True self-counterfeeding vowel harmony in Akan serial verb constructions*

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1. Introduction

The term *self-counterfeeding* (SCF) refers to a situation in which a rule creates additional inputs to itself but only applies once. Consider, for example, the rule that deletes word-final vowels in the derivation in (1).

(1)

UR	/CVCVV#/
$V \rightarrow \emptyset$ / _ #	CVCV
SR	[CVCV#]

The rule applies to an underlying representation (UR) that ends with two vowels and deletes the final vowel. The result of this application is a surface representation with a new word-final vowel. This surface representation meets the structural description of the rule, but the rule does not apply again. This example of SCF is therefore also an instance of underapplication opacity (Kiparsky 1971, Baković 2011).

Within rule-based phonology, different theories of rule application have been proposed that can account for SCF as in (1) straightforwardly. In SPE (Chomsky and Halle 1968), all rules applied noniteratively, which means that they apply once to the UR and cannot reapply to their own output. Johnson (1972) proposed an alternative theory of rule application, where a directionality parameter specifies for each rule whether it applies to the UR from left to right or from right to left. On this theory, the deletion rule in (1) applies only once because it applies from left to right, so by the time it reaches the end of the word and deletes the word-final vowel it can no longer go back and apply to the preceding vowel. A third theory is Anderson's (1974), where each rule comes with an iterativity parameter that specifies whether the rule applies iteratively or not. On Anderson's theory, (1) would be accounted for by marking the deletion rule as noniterative. SCF and noniterativity are tightly connected,

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in that rules that apply noniteratively and create additional inputs to themselves give rise to SCF.

For Optimality Theory (OT; Prince and Smolensky 1993/2004), it has been argued that SCF mappings pose the usual underapplication-opacity challenge and that OT is unable to generate them without special mechanisms (Kaplan 2008). To see why, consider the markedness constraint *V#, which penalizes word-final vowels, and the faithfulness constraint MAX[V], which penalizes vowel deletion. A ranking in which MAX[V] outranks *V# would imply that final vowels are never deleted, as illustrated in (2), whereas the opposite ranking where *V# outranks MAX[V] would imply that final vowels are always deleted, even when they become final as a result of the deletion of another underlying final vowel, as illustrated in (3). In either case, the desired candidate (b), where exactly one vowel is deleted, loses.

(2)

	/CVCVV#/	MAX[V]	*V#
☞ a.	CVCVV		*
☹ b.	CVCV	*!	*
c.	CVC	*!*	

(3)

	/CVCVV#/	*V#	MAX[V]
a.	CVCVV	*!	
☹ b.	CVCV	*!	*
☞ c.	CVC		**

The difference in how rule-based phonology and OT treat SCF has led to a debate about the empirical status of SCF. Kaplan (2008) argued that cases of SCF that had been reported in the literature can be reanalyzed as processes that do not create additional inputs to themselves (as we discuss in more detail later). His hypothesis is that natural language phonology does not have processes that give rise to SCF, and more generally, that processes that must be analyzed as noniterative do not exist. As noted by Kaplan, if this hypothesis is correct, it would provide evidence for theories of phonology that cannot generate SCF (e.g., basic OT without extensions) and against theories that can generate it (e.g., SPE or rule-based phonology with an [iterative] rule parameter). McCollum and Kavitskaya (2018) have responded to Kaplan, arguing that a couple of cases of SCF are attested that constitute counterexamples to his hypothesis.

In this paper we contribute to this debate by presenting a particularly clear case of SCF from Advanced Tongue Root (ATR) harmony in Akan, a Niger-Congo language spoken in Ghana. While the phonology and phonetics of Akan ATR harmony have been extensively discussed in the literature (e.g., Clements 1985, Dolphyne 1988, Hess 1992, O'keefe 2003, Casali 2012, Kügler 2015), our discussion is based on new phonological data from serial verb constructions, where the pattern is fully productive and reflected in speakers' judgments.

We will show that attempts to reanalyze this case along the lines suggested by Kaplan (2008) fail. The result is the strongest counterexample to Kaplan's hypothesis that we know of.

This paper is structured as follows. In Section 2 we provide background on Akan ATR harmony and present new data regarding the behavior of harmony in serial verb constructions, which suggest that the process applies noniteratively. In Section 3 we consider a few attempts to reanalyze the harmony process in ways that do not involve noniterativity and conclude that these attempts fail. Section 4 presents a possible analysis of the process within OT, and Section 5 concludes.

