AN ANALYSIS OF ATR HARMONY IN ALUR*

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1. Introduction

Alur (Western Nilotic; Uganda) is an understudied language with a complex ATR harmony pattern, described in a short paper by Kutsch Lojenga (1991). Based on this description, Alur harmony depends on the combination of whether a root is a noun or a verb, whether the suffix is of form V or CV, and whether the potential target vowel is [a] or not. To my knowledge, this pattern has not previously been theoretically analyzed.

In this paper, I analyze the Alur harmony pattern, as described by Kutsch Lojenga (1991). I show that both nouns and verbs in fact behave fundamentally the same way, and that the discrepancies between their behaviour arise from the fact that verb roots in the data are of form CVCV, whereas noun roots are of form CVC. I argue that the domain of harmony in Alur is a binary foot aligned to the left edge of the root, similar to the argument from Pullyeblank (2001) that the closely related language Lango limits harmony to a binary foot domain. Harmony in Alur is ATR-dominant; within the foot domain, whether it occurs depends on a combination of directionality, the number of intervening consonants, and whether an additional feature change is required to create an ATR vowel. Specifically, regressive harmony is exceptionless within the foot domain, whereas progressive harmony is blocked in the presence of a coda consonant or if the target vowel is [a], which must also change the feature [low] in order to become [ATR]. I propose a straightforward Optimality Theoretic analysis that captures the complex patterning of both nouns and verbs.

The paper is organized as follows: Section 2 describes the Alur harmony pattern and the generalizations that form the basis of my analysis, Section 3 formalizes the account, and Section 4 discusses some implications.

2. Alur vowel harmony pattern

2.1 Inventory

Alur has a nine-vowel inventory given in Table 1. High and mid vowels are paired for ATR, while the low vowel [a] is unpaired.

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	ATR			RTR		
	Front	Central	Back	Front	Central	Back
High	i		u	ɪ		ʊ
Mid	e		o	ɛ		ɔ
Low					a	

Table 1: Vowel inventory of Alur (Kutsch Lojenga 1991)

2.2 Absence of harmony with prefixes

Alur has a complex system of ATR harmony, triggered by ATR vowels and targeting RTR vowels. This harmony occurs only between roots and suffixes, as will be shown in the following subsections. However, prefixes are not involved in harmony, as the examples in (1) show. All data in this paper comes from Kutsch Lojenga (1991). Regardless of the ATR values of prefix or root vowels, prefixes never alternate and never trigger alternations in roots; the examples in (a) and (d) are disharmonic.

(1) a. ì-(nɛ́nɔ̀) '2SG-saw'
b. ɛ́-(nɛ̀nɔ̀) '3SG-saw'
c. ì-(ŋéyò) '2SG-knew'
d. ɛ́-(ŋèyò) '3SG-knew'

I propose that prefixes are outside of the domain of harmony, which I suggest begins at the left edge of the root. I will mark this domain with parentheses in the examples, and argue further about this domain throughout the rest of Section 2.

2.3 Suffix-to-root harmony

In Alur, harmony between root and suffix is described as depending on the interaction of a number of factors: whether the root is a noun or a verb, whether the suffix is of form V or CV, whether the potential trigger vowel is in the root or suffix, and whether the potential target vowel is low or not. I argue that both nouns and verbs behave fundamentally the same way, and that the complexities arise from a combination of domains, directionality, distance, and re-pairing, all of which are well-known phonological factors in the harmony literature.

The examples in (2) show the behaviour of suffix-to-root harmony in verb roots and noun roots respectively. ATR suffixes of form V in Alur, like the 2SG [í], always trigger harmony to underlyingly RTR roots, as seen in (2a) versus (2b) for verbs and (3a) versus (3b) for nouns. In verbs, ATR CV suffixes trigger no alternation (2c). In contrast, ATR CV suffixes do trigger harmony to noun roots (3c).

