An Optimality Theory Analysis of Vowel Harmony in Ndruna[1]

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ABSTRACT
This paper gives an optimality theory analysis of advanced tongue root (ATR) vowel harmony in Ndruna, a Central-Sudanic language in the Democratic Republic of Congo. ATR is lexically assigned, with [+ATR] spreading one vowel to the left across morpheme boundaries. In this analysis ten constraints are used, the key constraints being a markedness constraint *[+low, +ATR], NOSPREAD[+ATR], SPREADATR-L and NOSPREAD[-ATR].

1. Introduction

Ndruna is a Central-Sudanic language spoken in the north-eastern part of the Democratic Republic of Congo. It is said that this group came down from Sudan around the 17th century and now it is mostly spoken west of Lake Albert and the Semliki valley, and a bit across the border into Uganda. The majority are located in the Chiefdom of Walendu-Bindi in the province of Ituri. There are currently about 160,000 speakers of Ndruna, which is part of the larger language family Lendu (Lojenga 1994, Beattie and Williams 2008: vii).

There are many kinds of vowel harmony present in African languages. Ndruna exhibits advanced tongue root (ATR) vowel harmony. ATR on the roots is lexically assigned and with suffixes and prefixes the feature [+ATR] spreads one syllable to the left. It is not a highly agglutinating language like many of the neighboring Niger-Congo languages. The words tend to be shorter, so there is not much to account for with the small number of affixes. In spite of the small number though, it is clear that it moves in a direction which is very unusual cross-linguisticially.

This paper looks at a phonological analysis of ATR vowel harmony done by Kutsch Lojenga (1994) and analyses it using optimality theory. I give a brief summary of Lojenga's data and analysis of ATR vowel harmony. Following that I present an analysis of these processes using optimality theory.

2. The ATR vowel harmony process

2.1 Data

(1)	itsu	tree
	mùnovhì	soldier
	kìhihì	haze
(2)	ɨbhɛ̀	fish
	mùhɛndɨ̀	wedding feast
	kísɛ̀rɨ̀	measles
(3)	ɨdza	house
	abvɔ	species of vine
	abvo	corpse

[1]This language is also referred to as Ngiti in the literature.

2.1.1 Inalienable nouns

(4)	adzí	back
	adzí-du	my back
	adzí-nʉ	your back
(5)	abhu	grandfather
	abhu-du	my grandfather
	abhu-nʉ	your grandfather
(6)	ale-lí	in the mouth
	ale-dhúdhú	heart
(7)	alɛ-bɨ̀	ear
	bì-du	my ear
	al-ɔtɨ̀	navel
	ɔtì-du	my navel

2.2 Vowel inventory

There are nine different vowels in Ndruna. They can be distinguished by the features [high], [low], [back], [round], and [ATR]. The features can be shown as follows:

			[-back]	[+back]	
			[-round]		[+round]
[+high]	[-low]	[+ATR]	i		u
		[-ATR]	ɨ [ɪ]		ʉ [ʊ]
[- high]		[+ATR]	e		o
		[-ATR]	ɛ		ɔ
	[+low]	[-ATR]		a	

2.3 Lexical Vowel Harmony

In an autosegmental analysis of Ndruna, the [ATR] segment is placed on a separate tier from the underlying representation. The vowels in the underlying representation are all unspecified for [ATR] and the [+ATR] autosegment is linked to the root word. It is then attached to the root vowels and the V- or CV-prefix which is attached to the root morpheme. The [+low] vowel does not participate in vowel harmony and is not linked to the [ATR] segment (Lojenga 1994:64).

The following examples show how [ATR] is linked to VCV words. The examples in (8) have a lexically assigned [+ATR] segment which attaches itself to all the [-low] vowels. The words in (9) do not have an assigned [+ATR] segment and so show up as [-ATR] in the phonetic representation.

