

*Phonological phrasing and ATR vowel harmony in Akan**

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This paper examines phonological phrasing in the Kwa language Akan. Regressive [+ATR] vowel harmony between words (RVH) serves as a hitherto unreported diagnostic of phonological phrasing. In this paper I discuss VP-internal and NP-internal structures, as well as SVO(O) and serial verb constructions. RVH is a general process in Akan grammar, although it is blocked in certain contexts. The analysis of phonological phrasing relies on universal syntax–phonology mapping constraints whereby lexically headed syntactic phrases are mapped onto phonological phrases. Blocking contexts call for a domain-sensitive analysis of RVH assuming recursive prosodic structure which makes reference to maximal and non-maximal phonological phrases. It is proposed (i) that phonological phrase structure is isomorphic to syntactic structure in Akan, and (ii) that the process of RVH is blocked at the edge of a maximal phonological phrase; this is formulated in terms of a domain-sensitive CRISPEDGE constraint.

1 Introduction

This paper examines phonological phrasing in Akan, a Kwa language with two tones spoken in Ghana (Dolphyne & Kropp Dakubu 1988).¹ The

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¹ Akan refers to the largest ethnic group in Ghana (Nkansa-Kyeremateng 2004) and is spoken by about 8.3 million people in Ghana and the Ivory Coast (Christaller 1933, Lewis 2009). Akan has a number of dialects, some of which are more mutually intelligible than others (Schachter & Fromkin 1968). The dialects differ both at segment and at tone level (cf. Cahill 1985, Dolphyne 1988, Dolphyne & Kropp Dakubu 1988, Abakah 2000, 2005, Abakah & Koranteng 2007, among others).

general assumption in prosodic phonology is that the presence or absence of phonetic cues or phonological processes, for instance phrase-final lengthening, may provide a means of diagnosing the presence of prosodic phrasing (cf. Nespor & Vogel 1986, Selkirk 1986, 2011). This paper explores a hitherto rarely described process of regressive vowel harmony (RVH) between prosodic words as a tool for determining the placement of phonological phrase (φ) boundaries. RVH has been observed in a few other languages (Casali 2008), but has not yet received a great deal of attention. In this paper I argue that the edge of a maximal phonological phrase (φ_{\max}) blocks the general process of RVH. The data is analysed using Match theory (Selkirk 2011) for the formation of prosodic phrase structure. Any lexically headed syntactic phrase is mapped onto a φ . I assume domain-specific CRISPEGE constraints (Itô & Mester 1999, Selkirk 2011) that ban multiple linking of features across prosodic domain edges. In particular, I propose a domain-sensitive constraint of the CRISPEGE family to account for the fact that [+ATR] cannot spread regressively across the edge of a φ_{\max} . This proposal assumes recursive phonological phrasing (cf. Selkirk 2011, Elfner 2012, Ito & Mester 2012). A φ_{\max} is defined as a φ that it is not dominated by any further φ .

Vowel harmony is central to the analysis of phrasal phonology in Akan. The vowel system consists of nine oral and five nasal vowels, as shown in (1) (Dolphyne 1988). Oral vowels show a three-level height distinction, and a two-way front-back distinction. Only high and low vowels have nasal counterparts.²

(1) *Standard Akan (Asante Twi) vowel system*

| | |
|----------------|-----------------|
| a. <i>oral</i> | b. <i>nasal</i> |
| i ɪ u ʊ | ĩ ã ù õ |
| e ɛ o ɔ | |
| a | ã |

Asante Twi is one of the three largest dialects, and its influence is such that it is becoming the lingua franca of Ghana (cf. Osam 2003). The data in this study is based on Asante Twi; I will use Akan as a cover term throughout the paper. The data was elicited from two native speakers during a fieldwork visit in Accra and Kumasi (Ghana) in September 2012. Three further native Asante speakers reading the sentences were recorded in Kumasi. Some further data was elicited in June 2013 during a research stay by one of my informants in Potsdam.

² Throughout the paper, the data appear in IPA transcription. Orthographic representations are also given in italics. Akan orthography uses standard Latin script in addition to the IPA characters ϵ and o for the half-open front and back vowels (Dolphyne 1988: 7). In total, the Akan orthography has seven vowel and 16 consonant symbols. Note that the characters e and o are ambiguous with respect to [ATR]; e can be pronounced either as unadvanced front high [i] or as advanced front mid [e], o as unadvanced back high [u] or advanced mid back [o].

The following abbreviations are used in glosses: COMPL = completive; DET = determiner; FUT = future; IMP = imperative; NC = noun class; PERF = perfective; PL = plural; PRN = pronoun; PROG = progressive; RED = reduplicant; SG = singular.

As in many other West African languages, in particular Niger-Congo and Nilo-Saharan languages (cf. Casali 2008), vowel harmony is a feature of the phonology of Akan (e.g. Stewart 1967, Dolphyne 1988, Casali 2012). The harmonising feature is [ATR], and the vowels form two harmonic sets, as shown in (2). The advanced vowel series consists of the high and mid vowels, which have retracted counterparts. In addition, the low vowel /a/ belongs to the [-ATR] group.³ According to Dolphyne (1988), vowel harmony applies within the word, and word stems are underlyingly associated with either [+ATR] or [-ATR].

(2) *Akan harmonic vowel classes*

[+ATR]: /i e o u/

[-ATR]: /ɪ ɛ ɔ ʊ a/

Akan harmonic vowel classes have been the object of articulatory and acoustic studies, with the aim of understanding the exact underlying mechanisms of the [\pm ATR] distinction (Lindau 1975, 1979, Hess 1992, Tiede 1996). Articulatorily, the ‘relative size of the pharynx controls the phonological vowel harmony’ (Lindau 1975: 80), which was confirmed using ultrasound measures by Tiede (1996). The articulatory studies showed that there is almost no difference in degree of primary constriction, which means that the tongue dorsum maintains its height in the oral cavity, with the crucial difference arising through a decrease in the size of the pharyngeal cavity in the case of [-ATR] vowels.

Acoustically, an increase in the size of the pharyngeal cavity results in a raising of the first formant, confirmed independently for Akan (Lindau 1979, Hess 1992, Tiede 1996). The F1 dimension mirrors the degree of tongue height, which may be why the features [ATR] and [tense] are often used interchangeably in phonological theory. Given that Lindau (1975) and Tiede (1996) have shown articulatorily that in Akan the vowels differ in terms of pharyngeal size, Akan unambiguously exhibits a case of [ATR] harmony.

The paper is organised as follows. Word-level vowel harmony in Akan is given as background in §2, and data illustrating RVH between words is presented in §3, as well as a first analysis in terms of a prosodic interword markedness constraint that licenses RVH and a word-level CRISPEGE constraint that prohibits multiple linking of the [ATR] feature between prosodic words. §4 sets out the basic phrase-level analysis of RVH, and presents the empirical puzzle that RVH occurs in certain contexts while it is blocked in others. I propose an analysis in terms of syntax–phonology MATCH constraints to arrive at the relevant prosodic phrasing, such that each lexically headed syntactic phrase is matched with a \emptyset . In addition, I propose an analysis of recursive prosodic structure to distinguish

³ The low vowel /a/ does not take part in a systematic [ATR] alternation, and some researchers have argued that it behaves as a neutral vowel. However, there are instances of /a/ surfacing in [+ATR] surroundings as low front unrounded [æ], e.g. /aburo/ [æburo] ‘maize’.

between different levels of φ 's, φ_{\max} and $\varphi_{\text{non-max}}$, which are shown to be relevant for the application or blocking of RVH. The remainder of §4 discusses data where RVH applies or is blocked, to support the central analysis, while §5 analyses RVH as a domain-sensitive process. I argue that a domain-sensitive CRISPEGE constraint referring to φ_{\max} is required to account for the blocking of RVH. §6 summarises the paper.

2 ATR harmony within the word

The goal of this section is to illustrate bidirectional root-controlled word-level harmony in Akan, and to show that, from a point of underspecification theory, the [ATR] opposition is represented underlyingly. I propose that the vowel-harmony process can be accounted for by the interaction of a markedness constraint HARMONY and a positional faithfulness constraint IDENT[ATR]_{Root}.⁴

Vowel harmony in Akan has been the subject of a number of phonological studies (Stewart 1967, 1983, Schachter & Fromkin 1968, Clements 1985). According to Dolphyne (1988: 16), vowel harmony is 'a property of the word, that is, it characterises a whole word at a time'. That is, all syllables within a word agree with the [ATR] feature of the word stem, as shown by the data in (3).