(2) a. ɛ́-(nɛ̀n-á) '3SG-saw-1SG'
b. ɛ́-(nèn-í) '3SG-saw-2SG'
c. ɛ́-(nɛ̀nɔ̀)-wú '3SG-saw-2PL'

(3) a. (tʃɔ̀ng-á) 'knee-1SG'
b. (tʃòng-í) 'knee-2SG'
c. (tʃòng-wú) 'knee-2PL'

I propose that this distinction between nouns and verbs is due to domains: similar to what was argued for the closely related language Lango by Pulleyblank (2001), I suggest that the domain of Alur harmony is a bisyllabic foot aligned to the left edge of the root, marked with parentheses in the examples. Noun roots in all of the data from Kutsch Lojenga (1991) contain only a single vowel, meaning that both V and CV suffixes fall within this domain of harmony. In contrast, verb roots are of form CVCV, where the final root vowel gets elided with a V suffix, but not with a CV suffix. As such, with verb roots, only V suffixes can be incorporated into the harmony domain; CV suffixes are outside the binary foot, and therefore the result in (2c) is predicted.

2.4 Root-to-suffix harmony

As expected by the foot domain analysis, RTR V suffixes undergo harmony with ATR verb roots, as shown in (4a) versus (4b), while CV suffixes do not (4c). However, despite being in the domain of harmony, RTR CV suffixes do not undergo harmony with ATR noun roots (5c), even though RTR V suffixes do, as seen in (5a) versus (5b).

(4) a. ɛ́-(gùd-é) ‘3SG-hurt-3SG’
b. ɛ́-(nɛ̀n-ɛ́) ‘3SG-saw-3SG’
c. ɛ́-(gùdò)-gí ‘3SG-hurt-PL’

(5) a. (lìmb-é) ‘cheek-3SG’
b. (tʃɔ̀ng-ɛ́) ‘knee-3SG’
c. (lìmb-gí) ‘cheek-3PL’

I analyze this effect of suffix onset in nouns in (5c) as being due to distance and directionality. I propose that the NC sequences written by Kutsch Lojenga (1991), like in [lìmb] ‘cheek’, are behaving phonologically as prenasalized stops, not sequences. Under this analysis, all nouns in the data are of form CVC. As such, with V suffixes, there are no codas and only a single consonant intervening between the vowels, while with CV suffixes, the root-final C is a coda, and multiple consonants intervene. This structure is illustrated in the examples in (6), repeated from (5), with periods as syllable breaks.

(6) a. (lì.^{m}b-é) ‘cheek-3SG’
b. (tʃɔ̀.^{n}g-ɛ́) ‘knee-3SG’
c. (li^{m}b.-gí) ‘cheek-3PL’

While regressive harmony in Alur is exceptionless within the foot, I suggest that progressive harmony cannot cross multiple consonants, or alternatively cannot cross a mora. Similar moraic distance effects have been documented in related languages (e.g. Lango; Archangeli & Pulleyblank 1994). Thus, regressive harmony in Alur is strong enough to overcome the distance effect, while progressive harmony is not. Since codas do not appear in verb roots, this analysis remains consistent with the behaviour of verbs.

2.5 Behaviour of [a]

A final issue concerns the behaviour of [a], which has no ATR counterpart in the inventory. In suffixes, [a] is neutral to progressive harmony, in that onsetless [a] suffixes do not harmonize in the presence of ATR roots, unlike other onsetless RTR suffixes. This is shown in (7); compare (4a-b) and (5a-b) above.

(7) a. ɛ́-(gùd-á) '3SG-hurt-1SG'
b. (lìmb-á) 'cheek-1SG'

In contrast, [a] in roots does undergo regressive harmony in the presence of an ATR suffix, by re-pairing to the mid ATR vowel [e]. This is shown in (8) and (9); the root surfaces with [a] when the suffix is RTR, in the (a) forms, but with [e] when the suffix is ATR, in the (b) forms. Note that regressive harmony is strong enough to trigger harmony onto /a/ even when there is an additional intervening consonant, as in (9c).