(8) IzO = ízò ‘reed’

alI = ali ‘Semliki valley’
|
[ATR]

(9) IbhE = ɨbhɛ̀
Idza = ɨdza

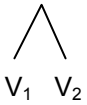
3. Analysis using Optimality Theory

A complication with ATR vowel harmony in Ndruna is that it is directionally assigned when affecting affixes. Baković (2000: 7) says that the majority of the languages with vowel harmony that linguists study are stem-controlled, i.e., the feature assimilates out from the stem. If the language has only has suffixes, then it is thought that the feature spreads from left to right. If there are only prefixes then the feature spreads right to left. If there are both prefixes and suffixes, then the feature spreads out from the stem, left to the prefixes and right to the suffixes. He also claims that in dominant-recessive systems, both vowels on either side of the dominant feature are affected. If it were directional, Baković claims, only one side of the vowel would be affected, something he claims is entirely unattested cross-linguistically.

However, in Ndruna, the feature [+ATR] will spread one vowel to the left across morpheme boundaries (Lojenga 1994). The stems have lexically assigned ATR values, so there is not an issue of spreading one way or another. When morphemes are attached, we can see that it is only the feature [+ATR] that spreads and that it only spreads left. The feature [-ATR] will not spread left from a suffix to a root. This appears to be a case of directional spread of a dominant feature onto a recessive feature, which Baković says does not happen.

3.1 Constraints

There are ten constraints that are used in this analysis of ATR vowel harmony. They are listed here with their name and an explanation of what they mean.

ALIGN (ATR, L, Root, L)	The feature [+ATR] spreads left so that the left-most vowel that is [+ATR] aligns with the left edge of the prosodic word.
$*\begin{bmatrix}+\text{low}\\+\text{ATR}\end{bmatrix}$	All [+low] vowels are [-ATR].
IDENT[ATR]	For every feature [αATR] in the input, there is a corresponding feature [αATR] in the output.
IDENT[ATR, Root]	For every feature [αATR] in the root input, there is a corresponding feature [αATR] in the root output.
ROOTHARMONY	All the vowels in a root must agree for [+/- ATR]
*[-ATR]	Don’t be [-ATR].
NOGAP	Multiply linked feature cannot skip elements.
SPREADATR-L	The feature [αATR] will spread one vowel to the left
NOSPREAD[+ATR]	The feature [+ATR] does not spread. * [+ATR] 

NOSPREAD[-ATR] The feature [-ATR] does not spread. * [-ATR]

The ALIGN-L constraint is used instead of an ALIGN-R constraint because the feature [+ATR] spreads left, although it is not possible to show this with just one word. Because there is only one prefix and two suffixes that occur with inalienable nouns and they never co-occur, it is not possible to show that ALIGN-L outranks ALIGN-R in a tableau. It can be seen with two different words shown in (10). Also because of the small amount of affixes, the constraint SPREADATR-L is needed and outranks the alignment constraint.

(10) alɛ-bɨ̀ 'ear' bI + du → bì-du 'my ear' (Lojenga 1994 :79)

The $*\begin{bmatrix}+\text{low}\\+\text{ATR}\end{bmatrix}$ constraint is a markedness constraint. The vowel that is [+low] in Ndruna is always [-ATR]. It is transparent, never being affected one way or the other by the features of the vowels around it. The roots are lexically assigned for the feature [+/- ATR]. Except for the inalienable roots, all the [-low] vowels will agree for ATR.

In order to show that the harmony only spreads to one vowel, the NOSPREAD constraint is used. It is then split into NOSPREAD[+ATR] and NOSPREAD[-ATR] because the spreading only goes one direction.

3.2 Constraint rankings

The following tableaux show the critical rankings of the previously mentioned ten constraints. The first one ranks IDENT[ATR, Root] over the markedness constraint that says "Don't be [-ATR]." The input is the root *vhɔgɛrɛ* 'species of fish' in which all the vowels are [-ATR]. Since [-ATR] is marked, the faithfulness constraint keeps them from changing to [+ATR].

IDENT[ATR, Root] >> *[-ATR]

Input:/vhɔgɛrɛ/	IDENT[ATR, Root]	*[-ATR]
☞ a. vhɔgɛrɛ		***
b. vhogere	*!**	

In this next tableau, we see that the markedness constraint for vowels that are [+low] and [+ATR] is ranked higher than the constraint that says that the ATR value spreads to the left. If the spreading constraint were ranked higher, then the first vowel would be [ä][2], which is not allowed in this language.

