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Monovalency and the status of RTR[*]

PHILLIP BACKLEY

Abstract

Cases of ATR harmony are numerous and widely documented in the literature, whereas languages in which RTR is harmonically active (e.g. Wolof) have received a good deal less attention. A description based on the bivalent feature [±ATR] is capable of representing both harmony types, but fails to encode naturally the clear difference in typological markedness separating the two. On the other hand, an Element Theory approach — employing melodic headship as the basis of tongue root distinctions — is unable to provide an adequate account of RTR harmony without compromising privativeness. In response, I propose a tier geometry analysis (Backley 1995) which succeeds in capturing the alternation facts of both ATR and RTR harmony systems, together with the markedness characteristics of each.

1 Terminology

Amid the general debate on the representation of vowel harmony, particular interest has been shown in those languages which display the type of harmonic agreement taken to involve an active tongue root or ATRness. This phenomenon is perhaps most widely distributed among the Nilo-Saharan languages of East Africa (e.g. Maasai) and the Niger-Kordofanian languages of West Africa (e.g. Akan), and typically involves a division of the vowel inventory into two distinct harmonic groupings. In the most straightforward of cases, harmony may be characterized as a co-occurrence restriction which bars a segment belonging to one harmonic set from existing alongside any member of the complement set within a specified (usually 'word') domain. While the distributional facts relating to this kind of harmonic patterning are now fairly well understood, the same cannot be said of the active harmonic property itself, the identity of which has been the subject of numerous different phonological analyses, both melodic

[*]I am indebted to Toyomi Takahashi for his contribution to the ideas expressed in this paper. My thanks go to John Harris for his invaluable comments on an earlier draft.

and structural.

The significance of tongue root position to phonological descriptions is recognized as early as Pike, who characterizes advanced vowels in terms of their 'fuller' or 'deeper' resonance (1947:21) which may be obtained by 'fronting of the tongue so that the root of the tongue is farther from the wall of the throat.' Stewart (1967) notes this observation, and constructs a linear analysis of vowel harmony in Akan around the notion of tongue root advancement/retraction. This is offered as an alternative to the (at the time, standard) tongue raising hypothesis, arguing that any differences in tongue height between the two harmonic sets are neither phonologically significant nor systematically employed. A non-linear description of harmony in terms of advanced/retracted tongue root is later exemplified by Clements (1981), who proposes an analysis based on the spreading of a [+ATR] autosegment.

In his discussion of harmony in West African languages, Stewart indicates a clear difference between his proposed tongue root analysis and an approach based on the tense~lax[1] distinction. He claims that, while the latter may be appropriate for encoding vowel contrasts such as (English) *keel~kill* and (German) *Fehl~Fell*, for example — which are typically found in Germanic languages and which regularly parallel the long~short contrast in nuclei — it cannot be successfully transferred to the cases of tongue root harmony found in African systems such as Akan. His motivation for treating the Germanic pattern as distinct from the African one stems from the lack of interdependence between tongue root quality and phonological quantity in the latter, together with the observation that the description 'tense' does not always correspond to 'advanced' (e.g. back vowels belonging to the advanced set in Akan tend to be phonetically lax).

Despite Stewart's efforts to draw a principled distinction between tongue root contrasts and the tense~lax opposition, we find many instances where the literature employs the two features [ATR] and [tense] as equivalent terms. Further evidence of the disagreement surrounding the identity of the active property in harmonic systems like Akan surfaces in Lindau (1978), where another descriptive label — one which refers to the expansion of the pharynx — is introduced as an alternative to both tenseness and tongue root advancement. Lindau's justification for a feature [expanded] stems from radiographic evidence indicating a phonological distinction based primarily on variations in pharyngeal size, achieved via movements of the tongue root combined with vertical displacement of the larynx.

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[1] For the feature [tense], see Jakobson & Halle (1962) and Chomsky & Halle (1968).

Further exploration of the relevant literature reveals yet more variation in the vocabulary used to refer to the harmonic property under scrutiny. Besides the features [ATR], [tense] and [expanded] mentioned above, we encounter labels such as 'breathy' (Tucker & Mpaayei 1955) and 'covered' (Berry 1957), for example. Whilst I acknowledge the extent to which each of these terms has been individually motivated in the description of particular systems or language groups, I shall nevertheless maintain that a considerable degree of overlap may be found in their respective phonetic characteristics.[2] On the basis of this assumed overlap, I adopt the label ATR throughout the remainder of this discussion as a cover term for all of the above — a label which now appears to have established itself as the standard terminology in the description of harmony systems.[3]

Assuming that the phonological property underlying harmonic alternation in languages like Akan can be uniquely identified, the question remains as to how it might be most appropriately encoded in the grammar. I consider three of the available options in §2, beginning with a spreading account which employs the bivalent feature [±ATR]. This is compared with two approaches couched within a representation system recognizing only monovalent primes — first, a structurally-oriented analysis using the mechanism of H-licensing, followed by an approach utilizing the notions of tier complement and melodic template (Backley 1995). These possibilities are evaluated according to their potential for encoding the markedness characteristics of different systems analysed as involving tongue root harmony. Specifically, I focus on the typological difference between a 'typical' ATR harmony language like Maasai and a more marked system such as Wolof or Yoruba, in which active tongue root retraction (RTR) is observed. I conclude that the tier complement analysis is unique in its ability to differentiate between the two system types in a way which intrinsically captures the relative markedness of each. The merits of the tier-geometric model are then exemplified in §3 with an account of RTR harmony in Wolof.

