β, γ}}, where α, β and γ are non-identical, and α, β and γ are members of the set of elements. In this illustration, α is the head, and happens to be placed on the left. 'Fusion' is no longer an operator, but a term used to refer to the comma ',' in the set notation.

Given the way Revised GP defines phonological expressions, there is no longer a formal role for the identity element as there is no asymmetrical operation for it to identify, in the sense that not every expression is composed of a head and an operator. The headless expression (A.I) is well-formed. v^0 can then be safely excluded from the notation. Furthermore, as the set of all possible subsets of the set of elements includes the empty set { }, the empty expression ( ), i.e. nothing, is automatically generated for all languages. ( ) can be usefully employed in explaining phonological phenomena, without the disadvantages that employing $(\underline{v}^0)^0$ brings.[12]

To summarise so far, phonological expressions in Revised GP are redefined to exclude the cold vowel. Phonological expressions can now be characterised as headed (e.g. (A.$\underline{\text{I}}$)), headless (e.g. (A.I)), simple (e.g. ($\underline{\text{I}}$), or (I)), and complex (e.g. (A.$\underline{\text{I}}$), or (A.I)).[13]

3.4 Theoretical and Empirical Issues

Direct comparison of the way Standard GP and Revised GP define well-formed phonological expressions, in terms of both theoretical and empirical issues is discussed below.

[12] Conventionally, ( ) 'nothing' is not indicated in GP. It can be lexically generated (e.g. in lexically empty nuclear positions), or be phonologically yielded from the decomposition of an expression.

[13] It is more straightforward to continue with the notation of Standard GP. The 'fusion operator' '.' of Standard GP is used in Revised GP as the notational equivalent of ','. As usual, '_' indicates the head which is, by convention, on the right in an expression.

3.4.1 Theoretical Issues

First, it can be seen that in terms of generative power, the two are equivalent. The Standard GP version (6b)[14] and the Revised GP version (6a) both generate exactly the same number of phonological expressions, as illustrated below.

(6) (a) All possible expressions in Revised GP

$(\underline{\mathrm{I}})$	$(\mathrm{I}.\underline{\mathrm{A}})$	$(\mathrm{A}.\underline{\mathrm{I}})$	$(\mathrm{A}.\underline{\mathrm{U}})$	(I)	(I.A)	(I.A.U)
$(\underline{\mathrm{A}})$	$(\mathrm{U}.\underline{\mathrm{A}})$	$(\mathrm{U}.\underline{\mathrm{I}})$	$(\mathrm{I}.\underline{\mathrm{U}})$	(A)	(I.U)	( )
$(\underline{\mathrm{U}})$	$(\mathrm{I.U}.\underline{\mathrm{A}})$	$(\mathrm{A.U}.\underline{\mathrm{I}})$	$(\mathrm{A.I}.\underline{\mathrm{U}})$	(U)	(U.A)	

(b) All possible expressions with a cold vowel.

$(\underline{\mathrm{I}})$	$(\mathrm{I}.\underline{\mathrm{A}})$	$(\mathrm{A}.\underline{\mathrm{I}})$	$(\mathrm{A}.\underline{\mathrm{U}})$	$(\mathrm{I}.\underline{\mathrm{v}})$	$(\mathrm{I.A}.\underline{\mathrm{v}})$	$(\mathrm{I.A.U}.\underline{\mathrm{v}})$
$(\underline{\mathrm{A}})$	$(\mathrm{U}.\underline{\mathrm{A}})$	$(\mathrm{U}.\underline{\mathrm{I}})$	$(\mathrm{I}.\underline{\mathrm{U}})$	$(\mathrm{A}.\underline{\mathrm{v}})$	$(\mathrm{I.U}.\underline{\mathrm{v}})$	$(\underline{\mathrm{v}})$
$(\underline{\mathrm{U}})$	$(\mathrm{I.U}.\underline{\mathrm{A}})$	$(\mathrm{A.U}.\underline{\mathrm{I}})$	$(\mathrm{A.I}.\underline{\mathrm{U}})$	$(\mathrm{U}.\underline{\mathrm{v}})$	$(\mathrm{U.A}.\underline{\mathrm{v}})$	

The two systems are then formally equivalent.

From a theory internal point of view, only the Revised GP version is capable of interacting with a theory of licensing constraints. Recall in chapter 2 the set of theoretical possibilities for the parameter pool of licensing constraints. If there is empirical evidence for the generalised licensing constraints of (21'), then constraints such as *elements cannot be heads* cannot be 'bolted on' to the Standard GP theory of the well-formedness of phonological expressions in which all expressions have a head and operator(s). Granted, without an identity element, it is necessary to have in principle two types of licensing constraint: constraints which refer to specific elements and their behaviour, such as *X must be a head*, and those which refer to phonological expression well-formedness in a language, such as *operators must be licensed.* If one accepts the need for licensing constraints (see chapter 1), and retain the identity element, then there is no need to have any licensing constraints other than those which refer specifically to element behaviour. However, in Standard GP, we have to live with the fact that the identity element v^0 is a member of the set of elements. Unfortunately, the anomalous behaviour of the identity element would also

[14] I have heavily adapted 'Standard GP' here for clarity. Charm is not indicated, and only the four elements *A*, *I*, *U*, and *v* are considered, so that a comparison with Revised GP can be clearly illustrated.

manifest itself in the interaction of *v* with the licensing constraints. This is illustrated below:

(7) (a) *v* must be a head
(b) *v* cannot be a head
(c) *v* licenses no operators
(d) *v* licenses operators

With respect to *v* in fusion, licensing constraints (a) and (b) cannot be understood as *parameters* on element behaviour. In (a), if *v* is in an expression then it can only be a head. This is true for *all* languages as it is a formal property of the theory. (b) would never be found in a language, ruled out universally because of the property of *v*.[15] These kinds of universal statements cannot be made about any other element.

Another theoretical problem arising from the inclusion of v^0 in the set of elements comes from its usage in the absence of any 'real' element. In terms of tiers, v^0 occurs in the absence of an element on an element tier. It is assumed by Harris (1994a) that v^0 (@ in his terms) is latently present in *all* phonological expressions, its appearance inhibited by the occurrence of other element heads. Apart from the problem that it is only @ or v^0 which enjoys this property, this usage of v^0/@ as an 'in-fill' element in the absence of another element gives the property of *not being A*, *I* or *U*, theoretical status. This does not sit well with the notion that elements are privative, as *not being present* is then valued.

A related issue to the notion of v^0 being latently present in all expressions is one of the quality of the default vowel in languages. Harris (1994a) points out that a schwa-like auditory effect is the independent manifestation of the element @ (or v^0). Schwa-like vowels occur in contexts of vowel reduction such as positions of weak stress, harmonically recessive nuclei and so on. It is assumed that the latently present

[15] One might argue that (7a) might be employed in the generation of English short vowels (characterised by being *v*-headed), and (7b) would generate English long vowels (characterised by being *I*, *U* or *A* headed, i.e. non-*v*-headed). A Northern English vowel system is discussed in 3.6 of this chapter. Unfortunately, (7a), in conjunction with *I/U/A cannot be a head* would also generate the expression ($\underline{v}$) - one expression too many for the five- vowel system. Also, (7b) in conjunction with *I/U/A must be a head* would generate the expression (v) in the long vowel system, for which there is no evidence.

@ manifests itself when other elements in these positions are suppressed. However, Harris also notes that in these contexts, many languages display a vocalic reflex other than schwa, for example *e* in Spanish, *i* in Japanese and *u* in Telugu. These are termed default vowels. "The appearance of a default element may be viewed as reflecting a language-specific quality that is latently omnipresent in representations."(Harris 1994a). Given this view, it is difficult to understand why some languages should opt not to employ the omnipresent neutral @/v^0.

In Revised GP 'default vowels' can be less arbitrarily referred to as simply the interpretation of the empty expression ( ). Some languages need no elements for this purpose: schwa[16] is the sound of nothing. Other languages use elements to interpret the empty expression.[17]

To summarise so far, although Standard GP and Revised GP generate the same number of elements, Standard GP suffers from a number of disadvantages - it cannot interact with a theory of licensing constraints, it values the absence of elements, and cannot theoretically unify 'default vowels'.

3.4.2 Empirical Consequences

So far we have seen that the two ways of defining phonological expressions are essentially equal in their generative capacity. The Revised GP version has the advantage of being compatible with a theory of licensing constraints (which I consider to be independently justifiable (see 1.6.2). Furthermore, when the expectations these systems give of the phonological world are considered, there are indeed further arguments to support Revised GP.[18]

As a member of the set of elements, we have expectations of the behaviour of v^0 in phonological processes. The inclusion of v^0 in the set of elements predicts v^0 to characterise a 'natural class', just as the presence of *I* and the presence of *U* pick out

[16] This is not a formal entity. I use the term 'schwa' here to indicate a i/ə -like sound.

[17] Recall that Uyghur employs locally available elements . When none are available, however, *I* is used to interpret a non-p-licensed empty nucleus.

[18] I focus on the empirical consequences of not having a cold vowel with respect to vowel processes. However, the absence of the cold vowel in the expressions dominated by non-nuclear points also needs consideration. In Standard GP, v^0 is the head element in velars such as *g*, *k* and so on. For a discussion of non-nuclear expressions see Jensen (1994) and Ritter (1996).

'natural classes' in the Uyghur vowel harmony proposed in chapter 2. In the element spreading phenomena in Uyghur, *I* and *U* spread from head positions in expressions (in the case of *I* from operator positions as well) from left to right from the first nucleus in an 'unbounded' fashion. i.e. the process does not necessarily stop after a single nucleus has been affected.[19] Given the identity property of v^0 as an operator, this would only be manifested in the case of v^0 as a head. The prediction is then that we expect v^0 to also be involved in spreading in an 'unbounded' fashion from left to right. However, as far as I am aware, there is no phenomenon which would need to call on v^0-spreading from left to right in its description.

'-ATR harmony' processes are not unpredicted in a theory of elements if one of those elements is something like the cold vowel. Indeed, such a prediction is claimed to be borne out, manifested by '-ATR harmony' in Pasiego Spanish (Harris 1990b). Harris (1990b) provides a treatment of Pasiego, cited as a -ATR harmony language by McCarthy (1984), Vago (1988) and Hualde (1989), in terms of @-head alignment. Although Revised GP lacks the theoretical machinery to implicate '-ATR' in a phonological process, predicting its non-existence, the literature abounds with analyses of '-ATR harmony'. In addition to Pasiego, various languages are cited as manifesting '-ATR' or 'laxing' harmony: Yoruba and Wolof (Archangeli and Pulleyblank (1989)), Andalusian (Zubizarreta (1979), Clements (1980)), Chukchee (Kenstowicz (1979), Calabrese (1988)), and Turkana (Vago and Leder (1987), Noske (1996)). Revised GP is therefore challenged to explain the processes in these languages in another way.

Whether or not '-ATR' is a salient feature in a phonological theory has been the subject of some debate in the literature, and is a question highly relevant to analyses which attempt to explain the parameters of vowel variation and distribution. Calabrese (1988) uses [-ATR] spread to explain the vowel systems and processes of Chukchee. Goad (1993) on the other hand, in a privative feature framework, dispenses with [-ATR] but treats some of the [-ATR] cases with analyses which utilise

[19] The same phenomenon, but this time with *A*, can be seen in Harris' (1994b) analysis of Chichewa, Marten's (1996) analysis of Swahili, and van der Hulst's (1988) analysis of Chukchee. Whether or not *A* spreads at all in long distance harmony process is a debatable issue. This is taken up in chapter 6.

machinery also unavailable to the Government Phonologist: the feature [RTR] (for Turkana), and the independent height feature [low] (Yoruba and Wolof).

Van der Hulst (1990) also argues for the non-existence of [-ATR] (in fact, for the non-existence of ATR altogether). Van der Hulst re-analyses the [-ATR] cases of Nez Perce, and Chukchee in terms of the spreading of the 'segmental atom' |a|.

Proving something does not exist is a never ending task. In this thesis, I therefore simply take 'high profile' -ATR harmony cases from the literature and suggest how they may be treated. Turkana is discussed in chapter 4, Yoruba in chapter 5, and the treatment of the other so-called '-ATR harmonies' in Revised GP, without recourse to the cold vowel, is postponed to chapter 6.

So far, the empirical arguments in favour of a Revised GP version of phonological expressions have focused on the negative aspects of the empirical consequences of Standard GP. However, there is an expectation raised by the formulation of Revised GP which is fulfilled, lending further support. Phonological expressions may be additionally characterised by their head status, as some phonological expressions are headed whilst others are not. Is there a phonological process which makes reference to this characteristic of headedness? Kaye (1993b) proposes that 'ATR' distribution can be captured by headedness. 'ATR' distribution with respect to vowel length is discussed in 3.6. Kaye (1993b) and Walker (1995) in treatments of 'ATR harmonies' make crucial use of headed expressions in a h(ead)-licensing principle - a formal principle which together with licensing constraints, explains the distribution of headed ('ATR') expressions in a domain. This mechanism is fully illustrated in the following chapter (4).

3.5 The Element ɪ^+

Various arguments have been put forward in the GP literature in favour of removing ɪ^+ from the set of elements. This is not a position exclusive to GP. Van der Hulst (1990) also suggests the removal of ATR as an element, proposing that 'ATR' phenomena might be more suitably explained utilising the privative feature |i|. The role ɪ^+ plays in Standard GP is more fully explored, and arguments for its abolition are summarised below.

In Standard GP, Ɨ^+ plays a crucial role in explaining the distribution of 'ATR' or 'tense' vowels in two ways. First, as a privative element, when Ɨ^+ is fused in an expression, its presence is manifested by the 'ATRness' or 'tenseness' of a vowel. Secondly, the element bears positive charm, and therefore plays a crucial role in the theory of charm markedness in explaining the implications for vowel systems discussed in chapter 1. In this section the properties of the ATR element Ɨ^+ in Standard GP are reviewed, and arguments for its abandonment are put forward. I present Kaye's (1993b) proposal that the headed-headless distinction in GP can be harnessed to explain 'ATR' distribution.

As mentioned in the discussion of markedness in chapter 1, the phonological process of vowels becoming 'ATR' vowels is traditionally considered widespread, whereas vowels becoming 'ATRless' vowels is considered rare. Standard GP makes this a strong generalisation, by proposing 'ATR' to be a property represented by the element Ɨ^+. The element is positively charmed, and plays an important role in Charm theory in the evaluation of naturalness with respect to the distribution of Ɨ^+. In computing the charm value of an expression, Ɨ^+ always contributes its positive charm to the expression in which it is fused. Thus Ɨ^+ may never fuse with A^+ to form a complex expression as both elements are charmed and have the same charm value - a generalisation KLV (1985) assume to be empirically borne out.

Unfortunately, Ɨ^+ is another element with a number of unusual properties. First, it is the only element whose contribution to the make-up of a complex expression is constant: it can only be fused as an operator in a phonological expression, and always contributes its charm value. This is in contrast with for example A^+, which contributes its positive charm value when it is the head of an expression, but not when it is an operator (this is the general case for charm computations). Secondly, any expression in which Ɨ^+ is fused, is restricted to being associated to the skeletal point of a nucleus. Furthermore, in KLV (1985), it does not have its own labelled tier to reside on.

Other arguments have been put forward in the literature. Both Harris and Lindsey (1995) and Walker (1995) point out that with respect to speech recognition, Ɨ^+ (like v^0) does not have a characteristic pattern shape in the way *A*, *I* and *U* do. Another anomaly pointed out by Harris and Lindsey (1995) is that in terms of element *composition* (i.e. charm markedness considerations apart), the unmarked three-vowel system is *a-ɪ-ʊ*, which fails to tally with the empirical record[20]. This criticism only applies to a theory of elements without something like charm markedness as well (the presence of a charmless segment implies the presence of its charmed counterpart). However, this demonstrates that unless charm theory is incorporated in the theory, the arguments in favour of an 'ATR' element are weakened.

An approach which does not include an element ATR is van der Hulst's 'extended' Depedency Phonology. In this framework, ATR phenomena is captured by the atom |i|. Generally speaking, when a dependant in a segmental representation, |i| contributes the 'modificatory property' ATR.[21] Like Standard GP's Ɨ$^+$ element, van der Hulst's strategy goes some way towards capturing some types of data. However, certain characteristics of 'ATR' distribution (considered below) indicate that 'ATRness' is a property that should not captured in terms of elements or atoms.

Most importantly, Ɨ$^+$ distribution in general manifests certain characteristics which cannot be found when examining the distribution of other elements, providing another argument in favour of its abolition. First, consider some of the properties of element distribution already discussed. Leaving aside *A*[22], recall the element spreading harmonies in Uyghur discussed in chapter 2. In Uyghur, the occurrence of *I* in a non-initial nuclear position, and the occurrence of *U* in a non-initial nuclear position, depends on whether *I* or *U* are present in the initial nucleus. As there are no restrictions on which expressions of the language may occur initially, it can be concluded that the initial nucleus is the head of the harmonic domain. Element (*I* and *U*) 'long distance' spreading harmonies appear to universally take place from left to right, usually beginning from the first nucleus in the domain in which any lexical expression may appear (Kaye 1994).[23]

[20] Harris and Lindsey claim *a-i-u* to be the unmarked vowel system.

[21] See van der Hulst (1988, 1990) for details.

[22] It may also be the case that *A* does not spread in harmony processes in the same way as *I* and *U*. Arguments to support this generalisation are discussed in chapter 6.

[23] In making this kind of generalisation, one would have to consider vowel harmony processes in languages such as Djingili where *I* appears to spread 'long' distance' from right to left as the following example shows. In this language, it seems that *I*, *U* and *A* cannot fuse.

Now consider some of the properties of 'ATR' distribution. 'ATR' harmonies on the other hand, are not unidirectional. In many cases they occur from right to left, such as in Vata. However, they also occur from left to right as demonstrated in the discussion of Pulaar and Turkana in chapter 4.

Another important difference is that 'ATR' distribution is sensitive to constituent structure. This is manifested in three basic ways. First, there is a correlation between Ɨ^{-} distribution and nuclei involved in P^0 governing relations as follows:

(8)

```
  N
 / \
x   x
```

In Standard GP only expressions which are positively charmed may be associated to the governor positions in these structures (the leftmost point). Thus expressions which lack A^+ as a head, must contain Ɨ^{+} instead if they are to be associated to these governing points. English, for example manifests a correlation between vowel length and vowel quality with respect to 'ATRness', as do many other languages.[24]

Secondly, KLV (1990) note that vowels in closed syllables (the nuclear heads of branching rhyme structures) do not require positive charm, even when the charm parameter of the vowel system in question is switched on (manifested by vowels in other positions demanding the association of Ɨ^{+} (i.e. having to be 'tense')).

Finally, some languages manifest restrictions with respect to 'ATR' distribution in the final nuclear position of a word, and in the penultimate nuclear

---

masculine singular		*stative*		(source: van der Hulst and Smith (1985))
gala	+ ji	gilili	*branch*	

When the stative is affixed, the *i* in the suffix appears to spread into the stem. However, this example does not necessarily illustrate a case of long distance *I*-spreading from right to left. One could also propose something like the following. Suppose some conditions on the licensing of *A* are not in force in the stative form. *A* would delink in these circumstances, and the resulting empty expression is interpreted using the element *I*. The above is not a firm proposal for this language, rather, I aim to show that this type of data does not necessarily constitute an exception to Kaye's generalisation.

[24] Some other examples are found in Zulu (discussed in chapter 4), Punjabi (Bhatia (1993)), Nyangumata (Yallop (1982)), Tagalog (Schachter and Otanes (1972)), Hausa (Abraham (1959)) and Khasi (Roberts (1891)).

position. Basically, only the 'tense' vowels of languages manifesting this process can occur finally, whereas only the 'lax' vowels (if they are 'short') can occur before a final 'consonant'. The examples below are from Quebec French, the alternation illustrating the restriction:

(9) vide *to empty* (source: Charette (1994))
vɪd *(s)he empties*

Quebec French also manifests the second constituent structure context discussed above. Other languages manifesting these types of distributional restrictions include English, Spanish, Kota and Andalusian.[25]

To summarise so far, the element Ɨ$^{+}$ in Standard GP has been illustrated in having a number of unusual properties, setting it apart from other elements. In addition, it is noted that 'ATR' distribution manifests a number of characteristics which indicate that this characteristic might better captured in a way that does not involve an element.

3.6 Headed and Headless Expressions Capture 'ATR' Properties

Kaye (1993b) proposes that instead of capturing 'ATR' distribution by the interaction of the 'ATR' element Ɨ$^{-}$ with charm theory, given the anomalies outlined above, Ɨ$^{+}$ should be removed as an element. Instead, it is proposed that the data be captured by the interaction of the headed-headless characteristic, constituent structure, and licensing constraints. The validity of this claim with respect to vowel harmony systems is explored in chapters 4 and 5.

Here I present Kaye's illustration of the role of headedness in capturing 'ATR' distribution in 'long vowel' structures. (The other two contexts mentioned above are discussed in chapter 6). The relationship of vowel quality (expressible by the headed/headless status of an expression) and constituent structure (in this case, nuclear points in P^0 governing relations) is found in English, which employs short-long vocalic contrasts correlating to a difference in vowel quality. Take, for example,

[25] Relevant data is presented in chapter 6.

a Northern England dialect of English. In the examples below from Kaye (1994), the expressions associated to the non-branching nuclei are on the left, those associated to the branching, on the right.

(10)	(a) (I)	*bit*	(b) ($\underline{\text{I}}$)	*beat*
	(U)	*put*	($\underline{\text{U}}$)	*boot*
	(A)	*pat*	($\underline{\text{A}}$)	*father*
	(I.A)	*pet*	(A.$\underline{\text{I}}$)	*bait*
	(U.A)	*pot*	(A.$\underline{\text{U}}$)	*boat*
			(U.$\underline{\text{A}}$)	*bought*

The expressions on the right are headed in response to the structural demands of a branching nucleus. Headless expressions cannot be associated to points of the type in (8). This is essentially the spirit of Lowenstamm's (1986) Cold Headed Constraint, in which it is proposed that a cold headed expression may not be simultaneously associated to two skeletal points. If this type of data is explained with an element for 'ATRness' (and without Charm Theory), it would seem arbitrary that Ɨ$^+$ must be present in governing positions. However, expressed in terms of headedness, this property is expected. Nuclear constituent governing potential is expressed in terms of headship.

3.7 Summary

This chapter has evaluated a theory which employs a cold vowel, Standard GP (also the relevant parts of Harris' framework) in comparison with a theory which does not, Revised GP. Treating v^0 as a fully-fledged element has been shown to have many disadvantages. Excluding v^0 from the notation has meant revising the formulation of the well-formedness of phonological expressions, which has the advantage of interacting with a theory of licensing constraints, as well as improving the relationship of the theory to the world of language data in terms of (a) its explanatory power in predicting something not to occur (v^0 spreading from left to right, '-ATR' harmony), and (b) its explanatory power to explain a process ('ATR' distribution).

This chapter has also considered the element Ɨ$^+$. Like v^0, Ɨ$^+$ displays a number of properties which distinguish it from *A*, *I* and *U*. In particular, it is argued that

'ATR' distributional restrictions are fundamentally different in character from those involving *I* and *U* elements. These two points are used to motivate ɨ^{+} not being included in the set of elements. 'ATR' distribution in Revised GP is expressed in terms of the headedness of a phonological expression.

CHAPTER 4

HEAD LICENSING

4.1 Overview

So far I have explored the notions of licensing constraints (chapter 2) and headedness (chapter 3), and presented arguments for their inclusion in Revised GP. In this chapter I propose that the interaction of licensing constraints with the h(ead)-licensing principle which exploits the notion of headedness presented in chapter 3, can explain a range of data traditionally described as 'ATR harmony'.

I begin by presenting the h-licensing principle as it is proposed by Kaye (1993b), and applied to an 'ATR' harmony language, Vata, by Walker (1995). As h-licensing is a process of inter-nuclear licensing, I propose that the two universal 'metrical' (projection government) structures proposed by Kaye (1990a) for GP, are also manifested by h-licensing processes (4.2). I also propose that, as in other inter-nuclear processes such as proper government and stress assignment, directionality is parameterised.

It is noted that in 'ATR' harmonies, *a* (and not any other vowel) is the vowel which sometimes fails to manifest an 'ATR' counterpart. This may be attributed to the activation of a particular licensing constraint (Kaye (1993b)). In illustrating the role of licensing constraints in h-licensing, I compare the cases of Vata and Akan (4.3).

In 4.4, I take up the issue of the two inter-nuclear licensing structures and the parameter on direction. An analysis of Pulaar by Dunn (1989) couched in terms of Standard GP, presents evidence of 'ATR' harmony with different characteristics to those manifested by harmony processes in Akan and Vata, including evidence of parameterised directionality. In order to capture data of this type, as well as the Vata type, for which the h-licensing principle is originally proposed, I propose some modifications to the original h-licensing principle (4.5).

The variety of types of h-licensing predicted to occur by the parameter setting on direction and the choice of type inter-nuclear licensing is presented in 4.6 where I present analyses of Zulu, Sesotho and Turkana. I present analyses of these languages to demonstrate that the characteristics manifested by the Pulaar harmony are indeed widespread. In addition, I show how a Revised GP treatment of Zulu can provide a unified account of vowel distribution in that language. The Sesotho vowel system and harmony process is widely debated in the literature. I show how a Revised GP treatment can contribute to this debate.

Finally, I summarise the properties of h-licensing in terms of inter-nuclear licensing by comparing the process to other inter-nuclear processes such as proper government and stress/pitch accent assignment (4.7).

The chapter is summarised in 4.8.

4.2 H(ead)-Licensing

With the abandonment of the 'ATR' element Ɨ$^{+}$, 'ATR' harmony phenomena is explained by the interaction of a h(ead)-licensing mechanism and licensing constraints (proposed by Kaye (1993b) and applied to Vata by Walker (1995)). H-licensing is a formal principle which explains the distribution of headed ('ATR') expressions in nuclei in a domain, building on the notion that headed expressions may only be accommodated in h-licensed nuclei. In order to illustrate h-licensing, I summarise Walker's (1995) analysis of Vata.

4.2.1 H-licensing in Vata

In traditional terms, an 'ATR-harmony' language such as Vata has ten vowels which may be grouped into two sets: 'advanced' (*i u e o ʌ*), and 'retracted' (*ɪ ʊ ɛ ɔ a*). Well-formed words must be drawn exclusively from one set. Examples are provided below (Walker 1995: 107):

(1) (a)	menʌ	*nose*	(b) vɛda	*cheese*
	neflu	*ear*	kɔla	*turtle*

The same type of harmony process, 'ATR agreement', also takes place optionally between lexical domains. Walker (1995) proposes the process to be right-headed showing the process to be right headed.[1]

(2) (a)	ɔ ka	za	pi	he will cook food
	he fut	food	cook	
(b)	ɔ ka	zʌ	pi	
(c)	ɔ kʌ	zʌ	pi	
(d)	o kʌ	zʌ	pi	

The example above shows the optional leftward spreading of 'ATR-ness': all the examples above are well-formed. However, the process may not skip any vowels (c.f. * o ka zʌ pi). These types of examples also show the relationship between the vowels of the two sets. For example, *ɔ* alternates with *o*, and *a* with *ʌ* in the examples above.

The formal mechanism employed to explain the process is that of h-licensing, formalised by Kaye (1993b) and applied to Vata by Walker (1995). The formal definition of h-licensing is as follows:

(3) H-licensing:

(a) Domain final nuclear positions are h-licensed.
(b) A nuclear position is h-licensed if it is h-governed.
(c) α h-governs β if they are adjacent on the relevant projection, and α is an h-licensor.
(d) A nuclear position is an h-licensor if it is identified by a headed expression.
(e) The status of h-licensor is immutable.[2]
(f) h-licensing obeys strict cyclicity in the sense of Kean (1974: 179):
"...on any cycle A no cyclic rule may apply to material within a previous cycle B without making crucial use of material uniquely in A."[3]

[1] Directionality cannot be simply assumed from data of the type in (1). In Vata, suffixes also agree in 'ATRness'. However, Walker demonstrates how right-to-left directionality is nonetheless maintained. See Walker (1995, section 6) for details.

[2] The relevance of this condition is illustrated in 4.6.4.3

The effects of h-licensing are illustrated below as applied to Vata (adapted from Walker (1995)).

(4) neflu - *ear*

```
           ↓‾‾‾‾‾‾‾|        h-licensing
           N       N        P¹ level of nuclear projection
           |       |
      /  O N   O   N  \
      |  | |   |   |  |
  h   (  x x   x   x  )     P⁰
      \    |   |   |  /
         n (A.I) fl (U)
```

In Walker's analysis, certain lexical items are marked as headed domains. This notion of lexical marking combines with h-licensing as follows. Walker interprets the h-licensing principle as a function which takes as input sets of headless expressions and maps them onto sets of headed expressions. The potential for lexical domains to contain headed nuclear expressions is expressed in the lexicon by the lexical mark h, found to the left of the brackets in the structure above.[4] If the lexical entry does not bear this mark, nothing happens.

The mechanism works as follows. Point (3a) of the h-licensing package states that domain final nuclear positions are h-licensed (i.e. they can accommodate a headed expression). The leftmost nucleus in the illustration in (4) above is also h-licensed, not by virtue of (3a), but because it is h-governed (3b). The governing relationship is described as follows. The final nucleus is α in the relationship defined in (3c). As α, the final nucleus h-governs the preceding one β, as they are adjacent at the level of nuclear projection, and α is an h-licensor. Nuclear positions are h-licensors if they are (1) identified by headed nuclear expressions (3d), and (2) h-licensed. The final nucleus in the example above satisfies the requirements of α: it is h-licensed (3a), and it has a headed expression at its disposal, indicated by the lexical

[3] See Walker (1995) for a discussion of cyclicity effects.

[4] The h mark is to denote a headed domain and should not be confused with Stewart's (1967) use of the prosodic feature H inserted at the right edge of a harmonic span to indicate tongue root advancement.

h-mark. (U) is mapped to ($\underline{\text{U}}$). As the leftmost nucleus is h-governed, it too is h-licensed, and its potential as an h-licensor is realised by the mapping of (A.I) to (A.$\underline{\text{I}}$), although in this string there are no more leftward nuclei to h-license. The last two points of the h-licensing package are not relevant to the example above, and are not discussed here.

The lexical expressions for Vata are provided below, grouped into two sets. (5a) shows headless expressions, and (5b) the headed expressions permitted in domain final nuclei and in nuclei in local relationships with the domain final nucleus (as defined in (3)).

(5) Expressions for Vata

(a)	(I) *ɪ*	(b)	($\underline{\text{I}}$) *i*
	(U) *ʊ*		($\underline{\text{U}}$) *u*
	(A.I) *ɛ*		(A.$\underline{\text{I}}$) *e*
	(A.U) *ɔ*		(A.$\underline{\text{U}}$) *o*
	(A) *a*		( ) *ʌ*

Notice that in the expressions above, (A) is mapped to ( ) in h-licensing domains. Walker's arguments for this analysis are summarised as follows. Walker assumes that as a normal state of affairs, *A* cannot be a head in an expression, unless it is especially licensed to be so. She employs this notion to motivate the mapping of the headless compound expressions (A.I), and (A.U) to their headed counterparts (A.$\underline{\text{I}}$) and (A.$\underline{\text{U}}$), and not to (I.$\underline{\text{A}}$) and (U.$\underline{\text{A}}$). In order to maintain this conclusion, Walker claims that the headless simplex expression (A) cannot be mapped to a headed counterpart, which would be ($\underline{\text{A}}$). Instead, (A) is mapped to ( ) - the empty expression; i.e. *A* is unlicensed and therefore uninterpreted in headed domains. The empty expression is manifested as *ʌ*.

Walker offers two arguments to support the conclusion that *ʌ* is the h-licensed interpretation of the lexically headless expression (A). First, in a pronoun selection process in which stems select the headless expression corresponding to the final expression in the stem, stems ending in both *a* and *ʌ* select *a* (A). In this process both stems *kpʌ - bench* and *jla - lion*, select *a* as the pronoun.

Secondly, in plural forms an optional process known as 'raising' (Kaye 1982), in which a mid vowel is raised to a high vowel. In the plural formation process, the domain final nuclear expression of the singular noun is 'replaced' with an expression containing the element *I* - either (I̲) or (I) depending on the lexical marking of the stem. Raising takes place only when both the following conditions are met:

(i) The noun must be an h-marked lexical domain.
(ii) Both nuclear expressions in the singular noun form must lexically contain an A-element.

Walker offers the following examples:

(6)	singular noun	plural 1	plural 2	
	(a) vɛda	vɛdɪ	*vɪdɪ	*cheese*
	(b) neflu	nefli	*nifli	*ear*
	(c) golo	goli	guli	*mound*
	(d) menʌ	meni	mini	*nose*
	(e) tʌkwʌ	tʌkwi	-	*basket*

Examples (a) and (b) above show that both conditions must be in place for raising to take place. (c) provides an example of the raising process. The example in (d) also exhibits raising. Given condition (ii) above, for Walker this demonstrates that *ʌ* stems from an underlying (A). Walker's motivation for *ʌ* being the interpretation of nothing in Vata focuses on example (e). Walker assumes the 'raising' process to be one of *A* delinking. As the plural 2 formation does not allow an *A* to be identified with a domain internal nuclear position, then we expect *A* to delink, yielding ( ). However, as plural 2 formation is possible only in headed domains, where (in Walker's account), (A̲) cannot occur, we expect ( ) in any case. Either way, there can be no plural 2 form for (e), as distinct from the plural 1 form.

Finally, Walker notes that in cross-domain h-licensing, *ʌ* cannot h-govern a preceding nucleus (*nu kpʌ/nʊ kpʌ *I made a stool*). Walker suggests that cross domain h-licensing has stricter identity requirements of the nuclei involved. Specifically, in cases where there are expressions containing the element *A* identifying h-licensors, these nuclei can only h-govern if the h-governee is identified by a expression also containing the element *A*. If the expression identifying the h-licensor contains *A*, and that in the licensee does not, then h-licensing is blocked. As the nucleus containing *ʌ* ( ) cannot govern a nucleus without *A*, (i.e. *i* or *u*), Walker concludes *ʌ* ( ) to originate from the lexical expression (A).

To summarise so far, 'ATR' harmony in revised GP is captured by the notion of h-licensing, a form of inter-nuclear licensing, manifested by the characteristic of headedness in phonological expressions.

4.2.2 Projection Government

Walker (1995) does not explicitly discuss the details of the type of governing structure h-government manifests. It is, however, clear from the h-licensing principle in (3), and Walker's analysis of Vata, that h-licensing involves government at the level of nuclear projection. The way nuclei at the nuclear projection are licensed by the h-government relation is assumed by Walker (1995), Cobb (1995a), and Denwood (1995) to manifest the structure in (a) below.

```
(7)      N ←N  ←N      P1     nuclear projection
         |   |   |
       O N O N O N
       | | | | | |
       x x x x x x     P0
       | | | | | |
       x x x x x x
```

In the structure above, the final nucleus h-licenses the nucleus to its left by h-government. The middle nucleus, in turn, h-licenses the nucleus to *its* left, and so on, leftwards. The structure assumed to be manifested by h-licensing, above, is the same structure that is assumed by Harris (1994b) to be the one that is manifested in vowel harmony processes in which an expression which is not harmonised (does not alternate) blocks harmony (traditionally termed 'opacity'). The structure is illustrated below in (a). This is in contrast with cases of vowel harmony where a non-alternating expression is transparent, which Harris claims to be manifested by the structure on the right below (b):

(8) (a) Opacity (b) Transparency (Harris 1994b)

```
(a)                               (b)
                                  N^(n+1)→          N^(n+1)
                                  :                 :
N^n→    N^n→    N^n               N^n→     N^n      N^n
:       :       :                 :        :        :
N       N       N                 N        N        N
|       |       |                 |        |        |
x1      x2      x3                x1       x2       x3
|       |                         |        |
[E]     [ε]                       [E]      [ε]
```

Harris derives opacity and transparency by proposing that spreading harmony processes are referenced to one of the two structures above. In the illustrations above, [E] and [ε] are the same elements, but differ with respect to whether or not they occur as a head in the expression. In both structures, x_1 is licensor of the remaining two positions. (a) depicts opacity. In this case, the harmony process makes reference to a level of projection at which all nuclei are present. Because x_1 and x_2 are adjacent, and it is assumed that [E] cannot merge with [ε], the requirement of locality ensures [E] cannot spread to x_3.

There are, however, two disadvantages in assuming Harris' structure in (a) above, for h-licensing. First, it is so far proposed only for inter-nuclear licensing in vowel harmony processes. Secondly, the structure does not sit well with the general principles which govern the architecture of GP. Specifically, the x_2 in (a) above is both a governor and a governee. This is anomalous in a theory which has strict criteria for defining governors and governees. It is unlikely that a position can satisfy both roles. In metrical terms, for example, a single nucleus cannot be simultaneously both head and complement.[5]

In GP, Kaye (1990a) proposes two structures as manifestations of projection (inter-nuclear) government (the structure in (a) above is not one of the two). In contrast to P^0 government, projection government is neither strictly local nor strictly directional.

[5] In terms of my analysis presented here, opacity is a case of the interaction of licensing constraints, governing relations and projection. See section 4.3.

Kaye (1990a) follows the formalism of Halle and Vergnaud (1987), and proposes two possible governing configurations: unbounded (a), and bounded (b) structures.[6]

```
(9) (a)                            (b)
          N  ←           N         P^3
          |              |
          N    N   ←     N         P^2          N      ← N
          |    |         |                      |        |
          N    N    N←   N         P^1      N ←N     N  ←N
          |    |    |    |                  |   |    |   |
       O  N  O N  O N  O N               O  N O N  O N O N
       |  |  | |  | |  | |               |  | | |  | | | |
       x  x  x x  x x  x x         P^0   x  x x x  x x x x
```

In the unbounded structure in (a), there is only one instance of government, contracted at each level.[7] In the bounded structure (b), there is more than one governing relation at P^1. Projection governing relations may be established at levels higher than P^1, but are not necessarily driven by the same processes. For example, Charette (1991) illustrates projection government in French. Proper government (manifested by vowel-zero alternations) occurs at P^1, manifesting the structure in (9b)). Projection government at P^2 is driven by stress assignment (ultimately, the licensing principle).

The examples above happen to be right-headed, but this is not necessarily the case. The direction of projection government is determined by a parameter setting. The direction of government may vary not only in the nuclear processes language to language, but also from level to level of nuclear projection. One example is in

[6] I use the term 'bounded' here instead of the more traditional 'binary'. This makes sense given that all instances of government are binary in GP as they involve only one governor and one governee in each relation. Kaye (1990a) notes that Halle and Vergnaud admit ternary structures.

