Nata is a Lacustrine Bantu language spoken in western Tanzania by about 6,000 people.
Nata is a language with very sparse specifications of high tone, typically with a single high tone syllable per word.

Proposed analysis

- In the input, morphemes have either no tone, high tone or low tone.
- Output tones are located relative to constituent boundaries.
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# Nata

## Morphological background

<table>
<thead>
<tr>
<th>Verbs</th>
<th>Tense</th>
<th>Object</th>
<th>Root + Extensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aspect</td>
<td></td>
<td>Tense</td>
</tr>
<tr>
<td></td>
<td>Subject</td>
<td></td>
<td>Aspect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nouns</th>
<th>PPF</th>
<th>Class prefix</th>
<th>Word</th>
<th>Macrostem</th>
<th>Stem</th>
</tr>
</thead>
</table>
Both nouns and verbs contain a macrostem.

(1) Verb morphological template
Prefixes [Macrostem
ni- ka [ki- som -a
SM1sg NAR OM7 read FV

(2) Noun morphological template
Preprefix [Macrostem
ε- [ki- náata
PPF C7 Nata language
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Two noun classes have prefixes that fuse morphemes inside and outside of the macrostem.

/tʃaa-/ of c10 and /rii-/ of c5 occupy prefix positions corresponding to both the PPF and the class prefix.

<table>
<thead>
<tr>
<th>Nouns</th>
<th>PPF</th>
<th>Class prefix</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>tʃaa-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rii-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>Macrostem</td>
<td>Stem</td>
<td></td>
</tr>
</tbody>
</table>

We analyze these fused forms as falling outside the Macrostem for reasons discussed below.
Toneless inputs predictably surface with a high tone on the first syllable of the macrostem.

(3) Narrative past tense with the verb root *som* ‘read’

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
<th>Word</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. SM1sg</td>
<td>ni- ka- [som -a] ηga[sóma]</td>
<td>‘I read’</td>
</tr>
<tr>
<td>b. SM2sg</td>
<td>u- ka- [som -a] uka[sóma]</td>
<td>‘You read’</td>
</tr>
<tr>
<td>c. SM3sg</td>
<td>a- ka- [som -a] ηga[sóma]</td>
<td>‘S/he read’</td>
</tr>
<tr>
<td>d. SM1pl</td>
<td>tu- ka- [som -a] tuyα[sóma]</td>
<td>‘We read’</td>
</tr>
<tr>
<td>e. SM2pl</td>
<td>mu- ka- [som -a] μuya[sóma]</td>
<td>‘You (pl) read’</td>
</tr>
<tr>
<td>f. SM3pl</td>
<td>βa- ka- [som -a] βaya[sóma]</td>
<td>‘They read’</td>
</tr>
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</table>

| SM NAR | read-FV |
(4) Narrative past tense with one object marker

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
<th>Word</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. SM1sg ni-ka-[kisOm-a]</td>
<td>ηka[γíscma]</td>
<td>‘I read it’</td>
</tr>
<tr>
<td>b. SM2sg u-ka-[kisOm-a]</td>
<td>uka[γíscma]</td>
<td>‘You read it’</td>
</tr>
<tr>
<td>c. SM3sg a-ka-[kisOm-a]</td>
<td>aka[γíscma]</td>
<td>‘S/he read it’</td>
</tr>
<tr>
<td>d. SM1pl tu-ka-[kisOm-a]</td>
<td>tuka[γíscma]</td>
<td>‘We read it’</td>
</tr>
<tr>
<td>e. SM2pl mu-ka-[kisOm-a]</td>
<td>muka[γíscma]</td>
<td>‘You (pl) read it’</td>
</tr>
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<td>f. SM3pl βa-ka-[kisOm-a]</td>
<td>βaka[γíscma]</td>
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</tr>
</tbody>
</table>

As we add object markers, the high tone remains on the left most OM; also the left most syllable of the macrostem.