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[2] In his analysis of tongue root harmony in Kalenjin, for example, Lodge (1995) describes the phonetic manifestation of ATR in terms of a suite of different effects, including peripheral tongue position in vowels, shorter consonant duration and even final voicelessness in coda approximants!

[3] See Hess (1992) for a discussion of the physical (acoustic) correlates of ATRness described in terms of formant bandwidth.

2 The representation of tongue root contrasts

2.1 ATRness as a bivalent feature

While an array of different labels has been variously employed in the description of ATRness, the majority of analyses are agreed on the status of the tongue root opposition as a single binary-valued feature such as [±ATR].[4] This bivalent approach is exemplified in Archangeli & Pulleyblank 1994 (henceforth A&P) who, like Clements, describe the mechanism of ATR harmony in languages such as Akan and Maasai in terms of the spreading of the feature value [+ATR]. Additionally, the acceptance of a bivalent feature [±ATR] permits a straightforward analysis of harmony in systems where RTR[5] participates as the active harmonic property. In these latter cases, the spreading of a [−ATR] autosegment is proposed — as illustrated by the account of Yoruba vowel harmony offered in Archangeli & Pulleyblank (1989).

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

(1) *[ATR] Markedness Statement* (A&P 1994:184)

a. [ATR] tends *not* to be used actively

b. If used actively, the active value of [ATR] tends to be [+ATR];
the passive value of [ATR] tends to be [−ATR].

In the tradition of generative phonology, we might expect such tendencies to be explicitly encoded in individual grammars, perhaps in a manner which reflects descriptive or representational simplicity. In the feature-based model assumed by A&P,

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

[5] I shall treat the label 'RTR' (Retracted Tongue Root) as no more than a notational variant of [−ATR]. So the opposition between the two monovalent features [ATR]~[RTR] may be considered phonologically equivalent to the binary opposition [+ATR]~[−ATR].

however, it is unclear how naturalness relations of this sort can be expressed in a non-arbitrary manner.

With respect to tongue root properties, the statement in (1) identifies three clearly defined markedness levels:

(2) a. *unmarked*: [±ATR] non-distinctive
(e.g. Spanish, Turkish)

b. *relatively marked*: [+ATR] contrastive or harmonically active
(e.g. Turkana, Maasai, Bari)

c. *highly marked*: [−ATR] contrastive or harmonically active
(e.g. Wolof, Yoruba)

The basic distributional facts underlying this 3-way typological distinction are captured in a straightforward manner within an equipollent feature system: either value of the bivalent feature [±ATR] may be active, predicting the system types represented by (2b) and (2c); alternatively, ATR may behave as a redundant feature supplied by phonetic rule, giving the system type in (2a). Significantly, however, the relative markedness of each category in (2) can only be determined on the basis of externally motivated conditions — formulated within A&P's Grounding Theory as a set of grounding conditions, whereby feature combination is controlled by (or 'grounded in') the physical correlates of the individual features involved. These restrictions on feature co-occurrence take the form of implicational statements, either positive ('sympathetic') or negative ('antagonistic'). The following examples are taken from A&P (1994:174-76):

(3) *Grounding condition* — *Influence on melodic structure*

ATR/HI: 'If [+ATR] then [+high]'
or 'If [+ATR] then not [−high]'

LO/ATR: 'If [+low] then [−ATR]'
or 'If [+low] then not [+ATR]'

RTR/HI: 'If [−ATR] then [−high]'
or 'If [−ATR] then not [+high]'

A reliance on extrinsic marking conventions of this sort has characterized a number of theoretical approaches to melodic structure, including SPE (Chomsky & Halle 1968), various instantiations of Underspecification Theory (Archangeli 1988) and, more recently, Optimality Theory (Prince & Smolensky 1993). In the final chapter of SPE, for example, a theory of markedness is introduced in an attempt to preserve the proposed correlation between naturalness and representational simplicity. The generalisations are presented as a set of implicational statements which express the unmarked values of individual features (e.g. [*u* nasal] → [−nasal], where *u* represents the unmarked value). In Optimality Theory (OT), on the other hand, relative markedness is expressed as a ranked dominance relation (the following example is taken from Prince & Smolensky (1993:181)):

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

The ranking in (4) states that to parse a configuration in which a place node (PL) dominates the feature [labial] amounts to a structural violation that is more serious (by virtue of its more highly ranked position) than the parsing of an otherwise similar melodic structure where PL dominates [coronal]; in short, [coronal] as a place of articulation is less marked than [labial].

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

Along with this peripheral status of the markedness conventions comes a certain degree of arbitrariness in the markedness statements themselves. In the case of OT, the ranking in (4) could quite easily be reversed; the resulting hierarchy would still accord with the established formalism, yet would encode a markedness relation that has little empirical support. Similarly, the universal marking conventions presented in SPE remain largely unexplained; to conceive of an alternative set of markedness statements with very different predictions — such as [*u* nasal] → [+nasal], for example — presents no real challenge to the model. And again, the suitability of A&P's approach may also be challenged on similar grounds. What, for instance, motivates the grounding condition ATR/HI given in (3)? The abundance of vowel systems containing ATR mid vowels renders this particular statement a rather weak generalization — in turn, opening the way for other conditions that are similarly lacking in independent motivation (either phonetic or phonological).

