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## ATR harmony in English borrowed words in Ng'aturukana: An optimality theory account

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### Abstract

Ng'aturukana, a language spoken by the Turkana people of North Western Kenya, gets into contact with English through trade, education, among other fields. As a consequence, the borrowed words have to be assimilated, especially through vowel harmony to befit Ng'aturukana. Vowel harmony which was observed to be bidirectional (both progressive and regressive) under the rule-based Generative Phonology was problematic in rule ordering. Optimality Theory was the better option to account for the vowel harmony phenomenon noted in this paper. From the analyses, this paper reports three outcomes of Vowel Harmony in the borrowed words; firstly, regressive sharing of ATR feature was observed in situations where the root or suffixes ATR feature was stronger than the preceding root vowels. Secondly, both progressive and regressive ATR harmony simultaneously occur in situations where the root ATR was stronger than the preceding and following roots vowels. Lastly, some vowels manifested opacity where regressive ATR was blocked from spreading to the preceding vowels.

**Keywords:** alignment, borrowing, ATR harmony, constraints, language contact, ng'aturukana

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### Public Interest Statement

For public interest, this study explains that both progressive and regressive ATR harmony simultaneously occur in situations where the root ATR was stronger than the preceding and following roots vowels.



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## 1. Introduction

Borrowing of terminologies is linguistically necessitated by a lack of adequate terminology for new objects in the borrowing language lexicon, especially in a contact situation (Mwaniki, 2013). It is motivated by the lack of a reference term in one's native language in an existing linguistic contact situation (Haspelmath, 2009). Consequently, English has been identified as one of the leading contributors of vocabulary in Ng'aturukana (Tioko, Nandelenga & Itumo, 2020). The borrowing of words is not a haphazard phenomenon because new words from a source language would partially or fully conform to the structure of the borrowing language. Conformity occurs in the form of adaptation processes, especially morphological and phonological. Furthermore, some processes tend to be natural (unmarked) in one language and marked in another. Unmarked processes are prevalent and unavoidable in a language, thus, mostly realized in any language adaptation process.

One such morphophonological and unmarked process in Ng'aturukana is Vowel Harmony. According to Walker (2011), Nandelenga (2013) and Barasa (2018) vowel harmony is the sharing of the tongue root advancement/retracted features [ATR] among vowels in a given word, that is; all vowels must either be [-ATR] or [+ATR] in a prosodic word. ATR harmony has, over time, been noted by many scholars as a common characteristic of the Nilotic group of languages (Dimmendaal, 2000, 2018; Schroeder, 2008; Kramer, 2012). This study, therefore, sought to find out if vowel harmony is observed in the English loanwords existing in Ng'aturukana. It also sought to examine the different dichotomies existing in the vowel harmony of the identified loanwords in Ng'aturukana. Ordinarily, Ng'aturukana is heavily marked by vowel harmony while English is not.

Dimmendaal (1983), Noske (2000) and Tioko, Nandelenga and Itumo, (2020) while studying Ng'aturukana posit that Ng'aturukana has a distinct grammatical gender system. All vowels including the under-marking vowels in a word must agree for vowel harmony. Therefore, any disagreement between and among the different vowels in a word renders a word alien hence disharmonic. They also confirm that Ng'aturukana's [low/central vowel /a/ to be phonetically [-ATR] and has no [+ATR] counterpart. Besides, Dimmendaal (1983; 2000), Noske (2000) and Grimm (2012) also affirm that Ng'aturukana number system is complex due to the [ATR] adjustments that must take place. Moreover, the masculine grammatical gender is unspecified for [ATR] but becomes [ $\pm$ ATR] in the context of the other subsequent root vowels.

Tioko, Nandelenga and Itumo (2020) and Tioko (2021) while examining gender marking in the loanwords in Ng'aturukana confirmed that English loanwords borrowed to Ng'aturukana are gender marked. The loanwords pick the same native Ng'aturukana {a}-{ $\eta$ a} and {e}-{ $\eta$ i} prefixes to mark grammatical gender in singular and plural marking, respectively. Phonologically, however, the masculine grammatical gender vowels change their forms with respect to vowel harmony triggered by the dominant syllable's vowel ATR harmony.