- | | | | |
|--------|--------|---------------------------|--------------------------------|
| (3) a. | màɛ̀dí | <i>ma-a-dí</i> | 'I've eaten it' |
| | | 1SG-PERF-eat | |
| | | | [+ATR] |
| b. | màtótó | <i>ma-a-tó</i> | 'I've bought it' |
| | | 1SG-PERF-buy | |
| | | | [-ATR] |
| c. | vóbétú | <i>wo-be-tu</i> | 'you will move from the house' |
| | | 2SG-FUT-move from a house | |
| | | | [+ATR] |
| d. | vóbétó | <i>wo-be-to</i> | 'you will throw' |
| | | 2SG-FUT-throw | |
| | | | [-ATR] |

In the verbal morphology of Akan, tense, aspect and mood markers, as well as pronominal suffixes, are cliticised to the verb stem (Paster 2010). The [ATR] feature spreads leftwards from the stem through the whole word, including all affixes. (3) illustrates the agreement of [ATR] across two

⁴ Since this paper is about vowel harmony between words, the facts on word-level harmony are presented only briefly. Extended work on vowel harmony in OT can be found in Baković (2000); for an overview see Walker (2012). Ballard (2010) proposes an OT approach to Akan vowel harmony in terms of alignment constraints, which at the word-level captures the harmony patterns correctly. However, he assumes that RVH applies at the level of the *ɪ*, and not at the level of the φ , as proposed here.

prefixes, the subject pronoun and a tense marker (perfective in (a, b), and future in (c, d)). In (3a), the [+ATR] feature of the word stem /di/ affects both the perfective tense, which is realised as vowel lengthening, and the 1st person singular pronoun. The same holds for the [-ATR] feature of the word stem /tɔ/ in (b). The future tense in (c, d) is realised with the prefix /bE/, which does not merge with the preceding pronoun.⁵ Like other prefixes, the future tense marker varies as a function of the [ATR] specification of the verb stem, as in (c) ([+ATR]) and (d) ([-ATR]).

As well as spreading across all affixes, the harmony process extends from the stem vowel(s) bidirectionally over the whole word (Stewart 1965, Schachter & Fromkin 1968, Dolphyne 1988). In the case of the completive aspect, which expresses past tense (cf. Osam 2003), the aspect marker is realised as a suffix. Relevant examples from Dolphyne (1988: 16) are given in (4). The [+ATR] of the verb stem /hunu/ in (a) spreads leftwards to the subject pronoun and also rightwards to the completive aspect marker. Spreading of [-ATR] is shown in (b).⁶

- (4) a. *o-hunu-i* òhùì b. *ɔ-kɔ-e* òkòì
 3SG-see-COMPL 's/he saw' 3SG-go-COMPL 's/he went'

Root-controlled word-level vowel harmony in Akan can be accounted for by the interaction of the markedness and positional faithfulness constraints in (5). The markedness constraint in (a) ensures that all vowels in a given word agree in their [ATR] feature. In contrast, the faithfulness constraint in (b) prevents a word stem that is specified for [ATR] from changing its feature value.

- (5) a. HARMONY
 All vowels within a prosodic word must agree in the feature [ATR].
 b. IDENT[ATR]_{Root}
 Every root vowel in the input with the value [α ATR] must have a corresponding root vowel in the output with the value [α ATR].

The tableau in (6) illustrates the constraint interaction with a disharmonic verb root /bisa/ 'to ask'.⁷ The input consists of the verb stem, a 3rd person

⁵ As shown in (3), pronouns, as well as tense and aspect markers, vary according to the [ATR] specification of the stem. I therefore assume, with Clements (1985), that pronominal prefixes, tense, aspect and mood markers, as well as nominal affixes, are underspecified for [ATR]; their vowels are represented by capital letters in underlying representations.

⁶ These verbs usually occur with an overt object in Akan; if not, the resumptive pronoun /ɛ/ is suffixed to the verb. This pronoun is not affected by vowel harmony, and remains [-ATR], giving (a) /o-hunu-i-ɛ/ and (b) /ɔ-kɔ-I-ɛ/. In case of an overt object, the final vowel of the verb is lengthened, as in /o-hunuu kube/ 's/he saw a coconut' and /ɔ-kɔɔ fie/ 's/he went to the house'.

⁷ In addition to completely harmonising words, disharmonic stems exist in Akan, e.g. /sika/ 'money' and /bisa/ 'to ask'. In such cases, affixes receive their [ATR] specification from the corresponding adjacent stem syllables, as in (i).

- (i) *o-bisa-i* òbìsàì
 3SG-ask-COMPL 's/he asked'

singular subject pronoun /O/ and a completive aspect marker /I/. The optimal candidate, (a), satisfies the positional faithfulness constraint, but violates the markedness constraint, since the disharmonic word stem shows an instance of two adjacent vowels with different values for the harmonic feature. Note that completely harmonising forms such as (3) and (4) do not show any violations of the two constraints. If the word stem harmonises either to [+ATR], as in (b), or to [-ATR], as in (c), positional faithfulness requiring root identity is violated. In both cases, the markedness constraint also incurs one violation, since the word stem and one of the affixes differ in their [ATR] values. If, on the other hand, the word stem does not change its [ATR] specification, obeying the positional faithfulness constraint, but has only [-ATR] affixes, the markedness constraint is violated twice, as shown for candidate (d); there are two instances of two adjacent vowels with a change of the harmonic feature within the word. Similarly, (e) illustrates that, with two [+ATR] affixes, HARMONY is violated twice.

| (6) | O-bisa-I [+ATR] [-ATR] | IDENT[ATR] _{Rt} | HARMONY |
|-----|----------------------------------|--------------------------|---------|
| a. | o-bisa-i [+ATR] [-ATR] | | * |
| b. | o-bisæ-i [+ATR] [-ATR] | *! | * |
| c. | o-bisa-i [+ATR] [-ATR] | *! | * |
| d. | o-bisa-i [-ATR] [+ATR] [-ATR] | | *!* |
| e. | o-bisa-i [+ATR] [-ATR] [+ATR] | | *!* |

Such disharmonic stems (or words) illustrate that the faithfulness constraint is ranked above the markedness constraint, which, as shown in (7), is ranked higher than a general faithfulness constraint requiring input–output identity for the feature [ATR], which plays no role here.⁸

Almost all disharmonic stems have /a/ as the [-ATR] vowel, except for the word /nɪnsɛn/ ‘be pregnant’ (cf. Dolphyne 1988). Stewart (1983: 126–127) argues that all disharmonic stems originate from lexicalised compounds (cf. also Obeng 2000 on vowel harmony in lexicalised toponyms in Akan). The fact that disharmonic stems show an asymmetry between the [ATR] specification of a prefix and a suffix provides an argument that [-ATR] is represented underlyingly in Akan.

⁸ Although the analysis shown here follows the assumption that any verbal affixes are underlyingly underspecified for the feature [ATR] (cf. Clements 1985), the question of underspecification is irrelevant, because positional faithfulness requires stem identity only. For instance, assuming a [+ATR] input for the personal pronoun

(7) IDENT[ATR]_{Root} ≫ HARMONY ≫ IDENT[ATR]_{IO}

According to Casali (2003, 2008), a root-controlled vowel-harmony language like Akan has [+ATR]-dominant harmony. Criteria for the [+ATR] feature being dominant involve a [+ATR] allophonic variant of /a/, as in (3) and (8) (note that for independent reasons, /ɔ/ lowers to /a/ in (8)), spreading of [+ATR] within a lexical compound (cf. (8)), spreading from a [+ATR] affix to a [-ATR] root morpheme and spreading of [+ATR] across word boundaries (cf. §3) (Casali 2003: 321). Except for [+ATR]-affix spreading, these criteria have also been observed in Akan (Dolphyne 1988).⁹

(8) òhíní fié → àhìnmfié ‘palace, chief’s house’
 chief home (Dolphyne 1988: 24, 74)

3 ATR harmony between words

According to Dolphyne (1988: 24), vowel harmony occurs also between words, as a consequence of an assimilation process. The structural prerequisite of this process is that two adjacent words differ in their [ATR] specification; more specifically, a word with [-ATR] vowels is followed by a word with [+ATR] vowels. The general rule is that, as the dominant feature, [+ATR] spreads regressively across the word boundary to the immediately preceding syllable, and delinks and reassociates the [ATR] specification of that vowel. The process is limited to the final syllable of the [-ATR] word, as shown in (9), and RVH does not extend beyond that syllable. The effect of RVH is thus that, on the surface, polysyllabic prosodic words may be disharmonic.