- High tone is insensitive to what morpheme it falls onto.
- High tone assignment references syllable count from edges of the macrostem.
(4) Narrative past tense with one object marker

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
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<tr>
<td>a. SM1sg ni- ka- [ki- som -a]</td>
<td>ɳka[ɣísoma]</td>
<td>‘I read it’</td>
</tr>
<tr>
<td>b. SM2sg u- ka- [ki- som -a]</td>
<td>uka[ɣísoma]</td>
<td>‘You read it’</td>
</tr>
<tr>
<td>c. SM3sg a- ka- [ki- som -a]</td>
<td>aka[ɣísoma]</td>
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<td>d. SM1pl tu- ka- [ki- som -a]</td>
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<td>e. SM2pl mu- ka- [ki- som -a]</td>
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A Unified Account of Nominal and Verbal Tone in Nata
### Toneless Verbs

#### (4) Narrative past tense with one object marker

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<td>e. SM2pl mu- ka- [ki- sm -a] muka[γíscma]</td>
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<td>f. SM3pl βa- ka- [ki- sm -a] βaka[γíscma]</td>
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SM NAR OM7 read-FV

- As we add object markers, the high tone remains on the left most OM; also the left most syllable of the macrostem.
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A Unified Account of Nominal and Verbal Tone in Nata
(5) Narrative past tense with two object markers

<table>
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<tr>
<th>Morphemic Breakdown</th>
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</tr>
</thead>
<tbody>
<tr>
<td>a. <strong>SM1sg</strong></td>
<td>ni- ka- [ki- mu- som -ɛr -a] ῃya[kémusoméra]</td>
</tr>
<tr>
<td>b. <strong>SM2sg</strong></td>
<td>u- ka- [ki- mu- som -ɛr -a] ဦ ya[kémusoméra]</td>
</tr>
<tr>
<td>c. <strong>SM3sg</strong></td>
<td>a- ka- [ki- mu- som -ɛr -a] אהב[kémusoméra]</td>
</tr>
<tr>
<td>d. <strong>SM1pl</strong></td>
<td>tu- ka- [ki- mu- som -ɛr -a] 터야[kémusoméra]</td>
</tr>
<tr>
<td>e. <strong>SM2pl</strong></td>
<td>mu- ka- [ki- mu- som -ɛr -a] 무야[kémusoméra]</td>
</tr>
<tr>
<td>f. <strong>SM3pl</strong></td>
<td>βa- ka- [ki- mu- som -ɛr -a] β야야[kémusoméra]</td>
</tr>
</tbody>
</table>

- Underlyingly, the verb roots have no tone and neither do any of the narrative past morphology.
- **Analysis:** Align(MacroStem, Left; H-tone, Left)
(5) Narrative past tense with two object markers

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<tr>
<td>a. SM1sg ni- ka- [ki- mu- som -er -a]</td>
<td>Ṋya[kémusomera]</td>
</tr>
<tr>
<td>b. SM2sg u- ka- [ki- mu- som -er -a]</td>
<td>Ṣya[kémusomera]</td>
</tr>
<tr>
<td>c. SM3sg a- ka- [ki- mu- som -er -a]</td>
<td>aya[kémusomera]</td>
</tr>
<tr>
<td>d. SM1pl tu- ka- [ki- mu- som -er -a]</td>
<td>tuya[kémusomera]</td>
</tr>
<tr>
<td>e. SM2pl mu- ka- [ki- mu- som -er -a]</td>
<td>muya[kémusomera]</td>
</tr>
<tr>
<td>f. SM3pl bα- ka- [ki- mu- som -er -a]</td>
<td>baya[kémusomera]</td>
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</table>

SM NAR OM7 OM1 read APPL FV ‘I (etc.) read it for him/her’

Underlyingly, the verb roots have no tone and neither do any of the narrative past morphology.

Analysis: Align(MacroStem, Left; H-tone, Left)
Narrative past tense with two object markers

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<td>a. SN1sg ni- ka- [ki- mu- som -er -a] ŋya[kémusomera]</td>
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<tr>
<td>b. SN2sg u- ka- [ki- mu- som -er -a] ʊya[kémusomera]</td>
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<tr>
<td>c. SN3sg a- ka- [ki- mu- som -er -a] aya[kémusomera]</td>
<td></td>
</tr>
<tr>
<td>d. SM1pl tu- ka- [ki- mu- som -er -a] tuya[kémusomera]</td>
<td></td>
</tr>
<tr>
<td>e. SM2pl mu- ka- [ki- mu- som -er -a] muya[kémusomera]</td>
<td></td>
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<tr>
<td>f. SM3pl b- ka- [ki- mu- som -er -a] baya[kémusomera]</td>
<td></td>
</tr>
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Underlyingly, the verb roots have no tone and neither do any of the narrative past morphology.

