1 Introduction

A development of Goad's (1991, 1993) theory of vowel height feature geometry is outlined and applied to tongue root and other harmony problems in three African languages. Tension is defined as a node in the feature geometry which covers both Advanced Tongue Root (ATR) and Retracted Tongue Root (RTR).

In Moore there are problematic mid vowels which alternate with high vowels under ATR harmony and are the only vowels subject to lowering in what Rennison (1990: 226) calls A-umlaut and monophthongisation. Both peculiarities find ready explanation under the proposed geometry when these vowels are regarded as lacking any height specification.

No new analysis is offered of ATR harmony in Kalenjin, but a brief account is included because an explanation is available for the syllables blocking the harmony being unaffected by it in contrast to the situation in Okpe, where the vowel which blocks RTR harmony is also subject to it.

It is this same blocking alternation, [e] ~ [a], under Okpe RTR harmony, which has proved difficult to distinguish phonologically from the [ɛ] ~ [a] alternation. An underlying ATR specification in the proposed geometry accounts for

i. the width of the alternation,
ii. its blocking of the RTR harmony and
iii. its undergoing of the harmony nevertheless.

The theory makes the falsifiable prediction that this difference in the blocking of ATR and RTR harmony, that ATR blockers resist ATR while RTR blockers accept RTR, is general.
2 Goad’s theory

This is not the place for a detailed critique of Goad’s impressively adequate and constrained thesis, but a brief account is offered with some motivation for the changes proposed.

Vowel height is handled by the Voc node. Three primary heights are represented as:

\[
\begin{align*}
\text{Voc} &= \text{(high)}, & \text{Voc} &= \text{(mid)}, & \text{Voc} &= \text{(low)}. \\
& & & | \\
& & [\text{open}] & & [\text{open}] \\
& & & | \\
& & & & [\text{low}] \\
\end{align*}
\]

ATR is shown to be a constituent of this node, adding two secondary heights:

\[
\begin{align*}
\text{Voc} &= \text{(high atr)}, & \text{Voc} &= \text{(mid atr)}. \\
& & & | \\
& & | & & [\text{open}] \\
& & | & & | \\
& & & & [\text{atr}] & & [\text{atr}] \\
\end{align*}
\]

The feature [atr] is anomalous in two ways: it can attach in two places, either to [open] or direct to the Voc node; and it cannot co-occur with [low].

Goad also argues that [rtr] is a Place feature that can co-occur with any Voc feature, including [atr]. The implication is that [low] and [rtr] are different features, though this seems to me to be weakened by the suggestion (1993: 186) that [low] might “link directly to Voc under marked circumstances”, acting effectively as [\text{-atr}].
Proposed geometry

I propose

1 to equate Goad's [low] and [rtr] as [RTR]

2 to attach [atr] only to the Voc node as sister to [open]

3 to attach [RTR] only to [atr], negating it as [open] negates Voc:

\[
\begin{array}{c|c|c}
\text{Voc} & \text{renamed as} & \text{Height} \\
/ & \backslash & / \backslash \\
[open] & [atr] & \text{open} \text{Tension} \\
/ & & / \\
[RTR] & & \text{RTR}
\end{array}
\]

It is this docking of [RTR] under Tension that helps to explain the asymmetric blocking of ATR and RTR harmony.

Moore 1

4.1 Introduction

Moore is a West African language related to Koromfe. The alternations treated by Rennison (1990: 211-229, 1992) as ATR-harmony and A-umlaut are re-analysed in a way that avoids the mutual blocking of ATR by A on the same tier.

1 Versions of this analysis were given at the Second Phonology Workshop at Manchester in May 1994 and printed as a peer-reviewed working paper as Prescott (1994), cited in http://linguistica.sns.it/QLL/QLL04_05/Calamai_Bertinetto.pdf
4.2 Data from Rennison (1990)

**ATR-harmony** is used to explain the alternations of suffix vowels shown in (4.1) depending on the vowel of the stem.

(4.1) after [i] [u] | after [i] [u] [e] [o] [ɛ] [ɔ] [a]

<table>
<thead>
<tr>
<th>[i]</th>
<th>[e]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[u]</td>
<td>[o]</td>
</tr>
<tr>
<td>[ʌ]</td>
<td>[a]</td>
</tr>
</tbody>
</table>

Two of these alternations are shown in the noun class suffixes [ri] ~ [re] in (4.2) and [gu] ~ [go] in (4.3).