2. Akan ATR harmony

2.1 Background

This section provides background on the distribution of ATR in Akan. All of the data we present in this paper are taken from the Asante Twi dialect, spoken mainly in the Ashanti region in southern Ghana (the first author is a native speaker of this dialect).

Akan vowels are divided into two sets based on their ATR value. The [+ATR] vowels are given in (4a) and the corresponding [-ATR] vowels are given in (4b).

(4) a. [+ATR] = {i, e, æ, o, u}
b. [−ATR] = {ɪ, ɛ, a, ɔ, ʊ}

In general, all vowels in a word stem that occurs in isolation belong to the same ATR set, as illustrated in (5). There are a few exceptions to this generalization, such as [sika] 'money', which has a [+ATR] vowel followed by a [-ATR] vowel, but we are not aware of exceptions with a [-ATR] vowel followed by a [+ATR] vowel.

(5) a. etuo 'gun'
b. ɛtʊɔ 'tax'

The distribution of ATR in morphologically complex words suggests that [+ATR] spreads leftwards: an underlying sequence of [-ATR][+ATR] vowels created across morpheme boundaries (possibly with intervening consonants) surfaces as [+ATR][+ATR], as illustrated in (6a) and (6b).[1] When the underlying ATR values of two adjacent vowels across a morpheme boundary are identical, or when the underlying sequence is [+ATR][-ATR], there is no change in ATR on the surface. The mismatching [+ATR][-ATR] case is illustrated in (6c) and (6d).[2]

[1] The underlying ATR values we assume for each stem are its values when in isolation.

[2] There are a few affixes that behave differently with respect to ATR: pronominal prefixes and the past tense suffix always receive their ATR value from an adjacent vowel, regardless of its ATR value.

(6) *Morpheme combinations with mismatching [ATR] values*

a. [-ATR] stem + [+ATR] stem
/mʊː + tuo/ → [muːtuo]
rice gun 'riceballs'

b. [-ATR] stem + [+ATR] suffix
/ta + ni/ → [tæni]
twin person 'a twin person' (a person from the north of Ghana)

c. [+ATR] stem + [-ATR] stem
/kunu + pa/ → [kunupa]
husband good 'a good husband'

d. [+ATR] stem + [-ATR] suffix
/hu + fʊɔ/ → [hufʊɔ]
fear person 'a fearful person'

In phrasal combinations of mono-morphemic words, [+ATR] again spreads to the final vowel of the preceding word, as shown in the examples in (7).

(7) a. /yɛ + dede/ → [ye + dede] 'make noise'
b. /ama + su/ → [amæ + su] 'Ama cries'

Example (7b) further shows that spreading occurs only once even when the environment for further spreading is met within a word, as the word [amæ] has a [-ATR][+ATR] vowel sequence on the surface. However, this example does not yet show that Akan ATR harmony involves SCF – that is, that there is a spreading process that creates new inputs to itself and only applies once. This is because these data can be interpreted in alternative ways. For example, even though (7b) involves a [-ATR][+ATR] sequence, there might be some restriction on the harmony process that allows it to apply across a morphological boundary in (7b) but not within a morpheme. If this is the case, then the harmony process would not be creating a new input to itself by spreading [+ATR] onto the preceding word. To show that the process indeed involves SCF, morphological factors have to be controlled for, as well as other factors that might play a role in restricting further spreading. For this reason, we turn in the next section to serial verb constructions, which make multiple factors easier to control for.

2.2 ATR Harmony in serial verb constructions

Serial verb constructions are syntactic constructions in which multiple verbs share the same arguments in a single clause (see Agyeman 2002 and Osam 2003 on these constructions in Akan). An example of a serial verb construction with all [-ATR] vowels (and no ATR spreading) is given in (8), where there are four verbs that share a subject.

(8) ama da sɔrɪ pra kɔ hɔ
Ama sleep wake.up sweep go there
'Ama sleeps, wakes up, sweeps and goes there.'

In serial verb constructions in Akan, any number of verbs can be concatenated. This allows for testing the behavior and productivity of ATR spreading in long, novel sequences of vowels, by manipulating the underlying ATR values and keeping the rest fixed, as has been done by Kügler (2015). The two tables below provide new data not previously discussed in the literature. The data show that when monosyllabic verbs with different ATR values are concatenated in various orders within a sentence, [+ATR] spreads leftwards exactly once when preceded by [-ATR] vowels. The table in (9) shows sequences of three verbs and the table in (10) sequences of four verbs. These data indicate that the ATR harmony process is productive and is not memorized by speakers.