In sum, the binary feature analysis of tongue root contrasts employed by A&P can provide an adequate description of the different roles ATRness plays in a range of languages (see (2) above), yet proves less than ideal in the way it encodes the markedness characteristics of the languages that highlight those differing roles. If the grounding conventions cannot be adequately justified, then any theory of markedness based on the violation of such conditions must be considered, at best, unreliable.

2.2 ATRness and monovalency: a headship approach

Within a contrastive system built around single-valued melodic units, the option of recognizing the *absence* of ATR (that is, [−ATR] or [RTR]) as an active phonological property is categorically denied.[6] This leaves only the possibility of a privative opposition [ATR]~zero. However, since the primary motivation for abandoning equipollence has typically been a reduction in the scope for generating unobserved facts, it is entirely in keeping with the 'restrictivist' stance adopted by some models employing unary features that they have also opted to reject the [ATR]~zero contrast as a means of representing tongue root properties.[7] In the version of Element Theory assumed in Walker (1995) and elsewhere, nothing akin to the feature [±ATR] is recognized. Instead, the difference between ATR and non-ATR is represented structurally as a distinction in

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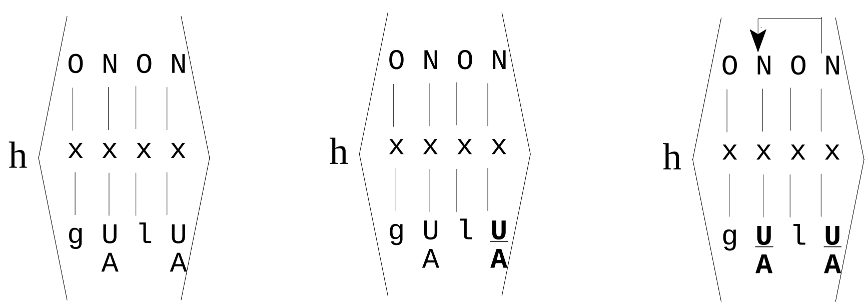
[6]The question of postulating two monovalent features [ATR] and [RTR] is addressed by Pulleyblank (1995), Steriade (1995) and Rose (1996).

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

headship: an ATR vowel corresponds to a headed expression such as **o** [U,A], whereas headless expressions like **ɔ** [U,A] denote non-ATR vowels. As for harmonic alternation, this is achieved via a lexical function termed H-licensing, which maps headless expressions on to their headed counterparts.

Walker demonstrates the mechanism of H-licensing — which may be viewed as a kind of 'headedness harmony' — with examples of ATR agreement in Vata. In essence, a harmonic span must contain a morpheme which is lexically marked as a headed domain *h*< >. This is illustrated in (5a).

(5) H-licensing in *h*<*gɔlɔ*> [golo]:



(a) (b) (c)

Unique to the domain-final position is the potential for supporting a headed melodic expression, as in (5b), which affords this nucleus the status of an H-licensor.[8] As such, this position proceeds to license a headed expression in the remaining nuclei within the domain, as shown in (5c); this is achieved via prosodic licensing relations contracted at the nuclear projection.

While H-licensing admits a satisfactory analysis of ATR harmony in systems of the (2b) variety (e.g. Vata, Akan), there appears no obvious way of adapting the mechanism so as to provide a natural account of vocalic agreement in type-(2c) languages such as Yoruba, where RTR behaves as the harmonically active property.
In the latter case, the presence of a headless, non-ATR vowel would require other vowels within the harmonic domain to be similarly headless — presenting a potential challenge to the headship harmony approach, since it would require well-formedness to be

[8]In the derivational steps shown in (5b) and (5c), melodic heads are underlined. Examples are taken from Walker (1995:111).

conditioned by the absence of particular representational entities (i.e. headed expressions) rather than by their presence. While negative conditions are included in the characterization of some theoretical frameworks — such as OT, where the burden of explanation lies primarily with the interaction between constraints, rather than with the precise formulation of the constraints themselves — I argue that they find a rather less natural setting amongst the positive, structure-building conditions employed in Government-based models.[9]

To summarize, it appears that a rejection of bivalency in favour of a unary system of contrast inevitably leads to the loss of the melodic property RTR as an independent phonological unit. In view of the highly marked status of those languages which exploit RTR as a linguistically significant property, this might well be considered a desirable outcome. On the other hand, we cannot afford to ignore the evidence provided by systems such as Yoruba and Wolof, which strongly indicates the status of RTR harmony as a legitimate phonological phenomenon. In response to the inability of the H-licensing argument to adequately account for such cases, I shall consider an alternative means of representing tongue root properties that exploits the notions of tier complement and melodic template introduced in Backley (1995).