(8) a. ɛ́-(tʃàk-á) '3SG-chose-1SG'
b. ɛ́-(tʃèk-í) '3SG-chose-2SG'

(9) a. (wàŋ-á) 'eye-1SG'
b. (wèŋ-í) 'eye-2SG'
c. (wèŋ-wú) 'eye-2PL'

Similar to the fact that CV suffixes trigger but do not undergo harmony in nouns, I analyze this effect as resulting from a stronger tendency for regressive than progressive harmony in Alur. Alur does not tolerate ATR low vowels as the product of harmony; there is independent evidence of this from the fact that RTR…ATR sequences with /a/ harmonize by changing the feature [low], as in (8-9). Given this fact about the grammar, we can understand the lack of harmony with [a] in ATR…RTR scenarios in (7) as upholding a ban on ATR low vowels in the language (i.e. structure-preservation), but opting for disharmony over re-pairing. Regressive harmony is strong enough to overcome the additional feature change required for re-pairing, while progressive harmony is not.

2.6 Summary of facts

To summarize, Alur has ATR-dominant vowel harmony between roots and suffixes. Within verbs, only V suffixes trigger and undergo harmony; within nouns, only V suffixes undergo harmony, but both V and CV suffixes trigger it. Within roots (both verbs and nouns), /a/ harmonizes to [e] in the presence of an ATR suffix; in contrast, suffix /a/ never harmonizes. I suggest that this complex pattern emerges simply through the interaction of straightforward phonological factors: a foot domain, stronger regressive than progressive harmony, a distance effect, and a re-pairing versus neutrality effect. In the subsequent sections, I will formalize this analysis in Optimality Theory and discuss broader implications.

It is worth noting some additional facts beyond the harmony system that these data show. Specifically, verb roots are CVCV, but the root-final vowel deletes in the presence of a V-initial suffix. Noun roots are CVC, and when there are two root-final consonants, they always consist of an NC sequence; these sequences seem to be behaving phonologically as prenasalized stops, and I analyze them as such.

3. Analysis

3.1 Analysis background

With respect to the domain, I propose that the domain of harmony in Alur is a foot, similar to what Pulleyblank (2001) suggested about the related language Lango. This foot in Alur is binary (in terms of syllables) and aligned to the left edge of the root.[1] All vowels within the foot are required to harmonize; vowels outside the foot are not. Since the foot is aligned to the left edge of the root, prefixes are always outside of the domain of harmony; suffixes may or may not be within the domain, depending on the number of vowels in the root. In CVCV verb roots, deletion of the root-final vowel with V suffixes means that V suffixes are part of the foot domain, but CV ones are not, since the root-final vowel does not elide in such cases. Thus, we expect harmony exactly between roots and V suffixes in verbs. In CVC noun roots, both V and CV suffixes belong to the foot domain; we would therefore predict harmony between the root and all suffixes.

There are two remaining points to explain: that CV suffixes do not undergo harmony despite being in the domain for nouns, and that suffix [-a] does not undergo harmony, even though root [a] does. These can be generalized. ATR-[a] sequences are permitted within the foot, even though [a]-ATR sequences are not, and ATR-CC-RTR sequences are permitted within the foot, even though RTR-CC-ATR sequences are not. The latter is only apparent with noun roots, but there is no contradictory data in verb roots, since the only place where VCCV sequences can arise is with a noun root (…VC-CV). Both of these facts are indications of the stronger regressive than progressive harmony, with progressive harmony limited by vowel quality ([a]) and by distance (CC). Table 2 summarizes the permitted and forbidden foot-internal vowel sequences, with rows indicating the first vowel and columns the second.

V1 ↓ V2 →	[a]	Non-low RTR vowels	ATR vowels
[a]	OK	OK	*
Non-low RTR vowels	OK	OK	*
ATR vowels	OK	OK across CC * elsewhere	OK

Table 2: Permitted and forbidden foot-internal vowel sequences

3.2 Formalization: Foot Structure

Before dealing with harmony, I formalize my analysis of foot structure and vowel deletion. In order to assign the correct foot structure and delete the root-final vowel in verbs before vowel-initial suffixes, we require the constraints defined in (10).