(9) *ATR spreading in sequences of three monosyllabic verbs*

Input	Output	Example	Gloss
- - -	- - -	/tɔ fa kɔ/ → [tɔ fa kɔ]	buy, take and go
- - +	-++	/tɔ fa di/ → [tɔ fæ di]	buy, take and eat
- + -	++ -	/tɔ di fa/ → [to di fa]	buy, eat and take
- ++	+++	/tɔ di su/ → [to di su]	buy, eat and cry
+ - -	+ - -	/di tɔ fa/ → [di tɔ fa]	eat, buy and take
+ -+	+++	/su fa di/ → [su fæ di]	cry, take and eat
++ -	++ -	/tu di kɔ/ → [tu di kɔ]	uproot, eat and go
+++	+++	/tu di su/ → [tu di su]	uproot, eat and cry

(10) *ATR spreading in sequences of four monosyllabic verbs*

Input	Output	Example	Gloss
- - - -	- - - -	/da tɔ fa kɔ/ → [da tɔ fa kɔ]	sleep, buy, take, and go
- - - +	- - ++	/tɔ fa bɔ di/ → [tɔ fa bo di]	buy, take, crack, and eat
- - + -	- ++ -	/tɔ ʃɛ di fa/ → [tɔ ʃe di fa]	buy, wear, eat, and take
- + - -	++ - -	/tɔ di ʃɛ fa/ → [to di ʃɛ fa]	buy, eat, wear, and take
+ - - -	+ - - -	/di tɔ fa kɔ/ → [di tɔ fa kɔ]	eat, buy, take, and go
- - + +	- + + +	/tɔ ʃɛ di su/ → [tɔ ʃe di su]	buy, wear, eat, and cry
- ++ -	+++ -	/tɔ di su fa/ → [to di su fa]	buy, eat, cry, and take
- + - +	++++	/fa tu ʃɛ di/ → [fæ tu ʃe di]	take, uproot, wear, and eat

In addition, speakers have conscious knowledge of this pattern. For example, for each of the examples above that meets the conditions for regressive [+ATR] spreading, a native speaker who artificially pronounces the relevant verb sequence without harmony would be corrected and pointed out to the right form. The same is true for a speaker who would spread [+] more than once. The ungrammaticality of the alternatives to obligatory noniterative spreading is shown in (11). We take these facts to further indicate that the process is internalized by speakers and should therefore be accounted for by the phonological grammar.

(11) *Possible and impossible pronunciations of 'buy, eat, wear, and take'*

/- - + -/ → [- + + -]	/tɔ ʃɛ di fa/ → [tɔ ʃe di fa]
/- - + -/ → *[- - + -]	/tɔ ʃɛ di fa/ → *[tɔ ʃɛ di fa]
/- - + -/ → *[+ + + -]	/tɔ ʃɛ di fa/ → *[to ʃe di fa]

3. No obvious reanalyses

A simple rule that accounts for ATR harmony in serial verb constructions is the rule in (12), which is marked as [-iterative] as in Anderson's (1974) theory of of rule application.[3]

(12) V → [+ATR] / _C_0 [+ATR]; [-iterative]

When this rule applies to an underlying /- - +/ ATR sequence, it yields [- + +] and thus creates an additional input to itself, giving rise to SCF.

Before we can conclude that this process constitutes a counterexample to Kaplan's hypothesis, we should note that Kaplan (2008:2) identified multiple properties of reported SCF processes that can help reanalyze them as processes that do not create additional inputs to themselves. The goal of this section is to discuss several such properties proposed by Kaplan and show that they do not hold in Akan, and therefore that the SCF aspect of Akan's ATR harmony cannot be reanalyzed along the lines suggested by Kaplan.

Four main properties discussed by Kaplan are presented in table (13). We will go over each property in turn and explain why it does not seem to be helpful in reanalyzing the Akan process.