[7] Superficially, the structure in (9a) is that of Harris' transparency structure in (8b). (8b) illustrates 'skipping', whereby an intermediary vowel which appears to not undergo harmony does not block the path of harmony. However, in this thesis, (9a) could never illustrate 'skipping' as this would violate principles of licensing and projection. In the case of element-spreading vowel harmony, if two elements cannot fuse, the potential governee in the process is not licensed, and its nucleus is projected to the next level of nuclear projection, blocking the path of harmony. This is manifested, for example, in Uyghur, where *A* blocks the path of a spreading *U*. On this view, the notion 'transparency' cannot exist.

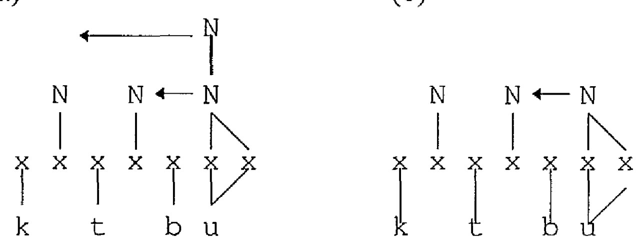
Yoshida's (1995) account of pitch accent in Japanese. Projection government is head-final at P^1, but head-initial at P^2.

The two structures are manifested in variety of phonological phenomena, for example stress, pitch accent and vowel-zero alternations. I illustrate Kaye's analysis of vowel-zero alternations in Moroccan Arabic here. This is explained by a type of projection government known as proper government (Kaye (1990a), KLV (1990)) which defines governing relations manifesting both types of structure above.

As well as the usual conditions for government, proper government has additional conditions as follows: (1) the governor must have phonetic content (which, when taken together with the Empty Category Principle (ECP) may be interpreted as, *the governor may not itself be p-licensed*). (2) the proper governor cannot govern across another governing domain.

Kaye (1990) illustrates two types of proper government, to explain vowel-zero alternations in two different dialects of Moroccan Arabic. In one, the proper government relation is contracted between nuclei in the fashion on the left above (see (a) below), and in the other, it is contracted according to the configuration on the right (see (b) below[8]).

(10) (a) (b)



ktbu: kitbu:

The choice of structures is not determined by the definition of proper government. Both are well-formed. The difference lies in that in (b), projection government is bounded.

Assuming that h-licensing is an instance of projection government at the level of nuclear projection, then it appears that the Vata case manifests the unbounded

[8] In the example in (10b), there happens to be only one governor in the string. In principle, in a longer string, more than one binary governing relation is possible.

structure. However, given the two types of licensing structures manifested by projection government above, a prediction is made. Like stress assignment, for example, h-licensing is expected to have a variety of manifestations. Specifically, we expect to find both bounded and unbounded h-licensing, both left-headed, and right-headed. So far, only the right-headed unbounded structure has been illustrated in Vata, but in the remainder of this chapter, I argue that the prediction is borne out.

To summarise so far, I propose that the h-licensing presented in section 4.2 does not manifest the type of structure proposed in Harris (1994b) in which the same nucleus is both a governor and a governee. Two other structures manifested by projection government proposed by Kaye (1990) are substantiated by phenomena such as accent assignment and vowel-zero alternations, and I propose that these are the appropriate licensing configurations for h-licensing.

4.3 The Interaction of Licensing Constraints and H-licensing

Before addressing the predictions made about the types of structures manifested by h-licensing, I turn to the issue of how licensing constraints interact with h-licensing. The significance of licensing constraints in constraining phonological expressions in h-licensing processes is illustrated by comparing two 'ATR' harmony languages, Vata and Akan. Generally speaking, Vata and Akan appear to manifest the same vowel harmony process: right-headed, unbounded, with a lexical marking system, and constrained by the licensing constraint *A cannot be a head*. However, I claim that the two languages differ with respect to their response to the licensing constraint A cannot be a head.

4.3.1 Vata

In Walker's (1995) analysis of Vata, *a* (A) is mapped to *ʌ* ( ). However, the examples in (1) and (2) show the expression *ʌ* ( ) to interact in h-licensing as expected, apparently identifying nuclear positions as h-licensors. Relevant examples are reproduced below:

(11) (a) menʌ *nose*

(b)	ɔ	ka	za	pi	he will cook food
	he	fut	food	cook	
	ɔ	ka	zʌ	pi	
	ɔ	kʌ	zʌ	pi	
	o	kʌ	zʌ	pi	

In both types of example above, *ʌ* takes part in the harmony process as expected, indicating that it might be a headed expression. Recall that Walker offers further arguments to support her claim that *a* (A) is mapped to *ʌ* ( ):

(i) In pronoun selection both stems *kpʌ* and *jla* select *a* as the pronoun.

(ii) In the plural formation process, 'raising' occurs in h-marked lexical domains if both nuclear expressions in the singular noun form must lexically contain an *A* (*golo*, *goli~guli*; *menʌ*, *meni~mini*; *tʌkwʌ*, *tʌkwi*).

(iii) In cross-domain h-licensing, *ʌ* patterns with *o* and *e*: Nuclei containing *A* cannot h-govern a preceding nucleus unless that nucleus also contains *A* (**nu kpʌ*/*nu kpʌ I made a stool*).

Walker's arguments based on the observations above, focus on demonstrating that, *ʌ* patterns with expressions containing *A*. However, these kinds of examples do not rule out the possibility of *ʌ* (<u>A</u>) as the headed counterpart of *a* (A). Assuming (<u>A</u>) to be the identity of *ʌ*, one could still maintain the generalisation that the three processes involve the element *A*.[9]

Given the discussion above, *ʌ* might be either ( ) or (<u>A</u>). The following licensing constraints are required to generate the system where *ʌ* is (<u>A</u>) (13a), and the system where *ʌ* is ( ) (13b):

(13) (a) I and U cannot co-occur[10]
and either... A licenses no operators
or... I licenses operators
U licenses operators
or... I cannot be licensed
U cannot be licensed

(b) I and U cannot co-occur
A cannot be a head

[9] A more detailed discussion of raising in Vata is provided in Chapter 5.

[10] This constraint is not one of the possible list of constraints presented in chapter 2. It seems, however, that it is needed for Vata to prevent the fusion of *I* and *U* in the same expression. I discuss this issue further in section 4.6.4.1.

In the constraints in (13a), I have suggested three possible ways of ruling out the A-headed complex expressions (I.A̲) and (U.A̲). All constraint types get the right results. Further analyses of different languages may reveal a generalisation. This question is set aside for the conclusions of this, and subsequent chapters. The essential difference between the two is that system generated by (13b) is constrained by *A cannot be a head*, whereas that in (a) is not.

In deciding which system of expressions to adopt, and ultimately which set of licensing constraints to propose, three further arguments are presented in favour of the system proposed by Walker (1995), generated by the set of constraints in (13b). First, Jonathan Kaye (personal communication) notes that ʌ does not sound like any kind of expression with the element *A* in it.

Secondly, if there were no constraint *A cannot be a head* to constrain the h-licensing principle, then the headless expressions (A.I) and (A.U) could be mapped to *either* (A.I̲) and (A.U̲) respectively, *or* (I.A̲) and (U.A̲) respectively. Walker (1995) points out that there is no evidence in the literature on Vata for this non-deterministic process, so *A cannot be a head* must occur. Admittedly, the other constraints in (13b), *I/U license operators* or *I/U cannot be licensed,* constrain the generation of A-headed expressions. However, constraints of this type which refer to the potential of elements to license other elements, or be licensed by them, may interact with h-licensing in different ways to constraints which refer to innate properties of elements in a language such as *A cannot be a head.* See 4.6.4.2 for a discussion of this point, and an illustration of it in Zulu.[11]

---

[11] An important question which arises from this discussion is whether or not there are languages which manifest 'ATR' harmony, but in which there is evidence for both (A) and (A̲). In principle, this is expected, since *A cannot be a head* is a parameter on *A* behaviour, and is therefore expected to be not active in some languages. However, as research in 'ATR' harmony has focused on West African languages which invariably manifest a lack of (A̲), we would need to look elsewhere for languages with (A̲) in their harmony systems. Ken Lodge suggested (in personal communication) that the Southern Nilotic language, Kalenjin, indeed manifests a full ten vowel system, with both (A) and (A̲). See Lodge (1995) for details. If this is the case, then the question of the differing roles of different types of licensing constraints must be addressed.

Finally, in addition to the 'ten-vowel' Vata presented here, another 'nine-vowel' varieties occur. In this 'nine-vowel' variety, Kaye (1981) demonstrates the in 'ATR' counterpart of *a* to be *e* for some speakers, and *o* for others. The 'nine-vowel' variety therefore clearly manifests the licensing constraint *A cannot be a head.* It is then desirable to treat the 'ten-vowel' variety in similar fashion, and not with a totally different analysis.

So far, I have argued in support of Walker's analysis of Vata, with *ʌ* ( ) occurring as the counterpart to *a* (A) in headed domains. If this is the case, then an important issue remains to be discussed. The empty expression ( ) appears to be an acceptable identifier of an h-licensor (c.f. *menʌ* - *nose*), a role defined by the property of being a headed expression, according to the h-licensing principle. Additionally, ( ) does not block the spread of harmony, as illustrated in forms such as *o kʌ zʌ pi* - *he will cook the food.* The empty expression does not have either a head or an operator. This being the case, it is impossible for us to predict how it will behave in a headed domain; i.e. whether it will pattern with the headed expressions or the headless ones in the harmony process. In Vata, it seems that the empty expression patterns with the headed group in identifying harmonising nuclei. This parallels the harmony process in Uyghur, where empty nuclei also play their part in the harmony process (see chapter 2).

To summarise so far, I have argued for Walker's vowel system for Vata with ( ) as the headed domain counterpart to (A). The generation of expressions is constrained by the licensing constraint *A cannot be a head.*

4.3.2 Akan

Akan manifests a similar harmony process to Vata. As in Vata, the vowels of words are drawn from either the headless set of expressions, or the headed, indicating that the lexical h-mark mechanism is active. Unbounded h-licensing takes place, constrained by the licensing constraint *A cannot be a head.*

Considering Akan, Backley (1995) identifies a vowel, which he transcribes as *ɜ*, as the 'ATR' counterpart of *a* based on its distributional properties. *ɜ* is found to the exclusion of *a* preceding high and mid 'ATR' vowels *i e u o* (headed expressions in Revised GP terms), as the examples below illustrate[12]:

(14)	yɜfunu	*belly*
	pɜtri	*slip*
	prɜko	*pig*

Not only does *ɜ* occur to the exclusion of *a* in domains lexically marked as headed, but it also appears to 'block' leftward h-government, as the examples below show.

(15) nɪnsɜm(u)	*in his hands*
wʊbɛpɜtri	*you will slip*

The examples above shows a headless vowel occurring to the left of *ɜ* in what is expected to be a domain marked for headed expressions. Backley notes this opacity to be the general case, and concludes that *ɜ* is the interpretation of an empty nuclear position. I concur with this conclusion, and propose that the licensing constraint *A cannot be a head* interacts with h-licensing as follows:

[12] I tested the examples cited in Backley (1995), with a native speaker. The forms provided here differ slightly from those in Backley as follows:

	Cobb	Backley	
	pɜtri/patri	pɜtiri	*slip*
	prɜko/prako	pɪrɜko	*pig*

Other examples here come from Stewart (1967), Clements (1981), again, tested with a native speaker. With respect to the data, two points need raising here. First, it seems that for the speaker consulted for this thesis, (empty) nuclei are licensed when flanked by certain pairs of onsets (e.g. *pɜtri - slip*), suggesting an inter-onset government domain (see Heo (1995) for details of empty categories and onset government). However, I have not yet embarked on researching this phonological event in Akan. Forms such as *wakɜri - he has weighed it out*, immediately pose a challenge for such a hypothesis, and the problem is not yet well understood.

Secondly, the speaker varies in his pronunciation of words such as *pɜtri* and *prɜko*, sometimes pronouncing them as *patri* and *prako*. Phonologically, *ɜ* and *a* behave the same way in the harmony process - they are both opaque. I have used *ɜ* in the transcription of the examples here in order to be consistent with transcriptions in the literature.

(16)

```
         N     N     N          N
         |     |     |          |         h-licensing
         N     N     N /←       N         P¹ nuclear projection
         |     |     |          |
      O  N  O  N  O  N  O  N  O N
      |  |  |  |  |  |  |  |  | |
  h   x  x  x  x  x  x  x  x  x x         P⁰
      |  |  |  |  |  +  |     | |
      w (U) b (A.I) p (A) t   r (I) 13
      wʊbɛpɜtri - you will slip
```

In the example above, the domain is marked as headed, and the final nucleus is a legitimate h-licensor, being both h-licensed (by virtue of being final) and identified by a headed expression. Accordingly, the preceding nucleus may be h-governed, but as the derivation is constrained by the licensing constraint *A cannot be a head*, (A) cannot be mapped to ($\underline{\text{A}}$), and the element is not interpreted. The empty expression is interpreted as *ɜ*. In contrast with Vata, the empty nucleus, containing an expression with neither a head nor an operator, is not h-licensed. As such it is projected higher, and intervenes between the h-governor and other potential h-governees in the string. The h-licensing chain is broken, and headed expressions may not precede the empty expression.[14]

I propose the expressions for Akan are as follows (17), with the licensing constraints to generate them in (18):

(17) Expressions for Akan

(a)	(I) *ɪ*	(b)	($\underline{\text{I}}$) *i*
	(U) *ʊ*		($\underline{\text{U}}$) *u*
	(A.I) *ɛ*		(A.$\underline{\text{I}}$) *e*
	(A.U) *ɔ*		(A.$\underline{\text{U}}$) *o*
	(A) *a*		( ) *ɜ*

[13] The string contains a p-licensed empty nucleus. I do not propose details of the p-licensing conditions here. However, as it is p-licensed, it is not projected above the first projection, and does not interact with h-licensing.

[14] A problem arises with assuming that Vata *ʌ* and Akan *ɜ* are interpretations of empty nuclei. If this is the case, then their distribution is not expected to be restricted to headed domains. They are also expected to occur in non-headed words. I have no answer to this problem at present, and set it aside for future research.

(18) Licensing Constraints for Akan

I and U cannot co-occur
A cannot be a head

Vata and Akan are not the only language having 'ATR' harmony to manifest the restrictive licensing properties of the element *A*. The analyses of Zulu, Sesotho and Turkana presented later in this chapter, show similar asymmetry with respect to the behaviour of *a* (A). As licensing constraints are a closed class of element licensing parameters, the licensing constraint *A cannot be a head* captures why it is *A* in particular, and not any other element, that behaves this way in some languages in the h-licensing process.

However, Akan also manifests a characteristic which is not expected given the lexical head marking and h-licensing presented so far. There are words which have headed expressions, but *a* finally (see (a) below). As Backley (1995), Clements (1981) and Stewart (1967) note, *ɜ* does not occur *domain finally* in Akan whether or not the domain is an 'ATR' one:

(19)	(a) sika	*money*	(b) kasa	*speak*
	ŋkruma	*okra*	brɛwa	*old*

a can occur in final position, irrespective of a headed or headless domain. Backley assumes that *A* element in the expression (A) in the final position in an 'ATR' domain cannot delink to yield *ɜ* ( ), even though the conditions for delinking are met: an 'ATR' domain. He attributes this to the special status of the nucleus as domain final, which in Akan is not permitted to be empty. In GP terms, this would be expressed in terms of the parameter d*omain final empty nuclei are licensed* **not** being active in Akan. However, Backley is not specific as to why *ɜ* (in his terms, an expression containing the 'dummy' element @), cannot interpret the decomposed (A) expression (i.e. ( )) in final position, and I am not sure how his appeal to the special status of the final nucleus explains this.

The h-licensing account provided here can neither account for why the headless expression *a* (A) is found finally in an h-licensed domain, nor why *ɜ* ( ) is prohibited from the final position in h-licensed domains.[15] First, in the h-licensing definition, domain final nuclei are h-licensed, and this defines the starting point of the h-licensing mechanism. As h-licensors must be both h-licensed and idenitified by a headed expression, only headless expressions are predicted to precede *a* (A) in the final position. Secondly, we would have to appeal to some special condition, as Backley does, to explain why the final empty expression in a headed domain cannot be interpreted as *ɜ*. This aspect of the distribution of *ɜ* and *a* is reconsidered in the light of the revised version of h-licensing proposed in section 4.5.

To summarise so far, the definition of phonological expressions in Revised GP is exploited by the h-licensing principle which, together with lexical marking, determines vowel distribution with respect to headedness in what were traditionally termed 'ATR harmony' languages. H-licensing is constrained by the licensing constraints as shown by analyses of Vata and Akan.

4.4 The Two Structures of Projection Government: evidence from Pulaar

So far, we have seen how Kaye's proposal to exploit the head-headless distinction in the h-licensing principle captures 'ATR' harmony in Vata and Akan . In this section I present some data which appears to challenge the h-licensing principle as it is formulated in (3). 'ATR' harmony effects are found in Pulaar, which does not appear to have the lexical marking strategy employed for Vata. The harmony does not take place from the final nuclear position. In addition, the harmony is found both unbounded and bounded.

I discuss an analysis by Dunn (1989) of Pulaar showing the two metrical structures proposed by Halle and Vergnaud (1987) to be active in Pulaar harmony. Finally, I discuss the Pulaar data in terms of h-licensing, to highlight the types of revisions that h-licensing requires if it is to also capture data of this type.

[15] I consider this also to be a challenge for Walker's analysis of Vata. Even though in Vata, empty nuclei are capable of identifying h-licensors, Walker would nonetheless be unable to capture the difference between Vata and Akan.

4.4.1 Pulaar Vowel Distribution[16]

Dunn (1989) claims that the Pulaar vowel system is essentially *i u ɛ ɔ a*. In addition, *e* and *o* occur in the following context: preceding *i* and *u*. This is shown in the examples below.

(20)	ɗereeji	*pages*	nofru	*ears*
	ɗɛrɛwɔn	*little pages*	nɔfɔn	*little ears*
	peeci	*crack*		
	pɛɛcɔn	*little cracks*		

The examples below show that *o* and *e* do not occur to the right of *i* or *u*:

(21)	hinɛrɛ	*hinere	*nose*
	limsɛrɛ	*limsere	*second hand clothing*

i and *u* are concluded to be the conditioners of the harmony, which occurs from right to left. Further examples show the process to operate in an unbounded fashion:

(22)	kel	noo	mi	*(that) I'd broken*
	rad	preterit	1sg	
	kɛl	nɔɔ	dɔn	*(that) you broke*
	rad	preterit	2pl	
	hel	no	mi	*He had broken me*
	3sg	rad	preterit 1sg	
	hɛl	nɔ	ʔɔn	*He had broken you (pl)*
	3sg	rad	preterit 2pl	

Like in Akan, *a* exhibits special behaviour with respect to the vowel harmony process. *e/o* cannot be found preceding *a*. *a* does not alternate like the mid vowels preceding *i/u* (examples (a) below), and if it intervenes between *i/u* and a preceding *ɛ/ɔ*, it blocks harmony (examples (b) below):

[16] See also Paradis (1986) for a discussion of the harmony facts presented here. Paradis offers a similar treatment of the unbounded harmony discussed by Dunn. However, the bounded harmony analysis is, as far I as know, original to Dunn.

(23) (a)	rawaa ^{n}du ^{n}du	*the dog*	gallee ji ɗii	*the houses*
	jaw ɗi ɗii	*the sheep*	ʔallu wal ^{ɲ}gal	*the black board*

(b)	jeeɗiɗi	*seven*	o dogii	*he/it ran*
	jɛɛtati	*eight*	ɔ dɔgaani	*he/it didn't run*
	lootinɔɔma	*had washed*	o defii	*he/it prepared*
	lɔɔtanooki	*hadn't washed*	ɔ dɛfaani	*he/it didn't prepare*

Another context can be identified. *e* and *o* are found to the exclusion of *ɛ* or *ɔ* in a second context: immediately **to the right** of *i/u* in morphologically complex domains:

(24)	hir de rad inf	*be jealous*	sɛk dɛ rad inf	*be angry*
	huur de rad inf	*cover*	sɔɔd dɛ rad inf	*buy*
	ful ɓe rad class marker	*Pulaar*	wɔr ɓɛ rad class marker	*men*
	mi ɗo pro 1sg	*I*	hɔɔ rɛ rad class marker	*head*

Unlike the first context, the harmony process is bounded, as shown below:

(25)	suuɗ rad	otɔ imperf3	nɔ preterit	*was hiding*
	suuɗ rad	etɛ imperf3 passive	nɔ preterit	*was being hidden*

In both examples above, the radical *suuɗ* is assumed to contain the harmony trigger. In the imperfective 3 forms *otɔ* and *etɛ,* only the first vowel of the words are affected by harmony. The second vowel, and the vowel of the following word *nɔ* are not affected.

Dunn (1989) offers an analysis of the harmony facts presented above using a Standard GP approach.[17] Basically, Dunn claims that *e* and *o* result from their being governed by *i/u*. In Standard GP terms, the expressions for Pulaar are as follows:

(26) Pulaar Vocalic system (Dunn (1987a))

```
ATR              Ɨ+    Ɨ+                       Ɨ+    Ɨ+
                 |     |                        |     |
                 |     |                        |     |
back/round       I0---U0---I0---U0---v0---I0---U0
                 |     |    |     |     |    |     |
                 |     |    |     |     |    |     |
high             v0---v0---A+---A+---A+---A+---A+
                 |     |    |     |     |    |     |
                 |     |    |     |     |    |     |
                 x     x    x     x     x    x     x
                 |     |    |     |     |    |     |
                 |     |    |     |     |    |     |
                [i]+  [u]+ [ɛ]0  [ɔ]0  [a]+ [e]+  [o]+
```

The right-to-left unbounded vowel harmony is presented first. Dunn proposes that the vowel harmony is the manifestation of a relation of government at the level of nuclear projection. The governor in Pulaar is the element Ɨ^{+}, and the governees are the neutrally charmed segments *ɛ* and *ɔ*. Ɨ^{+} harmony is effected via the metrical structure constructed according to the algorithm below:

(27) i. construct feet on the nuclear projections
ii. direction: right to left
iii. dominance: right (head final: w s)
iv. type of feet: unbounded

The algorithm above builds the following type of tree[18]:

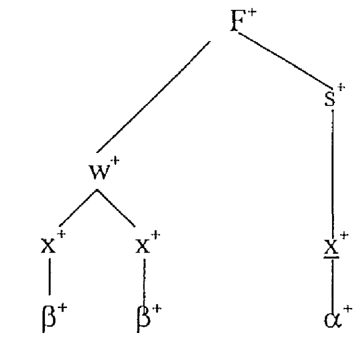
---

[17] I do not offer a detailed evaluation of Dunn's analysis. My intention is simply to present some of Dunn's insights with respect to 'ATR' harmony.

[18] Dunn does not claim that the weak node dominates a branching structure here, rather he supposes that the structure is subject to the OCP (Leben (1973)), thus

```
w  w                 w
|  |    becomes     / \
x  x               x   x
|  |               |   |
β  β               β   β
```

(28)



p e e c i *cracks*

α = governor (positively charmed segment with Ɨ$^+$

β = governee (segment of neutral charm)

The domain of government of the element Ɨ$^+$ is the foot. Ɨ$^+$ governs by 'feature percolation' as shown above.

The governing relation is subject to a condition of locality defined as follows:

(29) **Condition of Locality**

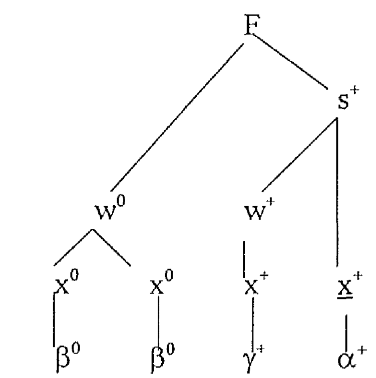
α locally governs β if α is adjacent to β. (α is a node *s*, β is a node *w)*

(α is adjacent to β iff there is no γ intermediary between α and β.)

The non-harmonisation of *a* follows from the interaction of the theory of charm with the theory of government: two expressions identically charmed cannot enter into a relation of government.

As for the reason why *a* blocks the harmony, this is explained structurally:

(30)



j ε ε t a t i *eight*

In the structure above, the head s^+ cannot locally govern the neutrally charmed node w^0 because it is not adjacent. Harmony would violate locality (the positively charmed w^+ node (*a/γ*) intervenes). This explains the opacity of *a* in the ATR harmony.

The second type of harmony exhibited by Pulaar also involves the spreading of Ɨ^+ via a metrical structure reflecting the contraction of a governing relation. The process differs from the one already outlined in three important respects: (1) it takes place from left to right; (2) it manifests a bounded structure; and (3) it is claimed to take place only in morphologically complex domains.

Further to the differences outlined above, the examples below highlight another crucial difference between the two harmony types. Notice in the examples below, the preterit marker *no* in (a) is harmonised by the preceding tense marker *ii*. However in (b) the preterit marker *nɔ* is not harmonised.

(31) (a) ɗoof ii no — *he had grabbed*
3sg rad tns preterit

(b) ɗoof ii nɔ bɛ — *he had grabbed them*
3pl

Dunn accounts for the harmonisation of *no* in (a), but the absence of harmony in (b) by suggesting that as only a vowel in the same *foot* as the harmoniser can be harmonised, feet are not only bounded, but are constructed from **right to left**. Dunn makes the prediction that if there are examples with one more nucleus in the string, the *o* will be harmonised. This is indeed the case.

(32) Abou su<u>uɗ ɔtɔ</u> — *Abou is hiding*
rad imperf3 Middle

kɔ Ali su<u>uɗ otɔɔ</u> — *It is Ali who hides*
imperf4 Middle

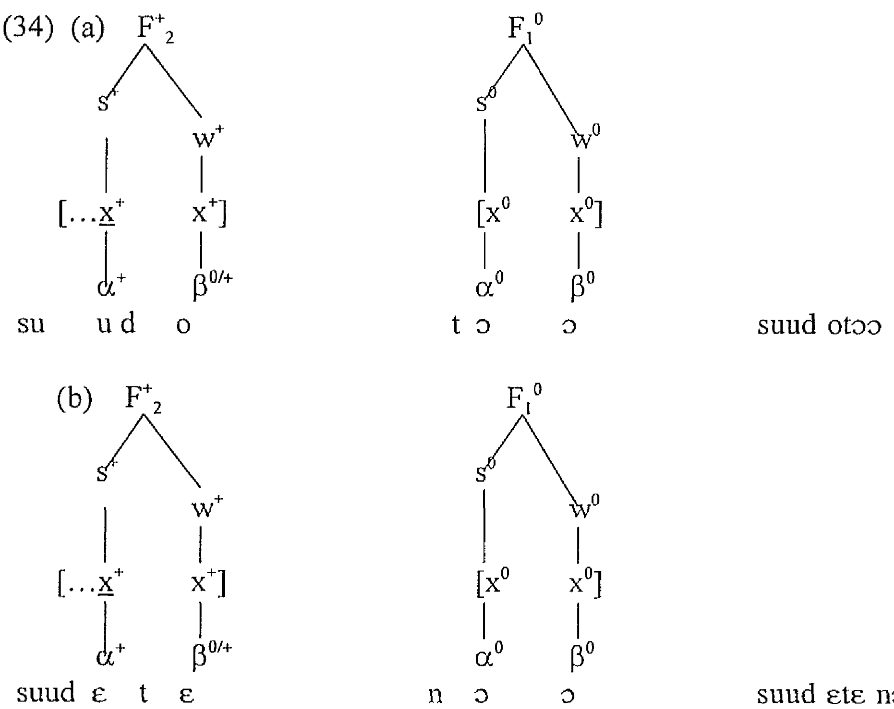
Abou su<u>uɗ etɛ nɔ</u> — *Abou was hiding*
imperf3 Passive

kɔ Abou su<u>uɗ ɛtɛ nɔɔ</u> — *It is Abou that we were hiding*
imperf4 Passive

To explain the different characteristics of the vowel harmony process manifested above, Dunn proposes that metrical structure in these cases is built according to the following algorithm.

(33) i. construct feet on the nuclear projections
ii. direction: right to left
iii. Dominance: left (head initial)
iv. type of feet: bound (binary)
v. sensitive to syllabic weight: yes. The weak branch cannot dominate a heavy rhyme. i.e. a rhyme which dominates two points of the skeleton.[19]

The algorithm produces the following bounded foot trees. The trees here also illustrate percolation:

(34)


In the illustration above, the nuclei are parsed into left headed bounded feet constructed from right to left. In the first example, as a result of the metrical parse, the governor *u* is in the same foot as the following mid vowel, which then receives the

[19] Dunn supposes the process to be senstive to syllabic weight, assuming branching nuclei, in which the complement may be a sonorant such as *n*. As nothing really hangs on this claim with respect to the basic harmony mechanism, I do not discuss the examples here.

percolated feature, $\underline{I}^{+}$. In the second example, however, the governor *u* does not belong to the same foot as the potential governee *ε*, and the conditions for harmony are not met.

To conclude so far, Dunn proposes a relation of government for right-to-left harmony which manifests the domain of an unbounded foot. The relation is subject to a condition of locality, and can structurally explain the opacity of *a*. As for the left-to-right harmony, Dunn shows that the relation of government is struck within a bounded foot.

4.4.2 Vata and Akan versus Pulaar: similarities and differences

In terms of h-licensing, the Pulaar harmony data manifests some similarities, and interesting differences when compared to the characteristics of Vata and Akan harmony.

In order to make a formal comparison, we must assume *i*, *u*, *e* and *o* to be headed expressions, and *ε*, *ɔ* and *a* to be headless expressions. Most strikingly, *headed complex* expressions in Pulaar are only found in nuclear positions which are adjacent to headed expressions (at the level of nuclear projection). Headless complex expressions cannot be found adjacent to headed expressions. This restricted distribution can be captured by the h-licensing of nuclear points via h-government described in points (b), (c),and (d) of the h-licensing principle in (3).

However, if we assume h-licensing to be active in Pulaar, certain differences between Pulaar on the one hand, and Vata and Akan on the other, with respect to the distribution of headed expressions, are also apparent. First, in Vata, headed expressions can only reside in nuclei licensed to accommodate them. This is achieved by point (a), *Domain final nuclei are h-licensed*, and by the h-governing relation defined by points (b), (c), and (d). By contrast, in Pulaar, the lexically headed expressions ($\underline{I}$) and ($\underline{U}$) do not reside in positions that are h-licensed in these ways. They may reside in nuclei preceding those containing headless expressions (i.e. not in h-licensed positions). However, if ($\underline{I}$) and ($\underline{U}$) are assumed to be h-licensors (αs) in terms of the h-governing relationship (assumed because headless complex expressions cannot precede them), then the fact that ($\underline{I}$)and ($\underline{U}$) do not reside in h-licensed positions as defined by the h-licensing principle, does not interfere with the governing potential of the nuclei dominating them. They are still able to govern.

Secondly, when considering the h-licensing principle as a whole, there is an asymmetry with respect to the two types of h-licensed positions (domain final, and h-governed), manifested by the behaviour of the complex headless expressions (A.U) and (A.I). In Pulaar, when these expressions are associated to nuclei which are βs (positions h-licensed because they are h-governed), they become headed expressions, and identify h-licensors. However, when the same headless expressions are associated to domain final h-licensed positions, they do not become headed (e.g. *hinɛrɛ*). The headed complex expressions in Pulaar seem only to be able to be headed in sites licensed to accommodate headed expressions, and of the two sites identified by the h-licensing principle, only β seems active in Pulaar.

To summarise, in Pulaar, headed complex expressions are found only preceding/following lexically headed expressions, and the relationship of h-government can capture this distribution. However, when compared with the analyses of Vata and Akan, Pulaar manifests certain differences. Lexically headed expressions do not have to reside in positions h-licensed by the h-licensing principle, whereas lexically headless expressions which are licensed by h-government do. Lexically headless complex expressions are headed only by being in local relationships with h-governors. In addition, headed complex expressions are not found in domain final positions. Finally, in one case, h-government is bounded.

4.5 H-Licensing in Pulaar

In this section, I attempt to reanalyse Pulaar vowel harmony in Revised GP terms, and develop a refined version of the h-licensing principle, using Dunn's insights regarding harmony in Pulaar, and drawing on proposals pertinent to governing relations set out in Kaye (1990a) and KLV (1990). Finally I argue (4.5.1) that this refined version can not only capture Pulaar type harmony more succinctly than the Standard GP analysis, but it can also capture the 'full blown' harmony manifested by Vata and Akan.

Dunn claims that the domain of 'ATR' harmony is the foot, which is to effectively say that it is an instance of projection government. In these terms, the

Pulaar right-to-left unbounded harmony manifests a right headed structure of the type in (9a). In the harmony process, the harmonic head, a nucleus with governing potential, projection governs a nucleus which is a potential governee.

In the spirit of Dunn and KLV (1990), who claim governors to be identified by charm (+/-), and governees to be identified by charmlessness, I follow Kaye (1993b) in assuming headed expressions to identify nuclear governors in the h-licensing process. Furthermore, I claim headless expressions to identify governees. I propose the lexical vowel system for Pulaar to be the following:

(35) headed expressions (identify nuclear governors): ($\underline{\text{I}}$) *i*, ($\underline{\text{U}}$) *u*
headless expressions (identify nuclear governees: (I.A) *ɛ*, (A.U) *ɔ*, (A) *a*

Leaving aside the issue that point (a) of the h-licensing principle (domain final nuclei are h-licensed) is ignored by Pulaar, let us focus on the h-government relation defined by points (b), (c) and (d). I propose that the properties of governors and governees outlined above, combine with the h-government relationship of the h-licensing principle which I have revised below[20]:

(36) **H-government**:
(a) α h-governs β if they are adjacent on the relevant projection, and α is an h-governor[21]; β is a governee. **(adapted from (3c))**
(b) A nuclear position is an h-governor if it is identified by a headed expression. A nuclear position is a governee if it is identified by a headless expression. **(adapted from (3d))**
(c) α is not itself h-governed. **(new proposal)**

The first two conditions on h-government simply state what has already been discussed. (a) is Kaye's definition of the governing relation, (b) is the conditions on the identity of the players. The third condition (c) is placed to prevent the

[20] I am not suggesting that the entire h-licensing principle in (3) be replaced with the h-government definition presented here. This h-government description is intended as part of the h-licensing package, which is discussed as a whole in the following section.

[21] I use the term h-governor here, instead of Kaye's h-licensor for purposes of clarity. In the discussion here, nuclei are h-licensed by h-government, so the term licensor is not distinct from governor. Since this part of the h-licensing principle refers to h-government, it makes sense to refer to h-licensors as h-governors.

construction of the unnecessary structure in (8a) - the inter-nuclear licensing configuration in which a nucleus is simultaneously a governor and a governee. In fact, (c) may well be a universal condition on projection government. It is proposed by KLV (1990) as a condition on proper government, and makes explicit the observation that a governor makes an unlikely governee.

The unbounded type of vowel harmony in Pulaar manifests two parameter choices: it is right headed, and unbounded. The derivation is below:

(37)

```
     Nβ              ←              Nα        P3
     |                              |
     Nβ     Nβ           ←          Nα        P2
     |      |                       |
     Nβ     Nβ          Nβ   ←      Nα P1
     |      |           |           |
   O N   O  N   O N O   N    O      N
     |   |  |   | | |   |    |      |
     x   x  x   x x x   x    x      x         P0
     |   |  |   |   |   |    |      |
  (A.U) h(A.I)l     n(A.U)   m     (I)
     o    hel        no      mi
```

At each level of the nuclear projection the conditions for h-government are met. At each level, the final nucleus is α, identified by the headed expression (I), and is not itself h-governed. The governees at each level of projection are βs because the nuclei in question contain lexically headless expressions. α and β are adjacent at the relevant projection.

The opacity of *a* can easily be explained assuming the licensing constraint *A cannot be a head* to be operative, interacting with inter-nuclear licensing by h-government.[22] This is illustrated below.

[22] I do not discuss which licensing constraints are required to generate the Pulaar vowel system in general. Zulu has essentially the same system, and a discussion of the necessary licensing constraints is postponed to section 4.6.4.1.

(38)

```
          N         N       N     Nα  P2
          |         |       |     |
          Nβ        Nβ      Nβ/<-Nα   P1
          |         |       |     |
     O    N    O    N    O  N  O  N
     |    |    |    |    |  |  |  |
     x    x    x    x    x  x  x  x   P0
     |    |         |    |  |  |  |
     j(A.I)    (A.I)t(A)t(I)
     jɛɛtati
```

In the structure above, (A) *a* superficially fulfils the role of identifying a governee. α is an h-governor, and α and β are adjacent at P^1. However, government fails to take place because, as in Akan, I propose the licensing constraint *A cannot be a head* constrains h-government. As h-government fails, the nucleus containing (A) is not licensed, and as such, it is projected to the next level. α cannot h-govern β at projection P^2 as the two nuclei are not adjacent: the unlicensed nucleus containing (A) intervenes.[23]

The left to right bounded harmony can be basically explained in the same way as the right to left unbounded harmony. The h-government relationship is the same, however, in this instance h-government is not only bounded, but appears to utilise metrical structure (i.e. inter-nuclear relations) independently constructed.[24] The h-governing relations are sensitive to local binary inter-nuclear relations contracted from the right edge of the string. The inter-nuclear licensing arrangement for these forms is illustrated below:

[23] The outcome of the h-licensing derivation with respect to (A) in Pulaar in different to that of Akan. In Pulaar, *A* cannot be a head, and its interpretation remains *a* (A). In Akan, in the same context, *A* delinks, yielding an empty expression, interpreted as *ɜ*. This is another example of variation with respect to the outcome of identical derivations. See chapter 2, footnote 5 for further examples.

[24] I do not know if this inter-nuclear licensing configuration is constructed for an independent purpose such as accent assignment. Dunn (1989) claims that it is not assigned for stress purposes, but offers no other reason.

(39) (a) (b)

```
(a)
     Nα   →/    Nβ
     |          |
     N→ N       N   →  N
     |  |       |      |
O N  O  N  O  NON   O  N
| |  |  |  |  | |   |  |
x x  x  x  x  x x   x  x
| |     |  |    |   |  |
s(U)   (U)d  (A.U)t(A.U)
suud ɔtɔ

(b)
P2          Nα  →/         Nβ
            |              |
P1      N   Nα  →Nβ        N  →  N
        |   |    |         |     |
      O N  ON O  N    O    N  O  N
      | |  || |  |    |    |  |  |
P0    x x  xx x  x    x    x  x  x
      | |   | |  |    |    |     |
      s(U) (U)d(A.U)t(A.U)    (A.U)
         suud otɔɔ
```

In (a) above, left-headed binary inter-nuclear licensing relations are established from the right edge at P^1. No h-government relation can be established as no pair satisfies the identity requirements of α and β. At P^2 the projected nuclei satisfy α and β requirements but an h-government relationship cannot be established at any level higher than P^1 as the process is bounded. In (b) above, inter-nuclear licensing relations as for (a) are established at P^1. The leftmost pair satisfy the identity requirements of α and β, and h-government takes place. The second pair are not α and β so no government takes place. H-government at P^2 cannot occur as the process is bounded.