$*\begin{bmatrix}+\text{low}\\+\text{ATR}\end{bmatrix}$ >> SPREADATR-L

Input:/abhu-nʉ/	$*\begin{bmatrix}+\text{low}\\+\text{ATR}\end{bmatrix}$	SPREADATR-L
☞ a. abhu-nʉ		*
b. äbhu-nʉ	*!	

The following tableau shows that NOSPREAD[-ATR] is higher ranked than SPREADATR-L. The latter constraint says that either value of the ATR feature spreads. In fact, only the [+ATR] feature spreads so we need a higher ranked constraint that says not to spread the feature [-ATR]. In the root of the input of

[2]The symbol /ä/ is used for the vowel that is [+low] and [+ATR]. This does not exist in this language.

this tableau, *abhu*, there is a vowel that is [-low] and [+ATR]. The suffix vowel is [-ATR] and could potentially spread onto the /u/ of the root, but the NOSPREAD[-ATR] keeps it from doing that. The output in which it has spread receives a fatal violation. The winning output receives a violation for not spreading, but it is not fatal.

NOSPREAD[-ATR] >> SPREADATR-L

Input:/abhu-nʉ/	NOSPREAD[-ATR]	SPREADATR-L
☞ a. abhu-nʉ		*
b. abhʉ-nʉ	*!	

The SPREADATR-L constraint is ranked higher than NOSPREAD[+ATR]. The NOSPREAD[+ATR] constraint is important for keeping the [+ATR] feature from spreading too far. It is only supposed to spread to the adjacent vowel on the left. It does need to spread the one time though, so if it does not spread at all onto the root, it receives a fatal violation for SPREADATR-L.

SPREADATR-L >> NOSPREAD[+ATR]

Input:/ OtdyU + du/	SPREADATR-L	NOSPREAD[+ATR]
☞ a. Otdyù-du		*
b. ɔtdyù-du	*!	

The SPREADATR-L constraint is higher ranked than IDENT[ATR, Root]. Although it is generally important that the root vowels stay the same, it is more important that the [+ATR] value on the suffix spread onto the adjacent vowel in the root. If it does not and the root vowels both stay [-ATR], that output receives a fatal violation.

SPREADATR-L >> IDENT[ATR, Root]

Input:/ OtdyU + du/	SPREADATR-L	IDENT[ATR, Root]
☞ a. ɔtdyù-du		*
b. ɔtdyù-du	*!	

The NOSPREAD[+ATR] is ranked higher than the ROOTHARMONY constraint. The [+ATR] value spreads onto the root from the suffix. If it only spreads onto one vowel it receives one violation for spreading and one violation for ROOTHARMONY because both vowels in the root do not have the same value for ATR. If the ATR value continues to spread, allowing the root to be harmonized, the NOSPREAD[+ATR] constraint is violated twice. The second one is a fatal violation.

NOSPREAD[+ATR] >> ROOTHARMONY

Input:/ OtdyU + du/	NOSPREAD[+ATR]	ROOTHARMONY
☞ a. Otdyù-du	*	*
b. otdyu-du	**!	

This set of rankings basically just shows better how the language is working. The initial /a/ of many of the words keeps the alignment constraint from working. Even as the [+ATR] value spreads left, it is blocked from alignment by the /a/. If it were to be aligned with the left edge by changing the value of the /a/ but not spread from the root, then it would violate the constraint that says to spread left.

SPREADATR-L >> ALIGN (ATR, L, Root, L)

Input:/ alɛ-dhúdhù/	SPREADATR-L	ALIGN (ATR, L, Root, L)]
☞ a. ale-dhúdhù		*
b. älɛ-dhúdhù	*!	