Analysis: Align(MacroStem, Left; H-tone, Left)
Toneless nouns generally surface with high tone on the first syllable of the macrostem.

(6) Toneless nouns

a. o- [rú- bɛɾɛ]
   PPF [C11 millet]
   ‘millet’

b. e- [ɣé- seku]
   PPF [C7 door]
   ‘door’
▶ Just like toneless verbs, these noun stems are underlyingly toneless and have a high tone aligned to the left edge of the macrostem.

▶ We consider the macrostem edge to be the class prefixes as they are the same set of morphemes as object markers.

▶ *Analysis as with verbs:* \( \text{Align}(\text{MacroStem}, \text{Left}; \ H\text{-tone}, \text{Left}) \)
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*Analysis as with verbs:* Align(MacroStem, Left; H-tone, Left)
High Tone Verbs

- High tone verbs have a high tone linked to a morpheme in the input.
- For instance, verbs in the past conditional surface with a high tone on /-ire/, which is the last syllable of the macrostem.

(7) Past conditional tense

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<tr>
<th>Morphemic Breakdown</th>
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</tr>
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<tbody>
<tr>
<td>a. ni- a- ñga- [h ire]</td>
<td>ñaaŋga[heeré]</td>
</tr>
<tr>
<td>b. ni- a- ñga- [nu -ire]</td>
<td>ñaaŋga[ñwiiré]</td>
</tr>
<tr>
<td>c. ni- a- ñga- [som -ire]</td>
<td>ñaaŋga[somiré]</td>
</tr>
<tr>
<td>d. ni- a- ñga- [sukur -ire]</td>
<td>ñaaŋga[sukwiiré]</td>
</tr>
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</table>

SM.SG1 PST COND V-ROOT PFV 'I would give (etc.)'
High tone verbs have a high tone linked to a morpheme in the input.

For instance, verbs in the past conditional surface with a high tone on /-ire/, which is the last syllable of the macrostem.

(7) Past conditional tense

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<tbody>
<tr>
<td>a. ni- a- ŋga- [h   -ire]</td>
<td>ŋnaŋga[heeré]</td>
</tr>
<tr>
<td>b. ni- a- ŋga- [ŋu -ire]</td>
<td>ŋnaŋga[ŋwiiré]</td>
</tr>
<tr>
<td>c. ni- a- ŋga- [sɔm -ire]</td>
<td>ŋnaŋga[sɔmiré]</td>
</tr>
<tr>
<td>d. ni- a- ŋga- [sukur -ire]</td>
<td>ŋnaŋga[sukwiiré]</td>
</tr>
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</table>

SM.SG1 PST COND V-ROOT PFV  ‘I would give (etc.)’
High tone verbs have a high tone linked to a morpheme in the input.

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<td>a. ni-</td>
<td>ni- nga- [h -ire]</td>
</tr>
<tr>
<td>b. ni-</td>
<td>ni- nga- [nu -ire]</td>
</tr>
<tr>
<td>c. ni-</td>
<td>ni- nga- [som -ire]</td>
</tr>
<tr>
<td>d. ni-</td>
<td>ni- nga- [sukur -ire]</td>
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<td>SM.SG1 PST COND V-ROOT PFV</td>
<td>‘I would give (etc.)’</td>
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</table>
Tones linked to the final syllable in a morpheme are protected to surface on the same morpheme instead of being aligned to the left edge of the macrostem.

**Analysis:**

```
MaxPath(H-tone) & Align(MStem, R; H-tone, R)
>>
Align( MStem, L; H-tone, L)
```
Tones linked to the final syllable in a morpheme are protected to surface on the same morpheme instead of being aligned to the left edge of the macrostem.

**Analysis:**

```
MaxPath(H-tone) & Align(MStem, R; H-tone, R) >>>
Align( MStem, L; H-tone, L)
```
The morpheme /-ire/ is analyzed as having morphologically conditioned high and low tone allomorphs. The high tone allomorphs are selected in the past conditional.

(8)

LEXICON: /-ire/: i r e \[+[PST COND]___
i r e \elsewhere
High tone nouns surface with high tone on the final syllable.

(9) High tone nouns
    a. e- [ɣi- saré]
       PPF [C7 twin]
       ‘twin’
    b. e- [βi- saré]
       PPF [C8 twin]
       ‘twins’
    c. rii- [saré]
       C5 [twin]
       ‘small twin’
    d. a- [ma- saré]
       PPF [C6 twin]
       ‘small twins’
These noun roots are analyzed as having an underlying high tone liked to their final syllable.