Treating vowel harmony in terms of h-licensing has a distinct advantage over harmony in terms of projection government involving $Ɨ^+$. Dunn's analysis rests on the notion that charmed expressions have governing properties, accounting for the fact that expressions with $Ɨ^+$ are governors. This being the case, Dunn cannot explain why the expression *a* $(\underline{A}^+)^+$ is not involved in government in the same way. In terms of h-licensing, however, *a* (A) is a lexically headless expression, and lacks the headed property required of h-governors.

To summarise, Pulaar appears to display examples of unbounded h-licensing, operating from right to left, and bounded from left to right which is sensitive to independently constructed metrical feet. H-licensing is constrained by the licensing constraint *A cannot be a head.* If we follow Dunn's assumptions about morphological complexity (the relationship of phonological domain to phonological domain), then it seems that the Pulaar harmony process treats the preterit phrases in (22) in the same way as the words in (20) and (21) - as morphologically simplex. Dunn claims that the left to right bounded h-licensing only takes place in morphologically complex phrases. The process then treats the phrases in (25), for example as manifesting complex domains.

4.5.1 Modifying H-Licensing

I have shown how a more specifically defined relation of h-government can explain 'ATR' harmony data in Pulaar. In this section, I examine the h-licensing principle as a whole, and propose a modified version which can capture both Pulaar-style harmony, and the 'full-blown' harmony as manifested by Vata. Recall that harmony in Vata is captured by a combination of a lexical marking system with the h-licensing principle. As I propose modifying h-licensing, the effects of this have to be examined in terms of the interaction of h-licensing with the lexical marking system.

If we take the more explicit version of h-government proposed in (36), and insert it into the original h-licensing principle in (3) we have the following (my revisions are bolded):

(40) **Modified H-Licensing (version 1)**

(a) Domain final nuclear positions are h-licensed.
(b) A nuclear position is h-licensed if it is h-governed.
(c) α h-governs β if they are adjacent on the relevant projection, and α is **an h-governor; β is a governee.**
(d) A nuclear position is an h-governor if it is identified by a headed expression. **A nuclear position is a governee if it is identified by a headless expression.**
(e) α is not itself h-governed.
(f) The status of h-governor is immutable.
(g) h-government obeys strict cyclicity in the sense of Kean (1974: 179):
"...on any cycle A no cyclic rule may apply to material within a previous cycle B without making crucial use of material uniquely in A."

I begin by discussing point (a) above, *domain final nuclei are h-licensed.* In the Vata harmony process, this point serves two purposes. It identifies the location of the h-licensor (h-governor), and it determines the right to left direction of the process. Recall, however, that in capturing the Pulaar harmony, point (a) never comes into play. In Pulaar, the h-licensor (h-governor) in the harmony process is not restricted to domain final position. In addition, Pulaar manifests harmony from both left to right, and right to left.

If the original point (a) (domain final nuclei are h-licensed) were absent, could the modified version capture the effect that the harmony begins at the right edge of the string for languages like Vata? I argue that it can. Languages like Akan and Vata may be understood as having h-licensing propagated by a right-headed unbounded structure. Point (e) (α is not itself h-governed) above plays a crucial role. It has the effect of ensuring that h-governors of a lexically marked domain in these languages, will be found only at *domain edges*, initial or final (depending on the direction of the harmony), as this is the only site which cannot be governed.

This immediately makes a prediction. If direction of harmony, and the position of the h-licensor is derivable from general principles and parameters on projection government, combined with the h-licensing principle (and the lexical marking system), the left-headed parameter setting on direction is expected to be found. That is to say, we expect to find a left-headed version of Vata and Akan. Later in this chapter, I present evidence from Turkana (an Eastern Nilotic language) to support that this is indeed the case. With respect to its harmony characteristics, Turkana appears to be a 'left-headed Akan'.[25]

Apart from being able to capture the Pulaar harmony, dropping (3a) (domain final nuclear positions are h-licensed) from the h-licensing definition has certain other advantages. Without (a) it is possible to account for the Akan harmony in which an *a* (A) can occur in final position even in an headed domain e.g. *sika* - *money* (referred to in section 4.3.2). Without (3a), the final position is not inherently h-licensed, and may accommodate an expression which is headless when the domain is marked for headed. Nor is the final position the only possible h-licensor (in Walker's terms, the first in the h-licensing chain). Thus h-licensing may take place from the penultimate nucleus in Akan headed domains. The reason only *a*, not *ɪ*, *ʊ*, *ɛ*, or *ɔ*, occurs finally in headed domains is explained by the licensing constraint *A cannot be a head*. The lexical h-mark is interpreted as something like 'use headed expressions'. The licensing constraint and the h-licensing principle condition the distribution of headed expressions. *a* (A) is the only expression without a headed counterpart.

[25] Denwood (1995) discusses the possibility of treating Khalkha Mongolian in terms of the left to right application of h-licensing.

H-licensing without (3a) can also explain why *ɜ* ( ) cannot be found domain finally in Akan. Recall that in Akan, *ɜ* is found to exclusion of *a* in headed domains in non-final positions, e.g. *pɜtri - slip*. In these cases, as vowels preceding *ɜ* cannot be headed, *ɜ* is concluded to be the interpretation of an empty expression. However, *ɜ* is never found in final position. Furthermore, in headed domains ending in *a*, any headed expression may precede *a*, but *ɜ* is never found. There is then the following asymmetry: in words with only a single nucleus, *ɜ* is excluded. Specifically, there are words like *sa* (*dance*), but no words like *sɜ*. Furthermore, in words with a single nucleus, when that nucleus is *a* (*sa - dance*, *ta - female twin*), *ɜ* is never found to the left. i.e. these words always behave as 'non-ATR' words. These distributional considerations show that ( ) *ɜ* only occurs as the h-domain counterpart to (A) in a β position. As the final nucleus in headed domains in a right-headed harmony can never be a β position, this explains why (A), never ( ) is found finally, even in domains where h-government takes place.

To summarise so far, I have argued for a version of h-licensing that does not include point (3a) of the original principle, and includes a modified version of h-government, including the point *α is not itself h-governed.*

(41) **Modified H-Licensing (final version)**

(a) A nuclear position is h-licensed if it is h-governed.[26]
(b) α h-governs β if they are adjacent on the relevant projection, and α is an h-governor; β is a governee.
(c) A nuclear position is an h-governor if it is identified by a headed expression. A nuclear position is a governee if it is identified by a headless expression.
(d) α is not itself h-governed.
(e) The status of h-governor is immutable.
(f) h-government obeys strict cyclicity in the sense of Kean 1974: 179:
"...on any cycle A no cyclic rule may apply to material within a previous cycle B without making crucial use of material uniquely in A."

[26] This point is no longer used in the sense of (3). In the original definition, headed expressions could only occur in h-licensed sites. H-licensing was achieved by either (1) position (final), or by being h-governed. This is no longer the case. Nuclear expressions are indeed h-licensed if they are h-governed, but headed expressions which identify h-governors reside in positions which are not h-governed, and are not necessarily final.

To conclude so far, in this section I have argued that a modified version of h-licensing, constrained by licensing constraints and combined with parameter settings on projection government, and (in certain languages) a necessary lexical marking system which indicates which forms are headed domains, can explain the characteristics of the various 'ATR' harmony types.

4.6 H-Licensing in Zulu, Sesotho and Turkana

So far, in developing h-licensing, we have examined harmonies which display the characteristics of unbounded and right-headedness (Vata, Akan and Pulaar), and bounded and left-headedness (Pulaar). I have also distinguished between languages which have a lexical marking system (Vata and Akan), and those which do not (Pulaar). In the remainder of this chapter, I examine languages which support h-licensing as the appropriate tool for capturing 'ATR' harmony. I analyse Zulu and Sesotho as exhibiting right-headed h-licensing without the lexical marking system (both bounded and unbounded). This is followed by a discussion of Turkana, which I analyse in terms of left-headed unbounded h-licensing employing a lexical marking system.

4.6.1 Approaches to Zulu and Sesotho

Sesotho and Zulu 'mid vowel raising' means that *e* and *o* are found to the exclusion of *ɛ* and *ɔ* preceding *i* and *u* (and sometimes *e* and *o* as well). Treatments of the process in the literature are united in assuming the spreading or changing of a feature. However, there is some variation as to what the feature should be, with individual frameworks influencing that choice.

Describing the 'raising' phenomenon of the type found in Zulu and Sesotho as a type of 'ATR' harmony has been rejected in the literature.[27] Odden (1991) raises the problems an [ATR] feature brings to the feature organisation in a model of feature

[27] Except by Stewart and van Leynseele (1979) who argue for a 'cross height ('ATR') vowel harmony' treatment for the Bantu language Nen, challenging the claim that Proto-Bantu does not exhibit cross height ('ATR') harmony.

geometry. In response, Clements (1991) introduces a new binary feature in place of [ATR] for Bantu vowel systems and 'height harmonies': [open], dominated by the organisational node 'aperture'. Harris (1987) also discards the [ATR] feature in his analysis of south-eastern Bantu harmony in favour of [-low]. Khabanyane (1991) proposes [+expanded] for Sesotho; Khumalo (1987) proposes [+raised] for Zulu.

In Revised GP, Zulu and Sesotho mid vowel raising can be straightforwardly explained in the same way Vata, Akan and Pulaar have been treated: as an instance of h-licensing.

4.6.2 Mid-vowel distribution in Zulu[28]

In this section, instances of Zulu vowel harmony are illustrated, and the contexts informally described. There are seven vowels in Zulu, corresponding to the symbols below:

(42)

i		*u*
e		*o*
ɛ		*ɔ*
	a	

The mid vowels, *e* and *o*, are distributionally predictable: they are found preceding *i/u*, the so-called 'syllabic nasals' *m* and *n*, and in what superficially appear to be 'long vowels'. The first context, preceding *i/u* is illustrated below:

(43) bonilɛ	*see (perfect)*	amazwɛ	*countries*
bɔna	*see*	ububɛlɛ	*kindnes*
leli	*this*	ɔbovini	*in the pus*
lɛlɔ	*it*	sisɛbendzilɛ	*work (perfect)*
izi-ndlovu	*elephants*		

In the examples above, *e/o* only occurs when preceding either *i* or *u*, otherwise *ɛ/ɔ* is found.

[28] The data has been collected from the literature (Doke (1926), (1947), Harris (1987), Khumalo (1987)), and confirmed by a native speaker.

Zulu is claimed to have three 'syllabic nasals': *m*, *n*, and *ŋ* (Doke 1926). Of these three, only *m* and *n* condition the occurrence of *e* and *o*, as the examples below illustrate:

(44) nemp?aka/*nɛmp?aka	*and the witch's cat*
nent?amɔ/*nɛnt?amɔ	*and the neck*
nɛŋk?umɛ/*neŋk?umɛ	*and a centipede*

Finally, although there are no instances of 'long vowels' contrasting with short counterparts in Zulu, they are found in certain conjugations. An example of this is in the prefix *ne:-/no:-/nɔ-/nɛ-* meaning and or with. In these cases, if the vowel is a mid vowel and 'long', then it is invariably *e/o*.

(45) (a)	ne:khanda	*with the head*
	no:bammbɔ	*with a rib*
	ne:zulu	*with a Zulu*
(b)	nɔbaba	*with my father*
	nokhulu	*with the grandparent*

The examples in (45a) illustrate three cases of 'long' mid vowels having to be *e* or *o*, irrespective of the quality of the following vowel. The examples in (45b) show that in the same conjugation, if the vowel is not 'long', its quality may be conditioned by a following *i/u* as expected.

Summarising the distribution of mid vowels, it can be claimed that *e/o* are found only in certain contexts, their presence (to the exclusion of *ɛ/ɔ*) conditioned by a following *i*, *u*, 'syllabic' *n* and *m*, and in 'long' vowels.

4.6.3 Previous Treatments of Zulu Harmony

In this section previous treatments of Zulu vocalic distributional restrictions offered by Harris (1987) and Khumalo (1987) are discussed.

Both Khumalo (1987) and Harris (1987) use bivalent distinctive features in their descriptions of Zulu vowels. Khumalo does not employ feature spreading, but feature changing in his two vowel raising rules. A first rule targets *ɛ* and *ɔ* ([-hi, -lo]), transforming them to [+raised] (*e* and *o*), triggered by the context [+hi] (*i* and *u*).

(46) Vowel Raising 1 (Khumalo 1987: 74)

$$\begin{array}{l}[-\text{cons}]\\ [-\text{hi}]\\ [-\text{lo}]\end{array} \quad \rightarrow \quad [+\text{raised}] \;\Big/\; \begin{array}{ccc} \text{rhyme} & \text{onset} & \text{rhyme}\\ | & /\ \backslash & | \\ \_ & \text{c}\ \ \text{(c)} & \text{v} \\ & & [+\text{hi}]\end{array}$$

Khumalo (1987) notes that for some speakers, the 'raised' mid vowels *e/o* (the output of the rule above), themselves trigger mid vowel raising, allowing for the forms for two different speakers represented by the examples in (a) and (b) below.

(47) (a)	akasɛbenzi	(b)	akasebenzi	*he doesn't work*
	isisɛbenzi		isisebenzi	*worker*
	akathɛkɛlezi		akathekelezi	*he doesn't tie up*

The mid vowel distribution in (47a) is consistent with the forms elicited from the speaker I consulted, and is captured by Khumalo with the application of the vowel-raising rule in (46). The mid-vowel distribution in (47b)[29] cannot be explained by Khumalo's rule. By transforming the mid-vowels to [+raised] by rule, the rule's conditioning context cannot be met by the [+raised] output (the context is [+hi]), and reapplication is blocked. Khumalo then proposes a second rule, with [+raised] as the conditioning context for mid vowel raising.

(48) Vowel Raising 2

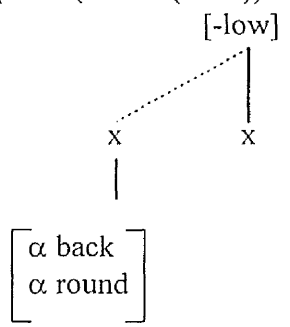
$$\begin{array}{l}[-\text{cons}]\\ [-\text{hi}]\\ [-\text{lo}]\end{array} \quad \rightarrow \quad [+\text{raised}] \;\Big/\; \begin{array}{ccc} \text{rhyme} & \text{onset} & \text{rhyme}\\ | & /\ \backslash & | \\ \_ & \text{c}\ \ \text{(c)} & \text{v} \\ & & [+\text{raised}]\end{array}$$

Applied after vowel raising, this rule then accounts for the mid vowel distribution in (47b). Apart from the inelegance of having two ordered rules to describe what is essentially the same process, Khumalo's approach is arbitrary in that it does not express any sense of locality or relationship between the target and the condition.

[29] Khumalo claims this to be the most common pronunciation.

Harris' (1987) account of 'mid vowel raising' in terms of feature spreading succeeds in tying the target to the context. Harris accounts for the alternations and mid-vowel distribution in a Lexical Phonology framework with a rule of [-low] Spread, applying from right to left.

(49) [-low] Spread (Harris (1987))



On this view, the mid vowels are not lexically specified for the feature [low], and the high vowels are specified for [-low]. When the context for [-low] Spread is met, the mid vowels receive the feature [-low]. *a* [+back, -round] is not targeted by the rule, and when the context for [-low] Spread is not met, the value [+low] is filled in as the default value. Harris himself points out in a later paper (Harris (1994a: 522)) the shortcomings of this approach. In principle, any feature or features may replace the ones in the square brackets in the rule above, in a harmony process in another language. This approach treats as accidental the fact that it is *i* and *u* which trigger harmony, and *a* which fails to undergo it, not only in Zulu, but in various other languages.

4.6.4 The GP Approach to Zulu

The analysis of Zulu vowel harmony that follows is basically in terms of a right to left unbounded h-licensing. First, I detail the generation of the Zulu vowel system, and the licensing constraints involved. I show how the interaction of licensing constraints with h-licensing, and universal conditions on constituent structure can explain the distributional constraints on the Zulu vowel system.

4.6.4.1 Phonological Expressions for Zulu

Given the theoretical tools of Government Phonology, the only way of capturing *i* and *u* with a single characteristic is in terms of the headedness of the expressions. Either both are headed or both are headless. The effect that *i* and *u* have on a preceding mid-vowel parallels the effect an h-governor has on its governee in Pulaar. I propose that *i* and *u* are therefore both headed expressions, identifying h-governors, and the effect on a preceding nucleus is, in the case of mid-vowels, one of h-government, manifested by the mapping of headless expressions to headed. The mid-vowels are then lexically headless.

a does not condition the alternation. It is not, therefore, a headed expression on this proposal. Furthermore, *a* does not itself alternate, thus manifesting the characteristic explained by the licensing constraint *'A cannot be a head'*. On this view, the following expressions are generated:

(50)	($\underline{\text{I}}$)	*i*
	($\underline{\text{U}}$)	*u*
	(A)	*a*
	(A.I)	ɛ
	(A.U)	ɔ

Generating out the expressions above, assuming that all elements may in principle fuse except as restricted by the licensing constraints, raises problems for the theory of licensing constraints outlined in chapter 2. No combination of constraints can generate out the system above. To facilitate the discussion, all possible phonological expressions are reproduced below:

(51)	($\underline{\text{A}}$)	(I.$\underline{\text{A}}$)	(U.$\underline{\text{A}}$)	(U.I.$\underline{\text{A}}$)	(A)	(I.A)	(U.I.A)
	($\underline{\text{I}}$)	(A.$\underline{\text{I}}$)	(U.$\underline{\text{I}}$)	(U.A.$\underline{\text{I}}$)	(I)	(U.I)	( )
	($\underline{\text{U}}$)	(I.$\underline{\text{U}}$)	(A.$\underline{\text{U}}$)	(A.I.$\underline{\text{U}}$)	(U)	(A.U)	

Unlike the Uyghur data discussed in chapter 2, Zulu manifests no examples where all three elements are fused in an expression. As we can see in the expressions for Zulu, *I* and *U* may both fuse with *A*, but not with each other. A constraint on the fusion of *I* and *U* is then required. What is more, an asymmetry with respect to element distribution is observable in the expressions for Zulu. When *I* and *U* occur in simplex expressions, this coincides with them occurring in headed expressions. However, when *A* occurs in a simplex expression, it is in a headless expression. The distribution of *A* may be explained by the licensing constraint *A cannot be a head.* However, it is difficult to imagine a constraint which would render illegal the headless expressions (I) and (U) from the set of possible expressions above. One strategy would be to propose the constraints *I must be a head* and *U must be a head.* These constraints would have the effect of eliminating (I) and (U), but unfortunately, they would also eliminate (I.A) and (U.A) from the Zulu set of expressions. The constraint *elements must be licensed* would have the same effect. Given the set of possible licensing constraints in chapter 2, no combination of constraints can eliminate (I) and (U) without also eliminating (I.A) and (A.U).

In order to accommodate the empirical finds in Zulu in Revised GP, a new 'natural class' needs to be defined. This may be performed by introducing the notion of *Natural Lexical Heads* (Kaye 1993b). *I* and *U* are Natural Lexical Heads. This status implies certain properties. First, if they can be heads in an expression, they will be. As a normal state of affairs, (I) and (U) will not be generated if *I* and *U* are Natural Lexical Heads in a language. Secondly, Natural Lexical Heads do not co-occur in the same expression in a language. Furthermore, if it is stated that *I* and *U* are Natural Lexical Heads we can then use the term *Natural Lexical Heads* as the subject of any of the licensing constraint possibilities suggested in chapter 2, as follows:[30]

[30] By using the notion of Natural Lexical Heads, it is hoped that two properties of *I* and *U* can be captured: (1) *I* and *U* do not combine, and (2) (I) and (U) are not generated. However, a problem immediately arises if we consider whether all languages prohibiting the fusion of *I* and *U*, also prohibit the generation of (I) and (U). In 'full blown' 'ATR' harmony languages such as Vata and Akan, *I* and *U* do not fuse in an expression, however, the headless expressions (I) and (U) are indeed generated. It seems then that these two properties are independent. It is, therefore, too early to dispense with the licensing constraint *I and U cannot co-occur*, as it is needed for vowel systems such as Vata, which do not have the property of Natural Lexical Heads, nor crucially require any licensing constraint with the term 'Natural Lexical Heads' as its subject. This aspect of licensing constraint theory needs much more research, and at this stage, unfortunately, is still not well understood.

(52) *I* and *U* are Natural Lexical Heads
Natural Lexical Heads license no operators
Natural Lexical Heads license operators
Natural Lexical Heads cannot be licensed

A is excluded from the set of natural lexical heads and consequently does not exhibit the properties associated with this class. In order to generate the expressions for Zulu in (50), I propose the following licensing constraints:

(53) Licensing Constraints for Zulu:

A cannot be a head **and**
either Operators cannot be licensed
or Natural Lexical Heads license no operators

The first licensing constraint is recoverable from the behaviour of (A) in neither undergoing nor triggering the harmony process. The second licensing constraint serves to ensure that any complex expression is headless, as evidenced by the fact that only mid vowels are targeted by the h-licensing vowel harmony process.

The notion of *Natural Lexical Heads* is ad hoc, but in its favour, it is at least restrictive, matching the empirical record more closely than if we did not employ it. The consequences of not having such a notion can be observed in a framework employing tier geometry such as in Backley (1995). In Revised GP, if we restrict the members of the set of Natural Lexical Heads to *I* and *U,* then at least no other element combination can form a 'natural class', either *I* and *A*, or *A* and *U*. However, in Backley's tier geometry this is indeed a possibility, although the vowel systems generated he claims are very unusual, perhaps unique. Backley suggests that *A/U* (high/round) labels a tier which dominates the *I*-tier in the vowel stem proposed for Chuvash. This generates the vowel system {i (I), u (U), a (A), ü (U.I), ɛ (A.I), ɯ ( )}. *I/A* (back/high) labels a tier in Mandarin Chinese, generating the vowel system {i (I), u (U), a (A), ü (U.I), ɤ (A.U)}. Goh (1996) demonstrates that the Mandarin vowel system is not that in Backley (1995). I speculate that the Chuvash vowel system also requires a different analysis.[31]

[31] Additionally, Backley's approach makes the claim that a tier label picks out a 'natural class' in a phonological process (a tier may be 'activated'). Thus it is predicted that in some language where A/U

To summarise so far, I have proposed licensing constraints to generate the vowel system of Zulu, and introduced the notion of Natural Lexical Heads, which may be the subject of a licensing constraint.

4.6.4.2 H-Licensing in Zulu

In order to explain that *e* and *o* occur only preceding *i* and *u*, to the exclusion of *ɛ* and *ɔ* (as in Pulaar), I propose that the set of lexically headed expressions in Zulu are h-governors; specifically (I) and (U). H-governees are the lexically headless expressions (A.I) (A.U) and in principle (A). H-government takes place from right to left and is unbounded. However, the licensing constraint *A cannot be a head* constrains the derivation. Examples of h-licensing are shown below.

```
(54) (a)              (b)                       (c)
                                                    Nβ   Nα      Nβ     Nβ       Nα   Nα.
                                                    |    |       |      |        |    |
       Nβ     Nβ         Nβ   ←Nα    Nβ             Nβ/←Nα       Nβ     Nβ/←  Nα     Nα
       |      |          |     |     |              |    |       |      |        |    |
   O   N    O N       O N    O N O N          O N O N O     N    O N O    N O N
   |   |    | |       | |    | | | |          | | | | |     |    | | |    | | |
   x   x    x x       x x    x x x x          x x x x x     x    x x x    x x x
   |   |    | |       | |    | | | |          | | | | |     |    | | |    | | |
   b(A.U)n(A)         b(A.U)n(I)l(A.I)        j(A)f(I)k(A.I)l(A)th(I)n(I)
   bɔna               bonilɛ                  jafikɛlathini
   see                see (perfective)        it-arrived-in-a-forest
```

In (54a) no h-governor is identified as no headed expression is associated. In (54c) the headed nuclear expression (I) identifies the position to which it associates as an h-governor and the preceding position contains a governee. However, the licensing constraint '*A cannot be a head*' constrains the derivation, and the nucleus containing (A) cannot be h-licensed.

In (54b), the middle nucleus is an h-governor identified by a headed nuclear expression (I). This point then fulfils the role of α in the governing relationship with a lexically headless expression taking the role of β. The nuclei are adjacent on the level of nuclear projection, and the governing relation is contracted, yielding a headed

labels a tier, expressions containing either *A* or *U* form the active set in a phonological process in that language. The same type of prediction is made with respect to the A/I tier.

complex expression. The expression must be headed because of the specific structural context of its position. In the same way, expressions in English are headed in the structural context of a P^0 nuclear government relationship, discussed in chapter 3.

This raises the issue of the role of licensing constraints. Some constraints express the innate property of an element to be the head, or not, of an expression, such as *U must be a head*, or *A cannot be a head.* Other constraints refer to the licensing properties of elements, such as *I licenses no operators*, or *Natural Lexical Heads license no operators.* Structural conditions such as branching nuclei and h-licensing can never affect the innate property of an element: it behaves in the way it is explicitly defined by the licensing constraints. For example in Uyghur, *U must be a head.* As such, this element could not spread to fuse as an operator in an expression. In the same way, in Akan and Zulu, *A cannot be a head.* No conditions can affect this innate property. However, those elements which lack potential to license operators, expressed by a licensing constraint such as *Natural Lexical Heads License no operators*, are able to gain licensing power in a specific structural context: by being licensed by an h-licensor, or by being doubly associated to two nuclear points involved in a P^0 governing relation. In this way, in Zulu, *I* and *U* are able to license operators in these specific contexts only, and these elements do not license operators in expressions in any other positions in a string. These two types of licensing constraint therefore interact with h-licensing in different ways.

Recall that for some speakers of Zulu, the harmony process is unbounded. However, for other speakers, the harmony process is bounded (see (47)). This may be explained simply as the manifestation of the two types of projection government structures. This difference is illustrated below.

(55) (a)

$$\begin{array}{ccccc} N_\alpha & N_\beta & /\leftarrow & N_\alpha & N_\beta \\ | & | & & | & | \\ N_\alpha & N_\beta & N_\beta \quad \leftarrow & N_a & N_\beta \\ | & | & | & | & | \\ x & x & x & x & x \\ | & | & | & | & | \\ s(\underline{I}) & s(A.I) & b(A.\underline{I}) & ndz(\underline{I}) & l(A.I) \end{array}$$

sisɛbendzilɛ *work (perfect)*

```
(b) Nα    Nβ         ←  Nα    Nβ
    |     |             |     |
    Nα    Nβ     Nβ  ←  Nα    Nβ
    |     |      |      |     |
    x     x      x      x     x
    |     |      |      |     |
  s(I)s(A.I)b(A.I)ndz(I)l(A.I)
```

sisebendzilɛ *work (perfect)*

Illustration (a) above shows the bounded h-licensing dialect of Zulu. A governing relation is contracted at the first level of projection, and although nuclei with suitable identities are adjacent at the higher projection, they are not adjacent at every level, and h-government may not take place. In (b), the unbounded dialect is represented. H-government takes place at the lower projection, as for (a). However, at the higher projection, h-government takes place again.

To summarise so far, I propose the distribution of 'tense' mid vowels in Zulu is captured by the interaction of h-licensing and a licensing constraint, with the differences in dialect explained by the different types of structure. Both bounded and unbounded types of harmony are found, operating from right to left.

4.6.4.3 'Syllabic nasals' in Zulu

Khumalo (1987) does not specifically address the contexts of 'syllabic nasals' and 'long vowels' of the type presented here with respect to the distribution of *e* and *o*. Harris intercalates the rule of [-low] Spread with other rules to explain the 'syllabic nasal' context and the 'long vowel' context. To explain the application of [-low] Spread in the 'syllabic' nasal context, Harris employs an extra Nasal Prefix Vowel Deletion Rule to eliminate the context for [-low] Spread after it has applied (that is to say, the [-low] vowel is deleted), in order to yield the 'syllabic nasal'.

On a GP approach, this strategy of vowel deletion is both untenable and unnecessary. Assuming the analysis so far presented, the occurrence of *e* and *o* to the exclusion of *ɛ* and *ɔ* preceding a 'syllabic nasal', can be simply explained. I propose that the 'syllabic nasals' *m* and *n* are simply headed nuclear expressions which identify h-governors. Doke (1926) claims that 'syllabic' *m* is derived from *nu*, and 'syllabic' *n* from *ni*. 'Syllabic' *ŋ* is derived from *ŋa*. The representations of 'syllabic nasals' are given are below:

```
(56) (a)  O N        (b)   O N        (c)   O N
          | |              | |              | |
          x x              x x              x x
          | +              | +              | +
          L U              L I              L A
          m                n                ŋ
```

In the structures above, *A*, *I* and *U* are uninterpreted in these nuclear positions. In (56a) and (56b) above, the lexical heads identify the nuclei as h-governors, whose status is immutable. This is property defined by point (e) of the final version of modified h-licensing (41), which originally occurred in Kaye's (1993b) proposal. A point which has been identified as an h-licensor by a headed expression, cannot lose this status. In (56c) on the other hand, *A* is not a lexical head. The nuclei in (56a) and (56b), interpreted with the preceding onset as *m* and *n*, exhibit h-governor properties.

This treatment of 'syllabic nasal' is not without precedent. I follow Yoshida (1995) who proposes this structure for the Japanese 'syllabic nasal'. Like Zulu, Japanese is a language where the parameter 'Word final Empty Nuclei are P-licensed' is not switched on. In the absence of left headed Proper Government then, all strings end in interpreted nuclei. Some examples of 'syllabic nasals' in Japanese are provided in (57b), with their structure in (57a) (Yoshida 1995: 120)[32]:

```
(57) (a)  O   N        (b)   hon      book
          |   |              mikan    tangerine
          x   x
          |
          N   U
```

Yoshida claims that Japanese 'syllabic nasals' are the interpretation of the structure in (57a).[33] Evidence to support this is of the following type. Millar (1967) claims that the negative affix in Old Standard Yamato was *-nu*. This is manifested in Modern Standard (Eastern) Japanese as *-nai* and crucially in Western dialects as *-n*. McClain

[32] Yoshida uses the element *N* for Nasality in Japanese, rather than the *L* used here for Zulu.

[33] However, why nasality is involved in interpreting an unlicensed empty nucleus rather than any other combination of elements (we do not find 'syllabic' counterparts for all expressions associated to onsets in Zulu and Japanese) remains unexplained.

(1981) also claims that the negative suffix is *-nu*, contracted to *-n* in Modern Standard Japanese in forms such as *arimasen* (*have/be not*). Some examples from a speaker of Nagoya (Western) dialect are provided below:

(58) Negation in Japanese

Old Japanese	**Nagoya**	**Standard Japanese**	
ika**nu**	ika**n**	ikanai	*don't go*
tabe**nu**	tabe**n**	tabenai	*don't eat*

Analysing Japanese 'syllabic nasals' in terms of the structure in (57) is supported by a distributional gap in Japanese nasal-vowel sequences. The sequences *na*, *ni*, *ne* and *no* are all well attested in Japanese. The sequence *nu* however is strangely absent.[34]

Whether there is a similar type of distributional gap in Zulu, in this case of *nu*, *ni*, and *na*, is more difficult to establish. First, final *-a* is a verbal suffix in Zulu. What precedes it is the stem. Therefore there appear to be many examples of words ending *-na* (e.g. *bɔna*). By the same token, some suffixes begin with *-i*, (e.g. *-ilɛ*), and consequently there appear to be many instances of the sequence *-ni-* (e.g. *bonilɛ*). As for the sequence *-nu-*, this seems to be much less in evidence. The number of words listed in the dictionary of Doke and Vilakazi (1953) beginning *nu-* is only 69 (compared with 270 for *gu-*, 287 for *khu-* and 121 for *su-*). Final sequences of *-nu-* are difficult to find (*khanu - of lust*), as are final sequences of *-ni* (e.g. *imi-ngandeni - envy, jealously*). However without extensive further investigation, it is not possible to claim that these apparent gaps are in any way significant.[35]

[34] The following frequencies are the results of a string scanning programme authored by Jonathan Kaye, and applied to a Japanese data base containing 68, 970 entries:

sequence	**number of occurrences**
na	3,823
ni	2,064
nu	298
ne	1,442
no	3,330

[35] As Zulu is written using the roman alphabet, spelling idiosyncrasies may also have to be taken into consideration. For example, spelling standardisation practises mean that there are only 8 words listed as beginning with *r-*.

4.6.4.4 'Long' Vowels in Zulu

Harris (1987), following Laughren (1984), claims that long vowels of the type in (45) are derived from the deletion of intervocalic *l* in certain noun prefixes. Examples are reproduced from Harris below:

(59)	u:-fudu ~ ulu-fudu	*tortoise*
	i:-khanda ~ ili-khanda	*head*

On Harris' story, long mid-vowels are further derived by a process of coalescence of *a* + *i:/u:* to yield *e:/o:*. In addition to the *l*-deletion rule and a coalescence rule, he employs an extra assimilation rule for the long vowel context, yielding the uninterpreted intermediary levels of representation characteristic of a Lexcial Phonology approach. Vowel length in itself is of no significance to the application of [-low] Spread.

The speaker consulted for this paper finds alternations such as *ulufudu*, *ilikhanda*, *nelikhanda*, ungrammatical in their dialect of spoken Zulu, confirming only the 'long' forms as acceptable: *u:fudu*, *i:khanda*, *ne:khanda*. The analysis that follows therefore makes no reference to any derivation of 'long vowels', calling instead on a single universal condition on lexical structure.

Neither the licensing constraints nor h-licensing constrain the distribution of *e/o* in 'long vowel' constructions. The appearance of *e* and *o* to the exclusion of *ɛ* and *ɔ* in the context of 'long' vowels is predicted in this analysis given universal principles regarding the association of expressions to timing slots. The distribution of mid-vowels in this context provides another piece of evidence pointing to the headed properties of *i* and *u*, and the headless status of *ɛ*, *ɔ* and *a*. The examples below show the 'long vowel' construction (a); the same conjugation with neither the 'long vowel' construction, nor any h-governor (b); and the same conjugation with no 'long vowel' construction, but an h-governor present (c).

```
(60) (a)                        (b)                       (c)     Nβ  ←     Nα
                                                                  |         |
          O    N     O N...       O    N    O N...           O    N    O    N...
          |   / \    | |          |    |    | |              |    |    |    |
          x  x    x  x  x...      x    x    x  x...          x    x    x    x...
          |   \  /   |  |         |    |    |  |             |    |    |    |
          n  (A.I)kh(A)nda      n(A.U)b(A)ba               n(A.U)kh(U)lu
          ne:khanda              nɔbaba                      nokhulu
          with a head            with my father              with the
                                                             grandparent
```

In (a), in spite of the lack of an h-governor, the constituent structure demands the association of a headed expression. Recall that universally, headless expressions may not associate to two skeletal points which **contract a governing relation at P^0** (this is essentially the spirit of Lowenstamm's (1986) Cold Headedness Constraint)[36]. This was exemplified by the English vowel system discussed in chapter 3, where long vowels have to be 'tense' (i.e. headed) e.g. *boot*, *beat*. The same conditon is manifested in Zulu. As expected, in this structural context, only the headed forms *e* (A.$\underline{\text{I}}$) and *o* (A.$\underline{\text{U}}$), *i* ($\underline{\text{I}}$) and *u* ($\underline{\text{U}}$) occur. The headless expressions *a* (A), *ɛ* (I.A) and *ɔ* (A.U) are never found in the pseudo-long constructions of the type in (a). (b) and (c) above serve to show that in the same class marking, mid-vowels are subject to h-licensing as expected. In (b), no h-governor is identified, so nothing happens. In (c), an h-governor is identified by the headed expression ($\underline{\text{U}}$), and h-government takes place.

To summarise so far, h-licensing, combined with licensing constraints and the demands of certain structural configurations can provide a unified explanation for the restricted distribution of *e* and *o* in Zulu.

4.6.5 Vowel Raising in Sesotho

Like Zulu, mid vowel raising in Sesotho also manifests right to left unbounded h-licensing, with no evidence of a lexical marking system. However, the vowel systems of Zulu and Sesotho differ in one important respect. *I* and *U* have the potential to

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[36] See Denwood (1995) for a discussion of 'long vowel' structures with respect to h-licensing. Walker's (1995:113) analysis of Vata contains examples such as *lɛɛ -spear*. However, these headless sequences are not analysed as nuclei involved in a P^0 governing relation.

license operators independently of structural demands. This difference between Zulu and Sesotho can be captured by the difference between the two languages in terms of licensing constraints.

Not only is the active feature in Bantu mid vowel raising harmony the subject of some controversy, but also the characterisation of the Sesotho vowel system. The literature may be divided in two groups: (a) those who claim seven vowels underlying, with the creation of two in phonological processes (total nine); (b) those who claim nine vowels underlying with an addition of two vowels created in phonological processes (total eleven). The various proposals are summarised below:

(61) (a) seven~nine vowel systems:

Tucker (1929): /i e ɛ a ɔ o u/ plus *ê*[37] and *ô* as alternants of *ɛ* and *ɔ*.
Doke and Mofokeng (1957): /i ɨ ɛ a ɔ ʉ u/ plus *e* and o as alternants of *ɛ* and *ɔ*.
Roux (1982): /i e ɛ a ɔ o u/ plus *ê* and *ô* as variants of both *e/o* and *ɛ/ɔ*
Harris (1987): /i ɪ ɛ a ɔ ʊ u/ plus *e* and *o* as alternants of *ɛ* and *o.*

(b) nine~eleven vowel systems

Khabanyane (1991): /i e E ɛ a ɔ O o u/ plus *ê* and *ô* as alternants of *e* and *o*.
Clements (1991): /ɪ i e ɛ a ɔ o u ʊ/ plus *î* and *û* as alternants of *i* and *u*.

Apart from the number of lexical vowels, the controversy is whether there are four high vowels underlyingly (Clements, Doke and Mofokeng, and Harris), or two high vowels (Khabanyane, Roux, and Tucker).[38] Before a GP analysis is offered, further

[37] The circumflex indicates a 'raised' version of the vowel on which they sit. This style of transcription departs from the usual dot placed under the relevant character. However, the transcription is essentially in the spirit of the original in all cases.

[38] One factor in the controversy may be discrepancies with respect to the transcription practices employed in transcribing Bantu data. This point is raised by Greenberg (1951) who modifies the traditional transcription practice established by Meinhof as follows:

Meinhof:	î i e a o u û
Greenberg:	i e ɛ a ɔ o u

Greenberg (1951:813 footnote 2) states "It seems advisable to replace Meinhof's transcription with a more normal one which moreover approaches the phonetic values of the vowels in these languages."

details necessary for the justification of such vowel systems (and the harmony processes they imply) are explored in the three most recent cases.