Barasa (2017, 2018) and Noske, (2000) while studying Ateso and Ng'aturukana languages [ATR] systems, respectively affirm that vowel harmony in this language is structured in that some vowels tend to be opaque and others transparent to [ATR]. According to the two scholars, opaque vowels prevent or block the regressive or the progressive sharing of [ATR] while transparent vowels participate in the sharing of [ATR]. Transparent vowels have an elaborate [ATR] marking.

Generally, vowel harmony is a special type of assimilation where vowels in the respective syllables or roots agree in terms of tongue root so that all belong to a harmonic set; Advanced Tongue Root [+ATR] or Retracted Tongue Root [-ATR] (Dimmendaal, 1983; Noske, 2000; Barasa, 2018, Tioko, 2021). Ng'aturukana is a nine (9) vowel system language. Phonetically, however, it has eighteen (18) vowels which are clearly categorized on the bases of voicing and ATR harmony. According to Dimmendaal (1983) and Noske (2000), Ng'aturukana has eight (8) [+ATR] and ten (10) [-ATR] vowels in Ng'aturukana. These are shown in the dichotomy below.

- |                                   |                              |
|-----------------------------------|------------------------------|
| • Voiced- /i/, /e/, /u/, /o/      | /a/, /ε/, /ɔ/, /ɪ/, /ʊ/      |
| [+ATR]                            | [-ATR]                       |
| • Devoiced /i̥/, /e̥/, /o̥/, /u̥/ | /ḁ/, /ε̥/, /ɔ̥/, /ɪ̥/, /ʊ̥/ |
| [+ATR]                            | [-ATR]                       |

This paper examined vowel harmony as an unmarked morphophonological process in English loanwords in Ng'aturukana. Using the Optimality Theory (OT) by Prince and Smolensky (1993), Kager (1999) and Mc Carthy (2004), the paper presents an account of vowel harmony phenomena in Ng'aturukana. The data used for this paper were drawn from the local radio stations broadcasting in Ng'aturukana language; Radio Akicha and Sayari FMs. The contexts of broadcasts were; education and trade, especially on school preparations, and items to purchase as students prepared to report to school in January, 2021. Parents would call live on radio to inquire, raise complaints and seek advices from other parents. Eight (8) radio shows of the first week of January from Tuesday to Friday at 9:00 am to 10:00 am were recorded, transcribed and given glosses. The main researcher being a native speaker of Ng'aturukana also generated some words. All the generated data were later given to four adult native speakers of Ng'aturukana to verify and validate. From the two methods, forty loanwords were collected. All the loanwords singular and plural forms were given. Both numbers were investigated for the vowel harmony. Optimality Theory (OT) was used in explaining the observations.

## 2. Opaque vowels

Opaque vowels are vowels that prevent or block ATR feature sharing in a word (Noske, 2000; Barasa, 2018, Tioko, 2021). In Ng'aturukana, this phenomenon is often regressive. Opaque vowels resistance to ATR sharing was observed in two forms of interaction in

the plural marking of the loanwords investigated: One, in cases where [+high] vowels are followed by [mid-high, +ATR] vowels as in data set 1 (i)-(iii) below), and two, in cases where a [+low] vowel /a/, is followed or preceded by [+ATR] vowels as in (iv) and (v) in data (1) below. Traditionally, /a/ vowel is [-ATR] distinct in the Teso-Turkana group of languages. Consider example (1) below:

1)	Eng. Input	BW. Sing	Gloss	BW. Pl	Gloss
i)	[tɔ:ʃ]	[ɛtɔcɪ]	‘torch	[ɲɪtɔcɪ-o]	‘torches’
ii)	[bʊk]	[a-bʊkʊ]	‘book’	[ɲa-bʊkɪ-o]	‘books’
iii)	[bɔ:l]	[ɛ-bɔlɔ]	‘ball’	[ɲɪ-bɔlɪ-o]	‘balls’
iv)	[səʊlə]	[a-sɔlə]	‘solar’	[ɲa-sɔlə-i]	‘solars’
v)	[rulə]	[a-rula]	‘ruler’	[ɲa-rula-i]	‘rulers’