In (9a) and (b) (from Dolphyne 1988: 24), the [-ATR] unrounded mid front vowel of the verb stems /pɛ/ and /frɛ/ becomes [+ATR], since the following object noun has [+ATR] vowels. This change of vowel feature is henceforth indicated by underlining. Acoustic analysis of vowel formants by Hess (1992) confirms Dolphyne’s observation that the effect of vowel harmony across word boundaries is regressive, and that it affects only the last vowel of the preceding word. The example in (9c) illustrates that only the last vowel of a preceding disyllabic stem /tɛirɛ/ is affected. Hence, independent of morphological complexity and stem complexity, [ATR] harmony between words is bounded, and affects only the immediately preceding adjacent vowel.

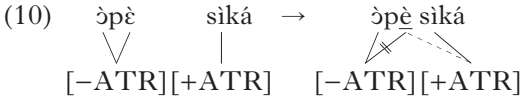
prefix in (6) would result in the same violations as shown for candidate (d). In addition, the lower-ranked IDENT[ATR]_{IO} constraint would be violated if affixes were specified for [ATR]. Thanks to a reviewer for pointing this out.

⁹ The dominance of [+ATR] can be captured by a *[+ATR] constraint that is ranked higher than a corresponding *[-ATR] constraint. *[+ATR] is implemented below, showing that RVH is bounded in Akan.

(9) RVH in sentences

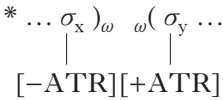
- a. τ - $p\epsilon$ *sika* δ - $p\epsilon$ *siká* \rightarrow $\delta p\epsilon$ *siká*
 3SG-like money ‘S/he likes money.’
- b. *fr* ϵ *Kofi* *fr* ϵ *kòfi* \rightarrow *fr* ϵ *kòfi*
 call.IMP Kofi ‘Call Kofi.’
- c. τ -*kyer* ϵ *kube* δ -*teir* ϵ *kùbé* \rightarrow δ *teir* ϵ *kùbé*
 3SG-show coconut ‘S/he shows a coconut.’

The basic pattern of RVH is illustrated in (10).



To account for RVH, I propose the prosodic markedness constraint in (11). The constraint drives the interword harmony process, penalising a configuration in which a sequence of [-ATR][+ATR] words does not show regressive association of the [+ATR] feature to the left-adjacent syllable. RVH occurs frequently in Akan, as subsequent sections will show, and I assume that it is a general phonological process in the grammar. The effect of the interword harmony process is that the change in the last vowel of a preceding word violates word-level harmony in that word.¹⁰

(11) *INTERWORD[-ATR][+ATR]



Assign a violation when a [+ATR] syllable at the left edge of a ω immediately follows a [-ATR] syllable.

This markedness constraint is similar in its effects to the constraint proposed by Copperbelt Bemba by Kula & Bickmore (2015). In Interword Doubling in Copperbelt Bemba, a H tone on a word-final TBU of one word spreads onto the first TBU of the following word. This process differs from Akan in both the direction of the feature spread and the type of autosegment that spreads: [+ATR] spreads regressively in Akan,

¹⁰ Lisa Selkirk raises the question whether the interword markedness constraint needs to refer to both prosodic word edges, as the formalisation in (11) suggests. Assuming a situation where a monosyllabic function word, which in many languages does not constitute a prosodic word on its own, spreads its [+ATR] feature to a word on its left, there would be no left prosodic word edge for the [+ATR] word. Since there is no data of this sort available, and I have not carried out a thorough analysis of the status of monosyllabic function words, the question of the presence or absence of a left prosodic word edge in (11) cannot be resolved. For the time being, I assume that both word edges need to be specified, since this formalisation captures the data considered in this paper.

while a H tone spreads progressively in Copperbelt Bemba. In both languages, crucially, an autosegment spreads across a word edge.¹¹

To account for the fact that [+ATR] does not spread in an unbounded fashion throughout the whole [-ATR] word, I assume the markedness constraint in (12), which penalises the occurrence of the feature [+ATR], similar to Kula & Bickmore's constraint which penalises the occurrence of H tones in Copperbelt Bemba.

(12) *[+ATR]

Assign a violation for each syllable that is associated with the feature [+ATR].

The fact that [+ATR] is dominant in Akan (Casali 2008, 2012) may speak in favour of an analysis where the constraint in (12) is ranked higher than a corresponding constraint penalising the occurrence of [-ATR]. The effect of the constraint in (11) in combination with *[+ATR] in (12) limits the spreading of [+ATR] to the immediately left-adjacent syllable.

The fact that *[+ATR] penalises all occurrences of advanced vowels may seem problematic at first sight, as pointed out by a reviewer. Indeed, *[+ATR] and HARMONY need to be dominated by IDENT[ATR]_{Root}, which ensures root identity with respect to the [ATR] feature. This ranking does not affect the basic word-level harmony pattern. Assume a [+ATR] word, e.g. /kube/ 'coconut', which surfaces as [kubɛ]. Although *[+ATR] would be violated twice, any candidate with a [-ATR] vowel would fatally violate the higher-ranked positional faithfulness constraint, since the [ATR] specification of a root vowel is no longer identical to its input. The fact that *[+ATR] also stops interword harmony from iterating through the next word is in line with the Emergent Non-iterativity Hypothesis of Kaplan (2008). In his discussion of RVH in Nez Perce (2008: 284ff), however, Kaplan employs a NON-FINALITY constraint, which clearly cannot account for the Akan data: in Nez Perce, both [-ATR] and [+ATR] optionally spread regressively across the word boundary, and NON-FINALITY refers to the presence of prosodic heads which are required not to be associated with the final syllable. This requires both values of the [ATR] feature to spread, which is not the case in Akan; therefore the lack of [-ATR] spreading must be accounted for. Thus, for the time being, I will assume that *[+ATR] prevents iteration of RVH.

The tableau in (13) illustrates the violation of the lower-ranked word-level harmony constraints if RVH applies (candidates (a, c)). The application of RVH thus produces a disharmonic word. If RVH does not apply, as

¹¹ The prosodic markedness constraint in (11) has a certain stipulative character, as a reviewer correctly points out. It remains unclear why it is only [+ATR] that undergoes RVH, and why RVH fails to operate in both directions. In particular, contrary to the structurally similar constraint in Copperbelt Bemba (Kula & Bickmore 2015), it remains unclear how the fact that [+ATR] only spreads regressively should be formalised. A tentative speculation about the first question would be Casali's (2003) proposal arguing for dominant features; in Akan, it is [+ATR] which is dominant. The interword effects would then be restricted to this dominant feature. However, I leave these issues for future research.

in (b), *INTERWORD[-ATR][+ATR] is fatally violated. The fact that the markedness constraint *[+ATR] is violated more often when the regressive spreading of [+ATR] affects more than the immediately left-adjacent vowel accounts for the bounded nature of RVH (candidate (c)); the more [+ATR] vowels arise through RVH, the more violations of *[+ATR].

| (13) | O-pe kube [-ATR][+ATR] | *INTERWORD [-ATR][+ATR] | IDENT[ATR] _{Rt} | *[+ATR]; HARMONY |
|------|--|----------------------------|--------------------------|---|
| a. | (ɔpɛ) _{ω1} (kubɛ) _{ω2} [-ATR][+ATR] | | * _(ω1) | * _(ω1) ** _(ω2) |
| b. | (ɔpɛ) _{ω1} (kubɛ) _{ω2} [-ATR][+ATR] | *! | | ** _(ω2) |
| c. | (opɛ) _{ω1} (kubɛ) _{ω2} [-ATR][+ATR] | | * _(ω1) | **! _(ω1) ** _(ω2) |

The resulting constraint ranking is given in (14). Since RVH is a general phonological process in Akan, the interword markedness constraint licensing this process must necessarily be higher-ranked than the word-level harmony constraints.