[1] Given the lack of available data on Alur, it is unclear whether there is any independent evidence, from tone or stress, for this type of foot structure in Alur. However, it is worth noting that Lango, which is fairly closely related and better documented, is described as having root-initial stress (Noonan 1992); if true in Alur, that would provide additional evidence for this foot-based analysis.

(10)
ALIGN-FT-RT(L,L): assign a violation for every foot that is not left-aligned to the left edge of a root
FT-BIN: a foot must be binary (at the syllable level)
PARSE-SYLL: all syllables should be parsed into feet
*VV: assign a violation for every VV sequence in the output
REALIZE-MORPHEME: assign a violation for every morpheme with null phonological exponence in the output (Kurisu 2001)

I first show that these constraints achieve the desired foot structure and root-final vowel deletion, and then omit them from further tableaux for space reasons; they do not interact with harmony except to define the domain.

The most interesting case is that of a verb root with a V suffix, shown in Table 3. Either the root-final vowel or the suffix vowel must be deleted because of *VV; the former is chosen because the suffix vowel needs to be maintained to satisfy REALIZE-MORPHEME.[2] The choice of foot placement and size is established through a combination of ALIGN-FT-RT(L,L), FT-BIN and PARSE-SYLL, requiring a single binary foot at the left edge of the root in both Table 3 and Table 4. In Table 4 in particular, FT-BIN keeps the suffix out of the domain of harmony.

	/ɛ́-nɛ̀nɔ̀-í/	ALIGN-FT-RT(L,L)	*VV	REALIZE-MORPHEME	PARSE-SYLL
	ɛ́-nɛ̀nɔ̀-í				**!**
	ɛ́-(nɛ̀nɔ̀)-í		*!		**
☞	ɛ́-(nɛ̀n-í)				*
	ɛ́-(nɛ̀nɔ̀)			*!	*
	(ɛ́-nɛ̀n-í)	*!			
	(ɛ́-nɛ̀n)-í	*!			*

Table 3: Deletion of root-final vowel in verbs with a V suffix

	/ɛ́-nɛ̀nɔ̀-wú/	FT-BN	PARSE-SYLL
☞	ɛ́-(nɛ̀nɔ̀)-wú		**
	ɛ́-(nɛ̀nɔ̀-wú)	*!	*

Table 4: Foot structure for verb with CV suffix

Thus, this combination of constraints, with the only crucial ranking being PARSE-SYLL below all other constraints, can correctly predict the proposed foot structure that functions as the harmony domain. I now assume the correct foot structure and vowel deletion patterns in all further tableaux.

3.3 Harmony constraints

I adopt four harmony constraints for Alur, all of which apply only within the domain of the foot. The style of no-disagreement constraint is adopted from Pulleyblank (2004), with an

[2] Alternatively, this constraint could be thought of as ANCHOR-L; V suffixes have only a single segment, and so deleting that segment means deleting the first one, thereby violating ANCHOR-L.

underline indicating the focus of the constraint for which violations are counted. Since regressive and progressive harmony pattern differently, Alur requires separate constraints for enforcing harmony in RTR…ATR (11b,d) and ATR…RTR (11a,c) sequences. Moreover, since the number of intervening consonants affects harmony, Alur requires separate constraints for harmony applying across a single consonant (11a-b) versus across any number of consonants (11c-d).[3] Presumably, there are additional similar harmony constraints, not restricted to the foot domain, that are too low-ranked to show an effect in Alur.