Suffix {o}, for instance, in (i)- (iii) is morphophonologically a [+ATR] mid vowel suffix. For this reason, its [ATR] only affects the mid open vowels by raising them to mid high vowels but not the [+High] vowels. Morphophonologically, [±ATR] mid suffixes do not affect the preceding [+high] vowels in Ng’aturukana. [+High] vowels occurring before a [+ATR] mid vowels are opaque to regressive assimilation of ATR features (Noske, 2000; Barasa, 2018). Suffix {o} is, therefore, affixed to the right of the ultimate roots above {-cɪ}, {-kʊ} and {-lɔ} respectively. The nuclei in the roots {-kʊ} and {-lɔ} first of all, change to {ɪ} before adding the suffix {o} according to Ng’aturukana specifications. Constructions such as {ʊ-o} and {ɔ-o} hardly occur morphophonologically in the noun group of Ng’aturukana. Voicing also changes when suffixation of {-o} occurs. Phonologically, a devoiced vowel becomes voiced when another structure is added after it in Ng’aturukana because voicing is the unmarked state of vowels as sonorants.

The suffixation of all the examples in 1 can be accounted for in OT. Because [ATR] is paramount in the data, we propose \*HI/RTR that militates against the change of a [-ATR] high root vowel to [+ATR] when followed by a [+ATR] mid vowel suffix {-o} (Noske, 2000, Tioko, 2021). To explain the alignments of suffixes affecting Ng’aturukana concrete nouns when inflected for number, ALIGN [AFFIX] R, PrWd, R constraint is proposed. The respective Grammatical Gender (GG) of the nouns is also catered for through prefixation of the alternate plurative GG prefixes, {ɲɪ}/ {ɲa} respectively. In that case, the ALIGN [AFFIX] L, PrWd, L is proposed. These ALIGN constraints are, however, general in the sense that ‘affixes’ vary in number in Ng’aturukana. This study replaced ‘affixes’ with actual morphemes that occupy certain positions for specific morphological functions; GG or number marking. In that respect, ALIGN [o] R is proposed for the suffix plural marker while ALIGN [ɲɪ] L or ALIGN [ɲa] L are used interchangeably when respective Masc. GG Pl or Fem.GG Pl prefixes are added.

A morphophonological issue also occurring in the data set 1 is to do with the ATR values in the other vowels. IDENT<sub>ROOT [ATR]</sub> that blocks any ATR changes of the root vowels

in the outputs is proposed. In addition, IDENT<sub>[ATR]</sub> (Do not change the ATR feature) that accounts for the possible [ATR] is also invoked. The proposed ranking of the above constraints is \*HI/RTR >> ALIGN [o] R, ALIGN [ŋɪ] >> IDENT<sub>ROOT [ATR]</sub> >> IDENT<sub>[ATR]</sub>. For example, a constraint interaction of the Input-Output (IO) mapping of entity (a) [ε-tɔci] – [ŋɪ-tɔci-o] ‘torches’ above is analysed as shown in the tableau 1.

Tableau 1: [ε-tɔci] + [o] [ŋɪ-tɔci-o] ‘torches’

{εtɔci} + {o}	*HI/RTR	ALIGN [o], R	ALIGN [ŋɪ] L	IDENT <sub>ROOT [ATR]</sub>	IDENT <sub>[ATR]</sub>
a. {etocio}	*!		*	**	***
b. {ŋɪtɔci-o}					
c. {εtɔci-o}			*!		
d. {ŋɪtɔcio}	*!			*	*

Candidate (b) is optimal in tableau 1. It satisfies the conditions set by the high ranked markedness phonological constraint; \*HI/RTR as well as the morphological GA, ALIGN [o] R, PrWd, R and ALIGN [ŋɪ] L, PrWd, L. It also satisfies the faithfulness conditions of the IDENT<sub>ROOT [ATR]</sub> of IDENT-IO<sub>[ATR]</sub> constraints. As such, the [-ATR] high vowel /ɪ/ is opaque to the leftward spreading of [+ATR] harmony from a [+ATR] mid vowel /o/. Besides, all the other vowels resist assimilation of the ATR features because it is blocked by the penultimate root vowel /ɪ/. Vowel /ɪ/ is a high vowel according to the vertical dimension of the tongue during articulation. High vowels are opaque to [ATR] sharing when ATR feature sharing is triggered from a mid-vowel. This is because they are already specified for the spreading [ATR] feature according to Under-specification Theory (UT-Kenstowicz, 1994).