2.3 ATRness and monovalency: a tier-geometric approach

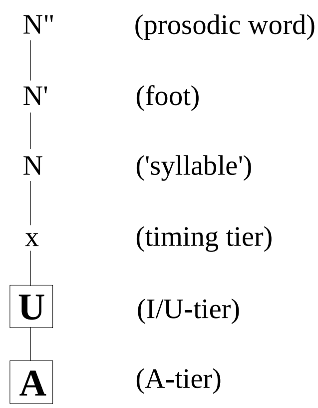
The tier-geometry (TG) approach to melodic structure attempts to enhance the explanatory potential of the Element Theory[10] model by incorporating a sub-segmental geometry of melodic tiers. At the melodic level, a hierarchy of element tiers is constructed according to the same principles of licensing that control prosodic structure — e.g. the Phonological Licensing Principle (Kaye 1990), head-complement asymmetry, and Licensing Inheritance (Harris 1992) — allowing a unified representational hierarchy (see (6) below) that highlights the interrelatedness between melody and prosody. The melodic geometry of a language is built around a set of parametric choices that control tier sharing/division and the structural (as opposed to *inherent* — see Ewen 1995)

[9]The basic assumptions of (and the more recent developments within) Government-based phonology are set out in Harris (1994) and Brockhaus (1995).

[10]See Harris & Lindsey (1995) for a summary.

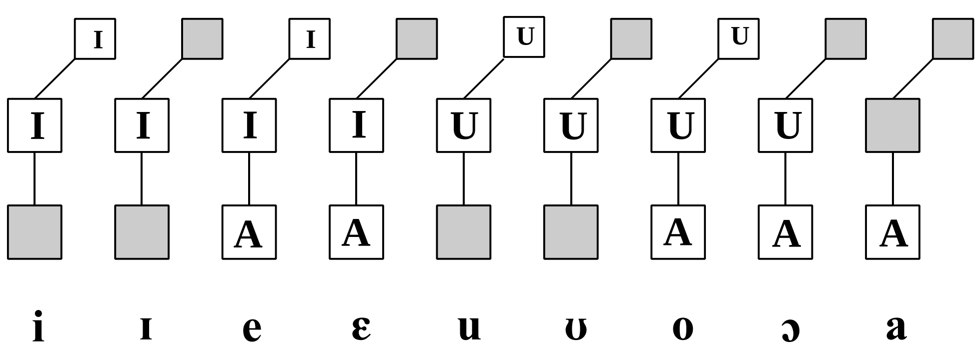
dependency relations holding between elements. For every language we must recognize a phonological hierarchy of the following kind, where a timing tier mediates between the prosodic structure and a system-specific melodic structure. The geometry in (6) gives the representation of a mid back rounded vowel within a 5-vowel system such as Hawaiian or Spanish.

(6)



Besides the distribution of elements across different tiers, an additional means of encoding cross-linguistic variation is through the licensing of a tier complement — again, subject to parametric control — which enhances the saliency of the elemental material occupying the relevant tier, effectively replacing the notion of melodic headship. To illustrate, consider the vowel inventory of the ATR harmony language Maasai:

(7)



We may describe the Maasai system as one employing a shared colour tier, consisting of the elements [I] and [U], and an independent aperture tier occupied by [A]. In this way, three distinct vowel heights may be generated, while the presence of rounding in front vowels is categorically ruled out (following the convention that elements residing on the same tier are unable to combine). These conditions are similar to those which hold for common five-vowel inventories, as found in, for example, Spanish. Additionally, however, the Maasai system involves an ATR opposition in non-low vowels, which is accommodated by allowing the I/U-tier to license a complement. I follow Takahashi (in preparation) in assuming that the phonetic effects of a tier complement, or [comp], are such that the acoustic properties of its head become enhanced.

The sub-segmental tier structure of a language provides a melodic template, latently present under all prosodic positions, which delimits the range of oppositions each position may potentially support. This template interacts with only a single kind of lexical instruction — ACTIVATE [α] — which typically applies within a minimal prosodic domain (i.e. one involving segment-sized units) to give the kinds of melodic contrasts found universally.[11] Lexical activation provides a necessary (though not sufficient) condition for element interpretation; additionally, certain prosodic conditions must also be satisfied — specifically, a melodic tier must be licensed before any element occupying that tier can be interpreted. Tier licensing is achieved through the operation of Licensing Inheritance (Harris 1992), according to which all units in a representation enter into asymmetric licensing relations with each other, and every licensee unit becomes licensed by receiving licensing 'potential' directly from its licensor. Furthermore, it is claimed that licensing potential is depleted each time a unit becomes licensed in this way.

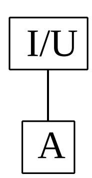
To illustrate, consider the structure in (6) above. Let us assume that the x-slot on the timing tier possesses a certain amount of licensing potential, by virtue of its participation in prosodic relations with other positions. But the same timing position may also be viewed as a projection of the highest level of the melodic hierarchy — in this case, the I/U-tier; accordingly, this colour tier has at its disposal the same stock of licensing potential as its projected nuclear position. Here I shall claim that the colour tier itself takes on the role of a licensor, when another licensing relation is contracted between it and the [A]-tier which it dominates in the structural hierarchy. Following the predictions made by Licensing Inheritance, we expect the aperture tier to inherit an amount of

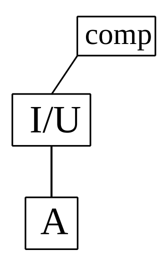
[11] Activation may also operate at higher prosodic levels, resulting in phenomena such as word-level harmony. See Backley & Takahashi (1996) for the reasoning behind element activation.

licensing potential which is smaller than that possessed by its licensor, the colour tier. This asymmetric licensing relation between the two melodic tiers allows us to identify an independent domain of licensing, in the same way that a licensing domain is recognized on the basis of relations contracted between prosodic positions. And just as the head of any prosodic domain can be singled out as the only unlicensed unit within that domain, similarly the head of this melodic domain (here, the colour tier) remains unlicensed at this level of structure. As a result, the same unit is projected up through the different levels of the prosodic hierarchy until a point at which it becomes licensed in the usual way.