4.6.5.1 Previous Analyses of Sesotho mid-vowel raising

Harris (1987) Clements (1991), and Khabanyane (1991) all provide rule-based accounts. As rules can manipulate any features in their structural descriptions, they treat as accidental the triggers and targets in vowel harmony processes (and sometimes the relationships between them).

Khabanyane proposes nine 'phonemic vowels' to distinguish the minimal and near minimal contrasts in Sesotho. The six underlying mid-vowels are proposed because of the occurrence of a single minimal triple in the examples there.[39]

To explain mid vowel raising harmony, Khabanyane offers the following rule.

(62) mid-vowel raising:

(a) **description:** /ɔ ɛ/→ [O E] / __ /i u/, /e o/, /ɲ ŋ ts/

(b) **rule:** V $\begin{bmatrix} +\text{low} \\ \alpha\ \text{back} \\ \alpha\ \text{round} \end{bmatrix} \rightarrow [+e]$[40] / __ [-low]

Mid vowel raising is claimed to yield the 'middle' mid vowel (also claimed to be underlying).

On Harris's story, Sesotho is superficially like Vata, with vowels occurring in tense/lax pairs, except for *a*. However, as [ATR] is apparently needed to distinguish two types of high vowel (*i*, *u*, versus *ɪ*, *ʊ*),[41] which together as a group are claimed to condition *e* and *o* realisations of preceding mid-vowels. The harmonic feature is [-low]. Harris proposes *ɛ*, and *ɔ* are unspecified for [low]. As for Zulu, a rule of [-low]

Greenberg goes on to transcribe the Kikuyu system as /i e ɛ a ɔ o u/, whereas, for example, Clements (1991) transcribes Kikuyu as /i ɪ e a o ʊ u/.

[39] These are transcribed (Khabanyane 1991: 7) as *hona* (*rain*), *hOna* (*this*) and *hɔna* (*it*)

[40] Khabanyane describes the vowel transformation as 'becomes higher', and assigns this phenomenon to the feature [+expanded].

[41] Using [ATR] to distinguish the two pairs in this way is not motivated on phonological grounds. i.e. [ATR] is not targeted in any rule. Rather, [ATR] is apparently needed to distinguish these pairs phonetically.

Spread provides the value for [low], and if the structural description of the rule is not met, a redundancy rule fills in [+low] as the default value.

Like Khabanyane, Clements adopts a nine-vowel system, and assigns numbers to identify vowel heights:

(63)	ɪ	ʊ	height 4	
	i	u	height 3	
	e	o	height 2a	
	ɛ	ɔ	height 2	
	a		height 1	plus height 3a (*î* and *û*)

Clements offers minimal and near-minimal pairs involving heights 2 and 2a, in claiming they are underlying. In Clements' raising analysis, *ɛ* and *ɔ* are raised to *e/o* preceding the four high vowels (like Harris). *e* and *o* are also claimed to trigger vowel raising.

Clements captures the process by a rule which raises height 2 to height 2a. Clements claims this is triggered by any higher vowel. Raised *ɛ* and *ɔ* (*e* and *o*) are the same as lexical *e* and *o*.

(64) Mid vowel raising rule (structure preserving)

aperture aperture

[-open]$_4$
(ɪ ʊ i u e o)

Clements claims that as the rule is structure preserving it cannot apply to low vowels, (i.e. *a*) because the output would be height 1a, so the rule does not need to be specified to target only non-low vowels.[42]

[42] A general review of Clements' approach is provided in chapter 1.

4.6.5.2 A GP Treatment of Sesotho Mid Vowel raising[43]

The discussion above shows that phonologists are by no means united as to the characterisation of mid-vowel raising in Sesotho, and the Sesotho vowel system it implies. In this section I explore mid-vowel raising and the Sesotho vowel system as the theoretical tools of Revised GP predict it to be. First, I claim the Sesotho vowel system to be that in (65) below, following Tucker (1927) and Roux (1982).

(65) i e ɛ a ɔ o u

The inventory above is motivated by the phonological behaviour of the expressions involved in the vowel raising processes. First, the following generalisations may be made. These seven vowels are all and only those vowels found word finally (no following conditioner) (66a). Also these seven are the only vowels found in stressed (penultimate) position (66b):

(66)	(a) motseli	*one who pours*	thepe	*type of vegetable*
	tsɛla	*to pour*	lekopokopo	*big can*
	lɔbɛlɛ	*eat greedily*	ŋkɔ	*nose*
	sebodu	*something rotten*		
	(b) dula	*sit down*	pɔta	*go around*
	thepe	*type of vegetable*	sebodu	*something rotton*
	dila	*smear*	lɔbɛlɛ	*eat greedily*
	ikatla	*hold oneself*		

Mid vowel raising takes place in an unbounded fashion, applying from right to left.[44] *e* and *o* are found to the exclusion of *ɛ* and *ɔ* preceding *i, u, e,* and *o*, as the examples below illustrate.

[43] The data here are collected from the published sources, and tested with a native speaker of Sesotho. Readers should be aware that the consultant is from South Africa rather than from Lesotho.

[44] Sesotho is also claimed to have high vowel raising. This is described by Clements (1991) and Khabanyane (1991), and in GP terms, would involve the alternation of *e* and *o* (but not *ɛ* and *ɔ*) with *i* and *u*, preceding *i* and *u*. However, the data elicited from my consultant did not reveal a general pattern. I follow Harris (1987: 271 footnote 5) in concluding that the "distributional details remain obscure". For this reason, I do not attempt to pursue any analysis.

(67) iketile	*has been engaged*	sebodu	*rotten*
thepe	*spinach-type vegetable*	lelele	*tall*
maɲolo	*fertilizer*	sibele	*rumour*

Sequences of mid vowels in words do not always 'agree'. *i/u/e/o* **can** be found preceding *ɛ*, *ɔ*, a, showing the harmony to occur from right to left.

(68)	diha	*cause to fall*	dula	*sit down*
	leba	*look towards*	loka	*be right*
	kharebɛ	*virgin*	lekhokɔ	*vanity*
	tekɔ	*trial*	lepɛra	*leprosy*
	posɛ	*to pour much*		

Like Clements (1991) I conclude that *e* and *o* are generated lexically (contrary to Harris (1987)). The following minimal pairs illustrate this:

(79) pɔta	*go around*	pota	*to be delirious*
tsɛla	*pour*	tsela	*cross a river*

I also follow Clements in analysing 'raised' *ɛ* and *ɔ* (*e* and *o*) as the same object as lexical *e* and *o*, as the example below illustrate:[45]

(70) potisa *send around* pota *be delirious*

The conclusions about the characterisation of the Seotho vowel system and its role in mid vowel raising rests on the following assumptions about phonological processes in Revised GP. Complex expressions (composed of more than one element) may in principle be characterised in three different ways: (i) *A*-headed (I.$\underline{\text{A}}$), (U.$\underline{\text{A}}$); (ii) *I/U* headed (A.$\underline{\text{I}}$), (A.$\underline{\text{U}}$); (iii) headless (A.I), (A.U). In principle then, a nine vowel system with six complex expressions (such as that implied by Khabanyane's transcription) could be described. Clements' and Harris' four high vowels (assumed to be simplex expressions) could also be described, with headed ($\underline{\text{I}}$) and ($\underline{\text{U}}$) versus headless (I) and

[45] Some support for this comes from Khabanyane's acoustic analysis of Sesotho vowels. The mean differences in F1 between 'raised' *ɔ* and *o*, and 'raised' *ɛ* and *e* Khabanyane states are not high. In scattergrams (F1 plotted against F2) of all ten tokens of each claimed mid vowel for two speakers, *ɛ* and *ɔ* are well separated from the higher vowels. However, [E] (raised *ɛ*) and /e/, and [O] (raised *ɔ*)and /o/ show frequent overlap in F1.

(U) (as in Vata and other 'full-blown' harmony systems). However, a vowel harmony process in which the four simplex expressions (I̲), (U̲) (I) (U) (but not (A) or (A̲)) trigger mid-vowel raising (manifested by either (I.A)/(U.A) being transformed to (A.I̲)/(A.U̲), or by (I.A̲)/(U.A̲) being transformed to (A.I̲)/(A.U̲)) cannot be explained. The four simplex expressions do not share a characteristic to which an expression in a local nucleus may harmonise. Nor could a harmony process be explained such as that proposed by Khabanyane whereby two complex expressions (*e* and *o*) induce a harmony on two other complex expressions (*ɛ* and *ɔ*), creating two additional expressions.[46]

GP then makes the strong prediction that no language will exhibit properties such that four high vowels form a 'natural class' in triggering vowel alternations akin to the mid vowel raising harmony described here, nor will a language exist where there are six mid vowels and mid vowel raising. Checking the validity of these claims is obviously an impossible task. However, as far as I am aware, the prediction is borne out.[47]

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[46] The only way this could be stated in GP would be a process in which the two headed expressions (A.I̲) and (A.U̲) induced an h-government process whereby the targets (A.I) and (A.U) became A-headed (I.A̲) and (U.A̲). If this were the case, the analysis would lack an explanation for the failure of (A) to undergo the process, as the element may then be assumed to be licensed to be a head in an expression. The only response to this would be a stipulation that the process is 'structure preserving', a strategy which has no place in GP. Even if this were possible, it would mean proposing (I.A̲) and (U.A̲) lexically, for which there is no evidence. I could find no minimal mid vowel tripples.

[47] As a starting point, I consulted Crothers (1978) who lists twelve languages (in a sample of 209) as having four high vowels *i u ɪ ʊ*. Of these twelve, Akan and Luo are noted as having full 'ATR' harmony.

Six languages relate vowel quality to length. In English the 'tense'/'lax' properties of the four high vowels correlate to vowel length, in the same manner as the mid-vowels in Zulu. This is also the case for Punjabi (Bhatia (1993)), Nyangumata (Yallop (1982)), Tagalog (Schachter and Otanes (1972)), Hausa (Abraham (1959)) and Khasi (Roberts (1891)).

Two languages have conflicting accounts. First, Reynolds (1980) indicates that Sinhalese has only two high vowels which may be either long or short. Karunatillake (1992) on the other hand claims four high vowels correlating to contrastive length. Secondly, Malayalam is claimed (Kumari 1972) to have no quality distinction between the long and short high vowels (i.e. there are only two qualities not four). On the other hand Mohanan's (1982) vowel chart indicates four high vowels with the expected correlation of length to vowel quality.

I propose that the four expressions which trigger *ɛ~e*, *ɔ~o* alternations are headed, with the targets headless. The following expressions are proposed for Sesotho:

(71) Expressions for Sesotho:

i	($\underline{I}$)
u	($\underline{U}$)
e	(A.$\underline{I}$)
o	(A.$\underline{U}$)
ɛ	(A.I)
ɔ	(A.U)
a	(A)

Assuming that Sesotho is a language manifesting Natural Lexical Heads, I propose the following licensing constraint.

(72) Licensing constraints for Sesotho:
A cannot be a head

I propose that h-government as described for Zulu operates in Sesotho in exactly the same way. As in Zulu, *a* neither triggers nor undergoes vowel harmony, and the licensing constraint *A cannot be a head* both generates the expressions above and constrains the derivation.[48]

Kpelle and Logbara remain. Kpelle is listed with having the same vowel inventory as Harris proposes for Sesotho. However, in Welmers (1962) account, the 'phonemes' are listed as the following: /i e ɛ a ɔ o u/. In any case, it appears not to have raising vowel harmony. As well as four high vowels, Logbara is also claimed in Crothers to have three mid vowels. Crazzolara's (1960) study, however, indicates only four mid vowels. Determining the phonological vowel system and whether there is vowel harmony is not straightforward, and would require further research beyond the scope of this thesis.

Crothers' transcription in principle allows for a language with three 'vowel heights' in the mid vowels, however, apart from Logbara, no such language is listed there.

[48] Other contexts conditioning mid vowel raising are found in Sesotho. Informally, these may be described as follows: preceding *ɲ* in the irregular causative, *ŋ* in the locative, imperative plural, and relative constructions, preceding 'syllabic' *n* in the causative and perfective, and preceding *ts* in the causative and perfective. These contexts demonstrate the interaction of h-licensing with other government relations and conditions on the interpretation of expressions in nuclei. See Cobb (1995b) for a fuller discussion.

I have presented an analysis of the Sesotho vowel system and harmony process which differs considerably from those presented in the recent literature (Clements (1991) and Khabanyane (1991)). My analysis is guided by the possibilities allowed by the tools of Revised GP, and I have tried to show that in the restrictive GP terms, Sesotho could not be analysed in any other way. Specifically, I illustrate that phonological processes reveal only seven phonological expressions. In support of this approach, I offer a brief discussion of Okpe, a language in which seven vowels are transcribed in the literature, but nine are revealed through phonological processes.[49]

Okpe is an Edo (Kwa) language, spoken in Nigeria. Hoffman (1973) aims to contribute to Stewart's (1971) claim that cross height (ATR) harmony languages which have less than the 10 vowels of languages such as Akan and Vata, will typically not have *ɪ*, *ʊ* and an 'ATR' counterpart to *a* (such as *ɜ* or *ʌ*). Hoffman analyses the vowel system with respect to the harmony process as follows:

(73) open set			close set[50]	
e		o	i	u
ɛ		ɔ	e	o
	a		(a)	

In the harmony process, the vowels of Okpe words are drawn from either one set or the other. In particular, this is revealed by verbal conjugation when affixes are selected. Hoffman claims that *e* and *o* are members of both sets, and therefore sometimes behave as open vowels, sometimes as close. Some examples are provided below[51]:

(74) imperative	Past 3 sg.	infinitive	
(a) dɛ	ɔ dɛre	ɛ dɛ	*buy*
tɔ	ɔ tɔre	ɛ tɔ	*dig*
re	ɔ re	ɛ ryɔ	*eat*
so	ɔ soro	ɛ swɔ	*sing*
da	ɔ dare	ɛ da	*drink*

[49] Many thanks to Monik Charette for suggesting the Okpe analysis.

[50] Hoffman remarks that 'close' refers to the 'basic physiological factor' of 'tongue-root advancing'.

[51] I have taken advantage of the way the data is presented in Halle and Clements (1983).

(b)

ti	o tiri	e tyo	*pull*
zu	o zuru	e zwo	*fan*
se	o seri	e se	*fill*
so	o sori	e so	*steal*

In the affix selection process, *e* and *o* occur in (a), which shows examples of open vowels, as well as in (b), which contains examples of close vowels. In terms of h-licensing, I assume that (a) exemplifies headless expressions, whereas (b) shows headed expressions in nuclei involved in h-licensing relations. Given this distribution, one might propose that the *e* and *o* which occur in (a) above are lexically headless expressions, and those in (b) are lexically headed. The two instances of *e* and *o* are therefore formally distinct objects. Given that *ɛ* (A.I) and *ɔ* (A.U) also occur in (a), *e* and *o* in this group must be the only remaining possible headless expressions (I) and (U).

In Okpe there is independent evidence to support this conclusion. The infinitive forms in the third column also illustrate what may be informally described as a gliding process. *u/o* alternates with *w*, and *i/e* alternates with *y*. The relevant examples are reproduced below.

(75)

imperative	infinitive	
(a) zu	e zwo	*fan*
ti	e tyo	*pull*
re	ɛ ryɔ	*eat*
so	ɛ swɔ	*sing*
(b) dɛ	ɛ dɛ	*buy*
tɔ	ɛ tɔ	*dig*
da	ɛ da	*drink*
se	e se	*fill*
so	e so	*steal*

The forms involved in the gliding process are presented in (a), those in which no gliding occurs are in (b). As the quality of the prefix *e/ɛ* shows, the gliding process is not conditioned by whether or not the stems are headed domains. (b) shows that neither the headless complex expressions *ɛ* (A.I) and *ɔ* (A.U), nor the headed complex expressions *e* (A.$\underline{\text{I}}$) and *o* (A.$\underline{\text{U}}$) are involved in the gliding process. The condition for gliding must be assumed to be the elements *I* or *U* in *simplex* expressions. *e* and *o* in group (a) are therefore assumed to have the formal identities of (I) and (U) respectively. This conclusion coincides with that from the harmony process.

Like Sesotho, it is the phonology of Okpe that reveals the identity of the phonological expressions. In spite of Hoffman's transcription, *e* (I) is therefore **not the same as** *e* (A.$\underline{\text{I}}$), nor is *o* (U) the same as *o* (A.$\underline{\text{U}}$). It can only be assumed that the transcription is not accurate.

To summarise, I have shown that an analysis of Sesotho harmony in terms of h-licensing makes certain predictions as to the nature of the vowel system, and can contribute to the debate on Sesotho vowel harmony. The process is analysed here as right to left unbounded h-licensing.

4.6.6 Turkana Vowel Harmony

Finally, I claim that Turkana, an Eastern Nilotic language, provides evidence of the remaining combinations of parameter settings with respect to the direction and locality on h-licensing. I propose that harmony operates from left to right in an unbounded manner.

In addition to being traditionally analysed as a '+ATR' harmony language, Turkana is a language which has received some attention as a '-ATR' harmony language. Noske (1996) presents an analysis of Turkana as exhibiting both '+ATR' and '-ATR' harmony. Her approach follows that of Vago and Leder (1987) who also interpret the Turkana harmony facts in terms of both '+ATR' and '-ATR' harmonies[52]. Before turning to this issue, I try to establish the case for left to right h-licensing. The data discussed below is from Dimmendaal (1983).[53]

Dimmendaal, by using alpha notation, presents an analysis of Turkana in terms of the activity of both + and - 'ATR' harmony. Turkana is claimed to have nine vowels as follows:

[52] Steinberger and Vago (1987) attempt an analysis of another Eastern Nilotic language, Bari, which also manifests 'ATR' harmony, in this case '+ATR' harmony, and not '-ATR' harmony.

[53] Unfortunately, I could find no consultant for Turkana, and the issue of '-ATR' harmony in particular cannot be resolved due to murkiness of the 'facts' as they are presented in the literature.

(76) duk	*build*	dʊk	*hide oneself*
rip	*skim off*	rɪp	*investigate*
ger	*harvest*	gɛr	*tattoo*
mor	*insult*	mɔr	*share food*
		ram	*beat*

Morphologically simplex words of more than one metrical beat are harmonic with respect to 'ATRness', as are stems with certain affixes. *a* does not undergo any harmonic alternation, and patterns with *ɛ*, *ɔ*, *ɪ*, and *ʊ* in a prefix harmony. In the examples below, the gender prefix is realised as either *e* or *ɛ*, depending on the 'ATRness' of the initial vowel in the stem:

(77) *Gender prefix e~ɛ*

ɛ-kabekebeke	*kind of tree*
e-com	*baboon*
ɛ-rɔnɪ	*famine*
ɛ-maɲ	*liver*

The form *ɛ-kabekebeke* shows that *a* may occur in a '+ATR' word, and in this case, it blocks the spread of harmony to the left. The prefix vowel is *ɛ*, not *e*.

The data presented so far suggest that an h-government analysis is possible to explain the events of Turkana vowel harmony. I propose that words are lexically marked as having headed domains, as in Vata and Akan. I propose that *i*, *u*, *e*, and *o* are headed expressions which identify nuclei as h-licensors. On this view, as *a* does not undergo h-government harmony, and does not activate it (as evidenced by the form *ɛ-maɲ* - *liver*, above), it seems that the licensing constraint *A cannot be a head* is active in Turkana.

As in Akan, the direction of the process within words, or roots, may be determined by observations with respect to *a*. Recall that in the right to left harmony in Akan, when *a* occurs in headed domains, it is found only in domain **final** positions. In a right to left harmony, this is the only position in which a headless expression with no headed counterpart could occur, as, according to the revisions to the h-licensing principle I propose, it is the only position which is not itself h-governed. This contributes to the claim that the direction of the process in Akan is from right to left within words.

In the case of Turkana, a survey of the data reveals that when *a* occurs in a word with expressions from the headed set, its distribution is limited to the **initial** nuclear position, as the examples of roots (bolded) show:

(78)	lɔ-ŋatun-o	*name of a tree ('at the lions')*	ŋa-arey	*two*
	ŋa-atuk	*cows*	ɛ-lado	*switch*
	a-kale	*nanny goat*	a-tapen	*guinea fowl*

Words marked for headed domains do not have sequences such as *e-a-ɪ*[54] With respect to the distribution of *a* in headed words, it appears that Turkana is the mirror of Akan. *a*, with no headed counterpart, may only reside in a position which is not itself h-governed. As *a* is only initial in h-domains in Turkana, this shows that h-licensing operates from left to right. This would mean that the 'prefix' harmony cases in (77) must therefore represent cases of analytic morphology which manifest a difference in the direction of the process (as seen in Pulaar).

To summarise so far, I claim that h-licensing takes place in an unbounded manner from left to right. Words are lexically marked as headed domains, and the licensing constraint *A cannot be a head* is active.

However, if we assume Turkana is the same as Akan, except for direction, we need to explain why *a*, or some vowel like the *ɜ* in Akan, does not occur in non-initial nuclei in an headed word, blocking h-government to its right (as would be expected if Turkana harmony is the mirror of Akan). This question is explored below.

The informal identity of *a*'s counterpart in a non-domain initial position in a word with h-licensing is revealed by the occasion of harmony between a stem and a

[54] Words with the following pattern are indeed attested:

iwar	*look*
iwal	*wear*
a-uwasɪ	*fence*

Notice that in these examples, the headed expression *u* or *i* preceding *a*, also precedes the glide *w*. I do not present an account of why this distribution occurs. I point out that these apparent counter-examples contain the context -*w*. Dimmendaal points out that vowels preceding *w* and *y* are **always** 'tense', irrespective of the quality of the vowel following *a*. Given this observation, I conclude that the examples above represent words which are not marked for h-government, and the occurrence of headed expressions preceding *y* and *w* is in response to some structural condition.

suffix. *a*'s h-governed counterpart is apparently *o*. Some relevant examples are presented below:

(79) Itive suffix *-ar~or*

a-buk-or	*pour out*
a-k-ilik-or	*take down*
a-dɛm-ar	*take away*
tam-ar	*think out loud*

In the examples above, the stems with headed expressions, *u* and *i* have the suffix *-or* (*e* and *o* also pattern this way), whereas the ones with *ɛ* and *a* have the suffix *-ar* (*ɪ*, *ʊ*, and *ɔ* also pattern this way).[55] *o* as the headed counterpart to *a* occurs in the harmony processes of other Eastern Nilotic languages: Bari, as well as Maasi also display *o* as the counterpart to *a* in what (in Revised GP terms) would be headed domains.[56]

We can uncover the formal identity of *a*'s harmonic counterpart by considering the following properties. Turkana *o* does not behave opaquely. There are no cases where non-headed expressions occur to either the left or right of it.[57] We may then conclude that *o* is a headed expression. As for an identification in terms of elements for the headed expression *o*, the occurrence of *a* in lexically headed domains in the initial position shows that *A cannot be a head* is operational in Turkana. *o*

[55] Some examples in (79) have a prefix *a-*. I have to assume this prefix is outside the domain of the harmony process.

[56] Dimmendaal (1983) provides examples for Maasai, Steinberger and Vago (1987) provide an analysis of harmony in Bari. *o* as the harmonic counterpart to *a* also occurs in a dialect of the Spanish language Lena Bable (Hualde (1989)), and in a dialect of the Kru (Kwa) language, Dida (Kaye, (1981)). Finally, Abiodun (1991) shows this connection to occur in Igede, an Idomoid language of the Benue-Congo family (spoken in Benue state, Nigeria) which also has *o~a* alternations as part of an h-government harmony system. The examples below are adapted from Abiodun (1991).

3rd person singular prefix o~a 'he'

a rʲɪ idzu	*he ate yam*
a rɔ ilo	*he bought a snake*
o wu idzu	*he planted yam*
o mile ide	*he swallowed saliva*

In the examples above, the personal pronouns agree in headedness with the following vowels of the verb stem. In headed words then, *o* is found instead of *a*.

[57] As far as I can determine, this is also the case in Bari, Dida, Igede, Lena Bable and Maasai.

therefore cannot be the headed expression (<u>A</u>). I suggest that it is in response to the licensing constraint that *o* occurs. *A* can only be interpreted in a headed expression as an operator. I propose that in this language, and in this context, *U* is an ambient element employed as a head here: (A.<u>U</u>).[58] The licensing constraint is not overridden, and we have an explanation of why the h-governed partner of *a* is not opaque.

Returning to the issue of '-ATR' harmony, interestingly, the various accounts in the literature do not concur as to which aspects of the Turkana harmony present cases of '-ATR' harmony. This is surprising as Vago and Leder (1987), Goad (1993), and Noske (1996) all claim to base their analyses of Turkana on data provided by Dimmendaal (1983). Goad assumes the '-ATR' (in her terms [RTR]) harmony to be a process whereby the distribution of consonants and the distribution of vowels are dependant. The data claimed by Noske (1996) to show instances of -ATR harmony, are neither these cases, nor those claimed by Dimmendaal (1983) to be instances of -ATR harmony. I am unsure as to why this confusion has arisen, and offer the following discussion simply to demonstrate that the so-called [-ATR] facts are less than certain. I begin with a discussion of Goad's analysis.

Goad (1993) employs a privative feature framework using [ATR]. '-ATR' is then an undesirable notion. However, instead of denying the existence of the apparent '-ATR' harmony, it is claimed that in some cases, the feature [RTR] is the active ingredient in a vowel harmony process. Goad's argument for the treatment of '-ATR' type harmonies as [RTR] harmonies is summarised as follows. It is claimed that [ATR] harmonies affect only vowels, whereas [RTR] harmonies affect consonants as well as vowels. The type of alternation Goad refers to as a [RTR] type harmony is the distribution of *k* and *q* in Turkana, dependant on vowel quality. *q* occurs in the neighbourhood of *o*, *ɔ*, or *a*, and is otherwise expressed as *k*. The main argument for [RTR] is that it is claimed that [RTR] harmony exists independently of [ATR] harmony. Goad claims that Turkana has both [ATR] harmony and [RTR] harmony. The [ATR] vowels are *i*, *e*, *u*, *o*, whereas the [RTR] vowels are *o ɔ* and *a*. In Goad's terms, the vowel *o* is then both [ATR] and [RTR] in its specification.

[58] The other logical possibility is *I*. Indeed, *e* is the counterpart of *a* in headed domains in another dialect of Dida, extensively discussed by Kaye (1981).

Without a much greater examination of the distributional relationship of elements in nuclei to those in onsets, I cannot offer an analysis of Goad's observations. I suggest that the *k-q* distributional restrictions in relation to *o*, *ɔ*, and *a* might be explained in terms of the elements available in Revised GP, without recourse to any feature or element 'RTR'. Generally speaking, processes where distributional restrictions on onset expressions go hand in hand with distributional restrictions on nuclear expressions, commonly occur. One widely known example of this is the process of palatalisation. In GP terms this is represented in terms of a sharing relationship involving an *I* element 'shared' between an onset and a following nucleus.[59] The distributional restrictions in Turkana may involve the element *A*. *o*, *ɔ*, and *a* behave as a group in Turkana as they are all expressions containing the element *A*, and may be involved in a sharing relationship with *q*.[60] Support for notion of *q* containing an *A* comes from the way in which unlicensed empty nuclei in Uyghur are interpreted. This is briefly referred to in chapter 2, footnote 11. In Uyghur, an unlicensed empty nucleus is interpreted as *ə*, rather than the expected *i* (which occurs in the absence of locally available elements), in the context of a neighbouring *q*. I suggest that *ə* is the interpretation of a headless expression containing *A*.

Goad's claims on [RTR] harmony aside, the so-called '-ATR' harmony facts claimed elsewhere in the literature come from two observations. First, there appear to be 'dominant' '-ATR' suffixes. Secondly, there is a phonetic observation made by Dimmendaal with respect to '+ATR' mid vowels, *e* and *o*, preceding suffixes containing an *ε* or an *a*. Dimmendaal refers to this phonetic effect as 'tensing', which is described as follows. "Vowels with the feature [-ATR] have a hard voice phonetically. The [+ATR] vowels normally sound somewhat breathy, but in the environment of specific [-ATR] vowels, the [+ATR] vowels with the feature [-high, -low] do not have this concomitant feature. Instead, they are realised as tense vowels" (Dimmendaal 1983: 18). Dimmendaal **does not** claim that 'tense' [+ATR] vowels are in fact [-ATR] vowels, and uses another notational device to separate the two types.

[59] See, for example, Kaye (1991) on Polish, Maeda (1994) on Japanese, and Cyran (1995) on Munster Irish.

[60] See Cyran (1994) for the formalities of sharing conditions. One would have to claim that the sharing relationship in Turkana is inhibited by the presence of *I*, in order to exclude *e* and *ε*.

Noske (1996) however, assumes that 'tense' mid vowels and [-ATR] mid vowels are one and the same thing, as reflected in her notation. This is illustrated below.

(81) Dimmendaal[61]	Noske	
abunêrɛ	abunɛrɛ	*come (subjunctive)*

There appears to be some confusion amongst the published sources as to which suffixes involve cases of the 'tensing' phenomenon as outlined above, and which suffixes are [-ATR] dominant. For example, Noske (1996) shows the itive suffix *-or/-ar* to be [-ATR] dominant. The suffix which triggers the harmony is claimed to be the one with the mid vowel (which Noske transcribes as *-ɔr*). However, Dimmendaal (1983), shows the suffix to be recessive in root controlled harmony (see the examples in (79)).

Vago and Leder (1987) show examples to support their claim that the instrumental locative suffix, *-ɛt* is [-ATR] dominant, which are reproduced below.

(81) *verb stem*		*Instrumental-Locative Noun* (Vago and Leder 1987:386)	
-ido-un-	*give birth*	ak-idɔ-ʊn-ɛt	*birth*
-pol-o-un	*grow*	a-pɔl-ɔ-ʊn-ɛt	*growth*

Vago and Leder use these examples to argue for a [-ATR] dominant harmony process triggered by the dominant suffix *-ɛt*. Noske (1996) however, would not concur with this claim.[62] In her analysis [-ATR] spreading is 'parasitic' on [-high]. i.e. [-ATR] harmony can only affect mid-vowels, not the high vowels shown in the examples above. She offers examples such as those below:

(82) akibu	abuɛt	*swell*
akitub	atubɛt	*judge*

In Noske's examples above, and in her terms, the [-ATR] suffix *-ɛt* does not alternate when affixed to a [+ATR] root. It is assumed then to be [-ATR] dominant. However,

[61] Dimmendaal uses a dot under the vowel, I have indicated 'tense' with a circumflex.

[62] This is speculative as Noske does not actually discuss Vago and Leder's analysis.

the preceding vowel *u* does not alternate as it is not specified as [-high] - the condition which must obtain for [-ATR] harmony to take place.

From the point of view of the h-licensing presented in this thesis, I predict that neither Turkana, nor any language, contains manifestations of [-ATR] harmony, which in GP is theoretically inexpressible. Unfortunately, given the confusion over the 'facts' in the literature, I cannot proceed to offer any analysis in other terms.

To summarise so far, I propose that harmonic alternations in Turkana occur of the '+ATR' type only, and that h-government, operating from left to right, combined with the licensing constraint *A cannot be a head*, and a lexical headed domain marking system, is capable of capturing the harmonic process.

4.7 H-Licensing and Other Types of Inter-nuclear Licensing

In order to strengthen the claim that 'ATR' harmony manifests characteristics best captured in terms of an inter-nuclear government relationship, rather than element spreading, I briefly compare it to other inter-nuclear processes, such as stress/pitch accent assignment, proper-government and spreading processes.

As in spreading processes, it seems that the inter-nuclear licensing is not necessarily driven for the purpose of satisfying the licensing principle (all positions in a phonological domain are licensed except one, the head of the domain). By this I mean that the h-licensor (the head of the harmony domain) is not necessarily the head of the phonological domain). Obviously, there are words composed of nuclei which contain only headless expressions. These words must satisfy the licensing principle in another way. Harmony expressed by h-licensing is therefore similar to harmony in terms of element spreading. In languages with element spreading, such as Uyghur, not all words contain instances of spreading elements. Kaye (1989) points out that many phonological processes have delimitative effects. That is, they give information about domain boundaries. Harmony processes contribute to this by helping to detect morpheme/word boundaries.

H-licensing is about the licensing of a particular aspect of the phonological domain: the licensing of a head element in a phonological expression. In this respect, h-licensing is like the licensing potential of elements inferred from the licensing constraints, and like the licensing of empty nuclei by proper government.

H-licensing obviously has some similarities with stress/pitch accent assignment, and proper government with respect to the characteristic bounded and bounded. Given the two structures proposed by Kaye (1990b), it is expected that processes involving projection government will manifest both types. This appears to be the case, and evidence for the bounded type of process is found in Zulu and Pulaar. Evidence for the unbounded type is found in Vata, Zulu, Sesotho, Pulaar and Turkana. In 4.2.2 the two types of structure are illustrated with respect to proper government. The two are also manifested in stress assignment. Charette (1991) analyses stress assignment in French in terms of the unbounded licensing. Segundo (1993) analyses Natal Portuguese in terms of the bounded type.

By contrast, element spreading as a manifestation of inter-nuclear licensing is always unbounded when it takes place from left to right, but always bounded when it occurs from right to left (such as in an umlaut process (See Kim (1996)).

Regarding direction, the direction of h-licensing does not appear to change from projection to projection in words, like proper government, and spreading. Stress/pitch accent assignment however, changes direction from level to level. As mentioned in section 4.2.2, in Japanese pitch accent assignment (Yoshida (1995)) nuclear projection government is head-final at P^1, but head-initial at P^2. Unlike proper government and spreading, and like stress/pitch accent assignment, the direction of inter-nuclear licensing may change when we consider the relationship of phonological domain to phonological domain. A change in direction may then indicate inter-domain harmony (as in Pulaar). Inter-domain h-licensing is not like inter-domain stress or pitch accent assignment, because of the strict requirements on the identification of the governors and governees. It is then more like Proper Government.

To summarise so far, 'ATR' harmony as a manifestation of h-licensing, exhibits many similar characteristics to other inter-nuclear licensing processes: it may be both bounded and unbounded, and may take place from either right to left, or left to right. However, the direction of the process does not change from level to level, as in stress/pitch accent assignment processes. Changes in direction indicate morphological complexity.

4.8 Summary

In this chapter I have shown how a modified version of h-licensing, interacting with a lexical h-marking mechanism, licensing constraints, and universal conditions on constituent structure, can explain a variety of 'ATR' data from different languages: Vata, Akan, Pulaar, Sesotho and Zulu and Turkana. I propose that the two universal structures which Kaye (1990a) proposes are sufficient to capture the variation from language to language, and indeed within one language, of 'ATR' vowel harmony processes. I propose that the direction of the process is determined by a parameter setting. The table below illustrates the possibilities:

(85)

	Bounded	**Unbounded**
Right to left	Zulu.	Zulu, Sesotho, Vata, Akan, Pulaar.
Left to right	Pulaar	Turkana, (Khalkha Mongolian)

In addition to the licensing constraints proposed for Uyghur in chapter 2, some licensing constraints from the hypothetical constraint pool are attested. These are summarised below including those which have *Natural Lexical Head* (NLH) as their subject.

(84)

Licensing Constraint	**Language**
I and U cannot co-occur	Vata, Akan, Turkana
A cannot be a head	Vata, Akan, Pulaar, Zulu, Sesotho, Turkana
Operators cannot be licensed/*NLH*s license no operators	Zulu, Pulaar

The table above is organised by licensing constraint, not by language. Each licensing constraint occurring in the analyses of this chapter appears in the left column, with the languages which manifest it on the right. In cases where there are alternative parameters which effect the same constraints, I have indicated these by using a forward slash, /. Zulu, Sesotho and Pulaar are languages which do not have a lexical h-marking system, and manifest Natural Lexical Heads. i.e. *I* and *U* are Natural Lexical Heads and as such may neither combine with each other, nor occur in the simplex expressions (I) and (U). Vata, Akan and Turkana, on the other hand, have a lexical marking system, and do not manifest Natural Lexical Heads. As such, they require a licensing constraint on *I* and *U*, to the effect that they may not combine.

CHAPTER 5

COMPLEXITY EFFECTS IN H-LICENSING

5.1 Overview

The previous chapter developed Kaye's (1993b) notion of h-licensing, a governing relation between nuclei manifested by constraints on the distribution of headedness of expressions in a phonological string. At the heart of h-licensing is the h-government relation which exhibits characteristics consistent with all governing relations in GP (such as conditions on the identification of governors and governees, locality and so on). In this chapter, I propose that h-government may conform to an additional condition of government: complexity. Harris (1990a) proposes that all sites of government are subject to the Complexity Condition (briefly discussed in chapter 3, with respect to the anomalous behaviour of the cold vowel). He claims that government at the level of nuclear projection is parametrically subject to complexity effects: some languages have it, others do not. The Complexity Condition as a condition on governing relations is then predicted to take effect in the h-governing relation. As h-government is contracted at the level of nuclear projection, it is predicted that h-licensing in some languages will manifest complexity effects, whilst others will not.

In this chapter I propose that the prediction that some languages will manifest complexity effects is indeed borne out. Natal (Brazilian) Portuguese and Yoruba are two vowel harmony languages which have received Standard GP analyses in terms of Ɨ^+-spreading across an A^+-bridge (Segundo (1993), Ola (1992) respectively). When analysed in terms of Revised GP, these 'special cases' of Ɨ^+-spread are instances of h-licensing with what appear to be rather stricter conditions on the identification of h-governors and governees than those defined in the modified version of h-licensing in chapter 4. I evaluate these conditions in terms of complexity.

To begin, data from Natal Portuguese is analysed in terms of h-licensing, and the tighter restrictions on vowel distribution are highlighted in section 5.2.

In section 5.3, an overview of the issue of complexity in phonology is provided. I draw on two proposals of complexity from the literature. First, Harris' (1990a) Complexity Condition is presented. Harris is concerned with defining how complexity is quantified and his arguments focus on its manifestation at different levels of projection of constituent structure.

Dresher and van der Hulst (1995) examine the manifestation of complexity effects in terms of head-dependant asymmetries, and define the notion of 'syntagmatic asymmetry' in terms very similar to Harris. Dresher and van der Hulst are also concerned with the different ways languages maintain syntagmatic asymmetry by defining paradigmatic asymmetry, and provide an enriched vocabulary for discussing complexity effects in h-licensing.

I go on to show that restrictions on vowel distribution in Natal Portuguese may be explained in terms of complexity conditions on h-government in section 5.4. The remainder of this chapter demonstrates that complexity conditions on h-government are not for the purposes of explaining Natal alone, but are manifested in a variety of languages. Section 5.5 examines complexity effects in Vata (mentioned in chapter 4). In 5.6 I suggest an approach to examining vowel alternations which are traditionally termed 'metaphony' in languages spoken in Northwestern Spain. I examine the case of Lena Bable. North-western Spanish languages also include the widely debated Pasiego, traditionally analysed as exhibiting [-ATR]-harmony, and a separate process of vowel 'raising'. However, a discussion of this language is postponed to chapter 6, as the data is less transparent.