Candidate (a) is the most disharmonic in the tableau. This candidate did not only violate the prohibited \*HI/RTR constraint but also ALIGN [ŋɪ] L and IDENT<sub>ROOT [ATR]</sub>. These three constraints are high ranked in Ng’aturukana, hence, all the violations incurred are fatal. Candidate (c) is also declared suboptimal because it fails to align the required affix {ŋɪ} leftward of the prosodic word. Because the noun for the gloss ‘torch’ is a countable concrete noun in Ng’aturukana, the satisfaction of ALIGN [ŋɪ] L constraint is mandatory. Similarly, candidate (d) is disharmonic. It also violates the high ranked \*HI/RTR and IDENT<sub>ROOT [ATR]</sub> both of which are crucial constraints.

### 3. Regressive [ATR] sharing

Regressive ATR, the leftward sharing of ATR, occurred in situations where the root or suffixes’ ATR are stronger than the preceding root vowels. Root [ATR] regressive sharing is specifically observed in GG prefixation of the loanwords while regressive suffix ATR affected the preceding root’ (s) vowels.

### 3.1. Regressive [ATR] sharing in the prefixes

Grammatical Gender prefixation in particular reveals an agreement of ATR features between and among prefix vowels, medial syllable roots and the ultimate roots in all borrowed noun words in Ng’aturukana. The GG marker vowel is aligned to the initial (left side) position of the input form in the output. Consequently, the surface form of this morpheme must agree with the vowels occurring in the root in terms of the [ATR] feature specification. The following samples exemplify the above postulations. The output forms in these samples exhibit two forms, the Underlying Representations (UR) and the Surface Representations. (SR) The data presented below traces the source of ATR harmony forms observed in the optimal output forms.

**Table 2: Sample data on VH**

Input (English)	Gloss	Output (Ng’aturukana)		Gloss
		UR- Input	SR-Output	
a) /vest/	‘vest’	[epesit]	[ɛpɛsit]	‘vest’
b) /redʒɪstə/	‘register’	[arɛ̃ʒɛsɛ̃tə]	[arɛ̃ʒɛsɛ̃tə]	‘register’
c) /glæs/	‘glass’	[egɪlas]	[ɛgɪlas]	‘glass’
d) /dɪɡri/	‘degree’	[edɪɡiri]	[ɛdɪɡiri]	‘degree’
e) /ləʊn/	‘loan’	[e.lə.ɔ̃n]	[ɛ.lə.ɔ̃n]	‘loan’

From the data set in Table 2 above, the masculine gender marking prefix vowel /e/ has two variants, /e/ and /ɛ/. While the feminine gender prefix is /a/. The feminine prefix, /a/ is deliberately ignored here because it is phonetically [-ATR] in Ng’aturukana. It lacks its counterpart for [+ATR] (Noske, 2000; Tioko, Nandelenga & Itumo, 2020; Tioko, 2021). The variations in the masculine prefix; /e/ and /ɛ/ are as a result of the following root’s vowel ATR harmony; if the following root vowel is [+ATR], the preceding prefix form also becomes [+ATR] and vice versa.

Noske (2000) argues in favour of the above phenomena that the prefixes in the input forms are unspecified for [ATR] feature value. Phonologically, acquisition of [ATR] value occurs through vowel harmony from a following root or invariant suffix form. Barasa (2018) also argues that [ATR] sharing involving number and GG affixes can only be regressive and not progressive. This supports the claim that prefix vowels or the root vowels do not share the ATR features with the neighbouring syllable/root on the right. This view is, however, limited and untrue when a weak [ATR] suffix vowel or a mid-high [+ATR] high vowels appear as trigger of harmony after [+ATR] strong roots or high vowels.