Having introduced some basic characteristics of the TG approach, I return to the question of typological markedness in the exploitation of tongue root properties. The distinction between a language such as Spanish — where the ATR quality of any vowel is predictable on the basis of other (contrastive) melodic properties — and a system belonging to the (2b) category is motivated by appealing to differences in structural complexity. Specifically, an ATR harmony language such as Maasai must recognize a colour tier complement as part of its melodic template, whereas the 5-vowel system of Spanish is able to generate the required set of lexical contrasts without this additional structure. It is entirely in keeping with the markedness device inherent in the TG model that the postulation of some additional structure should be necessary in order to capture an expanded set of melodic distinctions which includes advanced/retracted pairs. So the melodic template in (8b) is predicted to be more marked than the structure in (8a) — which is reflected in the capacity of (8b) to generate a larger inventory with contrastive ATRness.

(8) (a) *Spanish* (b) *Maasai*

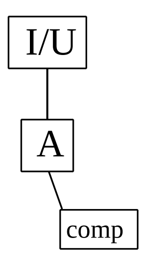




The relatively marked status of (8b) compared to (8a) is also reflected in the additional licensing burden that the configuration in (8b) involves: a greater number of units to be licensed in a structure should require a greater amount of licensing potential — generally, the more complex the structure,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

Having identified a direct association between markedness and complexity of structure, I now turn to the second of A&P's markedness generalizations given in (1b). Within the set of languages analysed as displaying tongue root harmony, the literature is largely united in the opinion that it is considerably more common to find ATR (in binary feature terms, [+ATR]) as the active property, rather than its opposite value RTR (that is, [−ATR]). In other words, as a phonological phenomenon, RTR harmony appears to be considerably more marked than ATR harmony. In order to capture this difference in structural terms, I shall propose that the melodic template in (9) is appropriate for representing the harmonic facts of those systems that have been most robustly shown to display active RTR.

(9) *tier geometry for Wolof and Yoruba*



This entails that (9) is a more marked configuration than (8b), a result that may be derived via the Licensing Inheritance Principle in the following way.

I shall claim that the licensing of a tier complement cannot be achieved without cost, but rather, that it consumes licensing potential in the same way that the licensing of other units do. So, in order to successfully sanction a complement, a strong enough licensor must be available (where 'strength' may be defined in terms of the possession of sufficient potential to pass on to a licensee). Since the colour tier in (8) and (9) is situated at a point higher up the licensing path than the [A]-tier, it is the former which possesses a greater amount of potential, and therefore, is predicted to be a stronger licensor and thus license a complement more easily. Nevertheless, there is no apparent reason for ruling out the possibility of the [A]-tier licensing a complement instead, which I claim is indeed the case in RTR harmony languages like Wolof and Yoruba. Of course, the [A]-tier must be considered a relatively weak licensor — given its position lower down the licensing path than its licensor, the colour tier — and as such, is expected to support a complement less easily. But the difficulty in licensing the structure in (9) compared to that in (8b) illustrates clearly the difference in markedness between the types of vowel system that each represents. To capture the characteristics of a language which displays either ATR harmony or an ATR/RTR contrast, we would posit a melodic template such as the one in (8b). To describe a much less common, more highly marked phenomenon like RTR harmony, however, it is necessary to refer to a more marked structure such as (9), which is predicted by the model to be less easily derived.

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

3 RTR harmony in Wolof

3.1 Introduction

Wolof[12] is analysed by A&P as a system which exhibits vowel harmony involving the active participation of the property RTR. This approach contrasts with an alternative proposal by Ka (1994), who suggests that a [+ATR] autosegment is responsible for harmonic agreement in this language. I shall illustrate below, however, that this latter view is problematic with regard to the treatment of high vowels: specifically, **i** and **u** must be analysed as harmonic triggers in word-initial position, but as neutral vowels elsewhere. Accordingly, I develop an RTR account of the facts within a tier-geometric context, which demonstrates the capacity for capturing (i) the identity of the two harmonic vowel sets and (ii) the transparent behaviour of neutral vowels. Here I argue

[12]A Niger-Congo language spoken primarily in the Gambia and Senegal.

for the structure in (9) as the only melodic template which will accommodate all the harmonic facts of this language.

The inventory of Wolof contains the eight vowels given in (10), dividing into the two distinct harmonic groups shown. Unlike the majority of ATR harmony systems (see (7) above), the two high vowels in Wolof have no retracted counterparts. Besides being neutral to harmony (i.e. non-targets), both **i** and **u** are also transparent to harmony (i.e. non-blockers); this fact, I shall argue in §3.3 below, results directly from the tier-geometric structure employed.