(4.2) *litri* 'litre' *sigre* 'altar'

(4.3) *wulgu* 'fog' *sebgo* 'wind'

The third, the [ʌ] ~ [a] alternation is exemplified in (4.5) below.

In **A-umlaut** [ɛ], [ɔ] alternate variably with [ɛ], [ɔ] before [a]. This is shown in (4.4), while (4.5) is an example of a high root vowel not subject to A-umlaut. The variation is analysed in section 4.3.

<table>
<thead>
<tr>
<th>Stem</th>
<th>Suffix</th>
<th>Phonetic form</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>ped</td>
<td>ga</td>
<td>pedga</td>
<td>'piece'</td>
</tr>
<tr>
<td>boe</td>
<td>ga</td>
<td>bɔɛga/bwɛga</td>
<td>'male goat'</td>
</tr>
<tr>
<td>mo</td>
<td>ga</td>
<td>moaaga</td>
<td>'Moose (Mossi)'</td>
</tr>
</tbody>
</table>

(4.5) *bi* *gʌ* 'child'.
4.3 Rennison's analysis

Rennison analyses the vowels as follows:

\[(4.6)\]

<table>
<thead>
<tr>
<th>tier</th>
<th>ATR, A</th>
<th>ATR</th>
<th>ATR, A</th>
<th>A</th>
<th>A</th>
<th>ATR, A</th>
<th>A</th>
<th>ATR, A</th>
<th>ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, U</td>
<td>I I I</td>
<td>I I</td>
<td>U U U U</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>skeleton</td>
<td>x x x x x x x x x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[\text{[i]} \text{[i]} \text{[e]} \text{[e]} \text{[a]} \text{[a]} \text{[a]} \text{[o]} \text{[o]} \text{[u]} \text{[u]}\]

and ATR-harmony as spreading of ATR, but only from a vowel without A. So ATR cannot spread from /ɪ/, /ʊ/.

Rennison sees **A-umlaut** as spreading of the A-element

\[(4.9)\]

<table>
<thead>
<tr>
<th>A</th>
<th>giving</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>x ... x</td>
<td>x ... x</td>
<td></td>
</tr>
</tbody>
</table>

\[\text{[e]} \text{[a]} \text{[e]} \text{[a]}\]

under the converse restriction to ATR-harmony ie only from a vowel without ATR to a vowel without ATR.

The data seem more complicated than \((4.9)\) implies and I think are better explained as
i. epenthesis of /a/, seen unmodified in moaaga,

ii. optional monophthongization of /e/ and this epenthetic /a/ as [ɛ] in pedga, bweega, (Rennison alludes (ibid:213) to a similar monophthongisation giving the alternations [ae] ~ [ɛ], [ao] ~ [ɔ]),

iii. optional further spreading of A leftwards in the variant bœega.

The important point is that the epenthesis does not happen when the root vowel is ATR in Rennison’s terms.

The ordering of ATR and A is crucial and made explicit in Rennison (1992):

- ATR cannot spread rightwards through A
- A cannot spread leftwards through ATR.

4.4 Proposed analysis

Let us reconsider the analysis of /ɪ/, /ʊ/. The set of vowels not subject to A-umlaut is /i/, /u/, /ɪ/, /ʊ/, traditionally [+high]. So I propose that /i/, /u/ have [Height, Tension], while /ɪ/, /ʊ/ have just [Height]. This [Height] is a feature not admitted by Rennison but it leads to a simple account of the blocking of A-umlaut. If /a/ has [Height, open], its epenthesis only takes place in a syllable which lacks a [Height] specification, which is what I propose (4.10) for /e/, /o/. There is now also a simple explanation for /ɪ/, /ʊ/ not causing ATR-harmony: their lack of [Tension] specification.

We still have a problem with [e], [o] which have to alternate with [i], [u] in ATR-harmony and with [ɛ], [ɔ] in A-umlaut. If they are unspecified for [Height] they can take on the [Height, open] of /a/ in A-umlaut, but in ATR-harmony they need to acquire [Height] as well as [Tension]. I will examine two ways of supplying the missing [Height]:

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i. Since the vowels which cause ATR-harmony also have [Height], the whole node [Height, Tension] could spread together. The snag with this is that the \([\alpha] \sim [a]\) alternation requires the spreading of [Tension] without [Height] ie a separate process.

ii. In the feature geometry proposed Tension requires to be governed by Height which must be generated when Tension spreads to a vowel unspecified for Height.