Using the example for ‘loan’ [e.lə.ɔ̃n/-[ɛ.lə.ɔ̃n] and ‘degree’ [edɪɡiri]- [ɛdɪɡiri] for instance, Ng’aturukana’s output prefix forms differ in the UR and the SR respectively. Both ultimate roots {-ri-} and {-lə-} contain vowels /i/ and /ɔ/ that are [+ATR] and [-ATR]. If epenthetic GG vowels /e/ would be adapted without assimilation, for example, the outputs would be incorrect when borrowed. Other than the GG vowels, other vowels preceding the ultimate roots must likewise assimilate for the feature [ATR].

Based on the data presented, it is notable that all the UR forms of the two outputs are erroneous mapped because their [ATRs] are not completely shared. On the other hand, SR ones are correct because the ATR feature has been shared regressively by the ultimate root. Because Walker (2011) and Kramer (2012) support the argument that VH systems demand a high-ranking faithfulness constraint to be identified and marked to a prominent position, the faithfulness  $IDENT_{ROOT [ATR]}$  is proposed. Although this is the case, the alignment constraint;  $ALIGN [+ATR] L$  ought to be included and must rank higher than the faithfulness constraint to account for why unspecified prefixes agree with the following root in [ATR]. Additionally,  $IDENT-IO_{[ATR]}$  which requires that ATR specifications of all the vowels are maintained is preferred to account for ATR feature changes undergone by the different vowels. For example, the loanwords; ‘loan’ and ‘degree’ in Table 2 above are favoured by the following constraint ranking hierarchy in Ng’aturukana;

- 1)  $[ε.lə.əŋ] -ALIGN [-ATR] L \gg IDENT_{ROOT [ATR]} \gg IDENT-IO_{[ATR]}$
- 2)  $[edigiri] -ALIGN [+ATR] L \gg IDENT_{ROOT [ATR]} \gg IDENT-IO_{[ATR]}$

Their respective tableaux are drawn below;

Tableau 2: [-ATR] Harmony: [e+ ləəŋ] [εləəŋ] ‘loan’

[-ATR] /e/ + [ləəŋ]	ALIGN [-ATR] L	$IDENT_{ROOT [ATR]}$	IDENT-IO[ATR]
a. [e. loon]	*!	*	***
b. [ε.lə.əŋ]			*
c. [ε.lo.on]	*!	*	**
d. [e.lə.on]	*!	*	*

Tableau 3: [+ATR] Harmony [e-digiri] [edigiri] ‘degree’

[+ATR] [ /e/ + [digiri]	ALIGN [+ATR] L	$IDENT_{ROOT [ATR]}$	IDENT-IO[ATR]
a. [e-di.giri]	*!*		
b. [e.di.gi.ri]			***
c. [ε.di.gi.ri]	*!		***
d. [ε.di.giri]	*!	*	**

Comparatively, the optimal candidates in the tableau 2 and 3 are candidates (b). These candidates, first of all, satisfy the conditions set by  $ALIGN [-ATR] L$  and  $ALIGN [+ATR] L$  constraints. As such, they apply regressive harmony to not only the GG vowels but also other vowels of the roots preceding the ultimate root vowel. These candidates, moreover, satisfy the high ranked  $IDENT_{ROOT [ATR]}$  constraint that is [ATR] conditioning. To satisfy the high ranked constraints, the optimal candidates (b) incur violations of the low ranked

IDENT<sub>[ATR]</sub> faithfulness constraint.

On the other hand, candidates (a), (c) and (d) in each of the tableau (2 and 3) are maladapted, therefore, suboptimal. Candidate (a) of tableau 2 violates all the high ranked and low ranked constraints while candidate (a) of tableau 3 violates ALIGN [+ATR] L undominated constraint. [ɛ.lo.on] (c) of 2 similarly violates the two high ranked; ALIGN [-ATR] L and IDENT<sub>ROOT [ATR]</sub> constraints, and the low ranked constraints; IDENT<sub>[ATR]</sub>.