(11) Harmony constraints
(a) $*[\text{ATR}]\text{C}\underline{[\text{RTR}]}_{\text{Ft}}$: within the foot, a [RTR] vowel may not be preceded by a [ATR] vowel from which it is separated by at most a single consonant.
(b) $*\underline{[\text{RTR}]}\text{C}[\text{ATR}]_{\text{Ft}}$: within the foot, a [RTR] vowel may not be followed by a [ATR] vowel from which it is separated by at most a single consonant.
(c) $*[\text{ATR}]\text{C}_0\underline{[\text{RTR}]}_{\text{Ft}}$: within the foot, a [RTR] vowel may not be preceded by a [ATR] vowel from which it is separated by any number of consonants.
(d) $*\underline{[\text{RTR}]}\text{C}_0[\text{ATR}]_{\text{Ft}}$: within the foot, a [RTR] vowel may not be followed by a [ATR] vowel from which it is separated by any number of consonants.

I also adopt the faithfulness constraints in (12). Two are related to changes in tongue root, with separate faithfulness for [ATR] versus [RTR] to analyze why harmony is ATR-dominant; a ranking of IDENT-IO[ATR] >> IDENT-IO[RTR] ensures that when a vowel is required to change to harmonize, ATR will always be preserved at the expense of RTR. A third faithfulness constraint to [low] is necessary to deal with the fact that /a/ sometimes changes its [low] value to harmonize to [e], but sometimes does not.[4]

(12) Faithfulness constraints
IDENT-IO[ATR]: for a segment x in the input and its correspondent x' in the output, assign a violation if x is [ATR] and x' is not
IDENT-IO[RTR]: for a segment x in the input and its correspondent x' in the output, assign a violation if x is [RTR] and x' is not
IDENT-IO[low]: for a segment x in the input and its correspondent x' in the output, assign a violation if x and x' do not have the same value for the feature [low]

To prevent direct harmony of /a/ to an ATR low vowel, we require the markedness constraint in (13). In other words, we want to prevent an ATR allophone [ʌ] of /a/ from

[3] Since feet are maximally bisyllabic, the constraint across any number of consonants could alternatively be conceptualized as one limited to adjacent syllables (regardless of non-syllabic intervening material) or even one that is completely unbounded. Moreover, assuming that the first consonant of a CC cluster is a coda and that Alur codas are moraic, these constraints could alternatively be expressed as harmony applying without an intervening mora versus across any intervening material. I use constraints expressed in terms of consonants for notational simplicity.

[4] For ease of exposition, I use only a single symmetric faithfulness constraint for [low], penalizing both [+low] to [-low] and the reverse, unlike the tongue root faithfulness constraints. However, it would be equally possible to view this constraint as two separate ones, and in practice, only faithfulness to [+low] is necessary in the present analysis.

occurring even in ATR contexts. The constraint in (13), ranked highly, ensures that [ʌ] does not exist in Alur. Note specifically that *ʌ >> IDENT-IO[ATR] is necessary due to Richness of the Base, to ensure that hypothetical underlying ATR low vowel does not surface.

(13) *ʌ: assign a violation for any occurrence of an ATR low vowel in the output

For space reasons, I will omit constraints that are irrelevant to a given candidate in the tableaux. The following constraints are unviolated in Alur, and must therefore be at the top of the ranking: *[RTR]C[ATR]$_{Ft}$, *[RTR]C$_0$[ATR]$_{Ft}$, *ʌ. Additionally, IDENT-IO[ATR] is violated only to satisfy *ʌ. Other rankings will be discussed throughout the derivations.

3.4 Derivations

Table 5 shows an RTR verb root with an ATR V suffix. Candidate (a), the faithful candidate, fatally violates the high-ranked harmony constraint *[RTR]C[ATR]$_{Ft}$. Candidate (b), the winner, in which the root harmonizes, violates only low-ranked IDENT-IO[RTR]. Candidate (c), in which RTR harmony occurs to change the suffix, fatally violates high-ranked IDENT-IO[ATR]. Candidate (d), in which the prefix also becomes ATR, has a second, fatal violation of IDENT-IO[RTR]; there is no motivation for the prefix to change, because it occurs outside the harmony domain. This tableau demonstrates that IDENT-IO[ATR], *[RTR]C[ATR]$_{Ft}$ >> IDENT-IO[RTR].