The second seems the simpler solution.

Expressing my analysis for Height only, neglecting Rennison’s I, U:

(4.10) \[ \text{i,u} \text{ i,o} \text{ e,o} \text{ \lambda} \text{ e,\varepsilon,a} \]

\[ \text{x} \text{x} \text{x} \text{x} \text{x} \text{x} \]

\[ \text{Height} \text{ Height} \text{ Height} \text{ Height} \text{ Height} \]

\[ \text{Tension} \text{ open Tension} \text{ open} \]

**ATR-harmony** is spreading of dependent [Tension] with generation of governing [Height] when necessary;

**A-umlaut** is epenthesis and variable spreading of [Height, open], both blocked by [Height].

The phonology and phonetics of the alternations are summarised in a table:
5. **Kalenjin**

This account is based on Lodge (1995). Because the harmony affects consonants as well as vowels, Lodge’s analysis is in terms of morphemes. Rewriting Lodge’s analysis in tension terms:

i. **dominant** morphemes are specified [Tension], represented by *ordinary type*; any neighbouring adaptive morphemes will take on this value;

ii. **adaptive** morphemes, represented by *CAPITALS*, are unspecified for [Tension] but can take it on from neighbouring morphemes; otherwise they get [Tension, RTR] by default;

iii. **opaque** morphemes are specified [Tension, RTR], represented by *italics*, are unchanged by neighbouring [Tension] and stop its spread.

---

2 The following comparison of harmony blocking in Kalenjin and Okpe was presented as 'Asymmetric blocking of tongue-root harmony in Kalenjin & Okpe' at *From Representations to Constraints* in Toulouse 2003
His example (11) illustrates:

(5.2) /KA + ka: +KO + ke:r + A/ → [kaya:yoye:ra] ‘he had seen me’

[Tension] spreads from dominant ke:r to neighbouring adaptive KO and A but is blocked by opaque ka: which already has [Tension, RTR]. Adaptive KA is shielded from the spread of [Tension] and gets [Tension, RTR] by default.

[Tension] harmony is blocked by another Tension specification but the dependent [RTR] is not deleted. The alternations are tabulated for comparison:

Kalenjin (vowels only)

<table>
<thead>
<tr>
<th>Height</th>
<th>Tension</th>
<th>front</th>
<th>round</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>ATR</td>
<td>i [i]</td>
<td>u [u]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>high</td>
<td></td>
<td>I [i]</td>
<td>U [u]</td>
</tr>
<tr>
<td>open</td>
<td>ATR</td>
<td>e [ɛ]</td>
<td>a [a]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>open</td>
<td></td>
<td>E [ɛ]</td>
<td>A [a]</td>
</tr>
<tr>
<td>open</td>
<td>RTR</td>
<td>e [ɛ]</td>
<td>a [a]</td>
</tr>
</tbody>
</table>

---

4 The ATR alternant is represented as [a] in the narrower transcription of Local & Lodge (1996) and sounds close to [ʌ].
6. Okpe

6.1 Introduction

Okpe is a Kwa language of Nigeria with a vowel harmony system described by Hoffmann (1973) in terms of tongue-root harmony and given a Radical Underspecification analysis by Pulleyblank (1986) as spreading of [+ATR], advanced-tongue-root.

The examples of Okpe are divested of tone diacritics in the interest of simplicity and on the assumption that these are orthogonal to the matter in hand. Ten phonetic alternations are presented, eight of which are analysed in terms of [RTR] harmony and two as a manifestation of [round] harmony.

6.2 The alternations

i. [i] ~ [e]  
   cf. the first syllables of (6.1), (6.2).

(6.1) [wizurû]  
   ‘you fanned’

(6.2) [wesoro]  
   ‘you sang’

ii. [u] ~ [o]  
   cf. the last syllables of (6.1), (6.2).

iii. [e] ~ [ε]  
   cf. the first syllables of (6.3), (6.4).

(6.3) [etjo]  
   ‘to pull’

(6.4) [etjɔ]  
   ‘to refuse’

iv. [o] ~ [ɔ]  
   cf. the last syllables of (6.3), (6.4).

v. [a] ~ [a]  
   cf. the first syllables of (6.5), (6.6).