(14) *INTERWORD[-ATR][+ATR] ≫ IDENT[ATR]_{Root} ≫ *[ATR], HARMONY

According to Dolphyne (1988), only [+ATR] spreads regressively (cf. Casali 2003). Hence, in (15) the [-ATR] of the object /ɛmʊ/ does not cause the [+ATR] of the verb stem /di/ to change into [-ATR]. Dolphyne (1988: 24) also notes that vowel harmony between words can only be regressive, as in (9). The context of (15) is identical to (9), where RVH occurs between the verb and object.¹²

(15) o-di ɛmo òdí èmó → òdí èmú ‘S/he eats rice.’
 3SG-eat rice *òdí èmú

The form in (9c) showed that the process of RVH is bounded in Akan. There are other languages that exhibit the phonological process of RVH; for most of them, however, its distribution remains unclear, because of a

¹² Progressive spreading of the [ATR] feature can be prohibited by means of a positional faithfulness constraint requiring word or stem-initial syllables to maintain their input [ATR] specification (cf. Kaplan 2008: 289). Hence, a candidate such as (ɔpɛ)_{ω1} (kubɛ)_{ω2} would violate positional faithfulness with the CRISPEDGE and *[ATR] constraints, since the first syllable of the second prosodic word changes the [ATR] specification. The main point of the present paper, however, is to characterise the distribution of RVH within the sentence, and thus any further discussion of progressive spreading is beyond the scope of the current analysis.

lack of data.¹³ One exception is Nawuri, a Kwa language spoken in Eastern Ghana (Casali 2002: 25ff). As opposed to Akan, Nawuri shows unbounded RVH across word boundaries. In the Nawuri example in (16) (Casali 2002: 25), all the underlying [-ATR] syllables of the verb become [+ATR]. In addition, due to other phonological processes, the stem-final /ɪ/ is deleted, with compensatory lengthening of the nominal class marker /a/. Note also that word-initially the low vowel /a/ has a [+ATR] allophone.

(16) ε-κɔɔɪɪ α-fulee → èkóó¹lǎǎfulèèʔ
 PROG-he.receive NC-money ‘He is collecting money.’

Spreading of an autosegment, whether unbounded or bounded, is not restricted to the feature [ATR], but has also been shown for H tones (cf. Hyman 2007 for an overview). The Bantu languages Ekegusii (Bickmore 1999) and Copperbelt Bemba (Kula & Bickmore 2015), for instance, exhibit both bounded and unbounded H-tone spreading.¹⁴

The examples in Dolfyne (1988: 24) (cf. (9)) show that regressive [ATR] harmony in Akan affects the last syllable of the verb. The following sections will examine further cases of RVH, and illustrate its distribution with respect to the phrasal organisation of the sentence. Further structures show regressive [ATR] harmony between words, and illustrate that this process occurs quite generally in Akan. The central issue is that, despite its broad distribution, in Akan, the RVH process is blocked at the edges of what I will argue are φ_{\max} 's.

4 Distribution of regressive vowel harmony in the sentence

4.1 Regressive vowel harmony across word boundaries

In simple SVO sentences, RVH occurs within the VP, as in (17) below, but does not extend from a verb that contains [+ATR] vowels to a preceding subject that contains [-ATR] vowels, as in (18). The data in these two examples show transitive sentences with a subject DP, a verb and an object.

¹³ Casali (2008) lists eleven such languages. Among these are further Kwa languages such as Chumburung (Snider 1985, 1989), Gwa Nmle (Obeng 1995) and Nawuri, as well as the Gur languages Deg (Crouch & Herbert 1997) and Dilo (Jones 1987), the Bantu language Kinande (Mutaka 1995), the Kru language Vata (Kaye 1982), the Nupoid language Igbira (Scholz 1976) and the Central Sudanic language Bongo (Kilpatrick 1985). Two further Kwa languages also show RVH, Tafi (Bobuafor 2013) and Efutu (Obeng 2008). Thanks to Kofi Dorvlo for drawing my attention to Tafi and Efutu. Kaplan (2008) mentions the American language Nez Perce, which shows optional bounded regressive vowel harmony across word boundaries, although for both [ATR] values.

¹⁴ It remains an open question whether the proposed interaction of *[+ATR] and *INTERWORD[-ATR][+ATR], which accounts for bounded spreading in Akan, would also account for unbounded spreading of [+ATR] in Nawuri, and whether Akan exhibits a particular subcase of a general unbounded RVH process.

In (17a, b), the structural requirements for the process of RVH are met by the [+ATR] vowels of the object and [-ATR] vowels of the preceding verb. Hence the specification of the monosyllabic verb changes to [+ATR], as shown in (9). (17a) also shows that RVH does not apply iteratively from the changed specification of the verb to the preceding subject, which contains [-ATR] vowels. The fact that RVH fails to iterate from the verb to the subject in (17a) is due to its limitation to just a single syllable; also, as the data in (18) show, [ATR] does not spread from the verb to the preceding subject. Comparing (17b) with (c) shows that [ATR] harmony does not spread progressively from a subject with [+ATR] vowels to a verb with [-ATR] vowels (cf. (15)). The application of RVH is indicated by ‘←’.

(17) SV←O

- | | | | |
|----|------------------------|-----------------|-------------------------------|
| a. | <i>adamfo to kube</i> | àdàmǹfò tǹ kùbè | |
| | friend throw coconut | | ‘A friend throws a coconut.’ |
| b. | <i>sukuuni to kube</i> | sùkù:ní tǹ kùbè | |
| | student throw coconut | | ‘A student throws a coconut.’ |
| c. | <i>sukuuni to toa</i> | sùkù:ní tó tòá | |
| | student throw bottle | | ‘A student throws a bottle.’ |

Although the examples in (18) contain a [-ATR][+ATR] word sequence, the final vowel of the subject DP does not change its vowel quality. Unlike (17), the verb in (18) has an [+ATR] feature. The blocking of RVH even though its structural context is met is indicated by ‘↯’.

(18) S↯VO

- | | | | |
|----|----------------------------|---------------------------------------|-------------------------------|
| a. | <i>adamfo di kube</i> | àdàmǹfò dí kùbè (*àdàmǹfù dí ...) | |
| | friend eat coconut | | ‘A friend eats a coconut.’ |
| b. | <i>akokɔ di aburo</i> | àkókó dí àbùrò (*àkókó dí ...) | |
| | chicken eat maize | | ‘A chicken eats maize.’ |
| c. | <i>Sebe di kɔtɔ du</i> | sèbè dí kòtó dú (*sèbè dí ...) | |
| | Sebe eat crab ten | | ‘Sebe eats ten crabs.’ |
| d. | <i>Anane bisa sika ɛnɛ</i> | ánàní bisá síká èné (*ánàní bisá ...) | |
| | Anane ask money today | | ‘Anane asks for money today.’ |
- (Genzel 2013: 58)

If vowel harmony within a sentence is a general process (cf. Dolphyne 1988), we would expect that the final [-ATR] vowel of the subjects in (18) should become [+ATR]. However, RVH is blocked between an NP and a VP.¹⁵

¹⁵ The small amount of data on RVH in Gwa Nmle shows RVH between a verb and subject (Obeng 1995); however, the subject–verb sequence is the only syntactic structure for RVH between words discussed in Obeng (1995). Therefore, we cannot draw any further conclusions for Gwa Nmle here.

RVH, however, does take place between NPs, in particular VP-internally in the case of ditransitive verbs, as in (19). The direct objects contain [+ATR] vowels, while the preceding indirect objects contain [-ATR] vowels. Vowel harmony spreads regressively from the direct object to the indirect object, turning the final vowel of the indirect object into [+ATR].

(19) SVO←O

- | | | |
|----|----------------------------------|---|
| a. | <i>Kofi akye meyere sika</i> | kòfí áteè mǐjírí síká |
| | Kofi PERF.give my.wife money | ‘Kofi has given my wife money as a gift.’ |
| b. | <i>Kofi akye madamfo kube</i> | kòfí áteè màdámfù kùbè |
| | Kofi PERF.give my.friend coconut | ‘Kofi has given my friend a coconut as a gift.’ |
| c. | <i>Kofi fem Sebe sika</i> | kòfí fém sèbè síká |
| | Kofi lend Sebe money | ‘Kofi lends Sebe money.’ |
| d. | <i>Kofi ma madamfo fufuo</i> | kòfí má màdámfù fùfúó |
| | Kofi give my.friend food | ‘Kofi serves food to my friend.’ |
| e. | <i>Kofi ma-a medɔ sika</i> | kòfí mà: mídó síká |
| | Kofi give-COMPL my.love money | ‘Kofi gave my love money.’ |

To account for the difference between the application of RVH between NPs and the blocking of RVH between NP and VP, I will assume a difference in prosodic phrase structure that arises through the matching of syntactic structure to prosodic structure according to Match theory (Selkirk 2009, 2011). A subject NP and following VP would be distinct φ_{\max} 's, not dominated by any further φ , whereas an indirect object and following direct object NP would each be φ 's, embedded in a higher φ . The basic assumption of Match theory is that a universal set of faithfulness constraints maps syntactic constituency into prosodic constituency. The relevant constituents are the syntactic domains of word, phrase and clause, which are mapped into the corresponding prosodic domains of prosodic word (ω), phonological phrase (φ) and intonational phrase (l). Given this mapping, Match theory predicts systematic recursion on all prosodic levels that is isomorphic to recursive syntactic structure. For the purposes of RVH in Akan, we need to establish the facts for φ formation, leaving the constituent structure of the word/ ω and clause/ l aside.