This chapter includes discussions of languages which manifest variation in the way in which the Complexity Condition is maintained (i.e. paradigmatic asymmetries) . I show in 5.7 how Ola's (1992) claim that Yoruba vowel harmony is an instance of I^{+} spread conditioned by OCP effects, may be straightforwardly explained in terms of complexity effects in h-government. This is followed with an analysis of a closely related language, Ogori, which manifests similar distributional constraints, but with a different paradigmatic asymmetry. Finally, the chapter is summarised in section 5.8.

5.2 H-Licensing in Natal (Brazilian) Portuguese

As in the literature on south-eastern Bantu vowel harmony, the literature discussing Standard Brazilian Portuguese has focused on the debate over the harmonic feature. [high], [raised], [ATR] and [open] have all been proposed.[1] Also under scrutiny is the issue of the precise nature of the conditions which trigger the harmony. Although all the analyses are, broadly speaking, cast within a Lexical Phonology approach, the nature of the harmony appears to remain controversial. Perhaps this is due to a combination of the nature of the data and the rule-based framework adopted.[2]

Segundo (1993) approaches the vowel harmony problem in the framework of Standard GP, in an analysis of a non-standard dialect, Natal, which exhibits a more transparent type of data. In her analysis, Segundo relies heavily on the I^+ element, but is unable to explain all the alternations in a non-arbitrary way. In this section, I reanalyse the vowel harmony process in Revised GP as the interaction of h-licensing, and licensing constraints. I then go on to highlight the particular characteristic of the vowel harmony which suggests the presence of complexity effects.

[1] For example, see Wetzels (1995) for a treatment using Clements' (1991) scalar height feature [open] (discussed in chapter 1), Quicoli (1990) for an analysis based on [high], Hancin (1991) on [ATR] harmony, and Lopez (1979) on [raised].

[2] Specifically, in Standard Brazilian Portuguese, vowel quality also appears to be conditioned by stress. In some cases it is difficult to ascertain whether it is stress assignment or the vowel harmony rule which conditions vowel quality. In rule-based frameworks it is possible to manipulate the values of features solely for the purposes of feeding the context for the application of a vowel harmony rule. Thus, many analyses of vowel harmony are possible within one framework.

5.2.1 The Natal Data[3]

The lexical vowels of Natal Portuguese are transcribed by Segundo (1993) as the following (1a), with examples in (1b)[4].

(1) (a) Natal vowels: a, i, u, e, ɛ, o, ɔ

(b) t'ira	*she/he removes*	k'ala	*she/he shuts up*		
p'ula	*she/he jumps*	f'esa	*she/he closes*		
z'ɛra	*she/he generates*	k'ɔla	*she/he glues*	fl'o[5]	*flower*

In the vowel harmony process, the following alternations are observable:

(2)

ɛ~(e~i)		ɔ~(o~u)	
(a) k'ɛbri	*break*	(b) k'ɔlu	*I glue*
kɛbr'ava	*I used to break*	kɔl'ava	*I used to glue*
kebr'ej	*I broke*	kol'ej	*I glued*
(c) f'ɛri	*(s)he hurts*	(d) t'ɔsi	*(s)he coughs*
fir'ia	*I used to hurt*	tus'ia	*I used to cough*

The process may be informally described as follows: in a pair of nuclei, the second of which is stressed, nuclei agree in 'height' and/or 'tenseness'. The following distributional generalisations contribute to this hypothesis:

(3)

N_1	N_2 (stressed)
*(ɛ, ɔ)	i, u, e, o
ɛ, ɔ, i, u, e,o, aɛ, ɔ, a	
e, o	e, o
*((e, o), ɛ, ɔ)	i, u
i, u, a	i, u, a, e, o, ɛ, ɔ

[3] All the data are reproduced from Segundo (1993), irrespective of whether she intends it for the purposes of illustrating vowel harmony effects. Her thesis contains 581 words which I used as a body of data against which to test the vowel harmony claims presented here.

[4] Here, and in other presentations of data in which stress is relevant, I indicate a stressed vowel by ' preceding the stressed vowel.

[5] Unlike the other examples in (1), this form is a noun. Segundo notes there is no verb stem with *o*, and concludes this to be an accidental gap. However, elsewhere she provides one form *floridu*, the past participle of the verb *to flower*.

Basically, 'lax' mid vowels cannot be found preceding any 'tense' vowel, and *in some cases*, 'tense' mid vowels cannot be found preceding the 'tense' 'high' vowels. The distribution of *i*, *u*, and *a* is unrestricted.

The harmony process appears to be bounded. 'Lax' mid vowels can indeed precede stressed 'tense' high vowels, but only when separated by an intervening nucleus, as the examples below show:

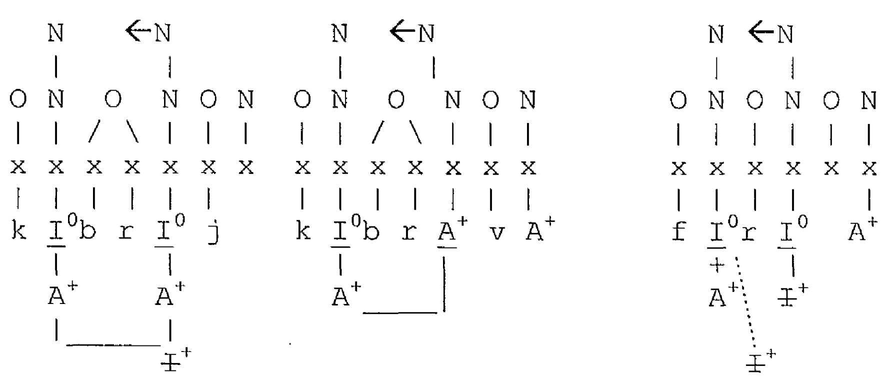
(4) dɛglut'ia *I used to swallow*
kɔlid'ia *I used to collide*

Segundo's analysis for the explanation of the alternations in (2) and constraints on distribution in (3) is based on a right-headed governing relation contracted between nuclei containing A^+ in specific head-operator roles (an A^+-bridge):

(5) **Vowel Harmony in Verbs in the Natal dialect (Segundo (1993))**
Where N1 is the pretonic nucleus and N2 the primary stressed nucleus (head of the domain), the realisation of the governed nucleus (N1) is directly related to the presence or absence of A^+ operators in both the head and in the pretonic (governed) position:
- (a) A^+ operators in governed positions (N1) can only be licensed by A^+ elements in the governing position.
- (b) Ɨ$^+$ spreads from N2 onto N1 across the A^+ bridge (a single element A^+ is attached to two adjacent nuclei).

The alternations manifested in (2) are then instances of the derivations in (6) below:

(6) (a) kebr'ej (b) kɛbr'ava (c) fir'ia



(a) may be explained as follows. The first and second nucleus in the string contract a right-headed governing relation, as the conditions described in (5) are met. The A^+ operator of the first nucleus (the governee) is licensed by A^+ elements in the second nucleus (the governor). Ɨ$^+$ spreads across the A^+-bridge formed by the A^+ licensing relation, and is linked to both nuclei. In (b), the first two nuclei are in a governing relation, as the operator of the first nucleus must be licensed by the A^+ in the second nucleus. However, in this case, although there is the requisite bridge, there is no Ɨ$^+$ to spread. In (c) the A^+ in the first nucleus needs a licensor from the following nucleus (an A^+). However, no licensor is available, and A^+ delinks. The remaining element in the expression is I^0. However, as 'lax' ɪ is not a lexical expression in Natal, Segundo calls on the notion of Structure Preservation to motivate the linking of Ɨ$^+$ as an ambient element, to yield a 'tense' *i*.

Although the proposal is adequate to explain the data, a number of limitations are apparent. First, the governing relationship between the nuclei contracted by A^+ is element specific: it is only A^+ as an operator in pretonic positions which requires special licensing.

Secondly, the derivation in (c), like the derivation in (a), results in Ɨ$^+$ linking. However, on the account here, although the linking is triggered by the same governing relationship, they are essentially unrelated: in (a) Ɨ$^+$ has a local source in the governing nucleus. In (c) Ɨ$^+$ is linked ambiently, as it has no local source.

Another problem is apparent in (c). Segundo claims that in the governing relation between the two nuclei, the governee needs to be 'weaker' than the governor. In Standard GP terms, 'strength' is equated with charm properties: positive charm is strong, neutral charm is weak. Segundo claims that A^+ is lost from the governee because it is positively charmed. However, as the positively charmed element Ɨ$^+$ is linked for the purposes of structure preservation, it is difficult to understand why this element in the governee should be considered by Natal as less of a burden than A^+. Furthermore, at odds with this analysis is the observation that the positively charmed A^+ may appear in the governee as a head in the expression $(\underline{A}^+)^+$ (when it contributes its positive charm to the expression), no matter what expression is linked to the governing position.

Segundo's analysis focuses on the three-way alternations manifested in (2). 'Lax' mid vowels are the only objects targeted in the vowel harmony process. Lexically 'tense' mid vowels do not alternate. Segundo does not attempt to explain why only 'lax' mid vowels are targeted by the process. On her analysis, sequences such as *e/o…i/u* should also be subject to the A^+ licensing conditions in (5), as *e* and *o* both have A^+ operators.[6] As such these sequences should be ruled out.

Finally, the analysis provided by Segundo cannot explain data of the type below:

(7) beber - drink		future	conditional
	1sg	bɛbɛr-'ajs	beber-'ias
	3pl	bɛbɛr-'ãw	beber-'iãw

In the examples above, the conditional *i* in the second column conditions the 'tense' realisation of preceding mid-vowels. However, on Segundo's story, $Ɨ^+$ is linked either via the governing relation manifested by the A^+ bridge, or by ambient $Ɨ^+$ linking in the interests of structure preservation. The examples above manifest no A^- bridge between the trigger and the target. Nor can structure preservation be called on: *ε* can be found lexically in Natal, and so the mid vowel does not have to depend on $Ɨ^+$ linking for its interpretation. In addition, the first nucleus in the string in (7) above is not expected to undergo harmony of any kind, as it is not left adjacent to the stressed governing nucleus.

5.2.2 A Revised Government Phonology Analysis

A Revised GP treatment of Natal vowel harmony provides a straightforward explanation of the data utilising h-licensing and licensing constraints, proceeding in the same way as the analyses of Pulaar and Zulu. I propose the lexical expressions for Natal are as follows:

[6] Segundo represents *e* and *o* as $(Ɨ^+.(A^+.\underline{I}^0)^0)^+$ and $(Ɨ^+.(A^+.\underline{U}^0)^0)^+$ respectively.

(8) lexical expressions for Natal[7]

i ($\underline{I}$)
u ($\underline{U}$)
e (A.$\underline{I}$)
o (A.$\underline{U}$)
ɛ (A.I)
ɔ (A.U)
a (A)

Assuming that Natal is a language which manifests the class of Natural Lexical Heads, these expressions are generated with the following licensing constraint:

(9) Licensing Constraints for Natal: A cannot be a head

The triggers of the harmony are the nuclei containing headed expressions which can identify h-governors in the h-government mechanism. The targets in the process are the headless expressions, as shown below:

(10) Harmony triggers = headed expressions: *i* ($\underline{I}$) *u* ($\underline{U}$) *e* (A.$\underline{I}$) *o* (A.$\underline{U}$)
Harmony targets = headless expressions: *ɛ* (A.I) *ɔ* (A.U), and in principle *a* (A) .

Note that in the set of targets above, *a* (A) is in principle a target of the vowel harmony process. However, the derivation is constrained by the licensing constraint *A cannot be a head*, explaining why *a* does not alternate. The interaction of the phonological expressions generated by the licensing constraints with h-government is illustrated below.

(11) (a) kebr'ej

```
   Nβ  ←  Nα
   |      |
O  N   O  N  O  N
|  |  / \ |  |  |
x  x  x x x  x  x
|  |  | | |  |
k  I  b r I  j
   _      _
   |      |
   A      A
```

(b) kɛbr'ava

```
   Nβ     Nβ    Nβ
   |      |     |
O  N   O  N  O  N
|  |  / \ |  |  |
x  x  x x x  x  x
|  |  | | |  |
k  I  b r A  v  A
   |
   A
```

[7] In Natal, *ɛ* and *ɔ* are headless expressions. However, this is not the case for all Brazilian Portuguese dilaects. See Kaye (in preparation) on the Mineiro, where *ɛ* and *ɔ* are *A*-headed.

The parameter settings for h-licensing are as follows: direction, right to left; licensing type: bounded. In (a) above, the headed expression in the second nucleus identifies the nuclear point as an h-governor, which head governs the preceding nucleus. In (b) there is no h-governing relationship between any of the nuclei in the string.

5.2.3 Remaining Data

Still to explain are the examples of the type below. Notice that a 'tense' mid vowel (*e*, *o*), yielded from the application of h-licensing, is not sustainable preceding a stressed high vowel (*i*, *u*) in the examples below (compare (a) with (b)). However, a 'tense' mid vowel (*e*, *o*) *is* allowed preceding a stressed mid 'tense' vowel (*e*) (compare (c) and (d) below). The relevant examples are provided below.

(12)	(a) f'ɛri	*(s)he hurts*	(b) fir'ia	*I used to hurt*
	t'ɔsi	*(s)he coughs*	tus'ia	*I used to cough*
	(c) kɛbr'ava	*I used to break*	(d) kebr'ej	*I broke*
	kɔl'ava	*I used to glue*	kol'ej	*I glued*

However, it seems that in some cases, 'tense' mid-vowels *can* occur preceding stressed 'tense' high vowels, as the following examples show:[8]

(13) fir'idu/*fer'idu *hurt (past participle)* **but...**
flor'idu/*flur'idu*flowered (past participle)*

kɔnvehz'ia	*to converge*
diverhz'ia	*to diverge*
kabes'ina	*little head*
mez'ina	*little table*

[8] Segundo's thesis does not contain many examples of this type. However, I assume many others to exist in Natal given the following: "throughout this analysis we have considered the behaviour of lax mid vowels that can be primarily stressed, since they are the only ones that can undergo simplification" (Segundo (1993: 59). The forms *kɔnvehz'ia - converge* and *diverh'ia - diverge* are listed by Segundo as counter examples, although she does not offer evidence that they contain lexical 'lax' mid vowels.

I propose that the observations above show complexity effects to be operative in Natal Portuguese, and that they may be explained by a combination of h-licensing, and the Complexity Condition (Harris (1990a)). Before an analysis proceeds, the issue of complexity is discussed below.

5.3 Complexity in Phonology

The issue of complexity in phonology has been discussed in the literature by Harris (1990a), and Dresher and van der Hulst (1995). Basically, Harris' Complexity Condition on sites of phonological government raises the expectation of complexity effects in h-licensing. Harris' formulates the Complexity Condition in terms of relative complexity: the governee may be no more complex that the governor. He focuses on the manifestation of complexity effects between nuclei in terms of the suppression of melodic material in the governee. Dresher and van der Hulst (1995) formulate complexity in similar terms to Harris: the head position allows for, or requires, a greater complexity than its dependant. However, they also observe that two types of asymmetry are captured: paradigmatic, and syntagmatic. In order to analyse in detail the complexity effects manifested in h-licensing, the proposals of both Harris (1990a) and Dresher and van der Hulst (1995) are briefly summarised below.

5.3.1 The Complexity Condition (Harris(1990a))

In Harris' Complexity Condition, the complexity effects of the Condition are such that a governee may never be more complex than its governor.

(14) **Complexity Condition** (Harris 1990a)

> Let α and β be segments occupying the positions X and Y respectively. Then if X governs Y, β must be no more complex than α.

Harris claims that the Complexity Condition is strictly enforced at P_0 (the skeletal level), but relaxed at the level of nuclear projection (where h-licensing takes place). Some systems enforce it, others do not. He points out (Harris 1994a: 178) that this variability is consistent with the variability of other phenomena manifested by inter-nuclear licensing in the sense that not all languages have vowel reduction or vowel harmony. *Complexity gradients within governing domains,* is then a parameter at the level of nuclear projection. In Harris' terms, segmental complexity is straightforwardly calculated in terms of the elemental composition of a segment.

Harris provides examples of when a complexity gradient is manifested in inter-nuclear licensing. As mentioned above, one manifestation of the complexity gradient is vowel reduction in a metrically weak position. This phenomena is analysed as a complexity issue by Harris (1994a, 1994c). Harris (1994) discusses Bulgarian and Catalan. In stressed position, Bulgarian manifests the vowel system *i*, *e*, *a*, *o*, *u*. In metrically weak positions, *i* and *e* neutralise to *i*, *o* and *u* neutralise to *u*, and *a* is reduced to *ɐ*. Catalan manifests a similar process. *e*, *ɛ* and *a* are reduced to *ɐ*, *ɔ*, *o*, and *u* are reduced to *u*. *i* remains *i*. In both these languages, vowel reduction manifests the maintenance of the Complexity Condition, as the positions in which reduction occurs (in terms of the suppression of elements), are recessive (i.e. they are governees of the stress head). Complex expressions are not licensed in recessive positions.

5.3.2 Head Dependant Asymmetries

Dresher and van der Hulst propose that phonological heads show the maximum complexity allowed by a grammar. Heads and dependants may be equally complex, but if there is an asymmetry, it will always be the head that is more complex than the dependant. They locate the origin of these Head-Dependant Asymmetries (HDAs) in the acquisition process. Learners begin with relatively impoverished representations and move to richer representations under pressure of data. The strategy of 'pay attention to heads' implies that heads will be expanded before dependants. In many cases, the dependants catch up, but when they do not, the result is an HDA.

Like Harris, Dresher and van der Hulst point out that complexity is a relative notion, as illustrated below.

(15) Local HDA (Dresher and van der Hulst 1995:403):

```
    (a) complex   simplex            (b) complex   simplex
           C         C                      C         C
          / \        |                      |
         D   D       D                      D
```

In the examples above the complex structure is always relatively more complex than the simple one. In (a), in the leftmost structure, node C branches and is therefore more complex than the node on the right, which does not. In (b), the left hand node does not branch, but nonetheless has a dependant. It is complex when compared with the node on the right, which has no dependant. Complexity is therefore relative, as what goes for complex in (b) is equivalent to simplex in (a). The structures above illustrate *local* complexity. By *local* complexity, Dresher and van der Hulst refer to the *immediate* dependants of the node C. However, *non-local* complexity may also play a role in HDAs. Non-local complexity manifests the structures below.

(16) Non-Local complexity (substantive HDA) (Dresher and van der Hulst 1995: 403-404)

```
    (a) complex              (b)   simplex
           C                          C
           |                          |
           D                          D
          / \                         |
         E   E                        E
```

In (16) the internal structure of the immediate daughters of node C (i.e. node D) is relevant, rather than the complexity of node C itself (compare with (15)).[9]

Dresher and van der Hulst go further in their characterisation of complexity, and define two basic types of asymmetry covered by the notion that the head position allows (or requires) a greater complexity than the dependant position. These types are

[9] Dresher and van der Hulst (1995) also refer to another type of non-local complexity, which they call visibility. This is the case of non-local complexity taking effect (i.e. being visible) only when a certain item is the head position. This same item does not manifest complexity effects (i.e. is not visible) when the item is elsewhere. This is different from substantive non-local complexity where head and dependant positions have specific complexity requirements. As the visibility/non-visibility type of complexity is not relevant to the data under discussion here, I do not go into details.

identified as (a) paradigmatic asymmetries and (b) syntagmatic asymmetries, as defined below.

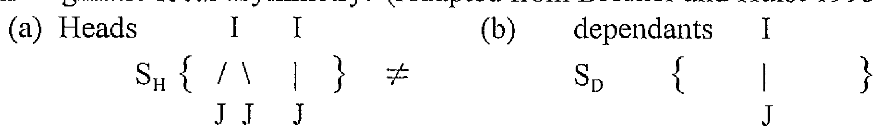
(17)

(a) Paradigmatic (lexical) asymmetry (Dresher and van der Hulst 1995:405)
The set of things, S_H, that may occur in H and the set of things S_D that may occur in D is non-identical: $S_H \neq S_D$

(b) Syntagmatic asymmetry
In a specific combination, C, what actually occurs in D may not be more complex than what occurs in H: $C_H \geq C_D$

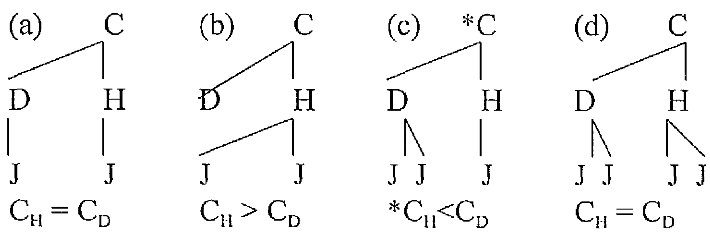
The two types of asymmetries are illustrated as follows. First, a paradigmatic local asymmetry is shown:

(18) Paradigmatic local asymmetry: (Adapted from Dresher and Hulst 1995: 405)



In the paradigmatic asymmetry above, in the head, node *I* may branch or not, but in a dependant, node *I* may not branch. The syntagmatic HDA is illustrated below.

(19) Syntagmatic Local asymmetry - permissible combinations



The definition of the syntagmatic asymmetry is essentially Harris' Complexity Condition. When applied locally in the structures above, the definition in (17b) permits (19a) and (19d) above, where the heads are of equal complexity to the dependants. (19b) is also permitted, where the head has greater complexity then the dependant. However, the structure in (19c) is not defined by syntagmatic asymmetry, and is ruled out.

Dresher and van der Hulst point out that a head is not only a constituent that is somehow more prominent or salient than a dependant, but must in addition have a well-defined relation to that dependant in terms of some higher level structure (in GP terms, a governing relation). They illustrate HDAs at all levels in the 'prosodic hierarchy'. For example, local HDAs, both syntagmatic and paradigmatic, are used to characterise the varieties of quantity sensitive trochees (left-headed binary metrical head-dependant relationships, referred to as a 'foot'), in terms of whether or not the head must branch, the dependant may not branch and so on.

(20) Varieties of quantity sensitive trochees (left-headed) H = heavy (complex)
Logical possibilities which manifest HDAs L = light (simplex)

Language type	**HL**	**LL**	**HH**	**LH**	**type of HDA**
(a)	yes	yes	yes	no	syntagmatic only
(b)	yes	yes	no	no	weak paradigmatic
(c)	yes	no	yes	no	weak paradigmatic
(d)	yes	no	no	no	strong paradigmatic

In the chart above, the foot types allowed by each language type are summarised. No quantity-sensitive language allows the dependant to be more complex than the head (*LH). All the language types therefore manifest a syntagmatic HDA. There is no paradigmatic asymmetry in (a) above since the set of 'syllables'[10] which can appear in the head (S_H) is the same set of 'syllables' which can appear in the dependent (S_D):in both cases, {H, L}.

However, the types of feet allowed by languages (b)-(d) exemplify the distinction between paradigmatic and syntagmatic HDAs. The asymmetry that may arise between S_H and S_D may take various forms. In (d), S_H and S_D are disjoint: S_H = {H} and S_D = {L}. (d) has a strong paradigmatic (lexical) asymmetry. There is no intersection between the head and dependant lexicon. The other two cases (b) and (c) illustrate weak paradigmatic asymmetry: in (b), S_D = {L} is properly included in S_H = {L, H}; in (c) it is *vice versa* - S_H = {H} is properly included in S_D = {L, H}. (b)

[10] The term 'syllable' has no formal identity in GP, and is used as a shorthand to refer to the P^0 licensing configuration driven by nuclear skeletal points. I use it here simply because I follow Dresher and van der Hulst.

specialises in the metrically weak lexicon (S_D): dependants cannot branch. (c) specialises in the metrically strong lexicon (S_H): heads must branch.

Dresher and van der Hulst point out that with respect to stress phenomena, 'syllable weight' can also be distinguished by non-local (in their terms 'segmental') properties. i.e. the number of elements which are contained within the expression in the nucleus. Like Harris, they note that various languages have different 'segmental' inventories for positions of stress heads, and the dependants of those heads, identifying these as HDAs. Similar data is discussed.

Constraints on the complexity of phonological expressions of heads and dependants in stress phenomena identified by Harris (and Dresher and van der Hulst) parallels the head-government cases under discussion in this chapter. Heads and dependants in the h-government relationship are defined non-locally (in Dresher and van der Hulsts' terms), as follows. Whether or not the nuclei in head positions branch is irrelevant to the relation. It is not the case for example, that only 'long vowels' can h-govern.[11] However, the composition of the phonological expression contained in the nucleus is relevant to the h-governor-governee relationship. This issue is taken up by returning to the Natal Portuguese analysis below.

5.4 Complexity Effects in Natal

Recall that in Natal, we have yet to explain why *ε* and *ɔ* alternate with *i* and *u* before a stressed high vowel *i/u* (e.g. *f'εri* → *fir'ia*), but *ε* and *ɔ* alternate with *e* and *o* before a mid vowel *e/o* (e.g. *kɔl'ava* → *kolej*). Supposing the Complexity Condition to be effective in Natal, the examples of this type (which are in (12)) can be explained by a combination of licensing constraints, and h-licensing.

[11] However, it may be the case that the branching nuclei may not be h-governees. This could be explained in two ways: (1) The Minimality Condition (see Charette (1989)), under which the P^0 nuclear governor projects its own governing domain, which may not be penetrated by an external governor; and (2) The 'Cold Headedness Constraint' explored in the previous chapter with respect to Zulu. As headless expressions may not be associated to branching structures, a branching nucleus can never be identified by a headless expression and can therefore never be identified as a β in an h-government relation.

(21) Complexity Condition effects in Natal

(a) fir'ia (cf. f'ɛri)

```
  Nα ← Nβ          P1
  |    |
O N  O N  O N
| |  | |  | |
x x  x x  x x      P0
| |  | |    |
f I  r I    A
  +
  A
```

governee more complex than governor

(b) kebr'ej

```
  Nα  ←  Nβ
  |      |
O N   O  N O N
| |  / \ | | |
x x x  x x x x
| | |  | | |
k I b  r I j
  |      |
  A      A
```

governor and governee of equal complexity

In example (a) above, the h-governing nucleus identified by (I̲) h-governs the preceding nucleus (lexically, the headless expression (A.I)). However, as the governor is less complex (in terms of elements) than the governee, the operator element, *A*, delinks. In (b), on the other hand, the h-governor is the complex expression (A.I̲), and the governee is of equal complexity. No operator delinking is then required. The Complexity Condition is maintained. The governee is no more complex than the governor.

Notice that complexity is a condition placed on h-government, a governing relation with specific identity requirements of its governors and governees. The distributional restrictions observed in Natal cannot be explained in terms of stress-induced reduction. Complex expressions (such as *ɛ* (A.I)) are indeed found preceding simplex expressions in stressed positions (such as *a* (A)). In addition, the complex expressions *e* and *o* ((A.I̲) and (A.U̲)) are found preceding *i* (I̲) and *u* (U̲). This distribution is not expected if we analyse it in terms of stress conditioned reduction. These last cases can only explained in terms of h-licensing: they are not in positions involved in h-governing relations.

In terms of Dresher and van der Hulst, the h-governing relationship is a non-local head-dependant asymmetry: all instances of h-government depend on governors and governees being identified *not by the structure of the nuclei themselves* (h-government is 'quantity insensitive' at the level of nuclear projection[12]), but rather the

[12] Although note the interaction of the general principles cited in footnote 10

structure of the expressions they dominate. In evaluating complexity, the notion of headedness obviously cannot be 'translated' into the branching, non-branching distinction in the illustrations of HDAs provided by Dresher and van der Hulst. HDAs in terms of complexity alone seems insufficient to define governing relations. In these terms, it would be impossible to distinguish between stress conditioned vowel reduction, and the type of 'height' harmony under discussion here. However, with respect to the complexity effects evaluated by the number of elements in an expression, a complex expression (two elements in the Natal examples) equates with a branching structure, a simplex expression (one element, here) is a simple structure:

(22) (a) substantive non-local HDA

```
Y' ←   X'
|      |
Y      X
|      |
x      x
|      |
I      (I)
+
A
```

In the illustration above, X and Y are nuclei which contract an h-governing relation via their projections (X' and Y'). In this example, the structure of the constituents X and Y is irrelevant to the conditions of government.[13] However, (22) shows the effects in a language like Natal Portuguese, where the structure of the (non-local) phonological expression is relevant to the governing relation. The expression in the governee is relatively more complex than the governor, and in response to this condition, the expression simplifies: the operator is delinked. In Dresher and van der Hulst's terms, governing relations in Natal are instances of substantive non-local syntagmatic HDAs.

An advantage of utilising some notion of complexity as a condition on the h-government relation is that it provides an explanation of Natal harmony without having to make special reference to the licensing of the *A* element. Complexity effects are not manifested when the expression (A) is in a stressed nucleus, nor when

[13] However, recall the general principles with respect to governees referred to in footnote 10.

it is in a pre-tonic nucleus because h-government does not take place when (A) occupies either of these positions in the string.

Complexity effects in h-government also explain the cases in (13) (reproduced as (23) below), where a headed complex expression precedes a headed simplex expression.

(23) fir'idu/*fɛr'idu *hurt (past participle)* **but...**
flor'idu/*flur'idu*flowered (past participle)*

kɔnvehz'ia	*to converge*
diverhz'ia	*to diverge*
kabes'ina	*little head*
mez'ina	*little table*

I propose that in these forms, no h-government takes place. The pretonic complex headed expression is generated by the licensing constraints as a headed expression, and is not the governee in an h-government relation. No simplification (A-delinking) is predicted to take place. This is supported by two distributional observations: (1) headed complex expressions can be found preceding headless expressions, indicating that lexically headed expressions do not depend on h-government for their interpretation (see (a) below), and (2) semantically and phonologically related forms do not manifest 'lax' mid vowels ((b) below):

(24) (a) fes'ava *she/he used to close*
amor'ɛku *sweetheart*
idirejt'ava *she/he tied up*

(b) kab'esa	*head*	kabes'ina	*little head*
m'esa	*table*	mez'ina	*little table*

Finally, data of the following type, which could not be explained by Segundo, remain to be explained:

(25) *drink*

	future	conditional
1sg	bɛbɛr-'ajs	beber-'ias
3pl	bɛbɛr-'ãw	beber-'iãw

In the examples above, the *i* in the conditional appears to condition the 'tense' realisation of the preceding mid vowels. However, given the analysis proposed here (h-licensing and the Complexity Condition), how is it possible that h-government does not induce complexity effects? Furthermore, the alternations above are anomalous in that *two* pre-tonic expressions appear to be affected. This is not expected, given that h-licensing in Natal is bounded.

To explain why h-government appears to have two governees, I suggest that the data above may be a case of the following generalisation Hancin (1991) makes for Standard Brazilian Portuguese. She proposes that the harmony process is non-iterative (unbounded), except in the cases where the trigger is preceded by two *identical* vowels:

(26) Standard Brazilian Portuguese (Source: Hancin (1991))

(a) form'ɔs-a	*beautiful*	(b) furmus-'ura	*beauty*
promet-'er	*promise*	promit-'idu	*promised*

Hancin explains this phenomenon in more traditional terms, by claiming that when the 'feature bundles' for two adjacent vowels are identical, the features are effectively doubly linked. The observation that harmony appears to apply iteratively only in the cases where the governees have identical expressions, seems to hold also for Natal.[14]

Following Hancin (1991), I suggest that h-government takes place in a strictly local fashion, but the complexity effects cannot be manifested, as the expression in the governee is strongly anchored (for clarity, I have not shown the association of expressions to onsets).

[14] In Segundo's thesis, all instances where harmony appears to take place in an unbounded manner are cases where the governees have identical expressions. However, it should be noted that Segundo's thesis does not contain any example where two pre-tonic headless expressions of different composition (as in (25)) occur preceding an h-governor, so the analysis I suggest here cannot be conclusively proven in the absence of this type of data.

(27)

```
      Nβ   ←  Nα   Nβ
     /   \    |    |
   O N O N O N O N O N
   | | | | | | | | | |
   x x x x x x x x x x
     \   /    |    |
     (A.I)   (I)  (A)
   beber'ias
```

I have no explanation for why (A.I) should be doubly anchored. The nuclei are not in a P^0 governing relation, so I assume an inter-nuclear licensing arrangement to hold at the level of nuclear projection.

To summarise so far, the analysis of vowel alternations in Natal as the interaction of licensing constraints, head-licensing, and the complexity condition provides a principled explanation of vowel distribution in Natal. In particular, it can explain why mid-vowels which undergo h-licensing yield 'tense' high vowels, without recourse to the notion of 'ambient' elements, the special licensing requirements of A^+, and without also creating the expectation that *e* and *o* will also be involved in harmony.

5.5 Complexity Effects in Vata

Complexity Effects in h-licensing can be observed generally, and are not simply proposed as a convenient solution for Natal. Complexity effects are also manifested in Vata in morphologically complex forms. The plural formation is briefly discussed in chapter 4 in the context of identifying the h-domain counterpart of (A). The relevant examples are reproduced below:

(28)

	singular noun	plural 1	plural 2	
(a)	vɛda	vɛdɪ	*vɪdɪ	*cheese*
(b)	neflu	nefli	*nifli	*ear*
(c)	golo	goli	guli	*mound*
(d)	menʌ	meni	mini	*nose*
(e)	tʌkwʌ	tʌkwi	-	*basket*

In the examples above, Walker proposes that the strategy for plural noun formation is to 'replace' the domain final nuclear expression of the singular noun with the element *I*, as shown below:

(29) plural noun formation (Walker 1995:116)

singular form	plural form
<vɛda>	<vɛdɪ>
h<nide>	h<nidi>

As the data in (28) show, in certain cases, two noun plural forms are possible, one which is simply the stem plus i/ɪ (*meni*); one which exhibits what Kaye (1982) terms 'raising' (*mini*). The data above show that the (raised) alternative plural is only available in h-domain words. In addition, both vowels of the singular must be drawn from the set {ʌ, e, o}.[15]

The fact that the raising process occurs *only* in h-domain words makes it a prime candidate for a complexity condition analysis. I propose the *e~i*, *o~u* alternations to result from h-government and the complexity condition, as illustrated below:

(30)

```
       Nβ ← Nα
       |    |
O      N  O N
|      |  | |
x      x  x x
|      |  | |
m      I  l (I)      meni ~ mini      noses
       +
       A
```

In the illustration above, the headed expression of the plural (I̲), identifies an h-governor which h-governs an h-governee to the left identified by a headless complex expression. Complexity effects are manifested: the headed complex expression in the

[15] Walker (1995) interprets this condition in terms of both vowels having to contain the element *A* lexically. Kaye (1982) interprets the condition in terms of the process being inhibited in forms where the second vowel of the singular is specified by [high] (*i*, *u*). I have nothing to contribute to identifying the condition here, and set the matter aside for further research.

governee position may not be more complex than the governor, triggering operator delinking.

In (28e) above, (*tʌkwʌ*, *tʌkwi*) there is no alternative plural even though the requirements are met: it is an h-domain, and both nuclei of the stem contain *A* in the singular. However, a nucleus containing *ʌ* (A̲) is not targeted by the process as this is not a complex expression, and cannot be more complex than its governor.

H-government and the Complexity Condition then make it no accident that raising effects are manifested only in h-domain words, and explains why the complex expressions are targeted by the process, but the simplex expressions are not. Like h-licensing the Complexity Condition seems to be optionally enforced only in these cases of morphological complexity. Raising is not shown (neither in Kaye (1982) nor Walker (1995)) to optionally occur in forms which are obviously morphologically simplex.

5.6 Complexity Effects in H-government: metaphony in north-western Spanish

Vowel harmony in languages from north-western Spain exhibit what is traditionally described as metaphony. The languages claimed to manifest metaphony effects are Lena Bable, Tudanca Montañés, and Pasiego Montañés. These harmonic effects have been variously described as 'fronting' 'centralising' 'raising' and 'lowering', with the issue of the nature of the process being widely debated (and continuing to be so)[16]. *i* and *u* behave as natural class in these languages in triggering harmony, and many of the treatments in the literature make heavy use of the feature [+high]. Indeed Kaze (1991) claims that a model lacking the feature [high] (specifically, Shane's Particle Phonology) is incapable of explaining metaphony.

Given the discussion of h-government and complexity effects presented in this chapter and the preceding one, Revised GP makes the strong prediction that where *i* and *u* behave as a natural class triggering vowel harmony, these cases are instances of h-licensing. In this section, I suggest an approach to analysing north-western (Asturias-Cantabria) Spanish vowel harmony founded on h-licensing (constrained by licensing constraints) and its associated complexity effects. I focus on

Lena Bable here, as the data (as it is presented in Hualde (1989)) presents a straightforward case. Tudanca and Pasiego are less transparent, and a discussion of these languages is postponed to chapter 6.

5.6.1 Vowel Harmony in Lena Bable

Lena is claimed to have a five-vowel system as follows: *i u e o a*. As there are only two mid vowels *e* and *o*, these are transcribed using the standard alphabet. As for their quality, their behaviour (detailed below), suggests they are 'lax'. However, as Hualde's (1989) analysis uses feature theory, this quality is not indicated.[17]

Words ending in *u* and *i* trigger a process called vowel raising in a preceding vowel. *e*, *o* and *a* are affected. *i* and *u* do not alternate. Some examples are provided below[18]:

(31) (a)

masc. sg.	masc. pl.	fem. sg.	
g'etu	g'atos	g'ata	*cat*
n'inu	n'enos	n'ena	*child*
f'iu	f'ios	f'ia	*son/daughter*
k'ubu	k'ubos		*pail*
ts'ubu	ts'obos	ts'oba	*wolf*
'isti		'esta	*this*
'isi		'esa	*that*

The trigger and target in this process have an added requirement: they must be the final, and the stressed nucleus in the word respectively. In the examples above, the trigger and target are adjacent, but this is not necessarily the case:

(32)

masc. sg.	masc. pl.	
silik'utiku	silik'otikos	*suffering from silicosis*
trw'ibanu	trw'ebanos	*beehive*

[16] See McCarthy (1984), Vago (1988), Hualde (1989), Harris (1990b), Polgardi (1996).

[17] Recall from chapter 1 that in feature theory, a vowel system such as that of Lena has only three heights. The features [low] and [high] are sufficient to describe this vowel system, without employing features such as [tense] or [ATR].

[18] It happens that very few words end in *i* anyway, so most of the examples are of *u*.

The harmony process therefore appears to be sensitive to the nuclear licensing configuration established for stress assignment.[19]

Hualde (1989) explains the distributional restrictions in Lena in terms of the leftward spreading of the feature [+high] via trees built for stress, stipulating that the trigger must be the final vowel, and the target must be the stress head.