[ɛ.di.gi.ri], (c) of tableau 4 is also suboptimal. This candidate violates the undominated, ALIGN [+ATR] L. Candidates d of tableau 2 and 3 fail to align ATR features regressively by violating ALIGN [-ATR] L and ALIGN [+ATR] L constraints respectively. Furthermore, they violate the demands of IDENT<sub>ROOT [ATR]</sub> and IDENT<sub>[ATR]</sub>. ATR is a crucial phenomenon in Ng'aturukana, Candidates (a) and (c) in both tableaux are penalized. None of them keeps to the requirements of ATR.

### 3.2. Regressive ATR sharing in suffixes

2) Eng.Input	Ngatur. Input	gloss	Ng'atur. Output	gloss
i) /reɪdɪəʊ/	[arɛdʒə]	'radio'	[ŋa-redʒo-i]	'radios'
ii) /pɪləʊ/	[ɛpɪlə]	'pillow'	[ŋi-pilo-i]	'pillows'
iii) /træktə/	[a-tarakɪta]	'tractor'	[ŋa-tarakɪta-i]	'tractors'
iv) /gɪə/	[ɛ-gɪja]	'gear'	[ŋɪ-gɪja-i]	'gears'

Contrary to the phenomenon in 3.1, the suffixes here are [+ATR]. Therefore, they trigger the leftward sharing of [+ATR]. As denoted in 2, [-ATR] vowel /ə/ in examples i and ii becomes [+ATR] when followed by [+ATR] vowel /i/. In examples iii and iv, vowel /a/ does not change its form when it precedes vowel /i/. Vowel /a/ is opaque to [+ATR] because it is [ATR] indistinct. Using example (ii) in data set 2, for instance, the correct plural form is constrained by the high ranked IDENT-IO SUFFIX [ATR] (IDENT<sub>SUFFIX [ATR]</sub>) constraint that penalises the change of ATR in the suffix (Noske, 2000). Noske postulates that some [+ATR] phonologically privileged suffixes resist progressive [-ATR] sharing when [+ATR] specified due to positional faithfulness constraints (Beckman, 2004). Instead, such vowels share their features regressively to the preceding [-ATR roots]. Ng'aturukana's suffix /i/ is characteristically a [+ATR] strong suffix.

In view of the above observations, suffix /i/ ATR feature overrides the root vowels ATR features. By behaving so, suffix /i/ ATR features must, therefore, be shared leftward such that all the vowels of the preceding roots are [+ATR]. This harmony is achieved due to the presence of ALIGN [+ATR] L. Note that the vowels of all the roots now exist as [+ATR] as opposed to the input's [-ATR] ones. We suppose that the same suffix /i/ is contextually (position) advantaged just like the other ordinarily high markedness ALIGN [+ATR] L constraints. The margins of the plural form {ŋi-pilo-i} 'pillows' indicated by the left and right hyphenated morphemes are realized through ALIGN constraints; ALIGN [ŋi] L and ALIGN [i]. These align constraints rank lower than the two already established ATR

constraints in Ng’aturukana. There is, therefore, no root privileged harmony in the form of positional faithfulness (Beckman, 2004, 2013; Nandelenga, 2013).

IDENT<sub>ROOT [ATR]</sub>, a low ranked constraint relative to alignment constraints is also proposed. This constraint naturally bars any ATR changes that affect the root. The constraints, so far mentioned, are ranked in the order of: IDENT<sub>[SUFFIX] [ATR]</sub>, ALIGN [+ATR] L >> ALIGN [ŋi] L, ALIGN [i] R >> IDENT<sub>ROOT [ATR]</sub>. The tableau below shows how the optimal candidate was assessed.