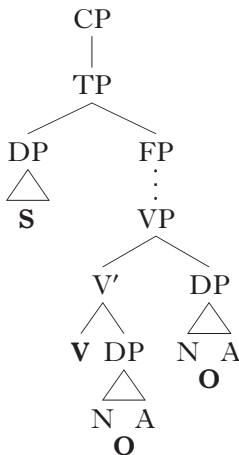
Selkirk (2011) defines two versions of MATCH constraints: a general one matching any syntactic constituency of type α into a phonological output constituent of type π , and a lexically specific one that restricts the relevant syntactic input to phrases that are lexically headed. The Akan data suggest that only lexically headed phrases are required to correspond to φ 's. We will see below that functionally headed phrases above VP in the clause appear to be ignored in the generation of prosodic constituent structure. The distinction of lexical and functional projections and its relevance for the syntax–phonology interface has also been argued for in edge-based theories (Truckenbrodt 1999).

(20) MATCH_{PHRASE}(LexP, φ)

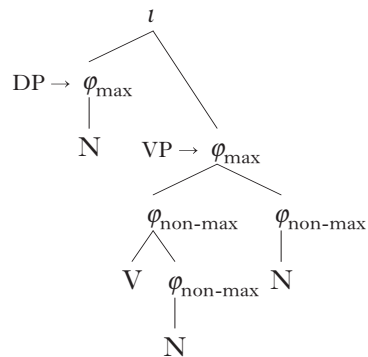
The left and right edges of a lexical phrasal projection in the input syntactic representation must correspond to the left and right edges of a φ in the output phonological representation.

Given the syntactic structure of a ditransitive sentence in (21a), the MATCH_{PHRASE} constraint in (20) produces two maximal phonological phrases in prosodic phrase structure, as in (21b). The first φ_{\max} is mapped from the subject DP, which appears in the specifier of TP (Saah 1994: 26, Boadi 2005: 9, Marfo 2005: ch. 2), showing that a syntactic phrase boundary not dominated by any further lexical phrasal projection. The second φ_{\max} is mapped from the VP, which shows recursive phonological phrasing of non- φ_{\max} 's mapped from the embedded object DPs. These two φ_{\max} 's are sisters dominated by the t .¹⁶ Given the syntactic representation in (21a) (cf. Saah 1994: 33), the MATCH_{PHRASE} constraint in (20) provides phonological phrasing which corresponds to lexically headed syntactic phrases.

(21) a. Syntactic structure



b. Recursive prosodic structure



Following Ito & Mester's (2012) proposal on recursive prosodic structure, the boundary between the object DPs in (21) is that of a non-maximal constituent, since each NP is dominated by a further phrasal projection, the VP. The boundary between the subject DP and the VP is that of a maximal constituent, since neither the subject DP nor the VP is dominated by any further φ . A $\varphi_{\text{non-max}}$ is thus recursively embedded in prosodic structure, and prosodic structure reflects syntactic structure (Selkirk 2011, Ito & Mester 2012). Recursion in prosodic structure refers to the dominance relations of a category κ , as formulated in (22).

¹⁶ The t is assumed to be the result of CP mapping (Selkirk 2011). Since t 's are not relevant for the current discussion, I omit this level of prosodic phrasing in all examples.

(22) *Recursion-based subcategories* (Ito & Mester 2012: 287)

- a. κ_{\max} = κ not dominated by κ
 b. κ_{\min} = not dominating κ

(22a) represents the largest projection of a prosodic category, and (22b) the smallest projection. This dominance view gives a three-way distinction between MAXIMAL, NON-MAXIMAL (OR NON-MINIMAL; cf. Elfner 2012), and MINIMAL prosodic constituents. The distinction between φ_{\max} and $\varphi_{\text{non-max}}$ is relevant for RVH in Akan.

Given the different subtypes of φ in (21), the proposal of this paper is that the blocking contexts involve φ_{\max} edges, while phrase edges in the non-blocking contexts are non-maximal. Elfner (2012) argues for a similar approach to recursion-based prosodic subcategories for Connemara Irish, which, however, makes reference to $\varphi_{\text{non-min}}$. The prediction of the present proposal is that, given any prosodic phrasing produced by the MATCH constraint in (20), the presence of a φ_{\max} edge blocks the application of RVH. The following sections examine whether various syntactic structures and their prosodic phrasing with respect to the presence or absence of φ_{\max} support the prediction of the proposed analysis of RVH.

4.2 VP-internal regressive vowel harmony

The examples given in (9), (17), and (19) show the occurrence of the process of RVH within the VP. This section gives some more examples of VP-internal structures which support the analysis that, within the VP, no φ_{\max} should arise as a result of the application of the MATCH constraint in (20). Hence I predict that the process of RVH should generally apply within the VP.

The harmony process applies in sentences with ditransitive verbs between an object and a verb (23a), between a direct object NP and an indirect object NP containing a modifier (23b), between a modified direct object NP and an indirect object NP (23c) and between two modified object NPs (23d, e).

(23) a. SV←OO

Kofi akye eno mmire
 Kofi PERF.give mother PL.mushroom

kòfí átɔ̀ɛ̀ énò m̀ìrè

‘Kofi gives his mother mushrooms as a gift.’

b. SVO_[NA]←O

i. *Kofi akye meyerē fefɛfɛ kube*
 Kofi PERF.give my.wife very.beautiful coconut

kòfí átɔ̀ɛ̀ mìjírí fɛ̀fɛ̀:fé̀ kùbé

‘Kofi has given my very beautiful wife a coconut as a gift.’

ii. *Kofi ma madamfo tenten fufuo*

Kofi give my.friend tall food

kòfí má màdámfù títí̀ fùfúó

‘Kofi serves food to my tall friend.’

c. SVO←O_[NA]

- i. *Kofi akye madamfo kube bebre*
 Kofi PERF.give my.friend coconut many

kòfí átɛ̀è màdámfù kùbé bèbrè:

‘Kofi has given my friend many coconuts as a gift.’

- ii. *Kofi akye meyere sika bebre*

Kofi PERF.give my.wife money many

kòfí átɛ̀è mìjírí síká bèbrè:

‘Kofi has given my wife a lot of money.’

d. SVO_[NA]←O_[NA]

Kofi akye meyere fɛfɛɛfɛ kube kɛsɛ

Kofi PERF.give my.wife very.beautiful coconut big

kòfí átɛ̀è mìjírí fɛ̀fɛ̀:ɛ̀fɛ̀ kùbé kɛ̀sí

‘Kofi gives my very beautiful wife a big coconut.’

e. SV←O_[NA]←O_[NA]

Kofi akye sukuuni fɛfɛɛfɛ kukuò kɛsɛ

Kofi PERF.give student very.beautiful pot big

kòfí átɛ̀è sùkù:ní fɛ̀fɛ̀:ɛ̀fɛ̀ kùkúò kɛ̀sí

‘Kofi has given a very beautiful student a big pot.’

Assuming the syntactic structure and the corresponding prosodic structure in (21), the prediction that RVH applies within the VP is borne out. An embedded object DP, whether modified or not, forms a syntactic phrase, satisfying the MATCH constraint. Note that NPs are right-branching in Akan, i.e. the modifier follows its head noun (Saah 1994, Boadi 2005, Aboh 2010). The NP corresponds to a φ , which is non-maximal, given the domination by the φ corresponding to the VP. RVH applies, as it is not blocked by φ_{\max} edges. In (23a), the final [−ATR] vowel of the verb becomes [+ATR], due to RVH from the following object noun. In (23b), the [+ATR] feature of the direct object spreads regressively to the final vowel of the preceding adjective that modifies the indirect object. The fact that the direct object is modified by an adjective does not influence the general process of RVH. In (23c), RVH takes place between the objects, independent of the complexity of the direct object. The data in (23d, e) show that RVH also applies when both object NPs are modified; the [+ATR] feature spreads regressively from the direct object to the modifier of the indirect object. Furthermore, (23e) shows that RVH may occur more than once within the VP, though not iteratively. In addition to between-object harmony, the indirect object carrying [+ATR] vowels affects the final vowel of the verb, as in (17) and (23a).