Hualde notes that one might be tempted to an analysis of lowering (in GP terms, A-spreading). He points out two factors which contribute to a rejection of this approach. First, in morphologically complex forms (In GP terms, analytic domains), the mid and low vowels of the alternating forms occur, rather than the raised counterpart, suggesting these mid and low vowels are lexical, rather than derived through spreading, as the examples below show:

(33) **masc sg**	**fem sg**		**complex form**	
f'undu	f'onda	*deep*	fond'iru	*lower*
p'eʃaru	p'aʃara	*bird*	paʃar'in	*little bird*

Notice the low/mid vowels (*e*, *o*, *a*) in the complex forms occur in the absence of any source for [low]. It is then the case that the masculine singular forms are derived from the stem manifested in the feminine singular forms, and not vice versa. This is supported by another factor. Consider the forms below:

(34) **masc sg.**	**fem sg.**	
f'iu	f'ia	*son/daughter*
f'iu	f'ea	*ugly*

If lowering harmony were are work, triggered by *e/o/a* in Lena, the feminine singular form for *son/daughter* would not be expected. However, a raising story in which harmony is triggered by *i/u* allows for both *fia* and *fea* as well-formed.

Following the analysis of h-licensing and complexity effects developed in this and the preceding chapter, I propose that the vowel harmony is a manifestation of

[19] In the examples in Hualde (1989), only *i* and *a* are shown to intervene between the final nucleus, and the stressed nucleus, in examples of 'antepenultimate' stress assignment. As only a few examples are provided, I cannot say whether or not this observation is in any way significant.

h-licensing and the Complexity Condition maintained by the decomposition of the h-governee. On this view, as *i* and *u* trigger the harmony, but do not themselves alternate, I propose they are headed expressions, ($\underline{I}$) and ($\underline{U}$) which identify h-governors (and cannot identify h-governees). *e* and *o* are lexically headless expressions, (A.I) and (A.U) and identify governees in the h-government process. As for the status of *a*, it never triggers the process, so I propose it is the lexically headless expression, (A). However, unlike Natal, *a undergoes* harmony, alternating with *e*.[20] From the discussion of h-licensing in chapter 4, it seems that this *e* could be one of two possible objects: either (1) the interpretation of a headed expression ($\underline{A}$), or (2) the interpretation of the empty expression, ( ), yielded through the application of the constraint *A cannot be a head*. This interpretation could in principle be (A.I) or (A.$\underline{I}$). One way of determining which expression is yielded would be by observing the behaviour of this *e* in terms of opacity (as is seen in the comparison of Akan, Vata, and Turkana). However, as the harmony process is bounded in any case, taking place only between the final nucleus and the stressed nucleus, opacity is not an issue. I return to the identity of raised *a* (A) after illustrating h-licensing. The h-licensing process is illustrated below:

(35)

```
        ↓_____________↑
        Nβ    →       Nα     h-government
        |             |
        N  →   N      N
        |      |      |
        N      N      N
        |      |      |
        x      x      x
        |      |      |
   trw  I   b (A)  n (U)
        +
        A
   trw'ibanu (cf. trw'ebanos)      beehive
```

[20] Hualde notes that in a neighbouring language, Nalon Valley, it is reported that in a similar process, *a* alternates with *o*.

In the illustration above, the rightward pointing arrows at each level of nuclear projection represent the inter-nuclear licensing arrangement for stress assignment.[21] H-government then shows sensitivity to the stress licensing structure, and it takes place between the stress head (h-governee) and its immediate licensee (h-governor). The governor and governee are of course identified by headed and headless expressions, ($\underline{\mathrm{I}}$) and (A.I) respectively.

H-licensing in Lena also manifests complexity effects. In the example above, at l-structure, β contains a headless expression (A.I). However, at p-structure, the Complexity Condition is manifested (an HDA) by the decomposition of (A.$\underline{\mathrm{I}}$) to ($\underline{\mathrm{I}}$), (exhibiting a syntagmatic asymmetry). This also occurs when an expression containing (A.U) is h-governed by a simplex expression. (A.$\underline{\mathrm{U}}$) decomposes to ($\underline{\mathrm{U}}$).

As the Complexity Condition clearly applies in these cases, the identity of *e*, the h-governed counterpart to *a* can be refined. As the headed complex expression (A.$\underline{\mathrm{I}}$) is barred from the p-structure governee (*e* alternates with *i*, see (35)), then the equally complex (A.$\underline{\mathrm{I}}$) yielded from lexical (A) must also be barred. Having ruled out an (A.$\underline{\mathrm{I}}$), the following possibilities remain. When (A) is h-governed, (1) ($\underline{\mathrm{A}}$) is possible as it has equal complexity to its governor (($\underline{\mathrm{I}}$) or ($\underline{\mathrm{U}}$)); or (2) (A.I) is also possible. On this last view, the licensing constraint *A cannot be a head* is enforced. The expression (A) decomposes in a β position, and the resulting empty expression is interpreted as (A.I).

Specific predictions are made by these two suggestions which contribute to discovering the identity of *e* further. First, as a headed expression, ($\underline{\mathrm{A}}$) *e* would be predicted to identify an h-governor. Secondly, (A.I) *e* as a headless expression is predicted never to identify an h-governor. The data shows that only ($\underline{\mathrm{I}}$) *i* and ($\underline{\mathrm{U}}$) *u* identify h-governors. I therefore conclude that (A) in a β position yields (A.I).

To summarise so far, I have shown that h-licensing with complexity effects, interacting with licensing structures built for stress assignment is capable of providing

[21] Hualde assumes stress to be assigned in basically the same way as it is for Castilian Spanish: build a left-headed foot from the right edge of the word. This recipe provides the 'unmarked' penultimate stress pattern. However, in the case of antepenultimate stress (as in the example above), the two nuclei to the right of the stress head are included as dependants in the foot.

a reasonably straightforward explanation of the vowel alternations traditionally termed metaphony in the Romance language Lena Bable.

5.7 H-Government and Complexity Effects in Yoruba and Ogori

Yoruba is a language claimed to exhibit [-ATR] harmony (Archangeli and Pulleyblank (1989)). However, Ola (1992) in a Standard GP approach demonstrates Yoruba to exhibit a special case of Ɨ⁺ harmony.[22] Ogori has also been analysed in terms of [ATR] harmony (Chumbow (1982), Calabrese (1988)).

In this section, I reanalyse Yoruba and Ogori harmony in terms of h-licensing, and propose that their 'special properties' are in fact a straightforward case of complexity effects. Complexity in h-licensing in these languages manifests not only the effects of the Complexity Condition, but also in Dresher and van der Hulst's terms, weak types of the paradigmatic asymmetry defined in (17), and illustrated with foot types in quantity-sensitive stress systems (20). I claim that Yoruba manifests a type of weak paradigmatic asymmetry specialising in the head lexicon (the set of expressions which may occupy governor positions). Ogori manifests a type of weak paradigmatic asymmetry specialising in the dependant lexicon (the set of expressions which may occupy governee positions). First, I present the Yoruba data, followed by a brief summary of the various treatments of the harmony process presented in the literature. Then, using the tools of h-licensing and complexity, I provide a Revised GP version of events. This is followed by a discussion of Ogori.

5.7.1 Yoruba Harmony Data

Yoruba appears to have seven lexical vowels (like the Sesotho system discussed in chapter 4), as the examples below show:

[22] Dunn (1989a) refers to a paper in preparation authored by Dunn and Nikiema titled 'Against [–ATR] harmony: the case of Yoruba'. However, I cannot find a reference to any published version, nor do I have access to the manuscript. I therefore base the discussion of Yoruba as a language exhibiting 'ATR' harmony on Ola's (1992) M. A. dissertation.

(36) (Source: Ola (1992))[23]

jɛ	*deliver*
ka	*read*
ʃe	*do*
ʃu	*make into a ball*
wi	*say*
gbɔ	*hear*
gbo	*mature*

In Yoruba, mid vowels in a word must agree in 'tenseness', as the tables below show (adapted from Ola 1992: 11)[24]. Note that (a) and (b) concern the same sequence. I have organised them in different ways so that the distributional restrictions can be clearly identified.

(37)

(a) N1[25]	N2	(b) N1	N2
i	i e ɛ a ɔ o u	o ɔ a ɛ e i	i
e	i e o u	o a e i	e
ɛ	i ɛ a ɔ u	ɔ a ɛ i	ɛ
a	i e ɛ a ɔ u	ɔ a ɛ i	a
ɔ	i ɛ a ɔ u	ɔ a ɛ i	ɔ
o	i e o u	o a e i	o
		i e ɛ a ɔ o	u

The restrictions on distribution can be informally summarised as follows. 'Lax' mid vowels (*ɛ ɔ*) cannot precede 'tense' mid vowels (*e o*), although they may precede the 'tense' high vowels (*i* and *u*). Moreover, it is claimed that 'tense' mid vowels (*e o*) cannot precede *a*, *ɛ* and *ɔ*, and are found only before *i*, *u*, *e*, and *o*. These restrictions are summarised below:

[23] Neither tones nor nasal vowels are transcribed here.

[24] Ola's analysis focuses on Archangeli and Pulleyblanks' (1989) treatment of Yoruba. On the whole, Archangeli and Pulleyblank restrict their discussion to disyllabic monomorphemic words which begin with a vowel. Ola follows this strategy. This is to ensure that the generalisations made with respect to harmony involve morphologically simplex (i.e. non-analytic) domains. However, as far as I am aware, the distributional restrictions on vowels with respect to 'ATR agreement' also hold for longer words, and those with initial consonants. However, some analytic compounds, and loan words appear to be disharmonic.

[25] Ola notes that *u* and nasalised vowels are not found initially in Yoruba if there is no filled onset string initially.

(38)

N1	N2
e, o, *ɛ, *ɔ	e
o, e, *ɛ, *ɔ	o
*o, *e, ɛ, ɔ	ɛ
*o, *e, ɛ, ɔ	ɔ
*o, *e, ɛ, ɔ	a

The restriction on mid vowel distribution appears symmetrical in that it is claimed that 'lax' mid vowels occur before 'lax' mid vowels, and 'tense' mid vowels occur before other 'tense' mid vowels.

Archangeli and Pulleyblank (1989) focus on the fact that *e* and *o* are not found before *a*, and consequently opt for a right-to-left [-ATR]-spread version of events. On their story, words are specified or not for [-ATR]. This strategy allows for the occurrence of *ɛ* and *ɔ* word-finally, a position in which the vowel could not receive the harmonic feature through spreading. On their view, *ɛ* and *ɔ* may occur preceding *i* and *u* in disyllabic words because the high vowels do not exhibit a contrast with respect to [ATR] (no *i/u* versus *ɪ/ʊ*). The high vowels are therefore opaque when they occur in the path of [-ATR] spreading from right to left, impeding the targeting of the mid vowels to their left.

Van der Hulst (1988) and Goad (1993) also assume *ɛ*, *ɔ*, and *a* to be the class which triggers the process, and *e* and *o* which undergoes it. However, as both Hulst and Goad employ privative feature theory, neither can tolerate [-ATR] in an analysis. In an 'extended' Dependency Phonology model, Hulst (1988) analyses the difference between *e/o* and *ɛ/ɔ* to be the atom |a|. In the context of a following *ɛ*, *ɔ* or *a*, *ɛ/ɔ* are the harmonised counterparts of *e/o*, (the latter are crucially *not* lexically defined by |a|), receiving |a| by harmony. Van der Hulst's vowel system for Yoruba is below:

(39)	/i/	/u/	/e/	/o/	/ɛ/	/ɔ/	/a/
	i	u	i	u	i	u	a
	|	|			|	|	
	i	i			a	a	

i and *u* are not targeted by |a| spreading as a 'complexity condition' rules out two dependants (the |i| dependants in the representations of /i/ and /u/ above contribute 'ATRness' to the expression).

In a privative feature geometry model, Goad (1993) interprets the Yoruba harmony in terms of [low] spreading. *e* and *o* have no [low] feature, and receive it through harmony (becoming *ɛ* and *ɔ*). The vowels are represented as follows:

<table>
<tr><td>(40)</td><td>i u</td><td>e o</td><td>ɛ ɔ a</td><td></td></tr>
<tr><td></td><td>voc</td><td>voc</td><td>voc</td><td>voc = vocalic node under which
vocalic features are organised</td></tr>
<tr><td></td><td></td><td>|</td><td>|</td><td></td></tr>
<tr><td></td><td></td><td>[open]</td><td>[open]</td><td></td></tr>
<tr><td></td><td></td><td></td><td>|</td><td></td></tr>
<tr><td></td><td></td><td></td><td>[low]</td><td></td></tr>
</table>

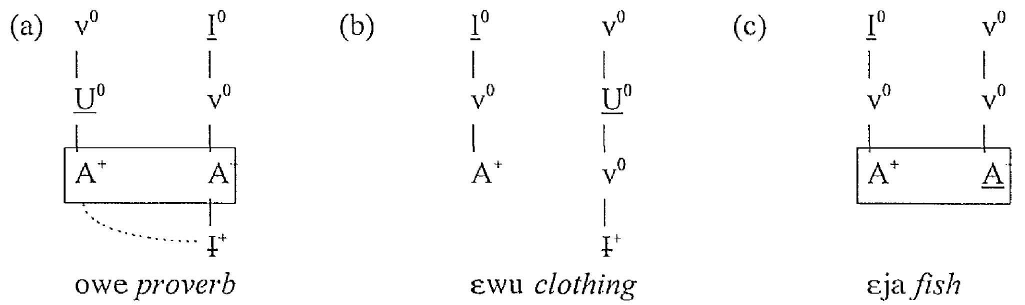
The high vowels *i* and *u* are outside the class of [low] bearing units as the harmony process applies at the level in the representation at which both target and trigger have a feature ([open] in this case).

Ola (1992) presents an analysis of Yoruba vowel harmony in a Standard GP framework, which denies her the machinery for describing a '-ATR' process. In fact, Ola analyses the restriction on mid vowel distribution in Yoruba as an instance of Ɨ$^{+}$ spread, which is subject to certain conditions. This approach is in line with Stewart's (1971) generalisations about vowel systems in Kwa languages (he discusses Akan, Ewe, Yoruba and Igbo). Stewart assumes the vowel systems of Kwa languages to be based on the ten-vowel 'cross height' (tongue root advancing) harmony system proposed (by Stewart (1967)) for Akan. On this view, Yoruba is an 'ATR' harmony language but without *ɪ* (I), *ʊ* (U) and *ɜ* (A̲).

To explain the Yoruba mid vowel distributional restrictions, Ola proposes that the vowels *i u e o* have the ATR element Ɨ$^{+}$ in their composition. In lexical words, when the ATR element is lexically represented in a nuclear governing head to the right of a sequence of vowels, it associates from right to left. The spreading is triggered when the following condition is met: an OCP[26] operation on A^{+} in adjacent nuclei.[27] The derivation is illustrated below:[28]

[26] Introduced initially for the treatment of tone phenomena, the Obligatory Contour Principle (Leben (1973)) effectively bans adjacent identical elements from a lexical representation.

(41)



In (a) both nuclei have A^+, and the OCP effect is indicated by the box. The nucleus on the right spreads its ATR operator to the nucleus on its left. In (b), although the nucleus on the right has an ATR element, no A^+ OCP situation obtains, and no spreading takes place. In (c) , OCP of A^+ occurs, but there is no ATR element in the right nucleus, and therefore nothing to spread.

The main factor in support of this approach is that Yoruba contains many examples of more generalised 'ATR' harmony, manifested by alternations in prefixes. Ola (1992) extends her ATR harmony analysis to include *i* and *u* as triggers in some particular cases.

Apart from the fact that 'lax' mid vowels cannot occur before 'tense' mid vowels, Ola claims that in two cases of prefixing, (the prefix is a mid vowel), mid vowel tense-lax alternations occur under the following conditions: stems beginning with an ATR vowel *i u e o*, prefix *o*, whereas those beginning with *a*, *ɛ* and *ɔ* prefix *ɔ*. She provides the following examples:

(42)

(a) agentive nominalisation prefix o~ɔ		(b) nominalisation prefix e~ɛ	
ɔkawe	*reader*	ɛda	*creature*
ɔjɔgbɔ	*professor*	ɛkɔ	*knowledge*
ɔdɛ	*stupid*	ɛbɛ	*pleading*
oʃiʃɛ	*worker*		
ogbufɔ	*interpreter*	eru	*cheating*
oʃeka	*cruel person*	ege	*segment*
ogbowɔ	*skilled person*	eso	*fruit*

[27] Ola (1992) proposes some additional conditions: (1) an OCP operation on U^0, to explain the absence of *ɔ* before *u*; and (2) a licensing condition on $Ɨ^+$: $Ɨ^+$ in an expression must be licensed by $Ɨ'$ in a following expression, otherwise it delinks.

[28] The notation follows Ola's directly. In her Standard GP analysis, the elements reside on tiers.

In addition, in monomorphemic trisyllabic nouns with a high vowel medially, the mid vowel to the left is invariably 'tense'. Some examples are provided below:

(43) elubɔ	*yam flour*
owurɔ	*morning*
odidɛ	*grey parrot*

In Ola's analysis, the prefix cases above are all instances of 'ATR' harmony, but this is not expected given the spreading proposed for monomorphemic disyllabic words shown in (41), in which Ɨ^+ spreading depends on an A^+ bridge. In order to explain the prefix cases, she must, therefore, define another set of conditions. First, Ola adds the following stipulation that all prefixes in Yoruba have a charm requirement: they must be positively charmed lexically, achieved either by having A^+ as a head (i.e. a prefix *a*), or by the Ɨ^+ element (i.e. a prefix *e*, *o*, *i*, or *u*) In (42), therefore, the prefixes are lexically *o* and *e*. Furthermore, if prefixes are positively charmed by having Ɨ^+ in their expressions, then the Ɨ^+ element in the prefix must be licensed by an Ɨ^+ element in the adjacent vowel in the stem. If this licensing arrangement is absent, Ɨ^+ delinks from the prefix:

```
(44)    I⁰        U⁰
        ‾         ‾
        |         |
        A⁺        A⁺
        +
        Ɨ⁺
        ɛ    k    ɔ
```

I suggest that attempting to explain the prefix cases above is unwarranted for various reasons. First, Ola's analysis is arbitrary in that the Ɨ^+-licensing arrangement is required only for 'ATR' mid vowels in prefixes. In monomorphemic words, both 'tense' and 'lax' mid vowels occur preceding *i* and *u*, as the examples below show:

(45)	eku	*a rat*	ɛku	*mask*
	esu	*devil*	ɛru	*fear*
	ewu	*grey hair*	ɛwu	*clothing*
	ori	*head*	ɔti	*wine*
	osi	*left*		

Secondly, in the trisyllabic monomorphemic cases where *i* and *u* are claimed to license the Ɨ$^{+}$ element in the preceding mid vowel (in (43)), Ola is forced to claim that these words are in fact morphologically complex, composed of a 'historical' prefix and stem.[29] She generalises that it is only in cases of prefixes that we find 'tense' mid vowels occurring to the exclusion of 'lax' ones, preceding *i* and *u* (as well as *o* and *e* above). Attempting to explain the trisyllabic monomorphemic cases in the same way is undesirable, because the acquirer, cued by the harmony process, would analyse the forms as having two domains. Presumably learners of Yoruba do no such thing as it is claimed in the literature that these forms are (in some sense) monomorphemic.

Thirdly, Rowlands (1969) states that the productive agentive prefix in Yoruba is *a-*, rather than *o-/ɔ-*. *o-/ɔ-* performs this agentive function, but cannot be used to form new words. The mid vowel prefix is limited to small number of nouns. In support of this claim, it can be observed from some of the examples in Ola (1992) that semantic relationship between both the agentive and the nominal forms and the verbs from which they are said to derive is not as obvious as one would expect with a 'productive' prefix. Some examples are given below:

(46)	ɔdɛ	*stupid*	**from...**	dɛ	*be tender*
	eru	*cheating*		ru	*disorganise*
	ɛmi	*breathe*		mi	*spirit*

In conclusion of the discussion above, I propose that extending the 'ATR' analysis to the prefix cases, and the trisyllabic monomorphemic words beginning with *o* is not justified, and that these forms are morphologically non-analytic. However, I consider the data presented by Ola (Archangeli and Pulleyblank offer similar forms to demonstrate (in their terms) the opacity of *i* and *u*) to show that ATR harmony was

[29] Furthermore, Ola claims the final vowel in these trisyllabic forms is in a separate domain. She claims that the governing domain within which 'ATR' harmony operates excludes the final nucleus in these cases: whatever the quality of the final vowel, it does not spread from the final nucleus to the preceding one in trisyllabic cases. Unfortunately, Ola does not provide examples such as the sequences *e-o-e*, *ɛ-ɔ-e* to support this claim.

once more widespread in Yoruba, with *i, u, e* and *o* triggering harmony (as in Akan and Sesotho). I agree with Ola that the trisyllabic forms beginning with *o* (43) were probably complex forms historically, however, I conclude that these, together with the prefix forms (42) are fossils of a more general ATR harmony process.

5.7.1.1 H-licensing in Yoruba

With respect to the generalisations on 'ATR' distribution in (38), I follow Ola's (1992) approach in analysing Yoruba harmony as essentially an 'ATR' type harmony. In Revised GP, I propose the following expressions for Yoruba:

(47) Expressions for Yoruba:

i	($\underline{I}$)
u	($\underline{U}$)
e	(A.$\underline{I}$)
o	(A.$\underline{U}$)
ɛ	(A.I)
ɔ	(A.U)
a	(A)

I propose Yoruba to have Natural Lexical Heads, so that the system above is generated by the following licensing constraint:

(48) Licensing constraints for Yoruba: *A cannot be a head*

In order to explain the vowel harmony where, in mid vowel sequences, there is head 'agreement', I propose h-licensing to be active in Yoruba. Headed expressions condition the occurrence of preceding headed expressions. This is illustrated below:

(49) owe *proverb*

$$\begin{array}{ccccc}
 & N_\beta & & \leftarrow & N_\alpha \\
 & | & & & | \\
O & N & O & & N \\
 & | & | & & | \\
 & x & x & & x \\
 & | & | & & | \\
 & (A.\underline{U}) & w & & (A.\underline{I})
\end{array}$$

In the illustration above, h-government takes place in the same way as shown in chapter 4. The lexically headed expression in the nucleus α identifies an h-governor which h-governs the nucleus adjacent at the nuclear projection as a β, identified by the lexically headless expression. H-government takes place from right to left. Unfortunately none of the data in the available sources shows whether or not the process is bounded. Further fieldwork is required to establish this point. The h-government relation is constrained by the licensing constraint *A cannot be a head*, which means that *a* (A) can neither condition nor undergo h-government.

Data containing 'long vowels' is provided by Archangeli and Pulleyblank, which supports the analysis of vowel distribution in Yoruba as involving the headed-headless expression distinction provided here. Recall that in Zulu, some instances of 'long vowels' occur, and in these cases, only 'tense' vowels are permitted, irrespective of the potential of the following expression to identify an h-governor. The following examples illustrate that this is also true for Yoruba.

(50)	oodɛ	*ɔɔdɛ	(odidɛ)	*grey parrot*
	eepɛ	*ɛɛpɛ	(erupɛ)	*earth*
	yooba	*yɔɔba	(yɔruba)	*Yoruba*

Archangeli and Pulleyblank assume these forms to be derived from 'elided' consonants (see the bracketed forms above). On their view, these 'long vowel' constructions are 'surface disharmonic', accounted for by applying ordered rules of high vowel deletion and consonant deletion. However, following my treatment of Zulu, the restrictions on 'long vowel' forms follow completely if it is assumed that *o* and *e* are headed expressions. I assume these 'long vowel' cases to be lexical strings containing a relation of P^0 nuclear government which is subject to the 'cold-headed constraint'. A lexically headless expression may not be associated to two skeletal points.[30] An example is provided below:

(51)
```
O  N   O N
|  / \  | |
x  x  x  x x
|  \  /  | |
y(A.U)b(A)
yooba  Yoruba
```

[30] This predicts that *a:* will never be found.

The complex expression in the illustration above is headed in response to a structural condition obtaining in the configuration of government between two nuclei. This situation is in response to a universal condition on structure, and not because of any h-government relation.

Neither *i* nor *u* trigger h-government although they have the basic requirement: they are lexically headed expressions in nuclei. Yoruba is another language which subjects h-government to complexity effects defined by the Complexity Condition (syntagmatic asymmetry in Dresher and van der Hulst's terms), although these are manifested in a different way from Natal Portuguese. In Yoruba, the asymmetry is in the fact that *heads must be complex.* Given the set of possible head identifiers in the h-government relation, $\{(\underline{I}), (\underline{U}), (A.\underline{I}), (A.\underline{U}), (\underline{A})\}$, Yoruba manifests only a subset of these: $\{(A.\underline{I}), (A.\underline{U})\}$. The governees in Yoruba, unlike say Akan or Vata, happen to be always complex themselves. In Dresher and van der Hulst's terms, Yoruba is then exhibiting a type of weak paradigmatic asymmetry, specialising in the head lexicon (the set of heads).

One issue with respect to distribution remains. One of the reasons why the Yoruba harmony has been diagnosed as [-ATR] harmony is the fact that the harmony appears to be symmetrical. In Revised GP terms, this means that not only are headed complex nuclear expressions found in positions preceding headed complex expressions, but they are also claimed to be absent preceding lexically headless expressions (A.U), (A.I), (A). This last point is not expected on an h-licensing story. As for Sesotho (and unlike Zulu), I claim the expressions for Yoruba to be lexical. Headed expressions identify h-governors, headless expressions identify h-governees. On this view, it should be possible to find examples where headed expressions precede headless expressions, since their distribution is not entirely controlled by h-government. Since Yoruba provides clues that it may once have had more extensive 'ATR' harmony, it is not then expected that examples of headed complex expressions preceding lexically headless expressions (i.e. *e/o…a/ɛ/ɔ* sequences) are abundant. However, I elicited the following examples from a native speaker:

(52) nilera	*healthy*	lailesɛ	*invincible*
abilekɔ[31]	*a married woman*	oja	*market*
agbesɔ	*market porter*	aileja	*cannot fight*
akojɔ	*accumulation*	rojɔ	*to complain*
ojola	*python*	awora	*an onlooker*
onirera	*proud person*		

The examples above show the asymmetry expected by the h-government analysis. Lexically headed expressions may be found preceding lexically headless expressions. However, headless complex expressions cannot be found preceding headed complex expressions as these nuclei identify the site of h-government.

To summarise so far, I have argued for an h-licensing analysis of Yoruba which employs the activation of the Complexity Condition. Furthermore, it manifests a weak paradigmatic HDA specialising in the head lexicon.

5.7.2 Ogori Vowel Harmony

Ogori is a Kwa language spoken in Nigeria which not surprisingly exhibits similar vowel harmony distribution to Yoruba. Chumbow (1982) and Calabrese (1988) both attempt to explain the restricted vowel distribution by a rule of [ATR] spread applying to vowels not specified for the feature [ATR]. The data seem to suggest a straightforward account of h-licensing and its associated complexity effects. However, unlike Yoruba, the weak paradigmatic HDA it manifests specialises in the dependant lexicon.

The following data and generalisations about the restriction on vowel distribution come from Chumbow (1982). Like Yoruba, Ogori has seven lexical vowels[32], as follows:

(53) fo	*die*	dze	*eat*		
sɛ	*hold*	jɔ	*go*		
su	*have*	ʃa	*come*	ti	*we*

Ogori manifests the following restrictions:

[31] The consultant remarked that this word is not commonly used these days.

[32] Ogori has a nasalised counterpart for each of these vowels which behaves in the harmony process in the same way as its oral partner.

(54) oboro	*good*	ɔdɔ	*axe*
roro	*think*	sɔrɛ	*fry*

Chumbow claims that in roots, the mid vowels *e* and *o* never co-occur with *ε* and *ɔ*, while *i u* and *a* may co-occur with all the mid vowels. Both Calabrese and Chumbow assume the harmony to be bi-directional, and acknowledge roots to manifest disharmony (in their terms, involving more than one harmonic domain). However, if the data in Chumbow is indeed representative, then an asymmetry is observable:

(55) oji	*rope*	jɔga	*shout*
ubo	*house*	fisɛ	*disappear (causative)*
iwu	*body*	kparɛ	*pluck*
uwobigbe	*force*	befuwa	*spoil*
ɛba	*type of food*	muwe	*laugh*
tijeguru	*sing*	bila	*return*

In the examples above, of the mid vowels, only *e* and *o* are found preceding *i* and *u*. *ε* (and presumably *ɔ*) is found following *i* and *u*. This suggests a right to left h-governing relation to be at work. I therefore suggest the following expressions:

(56) expressions for Ogori:

i	($\underline{\text{I}}$)
u	($\underline{\text{U}}$)
e	(A.$\underline{\text{I}}$)/($\underline{\text{A}}$)
o	(A.$\underline{\text{U}}$)
ε	(A.I)
ɔ	(A.U)
a	(A)

Licensing Constraint for Ogori:
A licenses no operators

Interesting alternations occur when roots are inflected by means of prefixes and suffixes. Prefix forms are illustrated below:

(57) **Personal pronouns**

i-je	*I call*	u-je	*you call*	e-je	*he calls*
ɛ-nɛ	*I fling*	ɔ-nɛ	*you fling*	a-nɛ	*he flings*
i-roro	*I think*	u-roro	*you think*	e-roro	*he thinks*
ɛ-kpɔ	*I climb*	ɔ-kpɔ	*you climb*	a-kpɔ	*he climbs*

Verbs	**Infinitives**	
su	bi-su	*have*
mune	bi-mune	*run*
ʃa	bɛ-sa	*come*

Not only in the examples above, but in a variety of affixes, *i* alternates with *ɛ*, *e* alternates with *a*, and *u* alternates with *ɔ*. The triggering contexts are informally described as follows. Stem vowels *i*, *u*, *e*, and *o* select the *i*, *u*, and *e* alternant prefix vowels. *ɛ*, *ɔ* and *a* select the *ɛ*, *ɔ* and *a* prefix vowels of the alternating forms.

I assume these data to present a straightforward case of h-licensing and the Complexity Condition. I propose that the vowels in the prefixes which alternate contain the lexically headless expressions *ɛ* (A.I), *ɔ* (A.U), and *a* (A), which identify h-governees. When followed by nuclei identified as h-governors by the lexically headed expressions *i* ($\underline{\text{I}}$), *u* ($\underline{\text{U}}$), *e* (A.$\underline{\text{I}}$) and *o* (A.$\underline{\text{U}}$), a right-headed h-governing relation is struck. The Complexity Condition is manifested by the mapping of the governee from (A.I) to ($\underline{\text{I}}$), and (A.U) to ($\underline{\text{U}}$).

Regarding the *a~e* alternations, when (A) *a* identifies a governee in the h-government relation, either (1) the derivation is not constrained by any licensing constraint on *A*, and the headed expression ($\underline{\text{A}}$) sounds like *e*; or (2) *A cannot be a head* is active, and the empty expression ( ) is yielded, interpreted as (A.I)/(A.$\underline{\text{I}}$). Regarding option (2), as Ogori has both 'tense' and 'lax' mid vowels, *e/o* and *ɛ/ɔ*, and the vowel in this case is transcribed as *e* (not *ɛ*), I assume (A.I) to be ruled out. Furthermore, the alternation of *ɛ* with *i* and *ɔ* with *u* in h-governed positions shows that complex expressions are barred from these positions, ruling out (A.$\underline{\text{I}}$) as the identity of *e*. I propose therefore that the h-domain counterpart of (A) is ($\underline{\text{A}}$). The h-government relation is illustrated below:

```
(58)   (a)                  (b)                  (c)
       Nβ  ←  Nα            Nβ  ←  Nα            Nβ ← Nα
       |      |             |      |             |     |
       N   O  N             N   O  N             N  O  N
       |   |  |             |   |  |             |  |  |
       x   x  x             x   x  x             x  x  x
       |   |  |             |   |  |             |  |  |
       I   j (A.I)          U   j (A.I)          (A) j (A.I)
       +                    +
       A                    A
      i-je  I call         u-je  you call       e-je  he calls
```

In the illustration above, the h-governor, identified by the lexically headed expression $(A.\underline{I})$ h-governs a preceding h-governee identified by the lexically headless expressions (A.I) (in (a)), (A.U) (in (b)), and (A) (in (c)). The Complexity Condition is manifested in all the h-governing relationships: the governee may be no more complex than the governor. This triggers operator delinking in complex expressions (a) and (b).

Furthermore, a type of weak paradigmatic asymmetry is manifested by Ogori h-government. The set of expressions identifying h-governors is not equal to the set of expressions contained in h-governees:

(59) p-structure expressions in governors and governees:
h-governors $\{(\underline{I}), (A.\underline{I}), (A.\underline{U}), (\underline{U})\} \neq$ h-governees $\{(\underline{A}), (\underline{U}), (\underline{I})\}$

H-governors may be identified by any lexically headed expression, simple or complex. H-governees however, must be simplex. Ogori therefore shows h-government to manifest a kind of weak (some of the expressions in the governee set are contained within the governor set) paradigmatic asymmetry, specialising in the dependant lexicon (the set of expressions in governees).

This treatment of Ogori makes a number of predictions for which, unfortunately, Chumbow does not provide the data to substantiate. First, in stems, *e* and *o* are found preceding *i* and *u*, *e* and *o*. According to my analysis, *e* and *o* in these contexts should be cases of lexical *e* $(A.\underline{I})/(\underline{A})$ and *o* $(A.\underline{U})$. In these cases no h-government relation is contracted, as no governee is identified, therefore no simplification occurs. However, *a* (A) is headless expression in Ogori, and is therefore expected to pattern with *ɛ*, and *ɔ*. i.e. it cannot occur in a position preceding an h-governor. The position is expected to be h-governed. It is therefore predicted that there should be no sequences of *a* preceding *i*, *u*, *e*, and *o* in roots.

The second prediction this analysis makes is that there should be prefix vowels *i*, *u*, *e*, and *o* which do not alternate, because they are the lexically headed expressions ($\underline{\text{I}}$), ($\underline{\text{U}}$), (A.$\underline{\text{I}}$)/($\underline{\text{A}}$) and (A.$\underline{\text{U}}$). However *a* (A) in a prefix should always alternate (if it is within the expected domain of h-government), as it is the lexically headless governee identifier (A).[33]

To summarise so far, the restrictions on vowel distribution manifested by prefix selection in Ogori provides support for the h-government with complexity effects analysis developed in chapters 4 and 5, and shows another type of complexity asymmetry defined by Dresher and van der Hulst (1995).

5.8 Summary

With 'ATR' effects now explained by h-licensing in Revised GP, the Complexity Condition, a parameter on governing relations at the level of nuclear projection, is predicted to apply in some cases. This chapter shows that the prediction is indeed borne out. Natal Portuguese is straightforwardly explained in terms of h-government and the Complexity Condition. To support the analysis, evidence from, Vata and Spanish is shown to also be straightforwardly explained in similar fashion, making the strong prediction that 'ATR' effects and 'raising' will often be found to operate in the same domains.

The harmony alternations of Yoruba and Ogori show that different types of asymmetry are manifested: weak paradigmatic asymmetry specialising in the head lexicon (Yoruba) and the dependant lexicon (Ogori).

One new licensing constraint is introduced in this chapter: *A Licenses no operators*, for the Ogori system. Natal and Yoruba have a 'Sesotho' type system, the Lena Bable vowel system is like that of Zulu.

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[33] Chumbow does not mention whether prefixes of this type exist. However, his analysis also suggests some non-alternating *i* and *u* prefix vowels as they are lexically bound to [+ATR] in roots (however, he does not mention the status of *i* and *u* in affixes other than in alternating forms).

CHAPTER 6

PREDICTIONS AND POSSIBILITIES

6.1 Introduction

The purpose of this chapter is to discuss the possibility of other data types being analysed in terms of h-licensing, licensing constraints and complexity. In the preceding chapters I have attempted to develop the notion of head-licensing combined with the lexical marking system, licensing constraints and the Complexity Condition as a package of mechanisms for the treatment of certain types of vowel alternations. This approach is demonstrated to be capable of explaining alternations of the traditionally termed 'ATR' type in Vata, Akan, Pulaar, Turkana and Ogori. H-licensing is also applied to Zulu, Sesotho and Lena Bable. The type of alternations manifested in these languages are traditionally referred to as some kind of' height' harmony. In addition, Yoruba has received I^{+}, [-ATR], [low] and A-spreading treatments in the literature, but has been analysed here in terms of h-licensing. Example languages from all the harmony types in the chart in chapter 1 have been analysed in terms of h-licensing.

As h-licensing, licensing constraints and the Complexity Condition seems then to be capable of explaining data of the '-ATR' and 'height' type, in this chapter I pursue the notion that neither '-ATR', nor 'height' are salient characteristics in the vowel systems of the world's languages. This may not appear to be a particularly ambitious aim, given that the non-existence of '-ATR' and 'height' is predicted by the absence of elements with '-ATR' or 'height' properties in the primitives of GP.

However, there are many cases of '-ATR' and 'height' harmony explained in the literature in terms of element spreading or element licensing. It appears that there is a degree of overlap. '-ATR' type harmony and 'height' harmony may be captured by either of two strategies: (1) element spreading and licensing, and (2) h-licensing, licensing constraints and the Complexity Condition.

In this chapter I discuss the possibility of extending the analysis developed in preceding chapters to phenomena analysed in terms of A-spreading (6.2) or licensing (6.3). Specifically, I examine two cases of A-spreading: that of '-ATR' harmony in Chukchee, and that of the 'height' harmony of Chichewa. Then I turn to the A-licensing analyses proposed for Pasiego and Kera. As data from published literature provides the bases for these analyses, it must be stressed that **the conclusions I arrive at here remain tentative**. However, in all cases, the approach developed in this thesis makes strong predictions about the vowel systems and expected phenomena in the languages discussed.

Finally, I turn to a problem for which an h-licensing explanation might be expected, but unfortunately escapes one for the present. This is a type of distributional restriction with respect to what may be informally described as 'tense'/'lax' vowels, known as 'closed syllable laxing'. This is where the distribution of 'tense' and 'lax' vowels (expected to be headed and headless expressions respectively in Revised GP terms) is sensitive to constituent structure contexts: the licensed empty nucleus, and the branching rhyme structure. One would expect the h-government formalism to play some role in explaining this type of data. However, no obvious analysis seems to present itself, and I am forced to set this problem aside for future research. The data discussed are from Andalusian, Castilian Spanish, and Quebec French (section 6.4). The chapter is summarised in 6.5.

6.2 '-ATR' and 'Height' Processes as A-spreading

In this section I discuss how h-licensing together with licensing constraints might interact to explain languages which have been traditionally identified as manifesting '-ATR' or 'height' harmony. I begin with a discussion of Chukchee, before turning to a discussion of Bantu 'height' harmony.