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

On the face of things, an adequate description of the distributional sets in (10) may be obtained from either of two possible melodic structures. One analysis posits a configuration of the type in (8b), where the members of the ATR set are defined in terms of the presence of an active colour tier complement. This characterization immediately excludes the RTR vowels and yields the desired split within the inventory. Two potential problems arise from this proposal, however. First, there is no obvious explanation for the absence of the RTR high vowels **ɪ** and **ʊ**;[13] given the melodic template in (8b), we might expect an active [U], for example, to contrast with an expression involving an additional active [comp]. Second, we would be forced to adopt a representation of **ə** that does not easily accommodate the characteristics displayed by this vowel. The most likely analysis would take **ə** as the interpretation of an empty nuclear position, while the distribution of **ə** in Wolof, together with its behaviour in harmonic alternations, provide sufficient evidence to refute this view.[14]

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

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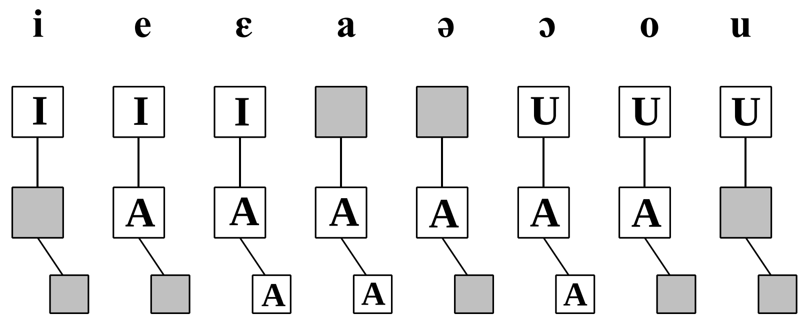
[13]The same two vowels are absent from the inventory of Yoruba, which receives a parallel RTR treatment in Backley (in prep.).

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

(11).

(11)



This representation of Wolof vowel contrasts allows us to identify the two harmonic sets in a straightforward manner — the members of the RTR set {ɛ,ɔ,a} all contain an active [A]-comp, whereas the same unit is inactive in the ATR set comprising {i,u,e,o,ə}. Accordingly, the system of RTR harmony observed in this language may be characterized as the lexical instruction **ACTIVATE [A]-COMP** applied at the prosodic word level.[15] Harmonic alternation is observed in the following non-high ATR~RTR pairs: **e**~**ɛ**, **o**~**ɔ**, and **ə**~**a**. The high vowels **i** and **u** do not participate in harmony. In the following sections I illustrate the distribution of these alternants using examples cited in Ka (1994).

A comparison between the [A]-comp structure employed in (11) and the less marked [I/U]-comp configuration given for Maasai in (7) brings to light one of the characteristics of the TG model not yet introduced. In keeping with the view of elements as cognitive categories (grounded in basic phonological notions such as contrast and alternation) as opposed to phonetically defined interpretable units, we inevitably find some degree of inconsistency between the melodic representation of an expression and the precise interpretation of that expression. The fact that the vowel system of Spanish contains phonetically advanced high vowels does not motivate the inclusion of a colour complement in the melodic template of that system. Such a move would fail to be supported by the phonological behaviour of the vowels in the language (e.g. no high vowel tongue root distinction is observed). A vowel sound may therefore be identified

[15] An analysis of RTR harmony involving the [A] element has been attempted within both Dependency Phonology (van der Hulst 1990) and Particle Phonology (Schane 1990).

by different phonological structures, according to the particular phonological characteristics of any given system: for example, the vowel **i** corresponds to active [I] in Spanish, but to active [I]-comp in Maasai. Similarly, the low vowel of Maasai is encoded as [A] in that system, whereas the phonetically similar vowel **a** in Wolof corresponds to the representation [A]-comp. See Backley (in prep.) for a fuller discussion of the non-phonetic basis of phonological categories.

3.2 Cases of 'regular' harmony

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

(12) a. *lexically ATR roots* b. *lexically RTR roots*

tilim	'to be dirty'	cɛrɛ	'couscous'
jigeen	'woman'	lɛmpɔ	'tax'
kəriɲ	'coal'	jafɛ	'to be expensive'
fitnə	'hardship'	mangɔ	'mango'
bukki	'hyena'	bakkan	'nose'
bəccəg	'daytime'	nɛlaw	'to sleep'

Each form illustrates the 'regular' pattern of harmony in Wolof, where the vowels are taken exclusively from one of the harmonic groups in (10).

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

(13) a. **-e** ~ **-ɛ** ('instrumental-locative' suffix)

door-e	'hit with'	xaar-ɛ	'wait in'
suul-e	'bury with'	xɔɔl-ɛ	'look with'
gən-e	'be better in'	dɛm-ɛ	'go with'

b. **-oon** ~ **-ɔɔn** (past tense suffix)

reer-oon	'was lost'	rɛɛr-ɔɔn	'had dinner'
tiit-oon	'was scared'	xaar-ɔɔn	'waited'
bəgg-oon	'wanted'	jɔx-ɔɔn	'gave'

c . **-ənte** ~ **-antɛ** ('mutual' suffix)

sedd-ənte	'share'	rɛy-antɛ	'kill each other'
dugg-ənte	'be friends'	baag-antɛ	'go back and forth'
bəgg-ənte	'love each other'	xɔɔl-antɛ	'look at each other'