(24) presents a case where RVH occurs between an adverb and a preceding object DP. The manner adverb contains [+ATR] vowels, and the preceding object noun [−ATR] vowels, which allows the [+ATR] feature to spread regressively. According to Saah (1994: 42), the manner

adverb is ‘base-generated VP-internally’, resulting in a phrase break between the object DP and AdvP. As was the case for the two objects in ditransitive sentences, manner adverbials occur within the VP, as shown in (24b). By MATCHPHRASE(LexP, φ), the resulting prosodic structure contains φ ’s which are embedded in a higher φ , corresponding to the VP. Thus the φ ’s formed by both the object and the adjunct are non-maximal.

(24) a. SVO←Adv

Kofi yε-ε Sebe defedefe
 Kofi do-COMPL Sebe completely

kòfi jè: sèbè defédéfé

‘Kofi destroyed Sebe completely.’

b. [[[S]_{DP} [[[V [O]_{DP}]_V [Adv]_{AdvP}]_{VP}]_{VP}]_{TP}]_{CP}

c. ((S) _{φ_{\max}} (V (O) _{$\varphi_{\text{non-max}}$} (Adv) _{$\varphi_{\text{non-max}}$}) _{φ_{\max}})_t

4.3 NP-internal regressive vowel harmony

This section examines NP-internal RVH, and shows that, because there is no φ_{\max} edge within an NP, the analysis in §4.1 correctly predicts that RVH occurs between ω ’s within NPs. (25a) illustrates the structure of an NP in Akan, where <N> represents the trace of N which has been head-moved. Because a complex NP itself corresponds to a φ (25b), any φ internal to it is necessarily non-maximal. So RVH is predicted to be found within an NP.

(25) a. [[N [<N>]_{NP} Modifier]_{NP}]_{DP}

b. (N Modifier) _{φ}

(26) illustrates that this prediction is confirmed; if a [-ATR] noun like /adamfù/ is followed by a [+ATR] modifier, RVH applies. The modifier is an adjective in (26a) and a quantifier in (26b).

(26) a. *adamfo hunu* àdámfù únú → àdàmfù húnú
 friend useless ‘useless friend’

b. *kεε bebreε* kèté bèbrè: → kèté bèbrè:
 mat many ‘many mats’

(27a, b) show that RVH applies within a complex NP embedded in a sentence, whether as a subject or object DP. As (27c) shows, RVH applies between a complex object and a preceding verb. This is because satisfying MATCH results in a recursive prosodic phrasing for the VP and its component phrases, with a resulting $\varphi_{\text{non-max}}$ status for the modified object, which is dominated by the φ of the VP.

- (27) a. $S_{[N \leftarrow A]}VO$
- i. *nnamfo hunu ha Kofi* $\dot{n}:\acute{a}r\acute{n}\dot{f}\dot{u}$ $h\acute{u}n\acute{u}$ $h\acute{a}$ $k\acute{o}f\acute{i}$
 PL.friend useless worry Kofi ‘Useless friends worry Kofi.’
- ii. *kεtε bebreε sese fam hε* $k\acute{e}t\acute{e}$ $b\acute{e}br\acute{e}:$ $s\acute{i}s\acute{e}$ $f\acute{a}m$ $h\acute{o}$
 mat many RED.lie ground there ‘(There are) many mats
 lying on the floor.’
- b. $SVO_{[N \leftarrow A/Q/Num]}$
- i. $\text{ɔ-}\dot{p}\acute{e}$ *nnamfo hunu* $\acute{o}p\acute{e}$ $\dot{n}:\acute{a}r\acute{n}\dot{f}\dot{u}$ $h\acute{u}n\acute{u}$
 3SG-like PL.friend useless ‘He likes useless friends.’
- ii. *Kofi tɔ kɔtɔ bebreε* $k\acute{o}f\acute{i}$ $t\acute{o}$ $k\acute{e}t\acute{e}$ $b\acute{e}br\acute{e}:$
 Kofi buy mat many ‘Kofi buys many mats.’
- iii. *Kofi kye kɔtɔ du* $k\acute{o}f\acute{i}$ $t\acute{e}ε$ $k\acute{o}t\acute{o}$ $d\acute{u}$
 Kofi catch crab ten ‘Kofi catches ten crabs.’
- iv. *Kofi kye kɔtɔ fitaa ko* $k\acute{o}f\acute{i}$ $t\acute{e}ε$ $k\acute{o}t\acute{o}$ $f\acute{i}t\acute{a}:$ $k\acute{o}$
 Kofi catch crab white one ‘Kofi catches one white crab.’
- c. $SV \leftarrow O_{[NA]}$
- Kofi bɔ kube keεε* $k\acute{o}f\acute{i}$ $b\acute{o}$ $k\acute{u}b\acute{e}$ $k\acute{e}s\acute{i}$
 Kofi break coconut big ‘Kofi cuts a big coconut.’

Postnominal modifiers within a complex NP in Akan follow a strict order, i.e. the adjective is closest to the head noun, followed by numerals, the determiner and finally quantifiers (Saah 1994, Boadi 2005). DP-internally, the MATCH constraint produces embedded ϕ 's, which are isomorphic to the corresponding syntactic structure. These ϕ 's are thus non-maximal, and RVH is predicted to occur within the complex DP.

- (28) a. $[[[S]_{DP} [V [[N [<N>]_{NP} \text{Modifier}]_{np} \text{Modifier}]_{DP}]_{VP}]_{TP}]_{CP}$
 b. $((S)_{\phi_{max}} (V ((O \text{Modifier})_{\phi_{non-max}} \text{Modifier})_{\phi_{non-max}})_{\phi_{max}})_i$

As predicted, in the case of complex DPs that contain more than one modifier, RVH applies between the modifiers (29a–c), as well as between the first modifier and the head noun (29d) (cf. (26)).

- (29) a. $SVO_{(NA \leftarrow Num)}$
- Kofi kye kɔtɔ kɔkɔ du* $k\acute{o}f\acute{i}$ $t\acute{e}ε$ $k\acute{o}t\acute{o}$ $k\acute{o}k\acute{o}:$ $d\acute{u}$
 Kofi catch crab red ten ‘Kofi catches ten red crabs.’
- b. $S_{(NA \leftarrow A)}VO$
- kraman tenten fitaa no we nam* $k\racute{r}\acute{a}m\acute{a}$ $t\acute{i}t\acute{i}$ $f\acute{i}t\acute{a}:$ $n\acute{o}$ $v\acute{e}$ $n\acute{a}r\acute{m}$
 dog tall white DET eat meat ‘The tall white dog eats
 meat.’
- c. $SVO_{(NA \leftarrow Q)}$
- Kofi di kɔtɔ kɔkɔ bebreε* $k\acute{o}f\acute{i}$ $d\acute{i}$ $k\acute{o}t\acute{o}$ $k\acute{o}k\acute{o}:$ $b\acute{e}br\acute{e}:$
 Kofi eat crab red many ‘Kofi eats many red crabs.’
- d. $SVO_{(N \leftarrow A Num)}$
- Kofi di kɔtɔ fitaa du* $k\acute{o}f\acute{i}$ $d\acute{i}$ $k\acute{o}t\acute{o}$ $f\acute{i}t\acute{a}:$ $d\acute{u}$
 Kofi eat crab white ten ‘Kofi eats ten white crabs.’

The word order of a possessive phrase (30) is possessor–possessee (Aboh 2010). Note that the DP represents a $\varphi_{\text{non-max}}$ if the DP is embedded in a further φ , but a φ_{max} if it forms its own non-embedded phrase, e.g. as a subject DP.

- (30) a. [[DP [N]_{NP}]_{POSSP}]_{DP}
 b. ((N) _{$\varphi_{\text{non-max}}$} (N) _{$\varphi_{\text{non-max}}$}) _{$\varphi_{\text{max/non-max}}$}

In the case of a [+ATR] possessee, the final vowel of the possessor is affected by RVH, as shown in (31).¹⁷

- (31) N_(Gen) ← N
 a. *Sɛbɛ nsuo no reboa atutu abunu*
 Sebe water DET PROG.help PERF.cast out fever
 sɛ̀bɛ̀ n̄́súó n̄́: bòà átùtù àbúnú
 ‘Sebe’s water is helping to cast out fever.’
 b. *kɔ̀ɔ mɔ̀gya kótó mógjá* c. *ɔ̀ɔ nsuo òdó n̄́súó*
 crab blood ‘crab’s blood’ love water ‘love’s water’

4.4 Time adverbials

Time adverbials do not trigger RVH, although manner adverbials do show RVH, as in (24) above. According to Saah (1994: 37), ‘the time adverbial is a syntactic adjunct to TP’. It is not contained within the VP, and is moreover not dominated by any further lexical projection. This syntactic configuration results in separate φ_{max} ’s corresponding to VP and AdvP, by MATCHPHRASE(LexP, φ), and in the prediction that RVH will be blocked between the time adverbial and the VP.