6.2.1 Chukchee Vowel Harmony

Chukchee, classified as a Paleo-Asiatic language (spoken in Siberia) is one of the languages widely cited in the literature as manifesting a [-ATR] harmony. An overview of the Chukchee data as it appears in the literature is discussed in detail by Calabrese (1988). I briefly summarise his discussion and conclusions below. I follow this with a discussion of a Dependency Phonology type analysis from van der Hulst (1988, 1990). Finally, the implications of a Revised GP treatment are assessed.

6.2.1.1 Chukchee Data

Calabrese (1988) makes the important point that two versions of the 'facts' exist in the literature, one based on Skorik (1961), one based on Bogoraz (1922).[1]

The data presented by Skorik (1961) is used in both Kenstowicz's (1979) and Krause's (1980) analyses of vowel harmony in Chukchee. The following is taken from Calabrese's (1988) presentation of Kenstowicz's (1979)[2] analysis.

Chukchee has the following vowels in its system:

(1)	i		u	(source: Calabrese (1988: 99))
	e		o	
	ɛ	ə	ɔ	
	æ	a		

In the harmony process, the sets of triggers, targets, and outputs are as follows:

(2) (a) triggers: {a, ɔ, æ} (b) harmonic mappings: i → e
    targets: {i, u, e} u → o…in the context of a/ɔ/æ
    outputs: {e, o, ɛ} e → ɛ

The harmony is claimed to be bi-directional, as the following examples show:

[1] Calabrese treats these as two different dialects, with different vowel harmony processes.

[2] However, note that Kenstowicz also cites Bogoraz as one of his sources.

(3) (a) Root controlled harmony

Absolutive Plural

tintin -ti	*ice*	mæməl-te	*seal*
mukəl-ti	*button*	qʔawal-te	*corner*
eŋer-ti	*star*	ɔcɔc te	*leader*

(b) Affix controlled harmony

kelik	*to write*	kɛle-jɔ	*written*
ejp-ək	*to close*	ɛjp-əjɔ	*closed*
tip-ək	*to poke through*	tep-jɔ	*poked through*

Two 'new' vowels (i.e. ones which are not 'underlying' or lexical), *ɔ* and *ɛ*, are then created as the outputs of the harmony process.

Calabrese analyses the alternations in terms of [-ATR] harmony, targeting all [+ATR] vowels. In his terms, Chukchee is subject to a morpheme structure constraint: all the morphemes must contain vowels of the same 'underlying' [ATR] values. An iterative, bi-directional feature changing rule delinks the [+ATR] feature from the targets *i*, *u*, and *e*, and [-ATR] is spread from the triggers *ɔ*, *a*, and *æ*.[3]

The second version of Chukchee vowel harmony follows the observations of Bogoraz (1917, 1922), which is followed by Jakobson (1952), and Comrie (1981). On this view, the vowels of the Chukchee system are as follows

(4) i u (source: Calabrese (1988))
e
ɛ ə ɔ
a

The triggers, targets and outputs are as follows:

(5) (a) triggers: {ɛ, ɔ, a}	(b) mappings: i → ɛ	
targets: {i, u, e}	u → ɔ	…in the context of ɛ, ɔ, a
outputs: {ɛ, ɔ, a}	e → a	

[3] Feature co-occurrence filters take care of the outputs, which are then 'cleaned-up' by rules to produce the (non-structure preserving) result. For example, when [-ATR] is assigned to /i/ and /u/ a UG filter is violated and repaired to yield *e* and *o* (further 'auxiliary' filters prevent these vowels from being lexically generated).

Unfortunately, data from Bogoraz (1922) is not available to me. However, if we substitute the transcription above, using the forms from Kenstowicz (1979) provided by Calabrese (1988) in (3), the following examples are obtained:

(6) (a) Root controlled harmony

Absolutive Plural			
tintin -ti	*ice*	mɛməl-tɛ	*seal*
mukəl-ti	*button*	qʔawal-tɛ	*corner*
eŋer-ti	*star*	ɔcɔc tɛ	*leader*

(b) Affix controlled harmony

kelik	*to write*	kalɛ-jɔ	*written*
ejp-ək	*to close*	ajp-əjɔ	*closed*
tip-ək	*to poke through*	tɛp-jɔ	*poked through*

To explain this second type of harmony system, Calabrese proposes three basic 'underlying' vowels, /a/, /i/, and /u/ which are specified for [-ATR] in a dominant morpheme, and [+ATR] in a recessive one. As before, the feature changing rule effects the harmonic alternations.[4]

A confusing factor occurring in both the sets of 'facts' is the occurrence of a vowel transcribed by the schwa symbol ə. Any analysis of Chukchee vowel harmony must extend to formally identifying this vowel as it interacts with the vowel harmony process. This interaction is briefly outlined below.

The first point to make about ə is that it is sometimes not interpreted, as the examples below show (the data are drawn from Calabrese's representation of Kenstowicz's (1979) examples):

[4] As before, feature co-occurrence filters and clean-up rules get the desired result. When the [-ATR] feature is assigned to /i/ and /u/, a UG feature co-occurrence filter is first violated, and then repaired, to give the 'surface' forms *ɛ* and *ɔ*. *a* does not violate the filter when [-ATR] is assigned, and may surface as *a*. When [+ATR] is assigned to /i/ and /u/, no filter is violated, and the vowels 'surface' as *i* and *u*. However, when [+ATR] is assigned to *a*, a filter is violated, and repaired to give the 'surface representation' of *e*.

(7)	(a)	*abs. sg*[5]	(b)	*abs. pl.*	
		imət		imti-t	*load*
		ekək		ekke-t	*son*
		lɔnəl		lɔnla-t	*walrus fat*

In the examples above, *ə* in the absolutive singular form alternates with zero in the absolutive plural. The examples also show that the alternating schwa does not change its vowel quality depending on which set of vowels occurs with it.

Additionally, Kenstowicz (1979) notes that there is a schwa which never alternates with zero in roots. This schwa appears to be two distinct phonological objects: one which triggers harmony, one which does not.[6]

(8) (a)	təlgətət	*a thaw*	(b)	pəlməpəl	*darkness*
	təlg-**et**-ek	*to get warm*		pəlm-**ɛt**-ək	*to get dark*

The stem *təlg-* appears to select the non-harmonic suffix *-et*, whereas the stem *pəlm-* selects the harmonic suffix *-ɛt*. The stem in (8b) is then dominant with respect to harmony.

Finally, some schwas which alternate with zero are involved in the harmony process as the following data shows.

(9)		Infinitive	Past 2	
	(a)	ŋət-ək	ge-**ntə**-lin	*cut off, divide*
		gər-ək	ge-**grə**-lin	*lasso*
	(b)	təm-ək	gɛ-**nmə**-len	*kill*
		jəp-ək	gɛ-**jpə**-len	*put on clothes*

The bolded forms above are the stems. A comparison of the infinitive and the past 2 forms shows that the vowels of the stems are schwas which alternate with zero.

---

5 A process which may be informally termed 'apocope' occurs here. No forms in the abs.sg. end in a vowel. However, some words have stem-final vowels manifested in other morpho-phonological alternations, such as the absolutive plural forms. A detailed analysis of this process is beyond the scope of this thesis.

6 Again, the transcription is consistent with Calabrese's representation of Kenstowicz (1979).

However, the past 2 forms with the prefix and suffix alternations show that the schwas in (b), but not (a) are harmony triggers.

To summarise so far, two versions of Chukchee vowel harmony have been presented. In one, the outputs of harmony are not equivalent to the triggers. In the second, the outputs of the process are the same as the triggers. In addition, there is a schwa which manifests two different identities: one is harmonic, the other is not.

6.2.1.2 An A-spreading Account of Chukchee Vowel Harmony

Van der Hulst (1988, 1990) provides an account of Chukchee harmony in terms of the spreading of the atom |a|. van der Hulst follows Skorik's (1961) presentation of the data (citing Krause (1980) and Kenstowicz (1979) as his sources).

For the purposes of clarifying the following discussion of van der Hulst's analysis, I first provide a brief explanation of the tools van der Hulst employs. In van der Hulst's notation, objects between slashes, /α/, represent 'underlying forms'. Objects in square brackets, [α], represent output. The arrows indicate the input-output mapping of two objects. In the representations beneath the bracketed objects, *a*, *i* and *u* are atoms arranged in a hierarchical structure composed of nodes (o) and association lines (| and /) known as the *spine*. / and | are not equivalent. / indicates a relationship of dependancy. The vocalic alternations are as follows:

```
(10) /i/→          [e] =     /e/→      [æ]      /ɛ/       /ə/       /ɔ/      /a/       [o]←      /u/
     o              o         o        o         o         o         o        o         o         o
     |          /   |         |     /   |    /   |     /  |    /   ||     /   |         |
     o         a    o         o    a   o    o    a    a   o    o    a         a    a    o         o
     |              |                        |            |     |                       |         |
     i              i                        i             o    o                       o         o
                                                                |                       |         |
                                                                u                       u         u
```

The triggers are those representations with |a|: /ɛ/, /a/ and /ɔ/. The targets are those representations lacking |a|: /i/, /u/ and the 'empty' representation defined only by the 'spine', /e/ (both |i| and |a| are added to it for its interpretation in non-harmonic domains). The resulting output representations have |a| as a dependant.

The schwa is represented by a dependant |a|. This is distinguished from [æ] as it has an additional empty spinal node. As some schwas fail to trigger harmony, van der Hulst claims these lack |a| underlyingly, acquiring it by either spreading, or by a 'spell-out' rule. There are then really two kinds of underlyingly empty representation in (10): /e/ and non-harmonic /ə/ (i.e. without a dependant |a|).

6.2.1.3 A Revised GP Analysis of Chukchee

A Revised GP version of Chukchee vowel harmony might either proceed as an h-licensing account, or an A-spreading account. For the purposes of evaluating the two approaches, I first adapt van der Hulst's analysis to the tool-kit of Revised GP. I present some of challenges this approach faces, before attempting to show that an h-licensing interpretation might offer a more satisfying analysis.

Following van der Hulst closely, one can argue that the triggers all have the element *A* in their expressions, whereas the targets lack it. The outputs of the harmony process are different from the triggers because of differences in the head-operator relation. The expressions are provided below:

(11)	triggers:	a ($\underline{A}$)	ɔ (A.U)	ɛ (A.I)	
	targets	e ( )[7]	u ($\underline{U}$)	i ($\underline{I}$)	ə (?)
	outputs:	æ (A)	o (A.$\underline{U}$)	e (A.$\underline{I}$)	

The harmony process would precede as follows. *A* spreads from the triggers to the targets, and in the case of the ($\underline{I}$) and ($\underline{U}$) targets, *A* fuses as an operator to yield (A.$\underline{I}$) and (A.$\underline{U}$) respectively. In the case of the target being the empty expression ( ), *A* spreads to interpret the expression as (A).

A problem arises with ə: the schwa triggers harmony, so it must have an *A* in its representation, yet be distinct from the other triggers and outputs in (11). The other schwa does not, but must be distinct from the other targets in (11). The harmonic schwa would have to be either (U.$\underline{A}$) or (I.$\underline{A}$). The non-harmonic schwa would have to be an expression without *A*, which resists harmony (it is claimed not to alternate). Representing such an expression is impossible, so if the A-spreading analysis is to work at all, the formal identities of the harmonising schwa and non-harmonising schwa must be the same as two of the other expressions in (11).

[7] Following van der Hulst, ( ) would be interpreted as (A.$\underline{I}$) in a non-harmonic domain.

In addition, a significant challenge presents itself when trying to incorporate the vowel-zero phenomenon with the vowel harmony analysis. There are two main aspects to this challenge. First, in *non-harmonic* domains, the empty expression ( ) is interpreted as *e* (A.I̲) (following van der Hulst), the same as one of the harmonised outputs. Van der Hulst seems to assume that the *A* in this expression is not expected to trigger harmony, since it is not underlyingly present. However, in the Revised GP approach, we expect the *A* element in the expression (A.I̲) to trigger harmony, and we would not expect (A.I̲) to occur in non-harmonised domains.[8]

One way around this problem would be to claim that the interpretation of ( ) in non-harmonic domains does not involve *A*. ( ) could be interpreted as it is. Indeed, Bogoras (1917) notes that the counterpart of *a* is an 'obscure vowel'. Jakobson (1952) transcribes this vowel as [ə].

However, considerations of the interpretation of the empty nucleus aside, the A-spreading analysis comes up against a further challenge when we consider the facts of vowel-zero alternation. In a language rich in vowel-zero alternations, unfortunately the nuclear object we have assigned ( ) (an empty nucleus), expected to be the most likely to alternate[9], never undergoes alternations with zero, as the data below show:

(12) *absolutive singular*	*absolutive plural*	
wiŋər	winrit	*hoe*
qepəl	qeplət	*ball*
ceŋəl	cenlet	*box*
eŋer	eŋerti *enrət	*star*
aqən	aʔnət	*fishing pole*

In the examples above, the final vowel, ə, in the singular alternates with zero in the plural. The process takes place in both harmonic and non-harmonic forms. In the

[8] Recall that in the I-spreading account of harmony in Uyhgur in chapter 2 the lexically empty expression in Uyhgur is interpreted as (I̲). As expected, this expression is involved in the harmony process in exactly the same way as the lexical expression (I̲): in Uyghur, this expression optionally triggers harmony.

[9] Recall that empty nuclei are subject to the phonological ECP. They require p-licensing if they are to remain uninterpreted. See Kaye (1990) and KLV (1990) for details.

plural form *eŋerti* above, the suffix *-ti* shows that the form is non-harmonic; i.e. the *e* of the stem is lexically ( ). However, *e* does not alternate with zero.

An A-spreading account could also be used to analyse the type of data presented by Bogoraz (1917, 1922). However, If we assume any kind of simplex expression containing the element *A* to be a trigger, we have to assume, as in the previous version, that one of the things it harmonises is a simplex expression lacking *A*, i.e. ( ). The same problems, specifically, not interacting with the vowel-zero alternation account, are encountered.

To summarise so far, the A-spreading account provides a possible explanation of the Chukchee vowel harmony process in Revised GP. However, other aspects of Chukchee phonology reveal that this account of vowel harmony, in particular the claim that the non-harmonic counterpart of (A) is ( ), shows that the A-spreading explanation cannot be maintained.

Factors pointing to an h-licensing analysis of the harmony in Chukchee are as follows. First, the harmony process appears to take place in both directions, and secondly, a vowel which alternates with zero is capable of triggering harmony. This is possible on an h-licensing account, as harmony is expected to take place in both directions, and as the status of an h-governor is immutable (illustrated in the case of Zulu in chapter 4).

Two important points need raising here. First, an h-licensing account predicts that the active harmony process is neither of the ones claimed in the presentation of the data in section 6.2.1.1. It is not the case that *ε*, *ɔ* and *a* are the active set in Chukchee vowel harmony, but rather *i*, *u*, *e*. Secondly, an h-licensing approach favours the Bogoraz (1917, 1922) transcription, and has no way of capturing the 'facts' described by the transcription employed by Skorik (1961).

On this view, *i*, *u* and *e* are headed lexical expressions identifying h-governors. *ε*, *ɔ*, and *a* are lexically headless expressions identifying h-governees.

(13) expressions identifying h-governors: i ($\underline{I}$), u ($\underline{U}$), e ($\underline{A}$)
expressions identifying h-governees: ε (A.I), ɔ (A.U), a (A)

Chukchee is characterised by the notion of Natural Lexical Heads. *I* and *U* must be heads if they can be. To generate out the expressions above, the following licensing constraint is recovered: *heads cannot license operators.* The process is illustrated below:

(14) (a)

```
          Nα      →    Nb
          |            |
     Nβ←  Nα           Nβ
     |    |            |
     ON O N O N     O  N
     |  | | | |     |  |
   [ x  x x x x] [x  x]
     |  | | |       |  |
    (A) N(A) r      t  I
                       +
                       A
```

eŋer-ti *star*

(b)

```
  Nβ     Nβ          Nβ
  |      |           |
O N   O  N   O N O   N
  |   |  |   | | |   |
  x   x  x   x x x   x
  |   |  |   |   |   |
(A.U) c(A.U) c   t(A.I)
```

ɔcɔc-tɛ *leader*

As words in Chukchee manifest complete agreement with respect to the harmonic and non-harmonic vowel sets, it seems that domains are lexically h-marked. As there are no ‘opaque’ vowels, determining the direction of the process within a lexical domain is not possible.[10] It is indicated as right-headed in the stem, and left-headed across domains (as in Pulaar).

In (a), the lexically headed expression in the initial position identifies the nucleus as an h-governor. The h-governor α h-governs all the β positions in the string, identified by lexically headless expressions. The suffix *-tɛ* is identified by a lexically headless complex expression. When a lexically headless expression falls within an h-licensing domain, it is harmonically headed, but the expression is simplified. This is the effect of the Complexity Condition. The governees may not be more complex than the governors.

The analysis above interacts with the ə-distribution ‘facts’ in the following way. This approach predicts that as *e* is the headed counterpart of *a* (A) (i.e. (A)), *e* will not alternate with zero as it is not lexically empty. This then is the *e* in the example *eŋerti.*

[10] Whether or not the process is bounded or unbounded is also difficult to establish. Most of the examples in the paradigms have at most two unlicensed nuclei. However, Kenstowicz (1979) has a longer example, the harmonic word *uwequc-husband* in the examples there. I therefore assume h-licensing to be unbounded in Chukchee.

I do not, however, deny an empty expression for Chukchee. I assume that the schwas which alternate with zero are lexically empty nuclei:

(15) ceŋəl	cenlet	*box*
aqən	aʔnət	*fishing pole*

What is the p-structure interpretation of a non-p-licensed empty nucleus? When the conditions for the licensing of the empty nucleus are not met, I assume the nucleus is interpreted by (A) in a domain with no h-governor, or (A̲) in a headed domain. i.e. the symbol ə has two identities. On an h-licensing approach, I suggest that the 'schwas' (A) and (A̲), should accordingly be transcribed as *a* and *e* (or ə if one follows Jakobson's transcription). Some *a*s and *e*s are therefore lexically empty, alternating with zero. When they are not p-licensed, they are involved in harmony as expected.

To conclude, I propose that an A-spreading interpretation of the vowel alternations in Chukchee is inappropriate as it cannot interact with vowel-zero alternations. Instead, I propose that the harmonically active set of expressions are those traditionally claimed as the complement set. H-licensing combined with licensing constraints and the Complexity Condition can provide an account of Chukchee, with specific predictions about the structure of the vowel system.

6.2.3 Bantu Height Harmony

Bantu height harmony phenomena have been analysed in terms of the spreading of elements or atoms (some kind of *A*). Goldsmith (1985) provides an analysis of Yaka, Rennison (1987) and Harris (1994b) discuss Chichewa, and Marten (1996) focuses on Swahili and the south-western languages Herero, Ndonga and Kwanyama (as well as commenting on Chichewa). I begin with the type of harmony manifested by Chichewa, Swahili and Yaka, represented here by Chichewa.

6.2.3.1 Chichewa

Harris (1994b) takes an A-spreading approach to Chichewa to explain alternations of the type below.[11]

(16) (a)

(i)	pitiliz-a	*continue*	(ii) pɛlɛkɛz-a	*escort*
	futuk-a	*give way*	fɔtɔkɔz-a	*explain*
	uzir-a	*blow cool*	kɔlɛz-a	*blow on fire*

(b)

	causative	*applied*	
pind-a	pind-its-a	pind-il-a	*bend*
put-a	put-its-a	put-il-a	*provoke*
bal-a	bal-its-a	bal-il-a	*give birth*
lɛmb-a	lɛmb-ɛts-a	lɛmb-ɛl-a	*write*
kɔnz-a	kɔnz-ɛts-a	kɔnz-ɛl-a	*correct*

(c)

chiŋgamir-a	*welcome*	pɔlam-a	*bend face down*
luŋgam-a	*be straightforward*	pɛndam-a	*slant*

Well-formed words in Chichewa draw vowels from one of two sets {i, u, a} (shown in (a(i))), and {a, ɛ, ɔ} (shown in (a(ii))). *a* is claimed to pattern with both sets, although the data to support this claim is limited to the type in (c) above (I return to this point later), as the final *-a* in all the examples is considered as an (analytic) verbal suffix. In (a) there are examples of well-formed morphologically simplex words. In (b) there are examples of alternating suffixes: stems with *i*, *u*, and *a* select suffixes with *i*; those with *ɛ* and *ɔ* select suffixes with *ɛ*.

Both Rennison (1987) and Harris (1994b) treat Chichewa harmony in terms of A-spreading, from mid vowels *ɛ* (A.$\underline{\text{I}}$) and *ɔ* (A.$\underline{\text{U}}$) to high vowel *i* ($\underline{\text{I}}$) and *u* ($\underline{\text{U}}$), from left to right.[12] The challenge for this kind of approach then lies in the

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[11] However, I have followed Mtenje's (1985) transcription of the mid vowels as *ɛ* and *ɔ* (rather than Harris' *e* and *o*).

[12] In addition, Swahili and Yaka also manifest the following pattern. Stems with the vowel *o* affix *o*; stems with *i*, *e*, *u*, *a* affix *u*. Marten's representation of Swahili is reproduced below (his transcription is preserved).

	reversive			*reversive*	
kunja	kunjua	*fold*	paka	pakua	*load cargo*
ziba	zibua	*stop up*	tega	tegua	*set a trap*
songa	songoa	*press*			

explanation of two facts: (1) the opacity of *a* in the propagation of the spreading process, and (2) the failure of *a* to trigger the harmony. Relevant examples are provided below:

(17)

(a) **Failure of *a* to trigger harmony**

bal-a	bal-its-a	bal-il-a	*give birth*
kaŋgaz-a	kaŋgaz-its-a	kaŋgaz-il-a	*hurry up*

(b) **Opacity of *a***

kɔnz-an-its-a	pɛlɛkɛz-an-il-a
lɛmb-an-its-a	kwɛz-ɛts-an-il-a

Assuming an A-spreading approach, in (a) above, stems with *a* are demonstrated not to trigger harmony, as the suffixes present *i*, not *ɛ*. However, *a* is expected to trigger harmony as it is represented by ($\underline{A}$). In (b), the opacity of *a* is demonstrated by strings with an intervening reciprocal suffix *-an-*. Again, this is unexpected, given that *a* is ($\underline{A}$). The stems with *ɛ* and *ɔ* which trigger harmony in the causative and applied forms in (16b), do not affix these suffixes with *ɛ*. Instead, *i* in the suffix occurs.

Explaining these two facts has focused discussion in treatments which assume the A-spreading approach to be basically the correct one (see Harris (1994b) and Marten (1996)). Recall from the discussion of structure preservation in chapter 2, Harris seeks to explain in a non-arbitrary way why *A* spreads as an operator, but not as a head. Harris calls on a strict interpretation of structure preservation ("Lexically established dependency relations remain stable under spreading"). Thus, *A* spreads as an operator to fuse as an operator. *A* cannot spread from the head of the expression to fuse as an operator. For Harris, the opacity of *a* ($\underline{A}$) in the harmony process is explained by assuming that head and operator occurrences of an element are distinct representational objects, unable to fuse for the same reason *I* and *U* cannot fuse: they

---

It appears that when *U* and *A* occur in the same expression, *A* is also associated to the following expression, but only if *U* is also present (*songoa*, but *pakua*). Chichewa is not claimed to have harmony of this type. An h-licensing account does not seem to contribute anything to the analysis of this phenomenon. This issue must be set aside for future research.

occur on the same tier. This failure to fuse ensures that *A* cannot spread beyond *a* (A̲), as illustrated in the forms in (17b).

Marten (1996) points out the shortcomings with this explanation: it does not allow for harmony data where *a* patterns with *ɛ* and *ɔ* in triggering harmony; i.e. where *A* also spreads from a headed simplex expression to fuse with *I* or *U* in a complex expression (such as in the south-western Bantu languages). I do not go into details of Marten's analysis here, except to state that in order to explain why *A* does not spread from (A̲) in a language such as Chichewa, he claims that it is because there is no operator in the expression. Unfortunately, this approach contains the very problem that Harris takes care to avoid: it is arbitrary in the sense that the spreading is dependant on a condition which has to be specified ad hoc, and cannot be derived from more general principles. That is to say, it is effectively a context feature sensitive rule of the type discussed in chapter 1.

6.2.3.2 Chichewa Vowel Harmony as H-licensing

An h-Licensing approach is in the spirit of Mtenje's (1985) treatment of Chichewa harmony in which it is claimed that the harmonic categories are [+tense] ({a, i, u} versus [-tense] ({ɛ, ɔ}). From the evidence of the restriction on the distribution of vowels in Chichewa and the alternations observable in suffixes, I propose that *a*, *i*, and *u* are the lexically headed expressions (A̲), (I̲), and (U̲) respectively. These expressions identify h-governors. The expressions *ɛ* (A.I) and *ɔ* (A.U) are lexically headless expressions which identify the governees. Chichewa appears to be a language with Natural Lexical Heads, and the licensing constraint for generating the expressions is *heads license no operators*. In the suffix alternation cases, the causative suffix is then assumed to be lexically *-ɛts-*, and the applied is *-ɛl-*. The derivation is illustrated below:

```
(18) (a)   Nα→ Nβ                    (b)   Nα→ Nβ
           |   |                           |   |
        O  NαO Nβ  O  Nα                O  NαO Nβ O   Nα
        |  |  |  |   |  |                |  |  |  |  |    |
        x  x  x  x   x  x                x  x  x  x  x    x
        |  |  |  |   |  |                |  |  |  |  |    |
        b (A) l  I  ts (A)               p (U) t  I  ts (A)
                 +                                +
                 A                                A
        bal-its-a                        put-its-a
```

In (a) and (b) above, a simplex headed expression identifies an h-governor which contracts an h-governing relation from left to right with an h-governee identified by a complex headless expression. The p-structure governee then simplifies in response to the Complexity Condition.

What about the apparent neutrality of *a*, exemplified in (16c) above (e.g. *pɔlam-a*)? Given that on the h-licensing treatment, *a* is predicted to be a headed expression (A), identifying an h-licensor, it is not expected that it should be neutral in any sense. Mtenje (1985) claims that in roots, vowels are drawn from either the [-tense] set {ɛ, ɔ}, or the [+tense] set {i, u, a}: "One never finds in this language verb roots with mixed vowels from the two harmonic sets" (Mtenje 1985: 27). If this statement is indeed an accurate generalisation about the distribution of vowels in Chichewa, then the forms in (16c) must be concluded to be morphologically complex.[13]

In h-licensing terms, there is no question of *a* behaving as an opaque vowel. It triggers harmony as expected, illustrated in (18a). *a* (A) is by no means opaque, but an active participant in the harmony process. In the string above, (A) identifies an h-governor which h-governs the h-governee to its right.

An h-licensing approach to Bantu mid vowel harmony makes a strong prediction. Given the notion of Natural Lexical Heads, the licensing constraints are unable to generate out the required vowel system. The expressions active in the harmony process are given below, with the licensing constraints involved in their generation:

[13] They could be explained in another way. As the harmony is from left to right, *a* (A) is indeed expected to occur *following* a lexically headless expression. This predicts that words with vowel sequences *ɛ/ɔ...i/u* should also occur.

(19) (a) Expressions in Chichewa vowel harmony: *a* (A̲), *i* (I̲),*u* (U̲), *ɛ* (A.I), *ɔ* (A.U)
(b) Licensing constraints for Chichewa: heads licence no operators

The licensing constraint does not rule out the possibility of having an additional expression, (A), in the vowel system. In fact, no licensing constraint can rule out the generation of the headless expression (A), without ruling out other expressions that are attested. The approach taken here for Chichewa vowel harmony then makes a prediction that Chichewa has in fact six lexical expressions, not five.[14]

Furthermore, this analysis makes a prediction that as well as suffixes with *a* which do not alternate, there should also be suffixes with the vowels *i* and *u* which do not alternate. Unfortunately no data of this type is presented in either Mtenje, Rennison and Harris (who all discuss basically the same examples)[15].

To summarise so far, Bantu 'mid' vowel height harmony can be given a relatively straightforward h-licensing analysis. On this approach, *a*, *i* and *u* are headed expressions, identifying h-governors, and are as such the active set in the process, reversing previous assumptions. Not only can Chichewa be treated this way, but also a wider group of Bantu languages which pattern in the same way, such as Kimatuumbi (Odden (1991)) discussed in chapter 1.[16] Specific predictions are made about the vowel systems of these kinds of languages.

6.2.3.3 Vowel Harmony in Herero, Ndonga and Kwanyama

Marten (1996) provides a Revised GP account of vowel harmony in Swahili, Herero, Ndonga and Kwanyama, following Charette and Göksel's (1994) treatment of Turkish and Altaic harmony processes. Marten analyses the harmony in terms of A-spreading.

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[14] Actually it is predicted to have seven, if we count the empty expression ( ).

[15] Watkins (1937:51) provides a table of verbal concordances which includes these forms, but unfortunately does not provide examples with stems of both vowel sets. I was unable to test these type of data with a native speaker.

[16] This claim requires further investigation. Note that Odden (1991) employs the transcription practice referred to in chapter 4's discussion of Sesotho. i.e. he claims the vowel system of Kimatuumbi to be {i, ɪ, u, ʊ, e, o, a}, and not the {i, u, ɛ, ɔ, e, o, a} system I proposed for Sesotho. If one converts Odden's data by converting the 'lax high' vowels *ɪ* and *ʊ* into tense mid vowels *e* and *o*, and the tense mid vowels *e* and *o* into lax mid vowels *ɛ* and *ɔ*, the system converts to a Sesotho-type system.

The restrictions on the distribution of vowels in these south-western Bantu languages are similar to those discussed above in Chichewa.[17] The essential difference is in the behaviour of *a*. Some examples are provided from Ndonga below[18]:

(20)	**causative**	**applied perfect**	(source: Fivaz (1986))
hipa	okuhipika		*be wet*
luudha	okuluudhika		*be dirty*
enda		endele	*go, walk*
londa	okulondeka		*climb*
hwama	okuhwameka		*catch fire*

In the conjugations above, stems with the vowels *i* and *u* are followed by suffixes with *i*. Stems with the vowels *e*, *o*, and *a*, however, are followed by suffixes with *e*. In these languages then, *a* patterns with *e* and *o*, rather than with *i* and *u*.

I propose that as for Chichewa, h-licensing and the Complexity Condition are at work. (<u>I</u>) and (<u>U</u>) are lexically headed expressions which identify h-governors, with (A), (A.I), and (A.U) identifying h-governees. As for Chichewa, the Complexity Condition appears to be operative. As (A) does not trigger the process I assume it to be lexically headless. The difference between, Chichewa (Yaka and Swahili) on the one hand, and these south-western languages on the other, lies then in the licensing constraint *A cannot be a head.*

This approach makes a strong prediction that *a* cannot undergo h-government harmony, and should be opaque. However, as Marten does not discuss this point, examples showing whether or not *a* (A) is opaque, are not provided. The analysis as a whole also makes predictions about the distribution of vowels within words (perhaps depending on the direction of the process). Again, examples are too few, and this prediction cannot be confirmed.[19]

[17] These languages are also claimed to exhibit A-spreading from *-o* to *-u*, as mentioned for Swahili and Yaka (see footnote 12 above).

[18] Although transcribed as 'tense', Fivaz's description of the mid vowels using the Cardinal vowel chart indicates that they are 'lax'.

[19] Marten's source (Fivaz (1986)) is not particularly enlightening. Conclusions about these kinds of predictions cannot be drawn without further investigation.

To summarise so far, A-spreading operations might be dispensed with, given that the data involving *i~e* alternations can be explained utilising h-licensing in conjunction with licensing constraints and the Complexity Condition.

6.2.3.4 H-licensing in Bantu without Complexity Effects

In the analysis of Chichewa, and the south-western languages presented above, I claim that the Complexity Condition is operational in all cases. However, it is expected that there are Bantu languages which manifest h-licensing, but no complexity effects. This indeed appears to occur, and I provide data from Lobala (Morgan (1991) attempts a Standard GP analysis) to support the h-licensing approach to Bantu Height harmony. Lobala is not the only Bantu language which appears to manifest this type of harmony, Kikuyu (Clements (1991)) superficially appears to pattern in exactly the same way.[20] Some applied conjugation examples from Lobala are presented below:

(21)	bin-el-a	*dance*
	ten-el-a	*cut*
	wand-el-a	*hit*
	bomb-el-a	*hide*
	tub-el-a	*sing*
	bɛl-ɛl-ɛ[21]	*circumcise*
	ɲɔl-ɛl-ɛ	*enter*

In the examples above, I suggest that *i*, *u*, *e*, *o*, and *a* are the headed expressions (I̲), (U̲), (A.I̲), (A.U̲), and (A̲) respectively. The expression of the applied suffix -el/-ɛl is lexically (A.I). The h-licensing process they are involved in does not manifest complexity effects. The p-structure governee is the complex headed expression *e* (A.I̲). The headed complex expression does not simplify, even though in some cases, it is more complex than its h-governor. The Complexity Condition then appears not to be active.

[20] Clements (1991) employs the transcription practice which describes Kikuyu as follows: {i, ɪ, u, ʊ, e, o, a}, not the {i, u, ɛ, ɔ, e, o, a} system Morgan proposes for Lobala. If one 'translates' Clements' data by converting the 'lax high' vowels *ɪ* and *ʊ* into tense mid vowels *e* and *o*, and the tense mid vowels *e* and *o* into lax mid vowels *ɛ* and *ɔ*, the system converts to a Lobala-type system.

[21] I cannot offer an explanation for the *ɛ~a* alternation. Palmada (1991) notes a similar type of phenomenon in a dialect of Western (Valencia) Catalan.

To conclude so far, Bantu height harmony data, presented in the literature as manifesting A-spreading suggests an analysis in terms of h-licensing, and the parametric application of the Complexity Condition. This conclusion reinforces the asymmetry between Natural Lexical Heads *I* and *U*, on the one hand, and the *A* element on the other.

A question raised by this analysis is whether it is a universal feature of the asymmetry between *I* and *U* on the one hand, and *A* on the other, that *I* and *U* spread in harmony processes (such as in Altaic), and *A* does not. The analysis of harmony in Bantu presented above contributes to a conclusion that *A* does not spread. However, in considering a universal generalisation, one would have to consider other cases where *A* appears to spread in 'long distance' harmonies of the type found in Nyangumarda (Nyangumata) (van der Hulst and Smith (1985), Rennison (1987)),[22] as well as the A-spreading in the U-context mentioned in footnote 12.

6.3 Height Harmony as A-Licensing

Height Harmony in element based approaches is also analysed in terms of A-licensing. In this section I suggest that h-licensing and the Complexity Condition combination might play a role in explaining data which has been explained in terms of A-licensing. A-licensing is proposed by Harris (1990b), and discussed in Harris (1994b, 1994c), and Polgardi (1996). The data claimed to manifest A-licensing is from the north-western Spanish language Pasiego, and the chadohamitic language Kera.

6.3.1 Vowel Harmony in Pasiego

In chapter 5, I proposed that the vowel harmony process in Lena Bable is a case of h-licensing with complexity effects. Pasiego is spoken in the same region as Lena

[22] The following examples illustrate what appears to be spreading of the elements *A*, *I* and *U*:

1st sg. future	*1st sg. unrealised actual*	
yurpa-lama-rna	yurpa-rna-ma-rna	*rub*
wirri-limi-rni	wirri-rni-mi-rni	*put*
kalku-lumu-rnu	kalku-rnu-mu-rnu	*care for*

The suffixes of both paradigms above appear to contain nuclei which are identified by the final vowel of the stem. It is therefore assumed that these suffix nuclei are lexically empty, and are interpreted by the 'nearest' lexical nuclear expression, the elements of which are assumed to have spread rightwards.

Bable, and I suggest a similar analysis can be extended to Pasiego, although the facts are less clear.

Pasiego vowel harmony has been characterised in a variety of ways in the literature, all based on two sources: an article and grammar provided by Penny (1969). Since the h-licensing approach ultimately challenges the 'facts' as they have been interpreted in the literature from these works, I do not provide a critical evaluation of the many individual analyses elsewhere in the literature. The 'standard analysis' I summarise here is from Hualde (1989).

Two harmony processes are claimed to be at work. A process called 'centralisation' (indicated by capitals) is claimed to be triggered from a 'centralised' final *u* (transcribed U), but *not i* (transcribed I). In addition, 'raising' is claimed to be triggered by a final *u* and *i*, as well as from a stressed high vowel (*u* and *i* again). The processes are both unbounded.

Some examples are provided below of the centralising and raising harmony processes:

(22)	AbIll'AnU	abill'anos[23]	*hazel*
	Istr'ItʃU	estr'etʃos	*narrow*
	Ag'UstU *hay harvest*	ag'osto	*August*
	tʃIp'UsU	tʃe'pos'os	*hunch-backed*

The nature of the alternations is not clear from the literature. With respect to the centralisation process, Penny (1969b) notes that the non-centralised set of vowels ({i, u, e, o, a}) correspond to the vowels of Castilian Spanish. However, this is not particularly illuminating given that Castilian is claimed to have seven vowels, *i*

[23] Hualde (1989) points out that *o* in post-tonic position has a range of phonetic manifestations, from open *u* to closed *o*. Thus, *o* may be confused with *u* post-tonically. This confusion is exploited by McCarthy (1984) who assumes the singular and plurals in these examples to be marked by *-u* and *-us* respectively. He concludes the masc. sg. *-u* to bear a lexical mark for [-tense], triggering [-tense] harmony. This view that centralisation harmony is morphologically conditioned is widely accepted. Hualde however, argues for a phonological conditioning of the harmony process: whenever *u* occurs finally it triggers harmony. The plural forms in (22) therefore do not trigger harmony because they end in *-os*, not *-us*. See Hualde (1989) for arguments against a morphologically conditioned treatment of the harmony process.

e ε a ɔ o u, with the 'lax' mid vowels occurring to the exclusion of the 'tense' ones in 'closed syllables'[24]. McCarthy assumes the centralised set to be characterised by the feature [-tense], but does not make a particularly strong case for this: "the impressionistic phonetic data available are insufficiently precise to allow the exact nature of this contrast to be identified. From a purely phonological standpoint, it is essential only that the feature system recognise a basic difference between two classes of vowels." (McCarthy 1984: 293). However, others pursuing the key to explaining the Pasiego harmony have all followed McCarthy's example, selecting [-ATR], [-tense], or [v^0] as the active feature.[25]

The examples in (22) not only exhibit centralising harmony, but mid vowel raising as well, operating from right to left, again triggered by the final vowel. In addition to *u*, *i* is claimed to also trigger raising, as the examples below show.

(23) (a)	'esta	*this fem*	(b)	'isti	*this masc*
	beb'er	*drink infin*		b'ibi	*drink!*
	kom'er	*come inf*		k'umi	*come!*

The forms in (a) present mid vowels, whereas their related forms in (b), which have affixed *i*, have only high vowels.