(6.5) [ajetjɛ]  
   ‘they are pulling’
vi. \=[e] \sim [a] \quad \text{cf. the second syllables of (6.5), (6.6).}

vii. \=[ɛ] \sim [a] \quad \text{cf. the last syllables of (6.5), (6.6).}

viii. \=[i] \sim [i] \quad \text{cf. the first syllables of (6.7), (6.8).}

(6.7) [mietje] \quad \text{‘I am pulling’}

(6.8) [miaswa] \quad \text{‘I am singing’}

ix. \=[i] \sim [u] \quad \text{cf. the last syllables of (6.1), (6.9).}

(6.9) [wisori] \quad \text{‘you stole’}

x. \=[e] \sim [o] \quad \text{cf. the last syllables of (6.2), (6.10).}

(6.10) [wedare] \quad \text{‘you drank’}

6.3 Tension harmony

Alternations i. - iv. are regarded as tongue-root harmony pairs with phonetic neutralisation of the retracted alternants of i., ii. with the advanced alternants of iii., iv.

The fact that the retracted alternants of v., vi., vii. are all [a] inclines me to choose [RTR] as the harmonic agent and this yields a coherent analysis in the feature geometry proposed.

The non-alternating [a] of v. represents an underlyingly [RTR] segment which is unchanged by the harmony, though if the explanation below of vii. is correct the harmony would be blocked anyway in this prefix.
Alternation vii. is just [open] with phonetic neutralisation of its unretracted alternant [ɛ] with the retracted member of [front, open] iii.

The explanation proposed for the two-step alternation vi. is to give it underlying [Tension]. Harmonic [RTR] can dock under this, tension switching accounting for the width of the difference between [ɛ] and [a]. Unretracted [open, Tension] is neutralised with the retracted alternant of i. and with the unretracted [front, open] of iii.

Justification of this unique [Tension] specification of vi. comes from its ability to explain the non-alternating [i] of viii.4 In all Hoffmann’s examples this [i] is shielded from the harmonic influence of the root by a member of vi. If this harmony in Okpe is the spread of not just [RTR] but of [Tension, RTR] then it can be blocked by another [Tension] specification, just as in Kalenjin. The difference is that the [RTR] is accepted by the blocking segment which thus undergoes the harmony, whereas in Kalenjin the [RTR] specification of the blocking syllable cannot be deleted by the bare [Tension] of the harmony. It seems appropriate to regard both harmonies as Tension Harmony.

6.4 Round harmony

In alternations ix, x, [round] is spread from a non-open root vowel to a non-open suffix vowel. This is included because it suggests the non-open front vowels are not specified for [front], which helps to make those neutralisations between vowels with and without [front] more plausible.

No explanation is offered for the non-participation of [open] vowels in round harmony.

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4 I am indebted to someone, whose name I failed to record, for the suggestion, when I presented a paper on Okpe at the 1991 Autumn Meeting of the LAGB at York, that the harmony is being blocked here
Okpe$^5$

<table>
<thead>
<tr>
<th>Height</th>
<th>Tension</th>
<th>front</th>
<th>round</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td></td>
<td>i [i] → u [u]</td>
<td>adaptive</td>
</tr>
<tr>
<td>high</td>
<td>RTR</td>
<td>i^♭ [e] → u^♭ [o]</td>
<td>dominant</td>
</tr>
<tr>
<td>open</td>
<td>ATR</td>
<td>ə [e]</td>
<td>semi-opaque$^6$</td>
</tr>
<tr>
<td>open</td>
<td></td>
<td>e [e] a [ɛ]</td>
<td>adaptive</td>
</tr>
<tr>
<td>open</td>
<td>RTR</td>
<td>e^♭ [E] a^♭ [a] a^♭ [a] o^♭ [ɔ]</td>
<td>dominant</td>
</tr>
</tbody>
</table>

7 Conclusions

The dependency relationship, in this development of Goad’s geometry, of the features Height - Tension - RTR is used to throw light on some phonological puzzles.

In Moore, node generation of Height in Tension harmony explains why the tense alternants of mid vowels are high and the lack of Height in these same mid vowels allows epenthesis of a Height node in A-umlaut.

In Kalenjin, Tension harmony is blocked by syllables specified for Tension whose dependent [RTR] remains, resisting the harmony.

In Okpe, [Tension, RTR] harmony is blocked by vowels specified for Tension which accept [RTR], undergoing the harmony.

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$^5$ The pharyngealization diacritic a^♭ is used instead of the RTR ə for better contrast with the ATR ə.

$^6$ This neat term for segments that undergo but do not pass on a harmony is due to Ribeiro (2002)
References


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