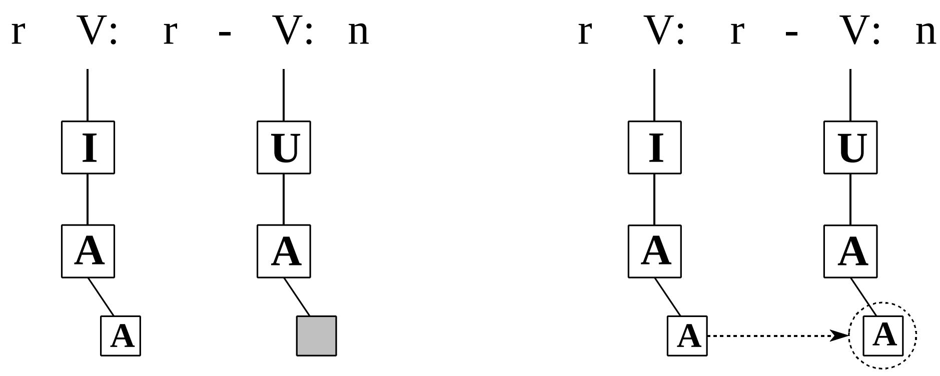
These examples demonstrate the co-occurrence restrictions on vowels in Wolof, such that the vowels within the word domain must agree in terms of tongue root quality — all must be either ATR or RTR. The structure proposed in (9) has already allowed us to identify the melodic property that distinguishes the two harmonic sets (i.e. an active [A]-comp). We may argue, then, that a characterization of vocalic agreement in this system refers to *the activation of [A]-comp at the level of the prosodic word*. To illustrate, consider the minimal pair in (14); these forms differ only with respect to the lexically active/inactive status of the melodic unit [A]-comp.

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

The form in (14b) contains an active [A]-comp, which manifests itself in the RTR quality of the vowel. I propose that the complement of [A] has a special status in Wolof, in that it is activated at the word level whenever it is lexically specified; indeed, it is in this way that the harmonic properties of this language are derived. So in cases of 'regular' harmony, [A]-comp activation under any nuclear position translates into its uniform activation throughout the entire word span. In (15) the addition of an alternating suffix to (14b) demonstrates how the scope of [A]-comp activation expands throughout the extended domain.[16]

[16]Here I make no claims as to the representation of long vowels in Wolof. The question of whether or not branching structure is permitted has no direct bearing on the present analysis.

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



[[rɛɛr] OOn] [rɛɛrɔɔn]

In the RTR context shown in (15), a suffix featuring the alternation **o~ɔ** harmonizes with the RTR quality of its root by allowing the activation of [A]-comp in the root to expand throughout the newly extended word domain.[17] The same mechanism applies to the examples given in (13) — including the **ə** ~ **a** alternations in (13c), which receive a parallel treatment under the present analysis. From (11) it will be recalled that **ə** is identified phonologically as an active [A] in this system; following the effects of harmonization, the additional activation of [A]-comp then results in the representation of a low vowel **a**.

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

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

3.3 Non-alternating vowels in Wolof

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

(16) *ATR roots* / *RTR roots*

gimm-i	'to open eyes'	sapp-i	'to lose taste'
wedd-i	'to straighten up'	lɛmm-i	'to unfold'
mən-in	'capacity'	dɔx-in	'way of walking'
təgg-in	'rhythm'	dɛfar-in	'way of making'
lett-u	'to braid hair'	sɛɛt-u	'to look in the mirror'
dindik-u	'to be taken off'	xappatik-u	'to be damaged'

Although [A]-comp is active (presumably at the word level, in line with all other cases in Wolof) in RTR forms such as *sɛɛtu* and *dɔxin*, the span of activation ceases at the point where the suffix vowel is interpreted. Clearly, this contradicts the regular harmonic pattern we have established above, and ideally we should like to find some natural (i.e. non-stipulative) explanation for the apparent irregularity shown by the set of high vowels. Such an explanation is readily available if we opt for the configuration in (9), rather than that in (8b), as the melodic template for Wolof.

Fundamental to the TG model is the assumption that a structure such as (9) employs two different kinds of licensing relations. First, the licensing of the [A]-tier relies on the presence of its dominating tier to act as a licensor; this relation alone is sufficient to create a configuration such as that given in (8a). Second, in order to license a complement we require not only the presence of a licensing tier but also its active status. So in (8b), [comp] cannot be licensed until either [I] or [U] is active; similarly, in (9) [A] must be active before it can license its complement.[18] In the context of the Wolof harmony process, this condition on the licensing of [comp] proves crucial in excluding the high vowels as harmonic targets. Having characterized harmony as the expansion of [A]-comp activation, it is clear that only those expressions with a lexically active [A] (to support the licensing of [comp]) are potential participants. Given that the high vowels form a set which is defined by the absence of active [A], it is predicted that neither **i** nor **u** can display RTR properties, even within an RTR domain. In this way, the fact that high vowels are denied the ability to license [comp] entails that they should behave as neutral expressions.

But besides the issue of non-alternation, the high vowels may also be described as transparent — that is, although they are never harmonic targets, **i** and **u** do not block the progress of harmony across a domain. This is illustrated in the following root forms (17a) and derived words (17b). The examples in (17c) are included in order to illustrate the alternating nature of the chosen suffixes.