Raising harmony is also claimed to take place from right to left when a high vowel, *i* or *u*, occurs in a *stressed* nucleus as follows:

(24) (a)	koxer'e	*I will take*	(b)	kuxir'ia	*I would take*
	koxer'as	*you will take*		kuxir'iamos	*we would take*

The forms in (a) above exhibit mid vowels pretonically, when the stressed vowel is *e* or *a*. However, in (b) the stressed vowel is *i*, which does not permit a preceding *e* or *o*.

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24 For more details on the distribution of 'tense' and 'lax' *e* and *o* in Spanish, see for example Macpherson (1975), Casas (1980), and Navarro (1968). This aspect of Spanish vowel distribution is discussed in section 6.4.

25 The harmonic mappings (Penny 1969b) are such that harmonically recessive *i* and *u* become 'centralised' and 'less closed' (*I* and *U*), *a* becomes 'fronted' and 'raised' (almost *ε*, like the recessive *e*). *o* becomes like the French *ø* or *œ*. *e* is claimed not to harmonise.

Both Harris and Hualde see centralisation and raising as separate processes: v^0 head alignment, and [-ATR] spread respectively for centralisation; A-licensing and [+high] spread for raising.

Focusing on the raising process, Harris proposes a special type of Complexity Condition (one with a 'harmonic twist') to be at work in Pasiego raising (1990b, 1994b). As in Natal, the Complexity Condition on simply a stress licensing relationship cannot fully explain the restriction on the distribution of the mid vowels. Why should *e* (A.$\underline{I}$) and *o* (A.$\underline{U}$) never occur before the simplex *i* ($\underline{I}$) and *u* ($\underline{U}$), but may occur preceding the equally simplex *a* ($\underline{A}$)? Harris analyses the restrictions in terms of a head-final inter-nuclear licensing relationship involving the element *A*. To explain the asymmetry, Harris proposes the following: Dependant [A] is licensed in a governed position only if [A] is already directly licensed in the governing position of the domain (see (a) below).[26] If A-licensing fails to take place, the element in the governed position delinks ((b) below)

(25) (a)

```
    ←-------
        ←---
    N   N   N
    |   |   |
  k x m x r x
    |\  |\  |\
    |[U]|[I]|[I]
    |   |   |
   [A] [A] [A]
```

komer'e

(b)

```
    ←--------
        ←----
    N   N    N
    |   |   / \
  k x m x r x x s
    |\  |\   \/
    |[U]|[I] [I]
    =   =
   [A] [A]
```

kumir'i:s

(From Harris and Lindsay (1995))

A-licensing raises the question of why *A* should need this kind of special licensing at all, whereas the other elements do not.

An h-licensing-Complexity Condition account of the type developed in chapters 4 and 5 is appealing because of some characteristics manifested by the process. First, in the data in (22), centralisation and raising operate in identical domains, as would be predicted on this approach. Although the trigger is claimed to

[26] This bears some similarity with the A^+ bridge analyses of Natal and Yoruba discussed in chapter 5.

be U in centralisation and I/U in raising, a closely related language, Tudanca, has similar raising and centralisation, claimed to be triggered by both i/I and u/U. In addition, the A-licensing described by Harris is effectively the A-bridge of Natal and Yoruba. Finally, like Natal, the licensing configuration of stress assignment is utilised by the harmony process.

An h-licensing approach, however, makes strong predictions that the vowel system is other than that presented in the literature. First, only one harmony process is possible. As i/I and u/U apparently trigger raising, irrespective of whether they are in a centralisation domain, they are predicted to be the two headed expressions *i* ($\underline{I}$) and *u* ($\underline{U}$), which trigger the single harmony process of h-licensing. The targets are the headless expressions *ε* (A.I) and *ɔ* (A.U) (I leave aside the question of the identity of *a* 'A' for the moment).

From an h-licensing viewpoint, the Complexity Condition effects the raising process. *i* and *u* as lexically headed expressions ($\underline{I}$) and ($\underline{U}$), identify nuclei which h-govern the preceding nuclei identified by lexically headless expressions. The A-operators in the governees delink in order to maintain the complexity condition. This is illustrated in (b) below:

```
(26) (a)                              (b)     N ←      N     N
                                              |        |     |
         Nβ     Nβ     Nβ                     Nβ  Nβ←  Nα    Nβ
         |      |      |                      |   |    |     |
      O  N   O  N   O  N  O  N             O  N  O  N  O  N  O  N
      |  |   |  |   |  |  |  |             |  |  |  |  |  |  |  |
      x  x   x  x   x  x  x  x             x  x  x  x  x  x  x  x
      |  |   |  |   |  |  |                |  |  |  |  |  |     |
      k(A.U)x(A.I)r(A)s                    k(U)x(I)r(I)      (A)
                                             +    +
                                             A    A
      koxer'as                             kuxir'ia
```

On an h-licensing view, in (a) above, nothing happens, predicting *a* to be the lexically headless expression (A), occupying the stress position. In (b), the headed expression ($\underline{I}$) identifies an α which h-governs two lexically headless complex expressions. On this view, Harris' A-licensing Condition is then rendered unnecessary.

We return to the question of the identity of *a*, and whether or not it has a headed counterpart. If lexically headless *a* (A) occurs preceding stressed *i* ($\underline{I}$) or *u*

(U̲), it should alternate with (A̲), unless the licensing constraint *A cannot be a head* is switched *on* in Pasiego. Phonetically, it is claimed to alternate. As for its identity, let us consider some of the implications of assuming it can be mapped to a headed expression. H-governed (A), i.e. (A̲), is predicted to be 'transparent' with respect to h-licensing and complexity effects, as follows. Consider the theoretical string below:

(27)

```
Nβ     ←    Nα
|           |
Nβ...  Nβ←Nα
|      |    |
x...   x... x
|      |    |
I̲...   (A̲)...(I̲)
+
A
i      æ    i
```

In (27) above, a sequence of three nuclei is shown, with an h-governor on the right, an h-governee identified by a headless complex expression (A.I) on the left, and an h-governee which is identified by (A) in the middle. As no licensing constraint prevents (A) from entering into an h-government relation, we expect that the β it identifies is licensed by h-government, and is not therefore projected to the next level of nuclear projection, allowing the governor α to h-license β at the next projection and exhibit complexity effects. The data below show that this prediction is indeed borne out:

(28) Il mAd'IrU	*the log*	**compared with…**	el p'elo	*hair (mass)*
pU l kAm'InU	*by the road*		po la k'alle	*by the street*
'IsI k'IsU	*that cheese (individual)*		'ise k'eso	*that cheese (mass)*

Unfortunately, any further predictions about what the Pasiego vowel system ought to be like cannot be made. The head-dependant asymmetries manifested by complexity in Pasiego seem to be an issue which is itself surprisingly complex. First, data from Penny (1969a) seem to suggest that when harmonised 'A' occurs in the stressed position (i.e. when it is in the governee position of an h-governing relationship contracted with the final nucleus) complex expressions may precede it in the string:

(29) AkOmb'AU	*curved*	sOld'AU	*soldier*
erm'AnU	*brother*	be'dAnU	*broad wood chisel*

Words of this type are not expected on the h-licensing analysis developed above. In Revised GP, complex headless expressions are predicted to precede stressed (A) a, because (A) is a headless expression. However, a symmetry, where *complex* headed expressions precede stressed ($\underline{\text{A}}$) ('A' above) is predicted *not* to occur. In the examples above, the final vowel -*U* is the h-governor, and as in the examples in (28), the nucleus containing ($\underline{\text{A}}$) is a (p-structure) governee. The nuclei preceding 'A' ($\underline{\text{A}}$) should be h-governable, yielding *i* or *u*, not the *O/e* indicated here.

Furthermore, contrary to the examples in (29), Penny claims there are many cases of words with 'A' in the stressed position which do behave as predicted above, optionally: "a form with [i] or [u] alternates freely with a form whose atonic vowel is [e] or [o]." (Penny 1969a: 159) Some examples are given below:

(30) sUl'AnU ~ sOl'AnU	*sunny*
U'xAnU ~ O'xAnU	*grub*
xU'rAkU ~ x'OrAkU	*hole*

Only the words on the left are predicted in an h-licensing version of events if 'A' in a harmonised domain is a headed expression. Whether or not this alternative pronunciation is a fact about words with stressed 'A', or whether it can be generalised to all words with h-licensing (complexity effects are not always manifested/visible in h-licensing), is difficult to establish from the data available.

In fact, whether any harmony process is going on at all comes into question the more that Pasiego is investigated. Penny lists a number of words which do not appear to undergo harmony at all, such as the following:

(31) ot'ubre (*ut'ubre)	*October*
dIn'erU (*din'iru)	*money*
pres'ura (*pris'ura)	*rennet*

In addition, many words are listed with alternative pronunciations which show that raising takes place even in words with a headless expression, *a* (A) in the stressed position, unexpected from a [+high]/A-licensing viewpoint as well as for an h-licensing version of events:

(32) kutʃ'ar ~ kotʃ'ar	*spoon*
kukar'atʃa ~ kokar'atʃa	*beetle*
pirux'al ~ perox'al	*wild pear tree*
sul'ana ~ sol'ana	*balcony*
ux'ana ~ ox'ana	*grub*

The forms on the left in the examples above seem to indicate a stress assignment induced reduction harmony of the type described by Harris (1994a) or Dresher and van der Hulst (1995).

To conclude so far, I suggest that as for Lena, h-licensing and complexity effects is a possible approach to vowel harmony in Pasiego, which means that no process such as centralisation can be viewed as distinct from a process of raising in this language. However, as the true distributional restrictions on vowels are not clear from the data, a full analysis cannot be presented. I set this aside for future research.

6.3.2 Vowel Harmony in Kera

Harris (1994c) extends the A-licensing analysis above, and puts forward an analysis of Kera[27] vowel harmony based on the interaction of a principle of Licensing Inheritance, whereby a licensed unit inherits its licensing potential from its licensor (Harris (1992)), and the A-licensing principle utilised in the Pasiego analysis (Harris (1990b)). The effect of these two principles are combined in a constraint active in Kera called License[A], the sense of which is reproduced below:

(33) License[A]: Within a domain, [A] must be licensed by another [A]. An [A] inherits its licensing potential from a dominant [I] or [U].

The Kera harmony data is presented below, presented here as by Harris (1994c), originally drawn from Egbert (1974):

[27] A Chadohamitic language spoken in Chad.

(34)

	(a) giid- *belly*	(b) gun- *wake up*	(c) seen- *brother*
2Masc.	giidim	gunum	seenem
2Fem.	giidi	guni	siini
3Masc.	giidu	gunu	siinu
3Fem.	giidə	gunə	seena

	(d) kol- *change*	(e) bal- *like*	(f) cəə- *head*
2Masc.	kolom	bəlam	cəərəm
2Fem.	kuli	bəli	ciiri
3Masc.	kulu	bəlu	cuuru
3Fem.	kola	bəla	cəərə

In the data presented above, *i* and *u* trigger the alternations *o~u*, *e~i* and *a~ə*. Harris claims that the schwa is the 'neutral quality interpretation' of a lexically empty nucleus, in the event of its not being interpreted by the spreading of elements from neighbouring nuclear expressions. License[A] operates in the following way:

```
(31) (a)  seen-a                                  kol-a     (Harris 1(994c))
          s V V n V                               k V l V
             |/    |                                 |   |
          -[I]-----                               -[U]---
           \  \    \                               \  \  \
          --[A]--[A]--                            --[A]-[A]-

     (b) giid-ə            gun-ə              cəər-ə
          g V V d V         g V n V            c V V r V
             |/                |
          -[I]----          -[U]---            --0------

          --0----<A>        --0--<A>           --0----<A>
```

A-licensing is illustrated in (a) above. The *A* element in the rightmost nucleus is licensed by a preceding *A*. This preceding *A* is itself licensed by an *I* or *U* element residing on the dominant tier. A safe licensing path is established, and *A* is retained in the representation. In (b) no licensing can be established, as none of the examples in (b) have *A* in the first nucleus. The *A* in the second nucleus is not licensed, indicated by the angle brackets which surround it.

For Harris, License[A] is a licensing condition that is maintained without directionality. Licensing takes place between 'melody' in positions, and is not 'prosodically' controlled. As well as explaining the distribution of *ə* in suffixes (35b), Harris also explains alternations in the stem vowels. This is illustrated below:

(36)

```
siini (c.f. seena)             kuli (c.f. kola)
s V V n V                      k V l V
   |/   |                        |   |
--[I]--[I]                     -[U]-[I]-

-<A>----0-                     -<A>--0-
```

In the illustrations above, the *A* in the stem does not have a licensor as there is no *A* in the suffix *i* [I]. It is therefore not licensed in the string, and is 'underparsed'.

Cases with only empty nuclei in the stem are illustrated below:

(37)

```
(a)  ciir-i          (b) cuur-u        (c) cəər-ə
c V V r V          c V V r V        c V V r V
        |                  |        --0------
       [I]                [U]       --0-----<A>
```

In the illustrations above, the V slots in the stem have no elements associated to them. They are then interpreted by the spreading of [I]/[U] from the suffix. In (c) above, [A] in the suffix is not licensed, as the conditions for License[A] are not met. As [A] is underparsed, it cannot spread into the stem. Both stem vowels and suffix are interpreted as *ə*.[28]

Finally, stems with only *A* in them are illustrated below.

(38)

```
(a) bəli          (b)  bəla
    b V l V            b V l V
          |                  |
    -----[I]-          ------0-
                              \
    --<A>-0-           -<A>--[A]-
```

In (a) above, the *A* in the stem is underparsed as there is no *A* element in the suffix to license it. In (b) the *A* in the stem is underparsed as although there is an [A] in the suffix, this [A] is not dominated by an *I* or *U* on the tier above. As such the stem [A]

[28] Although it is not clear why the [A] in the suffix cannot simultaneously spread into the stem and license itself.

is not licensed. However, on this view, the suffix [A] element is also predicted to be unlicensed, and underparsed.

To resolve this problem, Harris employs the terms of the theoretical formalisms familiar to an Optimality Theory[29] approach, the details of which are not entered into here. Basically, the form we expect given Harris' License[A] constraint, *bələ*, where neither of the *A* elements in the string are parsed, is ruled out because this represents a double violation of the constraint proposed to interact with License[A], ParseMelody. There are two, not one instances of the failure of *A* to be licensed, and therefore two instances of underparsed *A*. The form *bəla* is considered optimal as it contains only one instance of the violation of ParseMelody.

Harris' approach to harmony in Kera cannot account for the Kera paradigms of the type in (39a) below:

(39) (a)	hame	*eat*	(b) bele	*like, want*
	hamam	*eat you (M)*	bəlam	*like you*
	həmi	*eat you (F)*	bəli	*like you*
	həmu	*eat him*	bəlu	*like you*
	hama	*eat her*	-	

Harris, would predict *həmam* for the second person masculine form, and *həma* for the third person feminine form, in line with the *bele* type examples in (b). Harris assumes that examples of this type are exceptional. Egbert (1974) provides the *hame* examples as a regular paradigm in Kera, with the *bele* forms given as irregular.

In addition, the alternations in (b) are claimed (Egbert (1974)) to manifest a vowel 'dissimilation' process: *a* is 'dissimilated' to *ə* if it is followed by a single consonant + *a*. Thus sequences *ə...a* are yielded from lexical *a...a*. However, this explanation does not account for the form *bele* (**bale*), which then characterises the irregularity of this paradigm. Forms such as *hama* are claimed to be exceptions to this dissimilation process.[30] [31]

---

[29] See Prince and Smolensky (1993) and McCarthy and Prince (1993).

[30] Specifically, Egbert claims that words beginning with *h* and *ʔ* 'block' the process. e.g. *hamam*, **həmam - eat you*. *ʔasan *ʔəsan - know you.*

[31] Harris does not discuss why A-licensing does not apply in forms like *hamam* and *hama*.

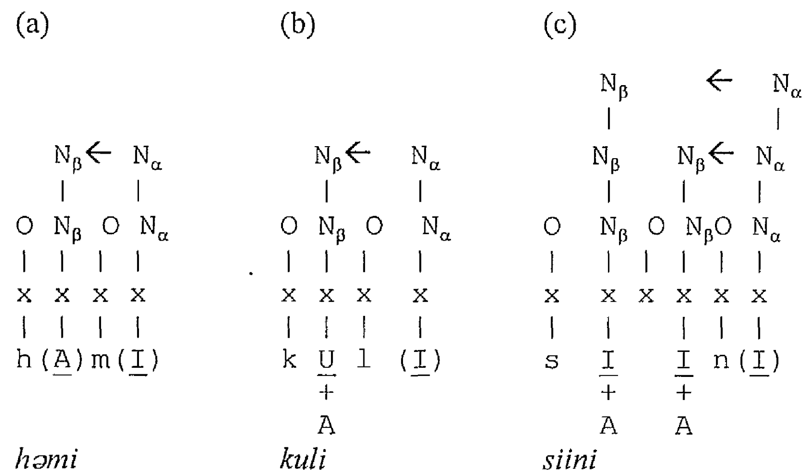
An h-licensing approach to Kera vowel harmony predicts that the forms in (a) are regular, and pattern as expected, but the *bele* paradigm is irregular. I focus on the following relevant examples reproduced below:

(40)

2Fem.	həmi	siini	kuli
3Masc.	həmu	siinu	kulu
3Fem.	hama	seena	kola
2Fem.	ciiru	guni	giidi
3Masc.	cuuru	gunu	giidu
3Fem.	cəərə	gunə	giidə

In the 2Fem. and 3Masc. forms above, I propose h-government takes place from right to left. The lexically headed expressions *i* (I̲) and *u* (U̲) identify h-governors which h-govern the nuclei to their left, identified by lexically headless expressions (A), (A.I) and (A.U). The derivation is illustrated below:

(41)



In the illustrations above, h-government takes place as expected, manifesting the Complexity Condition. In (b) and (c) therefore, the expression in the governee simplifies. In (a), the expression in the governee is not complex, and is not required to simplify. I assume the expression (A) capable of being mapped to the expression (A̲), which sounds like *ə*. Arguments to support this view are presented below.

In the third person feminine forms, I assume that the harmony is root controlled, and takes place from stem to suffix, i.e. from left to right. The suffix vowel alternates *a~ə*. The h-government relationship is contracted between nuclei containing expressions which are lexically headed, ($\underline{I}$), and ($\underline{U}$). No complexity effects are expected to be manifested as the simplex expression (A) identifies the h-governee in the relationship. The derivation is illustrated below (b).

```
(42)  (a)    Nβ    Nβ              (b)  Nα→ Nβ
             |     |                    |    |
          O  Nβ  O Nβ                O  Nα O  Nβ
          |  |   | |                 |  |  |  |
          x  x   x x                 x  x  x  x
          |  |   | |                 |  |  |  |
          k (A.U) l (A)              g (U) n (A)
          kola                       gunə
```

In (a) above, there is no α in the string, and so no h-government can take place. In (b) on the other hand, the headed expression ($\underline{U}$) identifies an h-governor, and the lexically headless expression (A) identifies the h-governee. The h-governing relation is contracted, the output of which is ə ($\underline{A}$).

Finally, I account for the *cə - head* paradigm above. I follow Harris in assuming that the nuclei of the stem are lexically empty. This explains why the second person feminine and third person masculine forms are interpreted as *ciiri* and *cuuru* respectively. The element of the suffix is used to interpret the empty nuclei of the stem. However, I do not assume ə to be the sound of an empty expression. Rather, it is interpreted as ($\underline{A}$). As in the Uyghur vowel harmony case discussed in chapter 2, the elements involved in the interpretation of the empty nucleus behave as expected. We observed the *ə~a* alternation in the third person feminine forms, where ə is the headed expression ($\underline{A}$).[32] It is then predicted that this expression can identify an h-governor. This is indeed the case, as illustrated below:

[32] I would have to assume that a lexical marking system is operative in Kera, and that roots are lexically marked as h-domains.

(43)

```
     Nα  Nα→ Nβ
     |   |   |
O  NβONαO  Nβ
|  |  || |  |
x  x  xx x  x
|  |   | |  |
c (A) (A) r (A)
cəərə
```

In the illustration above, the lexically empty nuclei are interpreted as (A), which identify h-governors. The lexically headless expression (A) identifies the h-governee (c.f. *kola*). The h-governing relation is contracted and the suffix is manifested as *-ə*. The h-licensing approach predicts that there should be an expression *a* (A) as the interpretation of a lexically empty nucleus, in non-harmony domains. However, given the limited data there is no independent evidence available to support this.

Some further points need to be cleared up. First, the irregular form *bele - like*. Some examples are provided below:

(44)	bele	*like, want*
	bəlam	*like you, want you*
	bəli	*like you, want you*
	bəlu	*like him want him.*
	balnan	*liked me*
	balnam	*liked you*
	bəlnu	*liked him*
	balla	*you must like*

Assuming that the first vowel in the stem is *a* (A), then the only unexpected forms are *bəlam* and *bele*.[33] I assume these forms to be irregular in the infinitive and the masculine second person form, but as no other examples are provided, I cannot take this any further.

Another observation made by Egbert is that phonetically there are two *e*s, two *o*s and two *a*s. In 'closed syllables', only the 'open' variety can occur, no matter how the stem vowel is realised. In each case, both forms are claimed to be involved in the harmony in the same way. This observation appears to be problematic to both

[33] Egbert mentions another verb, *ŋefe-meet*, is also given as having the forms *ŋafnam - met you*, and *ŋafla - you must meet.*

Harris' A-licensing account, as well as to the h-licensing analysis proposed here. On Harris' account, *A* resides on a tier which is dominated by the U/I tier. I am not sure how one would represent a further three expressions, and at the same time maintain the License[A] account, where [A] is licensed by another [A] which is dominated by an element specified on the I/U tier. As for the h-government account, I assume *e* and *o* to be lexically headless, as they do not pattern with *i* and *u* in the third person feminine. Recall that *i* and *u* suffix -*ə*, whereas *a*, *e* and *o* suffix -*a*. I maintain that with respect to harmony, *e*, *o* and *a* show headless behaviour, but I cannot explain three further expressions, distinct from (A), (A.I), and (A.U), yet behaving in the same way with respect to harmony. This question remains open, and is taken up in the following section.

To summarise so far, I have attempted to show that the h-government approach with the Complexity Condition might be capable of explaining vowel alternations previously explained in terms of A-licensing. However, in the absence of further research involving fieldwork, this claim remains tentative.

6.4 An Unresolved Issue

In this final section, I discuss a type of data which would be expected to have an explanation in terms of h-licensing. However, for the time being, it remains beyond an h-licensing explanation. I discuss the phenomena and the relevant data below.

The phenomenon is the process traditionally termed as 'closed syllable laxing' reported, for example in languages such as Kera (as discussed above), Andalusian, Kota,[34] Spanish, English and Quebec French. The analysis presented in this thesis has no explanation for this type of phenomena. In this section, I present the type of data which exemplifies the process. This is followed by a brief discussion of the data in relation to h-licensing.

6.4.1 The Data

The basic alternations are manifested by Quebec French and Spanish, as shown below:

(45) Quebec French (source: Charette (1994). Capitals indicate 'laxness')

vide	*to empty*	vId	*(s)he empties*
kule	*to flow*	kUl	*it flows*
rüze	*cunning (adj)*	rÜz	*cunning (noun)*
sede	*give up*	sEd	*(s)he gives up*
pivOte	*to pivote*	pivo	*pivot*
petrOl	*petrol*		
letO(n)[35]	*brass*		
betO(n)	*concrete*		
lEtü	*lettuce*		

In Quebec French, 'tense' vowels, to the exclusion of 'lax' vowels, are found word finally (with the exception of *E*, which can be found finally, and *a*, to the exclusion of *æ*). Whereas 'lax' vowels, but never 'tense' ones, are found preceding onsets licensed by word final licensed empty nuclei.

Similar restrictions are found in Spanish, as follows:

(46) Spanish (Castillian 'standard')

(a)	te	*tea*		
	tab'u	*taboo*		
	abl'o	*he spoke*		
	ak'i	*here*		
	ak'a	*over here*		
(b)	d'uke	*duke*	d'ukɛs	*dukes*
	c'oco	*coconut*	c'ocɔs	*coconuts*
	pl'aka	*plaque*	r'osas	*roses*
	y'ɔsu	(proper noun, Basque)	y'ɔsus	
	m'ari	*housewife* (slang)	m'aris	*housewives*

Unlike Quebec French, in Spanish (at least for the speaker consulted here), it seems that only the mid vowels are involved. *ɛ* and *ɔ* cannot be found finally. Only *i*, *u*, *e*, *o*, and *a* occur (a). *o* and *e* cannot occur preceding a domain final licensed empty nucleus, [36] as exhibited when comparing the singular and plural forms in (b) above. The distribution of *i*, *u* and *a* are unrestricted.[37]

[34] A Dravidian Language spoken in the Niligiris area of Tamil Nadu

[35] The bracketed *n* (n) indicates the nasal quality of the preceding vowel.

[36] Although it appears that in Spanish, the licensing power of a domain final empty nucleus is limited. Only *l*, *r*, *d*, *th*, *s*, *z*, and *n* are found in preceding onsets.

In addition to the restrictions mentioned above, Quebec French and Spanish present their 'lax' vowels (headless expressions) in structures assumed to be branching rhymes.[38] In Quebec French the expressions which may occur in the nuclear head of a branching rhyme are as follows: *i*, *u*, *ü*, *Ö*, *ɛ*, *ɔ*, and *æ*.[39] In Spanish they are *i*, *u*, *ɛ*, *ɔ*, and *a*.

The contexts for 'laxing' are given below:

```
(47)   (a)    R      O...        (b)  N  O  N
              |\     |                |  |  |
            ...N \   |                x  x  x← p-licensed domain
              |   \  |                |          final empty
            ...x   x x...           'lax'        nucleus
              |    | |
            'lax'  β γ
```

I also include Andalusian in the discussion of 'closed syllable laxing'. This language has been cited as manifesting 'laxing' harmony in the literature. However, I argue here that it manifests phenomena of the type discussed above.[40]

It is claimed (Zubizarreta (1979) and Clements (1980)) that the property of 'laxness' is spread from right to left from the final vowel. Some examples are provided below:

---

[37] Kota (Source: Subbaiah (1986)) appears to pattern like Quebec French. In addition, there is a 'length' factor involved (a correlation of vowel quality to 'length' as in English). Word final vowels must be long and tense. Before a domain final empty nucleus, only short lax vowels occur. There seems to be no evidence of the branching rhyme structure in Kota.

[38] I assume the Standard GP structure here (KLV (1990)):

```
  R      O...
  |\     |
...N \   |
  |   \  |
...x   x x...
```

[39] Monik Charette, personal communication.

[40] In an attempt to clarify the data as it is presented in the literature, I consulted two native speakers. The fieldwork is of a preliminary nature, and the conclusions here are tentative. Neither speaker comes from Granada which is where the data in the literature is apparently spoken (Nick Clements, personal communication). I refer to the consultants as speaker 1 (male, late-twenties, from the Jerez area) and speaker 2 (female, mid-seventies, from the Malaga area).

(48)

singular	*plural*		(source: Clements (1980)
p'eso	P'EsO	*weight*	(CAPITALS indicate 'laxness')
mom'ento	mOm'EntO	*moment*	
b'oka	b'OkA	*mouth*	
ser'esa	sEr'EsA	*cherry*	
mol'ino	mOl'InO	*mill*	
ehkop'eta	EhkOp'EtA	*rifle*	
kolson'ero	kOlsOn'ErO	*mattress dealer*	
kom'erlo	kOm'ErlO	*eat it/them*	

In the literature it is assumed that the contrast in vowel quality between the singular and plural forms is attributable to the fact that the plural forms are marked by a final -*s* 'underlyingly', the context for a 'lax vowel'. 'Laxness' is then spread harmonically to all vowels from right to left.[41] Zubizarreta refines the contest for the process as follows: (i) the vowel preceding a lax vowel is also 'lax' if it is separated by at most one consonant, especially if the two vowels involved are identical, and (ii) 'laxing' harmony continues leftward up to and including the stressed vowel. In addition, she identifies a second process of 'laxing' in the context corresponding to a branching rhyme structure.

The set of 'lax' vowels which occur in complementary distribution with their tense counterparts is {*ɛ*, *ɔ*}. *i* and *u* are claimed not to be involved; *a* is claimed to be 'fronted and raised' in the laxing context found word finally, but not in the branching rhyme.[42]

From the description in the literature, the 'lax' vowels basically occur in the same context as in Quebec French and Spanish, mentioned above. In GP terms, this is (i) preceding an onset licensed by a following p-licensed empty nucleus, and (ii) in branching rhyme structures. However, the contexts are less straightforward to identify than in the languages discussed above. Three factors contribute to this difficulty: (i)

[41] It is also claimed (e.g. Navarro (1968)) that the lax vowels perform a morpho-syntactic function, serving to mark the plural form: "Before the voiceless aspiration of final *s* and *z*, the vowel of the final syllable acquires a relatively open timbre. When this aspiration disappears, the vowel keeps its open timbre thus assuming the semantic function corresponding to the eliminated *s* and *z*." However, Clements (1981) remarks that "These vowel shifts extend as well to singular nouns ending in historical *s*, such as *tos* [tO] *cough*, *voz* [bO] *voice*, *tesis* [t'EsI] *thesis*."

[42] Zubizarreta claims however that *ɪ* and *ʊ* are found to the exclusion of *i* and *u* in branching rhyme structures.

the type of onset which can be licensed by the final licensed empty nucleus are highly restricted[43], (ii) vowels sound 'lax' preceding certain types of onset in any case[44], and (iii) there is some overlap between the rhymal complements with those objects in (ii).[45]

Considering first the 'laxing' context of an onset followed by an a p-licensed final empty nucleus, discussed in Spanish and Quebec French, it seems that Andalusian also manifests a 'lax' vowel preceding the final (sometimes inaudible) onset + p-licensed empty nucleus. Only *ɛ* and *ɔ* are involved. In the examples below I illustrate these contexts: (a) words which, when compared with Spanish, are expected to end in an onset followed by a licensed empty nucleus, (b) words in the plural form claimed to be marked by inaudible *-s*, and (c) words ending in *-n*, the only audible final consonant for this speaker (All forms are from speaker 2).

(49) (a) *Andalusian* *Spanish*[46]

Andalusian	Spanish	
rɛ	rɛd	*net*
kɔntr'ɔ	kɔntr'ɔl	*control*
my'ɛ	my'ɛl	*honey*
flo	flɔr	*flower*

(b) (i)

singular	*plural*	
æm'o	æm'ɔre	*love*
flo	fl'ɔrɛ	*flower*
pæp'e	pæp'ɛlɛ	*paper*
ænim'æ	ænim'ælɛ	*animal*
æth'u	æth'ule	*blue*
klæv'e	klæv'ɛlɛ	*carnation*

[43] It is not clear from the literature cited here which consonants can occur finally. It seems that *l*, *r*, and *s* are claimed to 'aspirate' in 'final' position. I assumed in that case that *d*, *th*, *n* and *z* may also occur. I consulted two speakers here, who varied with respect to this issue. Speaker 1 has no 'final consonants' (and no final 'lax' vowels), and speaker 2 has one: *n*, and both 'tense' and 'lax' final vowels.

[44] Zubizarreta notes these to be *r*, and 'velar fricatives'. For speaker 1 here, they are *r* and *l*, and for speaker 2 they are *r*, *l*, and *x* (note that in some cases, where speaker 2 has *x*, speaker 1 has *y*, but not consistently so).

[45] Both speakers tolerate *n*, *m*, *h*, *r* and *l*.

[46] The Spanish forms were elicited from a Madrid speaker.

(ii)	rɛ	rɛ	*net*
	k'æmpo	k'æmpo	*field*
(c)	kɔræth'ɔn	kɔræth'one	*heart*

Following the assumption that a final 'lax' vowel indicates the presence of an (inaudible) onset licensed by an empty nucleus, the final 'lax' vowel in the first three examples in (a) above may be concluded to be in the laxing context.[47] However, in some forms the speaker gives the final vowel as 'tense', even though we might expect it to be 'lax', given the Spanish version, and the plural form. *flo* in the singular has *flɔrɛ* as the plural. In (bii) the plural is the same form as the singular. When compared with (bi) and (a), this shows that the plural formation is not systematic. Some forms do not alternate at all (*rɛ*); some are marked by *ɛ/e* with a preceding onset expression occurring (such as *r* or *l*), for example *flo, flɔrɛ*; some are marked only by *e* (c) (and presumably *ɛ*, although I did not happen to elicit this form).

As for the harmonic laxing process, for the speakers consulted here, it seems that no such process occurs. Consider the data above. In (bi) the plural seems to be marked by *e/ɛ*, preceded by *r* or *l*. In (bii) no audible plural marker is manifested. The singular and plural forms are identical. From this type of data, it is not possible to conclude that 'laxing' harmony occurs. In the plural forms in (bi), notice that *l* or *r* occurs preceding the plural vowel *e/ɛ* in all cases. In the singular forms which end in a mid vowel, this vowel appears to harmonically alternate in some cases, to agree with the lax final vowel in the plural (e.g. pæpe, pæpɛlɛ). However, this cannot be taken as evidence of 'laxing' harmony. The consonant which alternates with zero is *r* or *l*, before which mid vowels sound 'lax' in any case (c.f. *pɛlo - hair*, *ɔrixɛn - origin*). In addition, this speaker does not always have *ɛ* as the final vowel in the plural. Even when the vowel is 'tense' *-e*, the preceding vowel is lax if it is followed by either *l* or *r* (*æm'o, æm'ɔre*).

When considering the branching rhyme context, as expected (similar to Castillian Spanish), only *i*, *u*, *æ*, *ɛ* and *ɔ* can be found, never *e* and *o*. Some examples are provided below:

[47] Although it does not follow that the inaudible onset is interpreted by *d, r* or *l* in the plural form. For example, the plural of *rɛ* is *rɛ* for this speaker (c.f. Spanish *rɛd*).

(50) (a)	dy'**ɛn**tɛ	*teeth*	(b) b**ar**k'ɔn	*balcony*
	ɛhp'iritu	*spirit*	ʃ'**ar**ko*pool*	
	k**ɔn**tr'ɔ	*control*	v**æn**d'ɛræ	*flag*
			k**æm**po	*field*

The first three examples (a) display lax mid vowels in what I assume to be branching rhyme structures. The examples in (b) are given to show that in addition to the restrictions on mid-vowels, *a* occurs to the exclusion of *æ* in a branching rhyme structure where the rhymal complement is *r*.

To summarise so far, Quebec French, Spanish, and Andalusian display a phenomenon of 'laxing' in two contexts: the nuclear head of a branching rhyme, and preceding an onset licensed by a domain final branching empty nucleus. In addition, in domain final non-p-licensed nuclei, only tense vowels can occur.

6.4.2 Theoretical Considerations

Assuming the 'tense'/'lax' distinction to be a manifestation of headed/headless expressions, and given h-licensing, it is difficult to explain the contexts for the distribution of 'tense'/'lax' vowels described above.

First, headed expressions, to the exclusion of headless ones, are found in domain final non-p-licensed nuclei. This is true when there is the only one vowel in a word, as in the Spanish word for *tea*, *te*. H-licensing, however, cannot explain this.[48]

Secondly, the context for the headless expressions in penultimate nuclei, when the final nucleus is a domain final p-licensed one, licensing a preceding onset, can also not be explained by h-licensing, as headedness, not headlessness is the property manifested by h-government between adjacent nuclei.

Finally, the occurrence of the headless expressions of a language, to the exclusion of their headed counterparts in the nuclear head of a branching rhyme, also cannot be explained on an h-licensing approach. KLV (1990) explain this distributional asymmetry in terms of the charm parameter of a language. In their

[48] Regarding Quebec French, Charette (1994) attributes this to a requirement of the stressed nucleus which is the final non-p-licensed nucleus in Quebec French. However, as stress can be assigned to any of the last three vowels in both Spanish and Andaulsian, this requirement cannot be generalised.

terms, the presence of the Ɨ^{+} element is not always lexically significant, and the element is fused to neutrally charmed expressions in order to satisfy the charm parameter of this system. If the expression is in the nuclear head of a branching rhyme, positive charm (contributed by Ɨ^{+}) is not required. Therefore, no Ɨ^{+} element fuses and it remains neutral. This is then not a case of 'laxing', but rather the absence of 'tensing' (i.e. no association of the Ɨ^{+} element).

Following the spirit of KLV (1990), it seems that if we assume the distribution of some of the headed expressions in the languages illustrated above to be related to h-government, then a structural explanation may be sought to explain the branching rhyme context. One could argue that the branching rhyme structure establishes its own P^0 governing domain, which, given the Minimality Condition (Charette 1991) could not be penetrated by the h-government governing domain. Unfortunately, an analysis escapes the h-licensing proposal developed so far, which cannot explain the distribution of this type.

To summarise this section, I have presented data from several languages to illustrate further conditioning contexts for 'tense'/'lax' vowels: the nuclear position of a branching rhyme structure, word finally, and the nucleus preceding an onset followed by a p-licensed empty nucleus. An analysis in terms of h-licensing is yet to be found.

6.5 Summary

In this chapter I have attempted to extend the h-licensing - licensing constraint - Complexity Condition analysis developed in chapters 4 and 5 to explain data traditionally described in terms of '-ATR' and 'height' harmony. A complete analysis has not been possible in these cases, given the limitations with sources. However, it has been shown that such a treatment may at least be possible. I have tried to show that if one accepts the h-government analysis of the various harmonies discussed, then it may be possible to dispense with two other licensing mechanisms: A-spreading and A-licensing. Finally, some tense/lax alternations cannot be explained by h-licensing. This is presented as a problem for the analysis.

CONCLUSION

In this thesis I have shown that two recent innovations in Government Phonology, licensing constraints and h-licensing, can be exploited in combination with existing principles (especially the Complexity Condition) in analysing some types of vowel harmony data. By developing the principle of h-licensing with the introduction of parameters on direction and scope of domain, constrained by licensing constraints, a variety of 'ATR' harmony processes can be explained (chapter 4). Treating 'ATR' distribution in terms of a licensing mechanism (h-licensing), rather then using an element, raises expectations that general conditions on sites of government will be enforced. This is exactly what we find (chapter 5). The Complexity Condition, which applies parametrically at the level of nuclear projection, constrains h-licensing in some languages, displaying a range of head-dependant asymmetry types.

Using these tools means that some alternations traditionally assumed to manifest separate processes, most often 'height' and 'ATR' harmony, are in fact variations of the same basic phonological process: the interaction of licensing constraints, h-licensing and the Complexity Condition.

The account presented here is, of course, not intended to be a complete treatment of all 'ATR' and 'Raising' harmonies. It does, however, raise further issues. I have tried to show that with further development, my account might be capable of explaining harmony data which has previously been captured in terms of the spreading of A-element. This raises the theoretical issue that it may be the case that *A* does not spread. In addition, my treatment of harmony processes may also be capable of capturing harmony data previously analysed in terms of A-Licensing. This would allow us to dispense with arbitrary licensing conditions. I hope these issues will be taken up in future research.

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