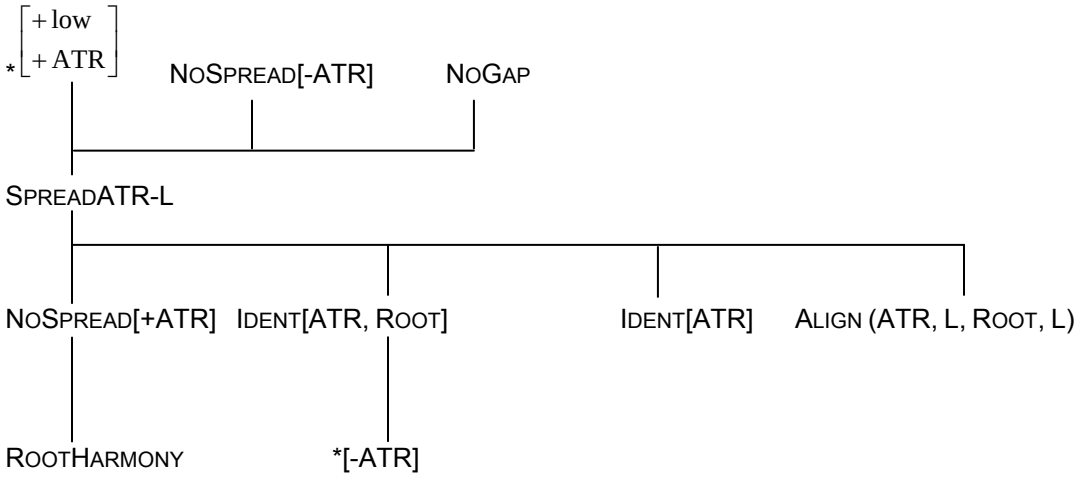
This last tableau is showing also that SPREADATR-L is higher ranked than IDENT[ATR], which is very similar to IDENT[ATR, Root].

SPREADATR-L >> IDENT[ATR]

Input:/ OtdyU + du/	SPREADATR-L	IDENT[ATR]
☞ a. ɔtdyù-du		*
b. ɔtdyu̱-du	*!	

These tableaux all come together in the rankings seen in (11). The interworkings of these constraints can be seen in the master tableau on the next page. Those that are separated by a comma, or by a dotted line in the master tableau, are not crucially ranked.

(11) $*\begin{bmatrix}+\text{low}\\+\text{ATR}\end{bmatrix}$, NOSPREAD[-ATR], NOGAP >> SPREADATR-L >> NOSPREAD[+ATR], IDENT[ATR, ROOT], IDENT[ATR], ALIGN (ATR, L, ROOT, L) >> ROOTHARMONY , *[-ATR]



Input: /OtdyU + du/	* [+low, + ATR]	NoSprd[-ATR]	NoGap	SprdATR-L	NoSprd[+ATR]	Ident[ATR, Root]	Align-L	Ident[ATR]	RootHarm	*[-ATR]
☞ a. Otdyù-du					*	*	*	*	*	*
b. otdyù-du					**!					
c. OtdyU + du				*!			**			**
Input:/alɛ-kOlOdzO/										
☞ a. alɛ-kɔlɔdzɔ										*****
b. alɛ-kolodzo						*!**	**	***		**
c. alɛ-kolɔdzɔ						*!	**	*		****
Input:/alɛ-dhúdhù/										
☞ a. ale-dhúdhù					*		*	*		*
b. ale-dhúdhʉ					*	*!	*	*	*	**
c. äle-dhúdhù	*!				**			**		
d. älɛ-dhúdhù	*!	*		*	**			*		*
e. alɛ-dhúdhù				*!			**			**
Input:/abhu-nʉ/										
☞ a. abhu-nʉ				*			*		*	**
b. äbhu-nʉ	*!				*	*		*		*
c. abhʉ-nʉ		*!	*	*		*		*		***
Input:/vhɔgɛrɛ/										
☞ a. vhɔgɛrɛ										***
b. vhogere						*!**		***		

4. Conclusion

This paper has discussed ATR vowel harmony in terms of optimality theory in Ndruna, a Central-Sudanic language in the DRC. It has lexically assigned ATR values on the root. When a prefix or a suffix is added, the feature [+ATR] spreads one vowel to the left.

Ten constraints were used in this analysis. The highest ranked were a markedness constraint that said there should not be any vowels that are [+low] and [+ATR]. The constraint NOSPREAD[-ATR] was also highly ranked because the feature [+ATR] is a dominant feature and it is the only one that spreads. The feature [-ATR] is recessive and does not spread. Also important were SPREADATR-L and NOSPREAD[-ATR] which allowed the [+ATR] feature to spread once, but kept it from spreading more than once.

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