- (32) a. [[[[S]_{DP} [[V [O]_{DP}]_{VP}]_{VP}]_{TP} [Adv]_{AdvP}]_{TP}]_{CP}
 b. ((S) _{φ_{max}} (V (O) _{$\varphi_{\text{non-max}}$}) _{φ_{max}} (Adv) _{φ_{max}})_t

Consider the example in (33), with a time adverbial following an SVO sequence. The adjacent object and adverbial differ in their [ATR] specification, meeting the criteria for RVH. However, as predicted by the analysis of recursive prosodic phrasing, the [+ATR] feature of the adjunct does not spread regressively to the object, and hence the final vowel of

¹⁷ In Akan, there is no overt morphosyntactic marking of the nouns which reflects their syntactic relation. There is, however, an extra H tone which functions as an associative marker between a pronoun and a noun, and between two nouns in some cases (Cahill 1985: 45, Dolphyne 1988: 69ff, Abakah & Koranteng 2007, Abakah 2010). In (31a) and (c), downstep is indicated by an arrow. The associative marker, a floating H tone, delinks the lexical L tone of the head noun /n̄́súó/, which becomes a floating tone. This floating L tone causes following H tones to be downstepped (Stewart 1965, Dolphyne 1994, Genzel & Kügler 2011).

the object does not become the advanced vowel [e]. The time adverbial is not embedded, and thus forms an independent φ_{\max} .¹⁸

(33) SVO \leftarrow Adv

Kofi tɔ kɛtɛ wukuada kòfí tó kètè vùkúádá (*... kètè vùkúádá)
Kofi buy mat Wednesday ‘Kofi buys a mat on Wednesday.’

4.5 Serial verb constructions

Serialisation in Akan is manifested in a multiverb construction, which according to Schachter ‘consists, on the surface at least, of a subject noun phrase followed by a series of two or more VPs, each containing a finite verb plus, possibly, the complement(s) of that verb’ (1974: 254).¹⁹ In what follows, it is shown why RVH does not apply between words from adjacent VPs in a serial verb construction.

Serial verb constructions have been recognised as a typical property of Akan since Christaller (1875). Osam (2003) distinguishes the clause-chaining type and the integrated serial verb construction as two main categories of serial verb constructions. The clause-chaining type combines constituents referring to a series of events; they can be separated by the conjunction /ná/ ‘and’, which allows for integration of adverbs between the first argument DP and the following verb. The integrated serial verb construction type, on the other hand, constitutes a case of the metaphoric meaning of the events expressed by the individual verbs. For instance, to express that one wants to play with an entity, one ‘takes that entity and eats it’. In other words, one ‘eats a game’ (cf. (36a) below). A similar example would be the use of the construction ‘eat sadness’ to express the fact that somebody is sad.

According to Baker (1989: 524), the two VPs in the syntactic representation are sisters within a higher functional projection, i.e. *v*P, AspP or T, and each of the verbs functions as a head of its own VP (Baker 1989, Osam 2003, Kambon 2012). The general assumption is that tense and aspect markers are copied to the head of a VP. Since the verbs of a serial verb construction share these features in Akan, Baker argues that all of them function as heads, as illustrated in (34) (from Baker 1989: 523f; glosses adjusted).

- (34) a. *me-yɛɛ adwuma me-maa Amma* ‘I work for Amma.’
1SG-do work 1SG-give Amma
- b. *ma-yɛ adwuma ma-maa Amma* ‘I have worked for
1SG.PERF-do work 1SG.PERF-give Amma Amma.’

¹⁸ Most time adverbials consist of [–ATR] vowels, e.g. /ɛnɛ/ ‘today’, /ennura/ ‘yesterday’, which do not meet the structural requirements for RVH.

¹⁹ Serial verb constructions have been defined using various criteria; for an overview with respect to Akan see Osam (2004). For our purposes, Schachter’s (1974) structural definition suffices to establish the fact that a serial verb construction consists of at least two VPs.

Crucially, there are two adjacent VPs, which are not dominated by any further lexical projection, as shown in (35). Applying MATCHPHRASE thus results in two separate φ_{\max} 's, each containing a verb and its complement. RVH is predicted to be blocked between the two VPs.

- (35) a. [[[S]_{DP} [[V [O]_{DP}]_{VP} [V [O]_{DP}]_{VP}]_{TP}]_{CP}
 b. ((S) _{φ_{\max}} (V (O Modifier) _{$\varphi_{\text{non-max}}$}) _{φ_{\max}} (V (O Modifier) _{$\varphi_{\text{non-max}}$}) _{φ_{\max}})_t

As predicted, although the structural prerequisite of two adjacent words differing in [ATR] specification is met in (36a), i.e. the first object /kɔtɔ/ and the second verb /di/, the mid back vowel [ɔ] of the object is not affected by RVH. (36a) is an example of the integrated serial verb construction type.

- (36) SVO ≠ VO
 a. *Kofi de kɔtɔ di agorɔ* kòfì dé kótó dí àgóró (*... kótó dí ...)
 Kofi take crab eat game 'Kofi plays with a crab.'
 b. *menoa emo di* minùà èmó dí (*... èmú dí)
 1SG.cook rice eat 'I cook rice and eat it.'

The example in (36b) illustrates that RVH is also blocked in the case of a reduced serial verb construction, an example of the clause-chaining type. Structurally, (36b) is identical to (36a): the two VPs are adjacent to each other and express a sequence of events, and are sisters syntactically. In (36b), however, the second VP consists only of its head, and there is no overt argument DP. The two VPs share the object. In the case of inanimate objects such as /ɛmɔ/, the second object DP may be empty overtly; in the case of an animate object, the object DP must be realised as a resumptive pronoun, which is indexed in (37) (cf. Osam 2003, Duah 2013).

- (37) *Kwámé twà-à Kòfì_i pìrà-à nò_i* 'Kwame injured Kofi.'
 Kwame cut-COMPL Kofi hurt-COMPL PRN

5 An OT analysis of regressive vowel harmony in Akan sentences

The examination of the data above has shown two things. First, RVH is a general phonological process in Akan, driven by the interword featural markedness constraint *INTERWORD[-ATR][+ATR] in (11). Second, prosodic phrase formation using Match theory (Selkirk 2009, 2011), in combination with a theory of recursion-based prosodic subcategories (Ito & Mester 2012), provides the basis for the characterisation of the context where RVH is blocked at the edge(s) of a φ_{\max} . What remains to be made explicit in the OT analysis of RVH and phonological phrasing

is the markedness constraint that is responsible for the blocking of RVH at the edge(s) of φ_{\max} .

To account for the blocking of RVH, I employ a constraint of the CRISPEDGE family. Such constraints have been proposed to avoid multiple linking of a feature between prosodic constituents (Itô & Mester 1999, Selkirk 2011); instead, a feature should be crisply aligned with the edge of a given prosodic domain. The relevant prosodic domains are ω (CRISPEDGE $_{\omega}$), φ (CRISPEDGE $_{\varphi}$) and ι (CRISPEDGE $_{\iota}$). Assuming that the blocking of RVH occurs at certain φ 's would suggest that the relevant constraint is CRISPEDGE $_{\varphi}$. However, as we saw in the discussion of VP-internal and NP-internal RVH above, [+ATR] may spread across the edge of a φ ; cf. (23). Thus the data suggest that a CRISPEDGE constraint must be able to refer to recursion-based subcategories like φ_{\max} . This constraint, formulated in (38a), disfavors linking of [+ATR] across the edges of a φ_{\max} . It thus necessarily outranks the general phrasal and word-level CRISPEDGE constraints, as shown in (38b).

$$(38) \text{ a. CRISPEDGE[+ATR]}_{\varphi_{\max}}$$

$$* \dots \sigma)_{\varphi_{\max}} \quad \varphi_{\max} (\sigma \dots$$

$$[+ATR]$$

Spreading of the feature [+ATR] is prohibited across the edge of a maximal phonological phrase. Assign a violation mark if [+ATR] is not crisply aligned with φ_{\max} .

$$\text{b. CRISPEDGE[+ATR]}_{\varphi_{\max}} \gg \text{CRISPEDGE[+ATR]}_{\varphi} \gg \text{CRISPEDGE[+ATR]}_{\omega}$$

(39) shows that the optimal candidate, (a), violates the interword markedness constraint, but obeys the necessarily higher-ranked domain-sensitive CRISPEDGE constraint in (38a), which restricts RVH in the context of a φ_{\max} . Based on the assumption outlined above that functionally headed projections do not produce φ 's, the subject DP forms its own φ_{\max} (cf. (21)). A further φ_{\max} arises from the mapping of the VP. The optimal candidate thus consists of two adjacent φ_{\max} 's. The domain-sensitive CRISPEDGE constraint acts on this prosodic structure to ban RVH, and penalises any candidate, such as (b), that exhibits RVH across a φ_{\max} edge. If a candidate (e.g. (c)) exhibits a different prosodic structure, MATCHPHRASE is violated, showing that prosodic and syntactic structure are isomorphic in Akan. Theoretically, there could be a candidate with an incorrect phrasing pattern and no RVH. However, this candidate would also violate the MATCHPHRASE constraint, and would thus be ruled out, given that MATCHPHRASE is higher-ranked than any of the structure-sensitive constraints.