These roots fail to trigger an insertion of a high tone: OCP.

Finally, associated high tones are protected from realigning, so we do not predict that all high tone noun roots will surface with the high tone aligned to the left edge of the nominal macrostem.

\[(10)\]

**INPUT:**

\[
\begin{array}{c}
\varepsilon - [ \ \gamma \ \varepsilon - s \ a \ r \ \varepsilon ]
\end{array}
\]

**OUTPUT:**

\[
\begin{array}{c}
\varepsilon - [ \ \gamma \ \varepsilon - s \ a \ r \ \varepsilon ]
\end{array}
\]
These noun roots are analyzed as having an underlying high tone liked to their final syllable.

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\begin{align*}
\text{INPUT:} & & \text{OUTPUT:} \\
\varepsilon & - [ \gamma \varepsilon - s a r \varepsilon ] & \varepsilon & - [ \gamma \varepsilon - s a r \varepsilon ]
\end{align*}
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Morphemes with a high tone associated to the right most syllable form a class.

An example of such morphemes aside from noun roots is the noun class 10 prefix, /tʃaa-/

The combination of toneless noun root with a high tone prefix results in the high tone of the prefix surfacing and no insertion of the initial high tone (as occurs with toneless noun roots and toneless noun class prefixes prefix).

This correctly captures that fact that the noun root control the final tone pattern of the nominal word.

(11)

INPUT: 
\[ H \]
\[ \begin{array}{c}
  t \int a a - [ s u k u \beta i ] \\
\end{array} \]

OUTPUT: 
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\text{OUTPUT:} & \quad H \\
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\text{H} \\
| \\
\text{t} \quad \text{ʃ} \quad \text{a} \quad \text{a} \quad - \quad [ \text{s} \text{u} \text{k} \text{u} \text{β} \text{i} ] \\
\end{array}
\quad \\
\begin{array}{c}
\text{OUTPUT:} \\
\text{H} \\
| \\
\text{t} \quad \text{ʃ} \quad \text{a} \quad \text{a} \quad - \quad [ \text{s} \text{u} \text{k} \text{u} \text{β} \text{i} ] \\
\end{array}
\]
Morphemes with a high tone associated to the right most syllable form a class.

An example of such morphemes aside from noun roots is the noun class 10 prefix, /tʃaa-/. The combination of toneless noun root with a high tone prefix results in the high tone of the prefix surfacing and no insertion of the initial high tone (as occurs with toneless noun roots and toneless noun class prefixes prefixes).

This correctly captures that fact that the noun root control the final tone pattern of the nominal word.

\[(11)\]

\[
\begin{array}{c|c}
\text{INPUT:} & \text{OUTPUT:} \\
\hline
\text{H} & \text{H} \\
| & | \\
\text{t} & \text{t} \\
\text{ʃaa} & \text{ʃaa} \\
[\text{s} \text{u} \text{k} \text{u} \beta \text{i}] & [\text{s} \text{u} \text{k} \text{u} \beta \text{i}] \\
\end{array}
\]
When combined with prefixes that have a high tone (/rii-/, /tʃaa-/), the root high tone, which is provided by lexical redundancy, is preserved while the affixal high tone, which is lexical, is deleted.

(12)

```
INPUT:                                        OUTPUT:
H       H
\[ t \right a a - [ n a k \right w a a h a ] \] \[ t \right a a - [ n a k \right w a a h a ] \]
```
Low tone verbs have a low tone on the first syllable of the macrostem and a high tone on the second syllable of the macrostem.

(13) Hortatory subjunctive without object markers

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
<th>Word</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. n- u- [h -ε]</td>
<td>nuu[he]</td>
<td>‘(Please) give.’</td>
</tr>
<tr>
<td>b. n- u- [nu -ε]</td>
<td>nuu[nwe]</td>
<td>‘(Please) drink.’</td>
</tr>
<tr>
<td>c. n- u- [som -ε]</td>
<td>nuu[som]</td>
<td>‘(Please) read.’</td>
</tr>
<tr>
<td>d. n- u- [sukur -ε]</td>
<td>noo[sukur]</td>
<td>‘(Please) dump out.’</td>
</tr>
</tbody>
</table>