Tableau 4: [ε-pilo] ‘pillow’ + [i] [ŋi-pilo] ‘Pillows’

[-ATR] [+ATR] [ε-pilo] + /i/	IDENT- S U F F I X [ATR]	A L I G N [+ATR] L	ALIGN [i] R	ALIGN [ŋi] L	IDENT <sub>ROOT</sub> [ATR]
a). [ŋi-pilo-i]					**
b). [ŋi-pilo-i]	*!	**			
c). [ε-pilo-i]		*!		*	
d). [ŋi-pilo-i]		*!*			

Candidate (b) is the most disharmonic candidate from tableau 4. This candidate violates the two high ranked constraints: IDENT<sub>SUFFIX [ATR]</sub> and ALIGN [+ATR] L. This candidate indicates that [-ATR] feature is shared rightward instead of leftward (regressive). This, however, is an erroneous scenario as suffix /i/ [+ATR] feature ranks higher than the roots’ [-ATR]. The suffix [+ATR] should have been observed and more so, shared regressively. By violating the two constraints, the candidate is disqualified.

Candidate (c) is also suboptimal. This candidate portends a case whereby all vowels of the roots surface as [-ATR] while the suffix vowel is [+ATR]. What is occurring here, however, is untypical of Ng’aturukana vowels because there is no ATR harmony. Suffix /i/ which is [+ATR] does not trigger harmony. In addition, the candidate also fails to align the plural masc. GG prefix /ŋi/ to the base of this candidate. The candidate retains the singular Masc. GG prefix /ɔ/. The loanword for ‘pillow’ in Ng’aturukana specifications is countable, hence, requires /ŋi/ in plural. Because of these disharmonic traits, the candidate is declared suboptimal.

Candidate (d) is also disharmonic. It violates the constraint, ALIGN [+ATR] L that requires ATR features to be assimilated regressively by the preceding roots vowels. This candidate’s penultimate root vowel behaves as if it is opaque but in actual sense, it is not. The only opaque vowels are; [+low] vowel /a/ and a [+high] vowel preceding a [+ATR] mid high vowel (Noske, 2000, Tioko, 2021). By resisting regressive, assimilation then the candidate is eliminated.

The only remaining candidate so far is candidate (a). This candidate is granted the winning rights by the virtue of satisfying all the undominated constraints. Despite it

violating the lowly ranked constraint, IDENT<sub>ROOT [ATR]</sub>, it is optimal. The consequence of violating this constraint is less serious and does not lead to the disqualification of any candidate. This violation is, however, necessary if any lexical item has to fully fit in the borrowing language morphophonology.

#### 4. Bidirectional [ATR] Harmony

Both progressive and regressive ATR sharing simultaneously (bidirectional) occur in situations where the root ATR is stronger than the preceding and subsequent roots' vowels in the loanwords collected. Consider the sample data set 3.

3) Eng. Input	Bw. Input	Bw. Output	gloss
i) /ʊnɪfɔm/	[ɛ-nɪ.pɔm] + /o/	[ŋɪ-nɪ.pɔm.ɪ-ɔ]	'uniform'
ii) /laɪn/	[ɛ-la.ɪn] + /o/	[ŋɪ-la.ɪ.ɪnɪ-ɔ]	'line'
iii) /sælɒn/	[a-sa.lɒn] + /o/	[ŋa-sa.lɒn.ɪ-ɔ]	'salon'
iv) /kæntɪn/	[a-ka.ntɪn] + /o/	[ŋa-ka.ntɪn.ɪ-ɔ]	'canteen'

The data set 3 indicates a simultaneous assimilation of ATR features from a central vowel to the neighbouring vowels. As such, the root ATR feature is stronger than that of the suffix {-o} and the other preceding roots. Seemingly, the roots vowels align their [ATR] rightward and leftward at the same time; the ATR harmony is bidirectional. As a consequence of this assimilation, suffix {o} changes to {ɔ}. The former is [+ATR] while the latter is [-ATR]. Note that none of the above examples features {o} suffix but rather {ɔ}. The vowels of the other preceding roots must also resemble the penultimate root in ATR features. Insertion of vowel /ɪ/ before suffix /ɔ/ is phonologically determined for [-ATR] harmony.