(39)

| | [[[akukɔ] _{DP} [[di[aburo] _{DP}] _{VP}] _{VP}] _{TP}] _{CP} | MATCH PHRASE | CRISP EDGE _{φ_{max}} | *INTERWORD [-ATR][+ATR] | CRISP EDGE _φ |
|----|--|-----------------|--|----------------------------|----------------------------|
| a. | (akukɔ) _{φ_{max}} (di (æburo) _φ) _{φ_{max}} [-ATR] [+ATR] [+ATR] | | | * | |
| b. | (akuko) _{φ_{max}} (di (æburo) _φ) _{φ_{max}} [-ATR] [+ATR] [+ATR] | | *! | | * |
| c. | (akuko di æburo) _{φ_{max}} [-ATR] [+ATR] [+ATR] | *!* | | | |

Given the distinction between ϕ_{max} and $\phi_{non-max}$, the domain-sensitive CRISPEDGE constraint in (38) does not apply VP-internally in (40), because the boundaries are non-maximal.

- (40) SVO←O
- a. [[V [O]_{DP}]_{V'} [O]_{DP}]_{VP}
 - b. (V (O)_{φ_{non-max}} (O)_{φ_{non-max}})_{φ_{max}}

Given that syntactic and prosodic structure is isomorphic, RVH applies. Thus the general CRISPEDGE_φ constraint may be violated, showing that the phrase and word versions of the CRISPEDGE constraint need to be lower-ranked than the interword markedness constraint, as in (41).

- (41) *INTERWORD[-ATR][+ATR] ≧ CRISPEDGE[+ATR]_φ ≧ CRISPEDGE[+ATR]_ω

Consider now the case of time adverbials in (33), whose structure is given in (42). The syntactic structure suggests that the time adverbial occupies a position outside the VP. In particular, Saah (1994) argues that time adverbials occupy the adjunct position of TP, taking scope over the whole sentence. On the definition in (22), the VP constitutes a ϕ_{max} , since it is not dominated by any other ϕ within the ι . The AdvP also constitutes a ϕ_{max} , as there is no further lexical phrasal projection above AdvP. In other words, all daughters below TP which contain a lexically headed phrase are mapped into a ϕ_{max} . The presence of the edge of a ϕ_{max} of the VP thus prohibits RVH, with the domain-specific CRISPEDGE constraint being active.

- (42) SVO↔Adv
- a. [[[S]_{DP} [[V [O]_{DP}]_{VP}]_{VP} [Adv]_{AdvP}]_{TP}]_{CP}
 - b. (S)_{φ_{max}} (V (O)_φ)_{φ_{max}} (Adv)_{φ_{max}}

Finally, consider the case of the serial verb construction in (36), whose structure is given as (43). The syntactic structure in (35) above suggests, according to Baker (1989: 524), that the VPs are in a sister relationship. This means that each VP forms its own φ_{\max} , since there is no further lexical phrasal projection dominating the VPs. As before, the domain-specific CRISPEGE constraint thus prevents RVH across the edge of a φ_{\max} , i.e. between the two VPs.

(43) SVO \nleftrightarrow VO

- a. [[[S]_{DP} [[V [O]_{DP}]_{VP} [V [O]_{DP}]_{VP}]_{vP}]_{TP}]_{CP}
 b. (S) _{φ_{\max}} (V (O) _{$\varphi_{\text{non-max}}$}) _{φ_{\max}} (V (O) _{$\varphi_{\text{non-max}}$}) _{φ_{\max}}

6 Summary and conclusion

This article has dealt with regressive [+ATR] vowel harmony across word boundaries, which provides a hitherto unreported cue for phonological phrasing. Only a few languages so far described display RVH (Casali 2008). This very unusual process behaves similarly to other autosegmental phenomena such as H-tone spreading in Bantu languages (cf. Hyman 2007, Kula & Bickmore 2015), but has not yet received a great deal of attention.

In Akan, vowel harmony is a feature of the word (Stewart 1983, Clements 1985, Dolphyne 1988, Casali 2012). In addition, Dolphyne (1988) reports cases of vowel harmony between words where the dominant feature [+ATR] spreads regressively onto the immediately adjacent [-ATR] vowel of a preceding word. RVH in Akan is limited to the immediately adjacent vowel of a preceding word, and is thus bounded, as it is in Gwa Nmle (Obeng 1995), for instance. Other languages exhibit unbounded RVH, for example Nawuri (Casali 2002). RVH thus behaves like H-tone spreading in Bantu languages, where both bounded and unbounded spreading has been reported (Hyman 2007, Kula & Bickmore 2015). In particular, the Bantu languages Ekegusii (Bickmore 1999) and Copperbelt Bemba (Kula & Bickmore 2015) exhibit both types of H-tone spreading. The data shown in §4.2 and §4.3 suggested that RVH is a general feature of the grammar of Akan. However, §4.4 and §4.5 examined cases where RVH does not apply, even though the structural requirement of two adjacent words differing in their [ATR] value is met.

The present paper has argued that RVH in Akan is sensitive to prosodic structure. In particular, it has been shown that a φ_{\max} edge blocks the application of RVH. In other words, the process of RVH applies between words if the two adjacent words belong to the same φ_{\max} , independent of further non- φ_{\max} boundaries. The basis for this analysis of the domain-sensitivity of RVH is that it is blocked at a particular set of syntactic boundaries, in particular between a subject and a VP (18), between a VP and time adverbial (33) and between two VPs in a serial verb construction (36).

However, RVH is not blocked at syntactic boundaries within a VP, for instance (19), (23) and (24).

The analysis makes reference to the syntax–phonology interface and its consequences for prosodic phrasing. Match theory (Selkirk 2011) accounts for φ formation in terms of universal MATCH constraints. As Akan obeys MATCH constraints, prosodic phrase structure is isomorphic to syntactic structure in the default case. Within the syntactic clause, the phrasal complement of the complementiser head of CP is the TP, which is mapped onto an ι (21). In addition, all lexically headed daughter constituents of TP are mapped onto φ 's. The analysis proposed here employs structure-sensitive constraints which make appeal to recursion-based subcategories such as φ_{\max} and $\varphi_{\text{non-max}}$ (Ito & Mester 2012). Each lexically headed daughter of a TP corresponds to a φ_{\max} . According to Ito & Mester (2012), each such phrase is maximal, because it is not dominated by a further φ , but by an ι (cf. (21)).

The distribution of RVH in the sentence, in particular its blocking, can be simply characterised, given this approach. The fact that not all φ boundaries predicted by MATCHPHRASE block RVH can be expressed in terms of the subtypes of φ 's proposed by Ito & Mester (2012). The syntactic blocking contexts form a natural class in terms of the prosodic structure that is assigned to these configurations. Only the edge of a φ_{\max} prohibits the [+ATR] feature from spreading regressively. Recursively embedded phrases such as double objects or the components of complex DPs allow RVH, since in these contexts the phrase boundaries are non-maximal.

Finally, the data presented in this paper extend the analysis of phonological phrasing in Marfo (2005), which is mainly concerned with prosodic restructuring at the level of ι 's. Marfo claims, on the basis of certain tone rules, that topicalised and focused elements in Akan form separate ι 's. Based on vowel-harmony patterns, this paper has shown that φ 's below the ι level, specifically the organisation into φ_{\max} 's, plays a role in the distribution of vowel-harmony features in the sentence. The distinction between φ_{\max} and $\varphi_{\text{non-max}}$ is made in terms of a recursive prosodic structure, which matches up with syntactic structure in the default case. Whether or not tonal rules are sensitive to phonological phrasing, in particular the maximal–non-maximal distinction, remains to be shown in future research.

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