(13)

Property	**Example process**	**Generalization**	**Example**
(a) Domain confinement	Tudanca laxing harmony	Harmony occurs within a foot	/sekʊ́-lʊ/→[se(ká-lʊ)] 'to dry him'
(b) Distinct trigger and target	Bengali ATR Harmony	triggers are [+high], but targets are [-high]	/ɔʃɔt-i/→[ɔʃot-i] 'dishonest-FEM'
(c) Attraction to prominence	Lango ATR harmony	[+ATR] must affiliate with root	/amʊk-ni/→[amukki] 'your shoe'
(d) Non-finality	Nez Perce ATR harmony	The head of an ATR domain cannot be word-final	/minikune pakciqa/→ [minikuna pakciqa]

In languages with property (a), a process that spreads only once can be reanalyzed as being confined to a small representational domain that is assumed to exist independently of

[3]Note that this rule also accounts for harmony in complex words, presented in (6), and for harmony in other phrasal constructions, as in (7). A full rule-based account of the distribution of ATR in Akan would also have to account for the distribution of ATR in stems, as in (5), using a morpheme-structure constraint or some other mechanism. As far as we can tell, a full account would not affect our main claim regarding SCF in serial verb constructions, so we do not develop one here.

harmony, such as the prosodic foot. In the example from Tudanca, the final vowel of the stem ([a]) agrees in laxing with the following, suffixal vowel ([ʊ]). The first vowel of the stem ([e]) could potentially also change to agree with the following vowel, but it does not. This seems like SCF, because the harmony process applies regressively and fails to apply again even though the first vowel could undergo harmony. However, Kaplan claims that once the prosodic foot is considered, the process could be formulated as applying regressively only within the foot. On this formulation, the reason that harmony fails to apply to the first vowel is that this vowel is outside of the foot, so the environment for further spreading is not met. In Akan's serial verb constructions there is no independent domain that we know of that can help restate the harmony process in a similar way. Importantly, the very same surface environment in which iterative spreading should be blocked, as illustrated schematically in (14a), triggers spreading when it is underlying, as in (14b). This poses a general challenge to reanalyses that appeal to harmony-independent representational domains.

(14) a. /- - - +/ → [- - + +] (*[- + + +])
b. /- - + +/ → [- + + +]

In languages with property (b) in the table, the noniterativity of harmony can be reinterpreted using restrictions on different triggers and targets. In the example from Bengali, the final vowel of the stem ([o]) agrees in ATR with the following, suffixal vowel ([i]). Here as well the first vowel of the stem ([ɔ]) could change its ATR value to agree with the following vowels, but it does not. This seems like a noniterative process, but according to Kaplan the picture changes once it is recognized that only high vowels trigger harmony: the reason that the first [ɔ] fails to undergo harmony might be that the following vowel is not high, so harmony cannot apply. In Akan, all vowels participate in harmony and can serve as both triggers and targets, so a similar reanalysis is not available.

In languages with property (c) in the table, spreading can be limited to certain morphosyntactic domains. The example from Lango is again one in which the final vowel of the stem gets its [+ATR] value from the suffixal vowel but the initial vowel remains [-ATR]. This process is argued by Kaplan to be driven by a requirement that [+ATR] affiliate to the root, but nothing triggers further spreading within the root. In serial verb constructions in Akan, as far as we can tell, a reanalysis that appeals to independent morphological (or syntactic) domains again does not seem possible, for a similar reason given for processes with property (a): the very same morphosyntactic environment in which iterative spreading should be blocked also triggers spreading when it is underlying (see (14)).

Property (d), which is the fourth and last property we will discuss, is non-finality, which Kaplan uses to reanalyze seemingly noniterative processes that apply across word boundaries. In the Nez Perce example, the final vowel of the first word agrees in ATR with the first vowel of the following word. ATR spreading does not proceed further into the first word. According to Kaplan, further spreading does not occur because this process only affects word-final vowels (formulated as a restriction on an abstract ATR domain, the details of which we leave out). Since the process only affects word-final vowels, its environment is not met for further spreading. In Akan, a similar reanalysis would not get rid of SCF because, as we have seen in the previous section, ATR spreads only once in sequences consisting of monosyllabic words only. This means that even if the process is redefined to only affect word-final (or morpheme-final) vowels, its environment for further spreading would be met.

Since the main directions proposed by Kaplan for reanalyzing reported cases of SCF have failed in Akan, and since we have not been able to come up with alternative reanalyses, we conclude that ATR harmony in serial verb constructions in Akan constitutes an attested case of SCF and therefore of noniterativity.

4. Theoretical consequences

Our conclusion that ATR harmony in Akan's serial verb constructions is an attested case of SCF, if correct, has the following theoretical consequences.

First, theories of phonology should be able to generate SCF. For rule-based theories of phonology, this means that the previously hypothesized unattestedness of SCF does not constitute an overgeneration problem, and that theories of rule application have been correct to generate it.