		/ɛ́-nɛ̀nɔ̀-í/	IDENT-IO[ATR]	*[RTR]C[ATR]$_{Ft}$	IDENT-IO[RTR]
	(a)	ɛ́-(nɛ̀n-í)		*!	
☞	(b)	ɛ́-(nèn-í)			*
	(c)	ɛ́-(nɛ̀n-í)	*!		
	(d)	é-(nèn-í)			**!

Table 5: Suffix-to-root harmony in a verb root with a V suffix.

Table 6 shows the same verb root with a CV suffix. In this case, the faithful candidate (a) wins, because the suffix is outside of the foot, and therefore outside of the harmony domain. Candidate (b), in which the root harmonizes to the suffix, fatally violates IDENT-IO[RTR]. Notably, here is where it is crucial that the relevant harmony constraints are bounded to the foot; with the more general constraint *[RTR]C[ATR], as shown in the tableau, a harmonized candidate would be preferred. The ranking IDENT-IO[RTR] >> *[RTR]C[ATR] is what ensures that harmony is bounded to the foot. Even though the constraint *[RTR]C[ATR]$_{Ft}$ does not do anything in this tableau, I include it because it is relevant that the disharmonic candidate does not violate it.

	/ɛ́-nɛ̀nɔ̀-wú/	*[RTR]C[ATR]$_{Ft}$	IDENT-IO[RTR]	*[RTR]C[ATR]
☞ (a)	ɛ́-(nɛ̀nɔ̀)-wú			***
(b)	ɛ́-(nènò)-wú		*!*	*

Table 6: Suffix-to-root harmony does not occur in a verb root with a CV suffix.

Table 7 shows re-pairing of /a/ to [e] in a verb root with an ATR V suffix. Candidate (a), the faithful candidate, is ruled out by a violation of high-ranked *[RTR]C[ATR]$_{Ft}$. Candidate (b), the re-pairing candidate, violates IDENT-IO[low], but wins because this constraint is lower-ranked. Candidate (c), in which the vowel [ʌ] surfaces, is ruled out by *ʌ. Candidate (d), in which harmony is in this instance controlled by the RTR vowel, is ruled out by IDENT-IO[ATR]. This tableau adds the rankings *[RTR]C[ATR]$_{Ft}$, *ʌ, IDENT-IO[ATR] >> IDENT-IO[low].

	/ɛ́-tʃàk-í/	*ʌ	*[RTR]C[ATR]$_{Ft}$	IDENT-IO[ATR]	IDENT-IO[low]	IDENT-IO[RTR]
(a)	ɛ́-(tʃàk-í)		*!			
☞ (b)	ɛ́-(tʃèk-í)				*	*
(c)	ɛ́-(tʃʌ̀k-í)	*!				*
(d)	ɛ́-(tʃàk-í)			*!		

Table 7: Re-pairing of /a/ in verb roots

Table 8 shows root-to-suffix harmony from an ATR verb root to a V suffix. The faithful candidate (a) is ruled out by high-ranked *[ATR]C[RTR]$_{Ft}$; candidate (b) wins. This tableau demonstrates the ranking *[ATR]C[RTR]$_{Ft}$ >> IDENT-IO[RTR].

	/ɛ́-gùdò-ɛ́/	IDENT-IO[ATR]	*[ATR]C[RTR]$_{Ft}$	IDENT-IO[RTR]
(a)	ɛ́-(gùd-ɛ́)		*!	
☞ (b)	ɛ́-(gùd-é)			*
(c)	ɛ́-(gʊd-ɛ́)	*!		

Table 8: Root-to-suffix harmony to a V suffix from a verb root

Table 9 demonstrates that this harmony does not apply to suffix /a/. Candidate (a), the faithful candidate, wins despite violating *[ATR]C[RTR]$_{Ft}$. Candidate (b), the re-pairing candidate, fatally violates IDENT-IO[low], while candidate (c) fatally violates *ʌ. This tableau therefore illustrates the ranking IDENT-IO[low] >> *[ATR]C[RTR]$_{Ft}$. In particular, the difference between /a/ re-pairing in roots, as in Table 7, and not in suffixes here, comes from the fact that the regressive harmony constraint outranks IDENT-IO[low], which in turn outranks the progressive harmony constraint.