In OT, an English word like [laɪn] 'line' is morphologically structured as [ɛ-la.ɪn] 'line' and {ŋɪ-la.ɪ.ɪnɪ-ɔ} 'lines' in the singular and plural forms respectively in Ng'aturukana. We will consider the singular (Sg.) as our input here and the plural as the output. The plural loan form [ŋɪ-la.ɪ.ɪnɪ-ɔ] 'lines' is realized because of the conditions set by the constraints; ALIGN [o] R, PrWd, R that introduces /o/ suffix and ALIGN [ŋɪ] L that aligns the Masc.pl GG. Premier to these constraints are the: ALIGN [-ATR] R that facilitates the phonemic change of vowel /o/ to /ɔ/, ALIGN [-ATR], L that alters all the preceding vowels as [-ATR], \*LO/ATR which blocks the [ATR] in [+low] vowels, and IDENT-IO<sub>ROOT [ATR]</sub> that prohibits the change of the ATR features in the penultimate root. The [ATR] of the root vowel of the word in question is the one controlling the phonological adjustments of the ATR harmony observed in the optimal output. This is an instance of the root-controlled ATR harmony in Ng'aturukana. IDENT<sub>[ATR]</sub> is violated to fix the vowel ATR harmony in the penultimate root and the aligned suffix.

The constraints explained above are ranked in the order of; ALIGN [-ATR] R, ALIGN [-ATR] R, \*LO/ATR >> ALIGN [o] R, ALIGN [ŋɪ] L >> IDENT<sub>ROOT [ATR]</sub> >> IDENT-IO<sub>[ATR]</sub>. The interaction of these constraints is shown in the tableau 5.

Tableau 5: [ɛ-la.in] ‘line’ + /o/ [ŋi-la.i.ni-ɔ] ‘lines’

[ɛ-la.in] + {o}	ALIGN [-ATR] R,	ALIGN [-ATR]L	*L O/ ATR	A L I G N [o] R,	ALIGN [ŋi] L,	I D E N - T <sub>ROOT[ATR]</sub>	IDENT-IO [ATR]
a) . □ { ŋ i - la.i.ni-ɔ }							*
b . { ŋ i - la.i.ni-o }	*!	*					
c. {ŋi-la.i.n}		*!		*			
d . { ŋ i - la.i.ni.o }	*!		*		*	***	****

The tableau 5 present candidate (d) as the most disharmonic. Of the six high ranked constraints, this candidate has only satisfied the requirement of two constraints but violates the rest. The other candidate eliminated is candidate (b). It violates the requirement of the high ranked, ALIGN [-ATR] R and ALIGN [-ATR] L. Similar to d), candidate (b) violates the low ranked IDENT-IO<sub>[ATR]</sub>. It is, however, punished based on the lack of fit with the high ranked constraints. Candidate (c) has an anomaly too. It is not featuring the proper marking of Ng’aturukana’s concrete noun plural marking and proper [ATR] alignment. By not satisfying the demands of ALIGN suffix {o} right, it is misaligned and eliminated. Candidate (a) eventually remains as the only candidate that satisfies the demands of the high ranked constraints. On the other hand, this candidate violates the demands of the low ranked IDENT-IO<sub>[ATR]</sub>. However, these violations had to occur in order to modify the structure of the SL loanword so as to fit to be Ng’aturukana prosodic word structure. This candidate is selected on the principle of minimal violations.

## 5.0 Conclusion

Loanwords in both singular and plural forms inherently observe [ATR] harmony when borrowed into Ng’aturukana. Similar to Ng’aturukana’s native words vowel harmony modifications and marking, the data on the loanwords investigated in this study showed a tripartite form of vowel harmony. First, words which contained a [+low, back] vowel /a/ manifested opacity where regressive ATR is blocked from spreading to the preceding vowels. Second, regressive sharing of ATR feature is observed in situations where the root or suffixes ATR feature is dominant than the preceding root vowels. Third, both progressive and regressive ATR sharing simultaneously occur in situations where the root ATR feature is stronger than the preceding and subsequent root vowels. As regards OT and ATR, OT constraints, especially the alignment constraints can better capture ATR harmony than rule-based derivation approach of Generative phonology that had rule-ordering paradoxes. OT provides a straight forward account of both regressive and progressive harmony besides the bi-directional harmony. The role of positional faithfulness responsible for root triggered harmony or blocking is a central tenet that can be elaborately accounted using OT in Linguistics.

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