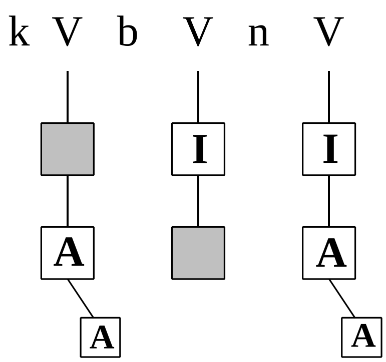
(17)	a.	kabinɛ	(*kabine)	'toilet'
		lantinɔɔr	(*lantinoor)	'funnel'
	b.	bɛy-u-lɔɔ	(*bɛy-u-loo)	'you did not cultivate'
		bɔkk-u-lɛɛn	(*bɔkk-u-leen)	'you are not good'
	c.	tox-u-loo		'you did not smoke'
		tiit-u-leen		'you are not scared'

I shall claim that high vowel transparency derives from the absence of anything within the structure of such expressions that could impose any potential blocking effect on the span of [A]-comp activation. In this analysis I have portrayed harmonic agreement in terms of an unbroken span of activation along a particular tier. Accordingly, the description of a harmonic blocker would amount to the identification of a melodic position (on that tier) which cannot harmonize, and which therefore interrupts the activation span. In direct contrast, to capture high vowel transparency we would have to

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

show that the representation of high vowels makes no reference to the melodic unit [A]-comp, not even to the point of indicating an empty slot. So, for the word *kabinɛ* 'toilet' we would have to posit the structure in (18).

(18) kabinɛ 'toilet'



In (18) the medial vowel **i** does not interrupt the span of [A]-comp activation, since it does not even license the presence of the melodic unit [A]-comp. But this fact about high vowels has already been established independently of the present issue — the licensing of [A]-comp (whether active or not) is impossible in the absence of an active [A] to assume the role of a suitable licensor. In this way, the harmonic span can progress unhindered throughout the domain, as nothing inherent in the representation of the vowel **i** can have a blocking effect on [A]-comp activation.[19]

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

[19]Backley (in prep.) addresses the question of locality and its significance to cases of transparency.

(19) a. *Word-initial high vowels*

suul-e	(*suul-ɛ)	'to bury with'
yiw-ədi	(*yiw-adi)	'to have a bad appearance'
tiit-oon	(*tiit-ɔɔn)	'was scared'

b. *Word-medial high vowels*

warugar	(*warugər)	'obligation'
sɔppi-lɛɛn	(*sɔppi-leen)	'change!'
xɔɔl-ulɔɔ	(*xɔɔl-uloo)	'you did not look at'

According to Ka's spreading analysis, ATR harmony is initiated by the word-initial high vowel in the examples in (19a), resulting in a ban on any subsequent RTR vowels. This is illustrated in (20a). In contrast, (19b) shows mixed forms consisting of a medial ATR vowel flanked by RTR expressions; and when the same autosegmental spreading operation is carried out, as given in (19b), an ill-formed sequence results.

(20) a.

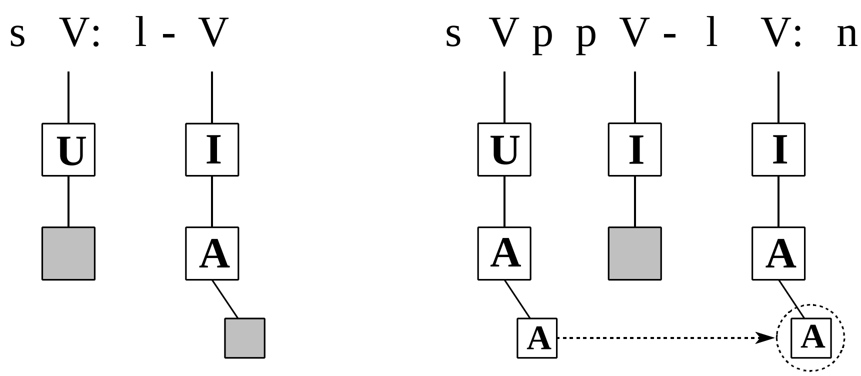
```
[+ATR]
  |  \
s u u l + E      →     suule (*suulɛ)
```

b.

```
    [+ATR]
      |  \
s ɔ p p i + l E E n   →   *sɔppileen
```

Ka is therefore forced to analyse the (19b) forms as featuring a non-triggering high vowel within an RTR morpheme. In contrast, the TG approach achieves a more straightforward interpretation of the facts in (19). Since RTR harmony is described with reference to an active [A]-comp, it follows that high vowels cannot act as triggers under any circumstances (see (18) above). So the forms in (19a) appear as exclusively ATR domains, owing to the absence of any harmonically active RTR. Those in (19b), however, may be treated as lexically specified RTR spans containing a transparent high vowel. An example from each is given in (21a) and (21b) respectively.

(21) a. suul-e (*suul-ɛ) b. sɔppi-lɛɛn (*sɔppi-leen)



While many interesting points relating to vowel distribution in Wolof have been omitted from this discussion, I have nevertheless introduced sufficient data to show how the observed harmonic patterns can be accounted for by assuming that [A]-comp activation is specified at the word level in this system. This analysis is able to describe the particular division of the vowel inventory into two harmonic sets, the facts of harmonic alternation, and the transparency of high vowels.

4 Conclusion

In this paper I have demonstrated the capacity of the TG model for describing two distinct types of tongue root harmony: while a system involving an active [I/U]-comp accounts for ATR alternation in languages such as Akan and Maasai, RTR harmony (e.g. Wolof, Yoruba) is represented in terms of an active [A]-comp. Unlike the analysis proposed by A&P, this is achieved within the restrictive context of a system of monovalent primes; furthermore, the TG approach is able to encode the differing markedness properties of the two system types without appeal to any extrinsically motivated evaluation metric.

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