/ɛ́-gùdò -á/	*ʌ	IDENT-IO[ATR]	IDENT-IO[low]	$*[ATR]C\underline{[RTR]}_{Ft}$	IDENT-IO[RTR]
☞ (a) ɛ́-(gùd-á)				*	
(b) ɛ́-(gùd-é)			*!		*
(c) ɛ́-(gùd-ʌ́)	*!				*
(d) ɛ́-(gʊd-á)		*!			

Table 9: Lack of re-pairing of /a/ in suffixes

The case of RTR CV suffixes with ATR verb roots is identical to the case of ATR CV suffixes with RTR verb roots in Table 6: harmony will not occur because the CV suffix occurs outside of the domain of harmony. Moreover, the patterns with V suffixes for nouns will be identical to those with verbs in Table 5; noun roots are CVC, and verb roots become CVC in the presence of V suffixes due to hiatus resolution. What remains is to illustrate the patterns for CV suffixes with nouns, which differ from those with verbs; nouns with CV suffixes are of form CVC-CV, while verbs are of form CVCV-CV. Thus, while CV suffixes were not part of the foot with verbs, they are with nouns. Here is where it becomes crucial to separate the harmony constraints based on whether a single consonant or multiple consonants intervene, as it is the first occasion in which the root and suffix vowels are separated by multiple consonants.

Table 10 illustrates suffix-to-root harmony with an RTR noun root and an ATR CV suffix. The root and suffix are both within the foot, meaning that the faithful candidate fatally violates $*\underline{[RTR]}C_0[ATR]_{Ft}$. Candidate (b), with harmony, wins despite violating IDENT-IO[RTR]. This result requires the ranking $*\underline{[RTR]}C_0[ATR]_{Ft}$ >> IDENT-IO[RTR].

/tʃɔ̀ng-wú/	$*\underline{[RTR]}C_0[ATR]_{Ft}$	IDENT-IO[RTR]
(a) (tʃɔ̀ng-wú)	*!	
☞ (b) (tʃòng-wú)		*

Table 10: Suffix-to-root harmony in noun roots with a CV suffix

Table 11 demonstrates the lack of root-to-suffix harmony with an ATR noun root and an RTR CV suffix. Candidate (a), the faithful candidate, wins despite violating $*[ATR]C_0\underline{[RTR]}_{Ft}$, which is low-ranked. Crucially, this candidate does not violate $*[ATR]C\underline{[RTR]}_{Ft}$, as there are multiple consonants intervening between the vowels. Candidate (b), with harmony, fatally violates IDENT-IO[RTR]. Thus, we require IDENT-IO[RTR] >> $*[ATR]C_0\underline{[RTR]}_{Ft}$. Specifically, progressive harmony behaves differently depending on whether there is only a single consonant intervening or multiple consonants. Crucially, while progressive harmony across a single intervening consonant outranks IDENT-IO[RTR], the more general progressive harmony across any number of consonants does not. In other words, $*[ATR]C\underline{[RTR]}_{Ft}$ >> IDENT-IO[RTR] >> $*[ATR]C_0\underline{[RTR]}_{Ft}$ is the ranking that ensures progressive harmony occurs across one consonant, but not more than that.

	/lìmb-gí/	*[ATR]C[RTR]$_{Ft}$	IDENT-IO[RTR]	*[ATR]C_0[RTR]$_{Ft}$
☞ (a)	(limb-gí)			*
(b)	(lìmb-gí)		*!	

Table 11: Lack of root-to-suffix harmony with a noun root and CV suffix

The full ranking required for dealing with Alur harmony is given in (14); it can capture all of the complex behaviour seen in Alur harmony, for both nouns and verbs.