FOC SM.1SG V-ROOT FV-SBJV
### Low Tone Verbs

#### (14) Hortatory subjunctive an object marker

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
<th>Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. n- u- [ki- h -ε]</td>
<td>noo[kiihɛ]</td>
</tr>
<tr>
<td>b. n- u- [ki- ṣu -ε]</td>
<td>noo[kįwɛ́]</td>
</tr>
<tr>
<td>c. n- u- [ki- ṣom -ε]</td>
<td>noo[ɣisóme]</td>
</tr>
<tr>
<td>d. n- u- [ki- sukur -ε]</td>
<td>noo[yesukurɛ́]</td>
</tr>
</tbody>
</table>

FOC SM.2SG OM7 V-ROOT FV-SBJV ‘Please read (etc.) it’

#### (15) Hortatory subjunctive two object markers

<table>
<thead>
<tr>
<th>Morphemic Breakdown</th>
<th>Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. n- u- [ki- mu- h -ε]</td>
<td>noo[kemúhɛ́]</td>
</tr>
<tr>
<td>b. n- u- [ki- mu- ṣu -er -ε]</td>
<td>noo[kemúŋwɛ́ɛɛ́]</td>
</tr>
<tr>
<td>c. n- u- [ki- mu- ṣom -er -ε]</td>
<td>noo[kemúsomɛ́ɛ́]</td>
</tr>
<tr>
<td>d. n- u- [ki- mu- sukur -er -ε]</td>
<td>noo[kemósukurɛ́ɛ́]</td>
</tr>
</tbody>
</table>

FOC SM.2SG OM7 OM1 V-ROOT APPL FV-SBJV ‘(Please) give (etc.) it to him/her.’
Low Tone Verbs

- Lexically, low verbs only have a low tone supplied by the subjunctive final vowel.
- A redundancy condition requires lows to be followed by a high tone.
- Below, the effect of the redundancy condition is notated by LH signifying the desired output of the condition.

(16)

\[
\begin{array}{c}
\text{INPUT:} & n - o o - [ \text{y}e - s u k u r - \varepsilon ] \\
\text{OUTPUT:} & n - o o - [ \text{y}e - s u k u r - \varepsilon ] \\
\end{array}
\]

\[
\text{LH}
\]
Low tone nouns have a low tone on the first syllable of the macrostem and a high tone on the second syllable of the macrostem.

(17) Low tone nouns

a. o- [ro- síri]  
   PPF [C11 rope]  
   ‘rope’

b. e- [ye- síma]  
   PPF [C7 well]  
   ‘well’

c. rii- [karí]  
   C5 [woman]  
   ‘small woman’

d. o- [mu- kári]  
   PPF [C1 woman]  
   ‘woman’
Low tone nouns combined with toneless affixes function like low tone verbs, as shown below.

(18)

\[
\text{INPUT: } \text{o - [ m u - k a r i ]} \\
\text{OUTPUT: } \text{o - [ m u - k a r i ]}
\]
(19)

\[
\text{INPUT: \quad r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{OUTPUT: \quad r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{* \ r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{* \ r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{* \ r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

\[
\text{* \ r\ i\ i\ - \ [\ k\ a\ r\ i\ ]}
\]

> **Analysis:** Root-H >> NonRoot-H, Align(MacroStem, Left; H-tone, Left), Lex-H >> NonLex-H
Though Nata has few high tones per word, a metrical account of tone placement is not desirable for several reasons.

The only evidence for metrical structure is high tone assignment itself; no independent evidence to support the metrical analysis.

A metrical account of nouns (Anghelescu 2013) requires that noun roots be indexed for inflectional classes as they have no structural differences, either morphosyntactic or phonological.
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In addition to tone assignment, vowel harmony has been argued to be regulated by cophonologies.

If both of tone and vowel harmony are regulated by cophonologies, then the total number of grammars required to capture Nata phonology is equal to the product of the number of cophologies for each phenomenon.

More disturbingly, since each combination of cophonologies is essentially its own grammar, the removal of a simple grammar (as a result of language simplification) would leave unpredictable asymmetries in the interactions between tone and vowel harmony (for instance).

This kind of interdependency between tone and vowel harmony does not seem to be attested cross-linguistically.
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This analysis maps any possible tonal input sequence to a well formed output sequence.

The underlying forms of morphemes in Nata reflect their surface realizations. From a learnability perspective, this is a more attractive situation than one in which a learner needs to posit abstract features to classify how a morpheme will behave with respect to tone assignment.
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