(14) Ranking for Alur harmony
*[RTR]C[ATR]$_{Ft}$, *ʌ, *[RTR]C_0[ATR]$_{Ft}$ >> IDENT-IO[ATR] >> IDENT-IO[low] >> *[ATR]C[RTR]$_{Ft}$ >> IDENT-IO[RTR] >> *[ATR]C_0[RTR]$_{Ft}$

4. Discussion and conclusion

Alur has a complex harmony system, described by Kutsch Lojenga (1991) as being distinct for nouns versus verbs, for V suffixes versus CV suffixes, and for [a] versus other vowels. In this paper, I have analyzed the first property as due to the difference in canonical structure of nouns versus verbs (CVC versus CVCV), the second property as due to a combination of whether the suffix is integrated into the foot domain and whether multiple consonants intervene between the root and suffix vowels, and the third property as due to whether changes in an additional feature (here, [low]) are required to make a vowel [ATR]. This analysis allows all aspects of the Alur pattern to be expressed through purely phonological motivations; the phonology does not have to refer to nouns versus verbs, or to V versus CV suffixes except in the implications of that to distance between the vowels (in terms of the number of intervening consonants).

Regressive and progressive harmony behave differently in Alur, with regressive harmony applying in more situations than progressive harmony does, which is a pattern that has been noted in a wide variety of languages (e.g. Hyman 2002). This fact is captured in the analysis by separating out progressive and regressive harmony constraints.

Within progressive harmony, harmony behaviour is different depending on whether there is only a single consonant intervening or multiple consonants, with the latter blocking progressive harmony. A similar effect of intervening consonants has also been noted for the related language Lango, and has been analyzed as harmony being blocked by an intervening mora (e.g. Archangeli & Pulleyblank 1994). In the present analysis, I have expressed this distance effect using two harmony constraints, one applicable with a single intervening consonant, and the other applicable with any number of intervening consonants. Alur instantiates both types of patterns predicted by this choice: regressively, harmony applies regardless of the number of intervening consonants, while progressively, it applies only across a single consonant. This choice of using the number of consonants (one versus any number) rather than the number of moras (zero versus any number) in the constraints is not crucial, in particular because given that Alur harmony is limited to a syllable binary foot, so the only possible intervening moras are coda consonants. Note that, because regressive harmony does cross coda consonants, the foot domain must crucially be binary based on syllables, not moras; as such, the explanation for why progressive harmony fails to affect CV suffixes cannot fall to the domain.

Further research into Alur should examine several aspects of the present analysis. First, the analysis of noun patterns required NC sequences to be prenasalized stops, rather than actual clusters. This analysis was what allowed consistent patterning with respect to how the number of consonants (or moras) affects whether harmony occurs. Specifically, if NC represents two separate consonants, then some nouns are CVCC, while others are CVC, and so it becomes impossible to distinguish the behaviour of V versus CV suffixes in progressive harmony with nouns based solely on distance. However, it is unclear whether there is any additional phonological or phonetic evidence in Alur supporting the analysis of NC sequences as prenasalized stops; this should be examined further. Second, the domain of harmony was established to be the foot, which is binary and aligned to the left edge of the root. A similar proposal with a different foot position was argued for Lango (Pulleyblank 2001), but the existence of foot structure has not been established in Alur. Research should look for further evidence from tone or stress for a binary foot at the left edge of the root in Alur. Third, for it to be sensible for distance in terms of number of intervening consonants to affect whether harmony occurs, it would make sense for those consonants to be moraic; again this has been proposed for Lango (e.g. Archangeli & Pulleyblank 1994), but has not been established for Alur; additional evidence about moraicity would be useful to examine. Finally, research should also examine any exceptional noun and verb stem types, to establish that is truly the canonical shape rather than the morphological category that determines how harmony operates. For example, if Alur has any nouns of form CVCV, we would expect them to pattern like the verbs in this dataset, given the argument that it is phonological shape rather than category that determines harmony. Evidence of this sort would be critical support for the present analysis.

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