OT needs to commit to some extension that can generate SCF, since, as noted by Kaplan (2008) and discussed in the introduction, the basic version of OT is unable to generate it. One possibility presented by McCollum & Kavitskaya (2018) is to combine autosegmental representations with markedness constraints that limit the range of possible autosegmental associations. An alternative within Optimal Domains Theory (Cole and Kisseberth 1994) could use constraints that limit the size of the optimal ATR domain. In the rest of this section, we present McCollum & Kavitskaya's (2018) OT autosegmental analysis.

In the autosegmental representation in (15), two adjacent vowels happen to both have the feature [F]. In (16), both vowels are again marked with [F], but here the occurrence of [F] on the first vowel has spread onto the second vowel, as indicated by the dashed association line. The result is that the same feature [F] is representationally associated with both vowels.

(15) *No spreading: single associations*

[F] [F]

V V

(16) *Spreading: double association*

[F]

V V

The surface representational distinction between a feature that has spread because of some process and a feature that has not spread has the effect of encoding the application of a spreading process on the surface. This allows OT to prevent an assimilatory process from applying more than once using a surface constraint against an association between non-adjacent vowels, which would have been the result of iterative application. The prohibited representation is shown in (17).

(17) *Iterative spreading: association between non-adjacent vowels (prohibited)*

*[F]

V V V

A more detailed OT analysis of ATR harmony in Akan's serial verb constructions following McCollum and Kavitskaya (2018) could include the following constraints:

(18) *Constraints*:

a. ∀-Harmony-Left: Assign a violation to every vowel to the left of a [+ATR] vowel that is not associated to that vowel's [+ATR] feature.

b. Adjacency[ATR]: Assign a violation to every autosegmental linkage of [ATR] between non-adjacent vowels.

c. Ident[+ATR]: Assign a violation to every output form that does not correspond to its [+ATR] input.

d. Ident[ATR]: Assign a violation to every output form that does not correspond to its input in [ATR] feature.

The markedness constraint in (18a), borrowed from Walker (2014), is the constraint that triggers regressive ATR harmony. The markedness constraint in (18b) blocks iterative harmony. The two remaining constraints in (18c) and (18d) are familiar faithfulness constraints that penalize changes in ATR between the input and the output.

The ranking of the constraints, as well an illustration of how it successfully prevents iterative spreading, is given in the tableau in (19), which has an input with an underlying /- - +/ ATR sequence. In this tableau we indicate autosegmental associations only when they are relevant for the constraint violations (the remaining association lines have been omitted for space reasons).

(19) *Illustration of an OT derivation of an underlying /- - +/ ATR sequence*

/tɔ fa di/	Adj[ATR]	Id[+ATR]	∀-Harmony-L	Id[ATR]
+ATR a. tɔ fa di			* *!	
+ATR ☞ b. tɔ fæ di			*	*
+ATR c. to fæ di	*!			**
+ATR+ATR+ATR d. to fæ di			**!*	**
-ATR e. tɔ fa dɪ		*!		*

To see why this ranking selects the correct output, consider first the faithful candidate (a). This candidate has two violations of ∀-Harmony-Left because the [+ATR] feature associated to the final vowel is missing two associations to the vowels on its left, one per preceding vowel. Candidate (c), in which [+ATR] has spread to the entire word, violates the high-ranking constraint Adjacency[ATR]. In candidate (d), the underlying [-ATR] specifications of the first two vowels have changed to [+ATR] on the surface. This candidate is phonetically identical to candidate (c), but it avoids a violation of Adjacency[ATR] because no spreading has occurred. Nevertheless, this candidate is eliminated because it violates ∀-Harmony-Left three times: two violations for the final [+ATR] feature (similarly to candidate (a)) and a third violation for the central [+ATR] feature, which is not associated to the vowel on its left. Candidate (e) avoids a violation of ∀-Harmony-Left through progressive [-ATR] spreading (rather than regressive [+ATR] spreading) and violates the high-ranking faithfulness constraint Ident[+ATR]. The correct candidate (b), in which [+ATR] has spread leftwards once, wins.

We conclude that the combination of autosegmental representations and the ability to state the constraints in (18) is one way to allow OT to generate ATR harmony in Akan serial verb constructions.

5. Conclusion

Using new data from serial verb constructions in Akan, we have argued that Akan has a noniterative process of ATR harmony that gives rise to SCF. We presented evidence that this process is fully productive and is internalized by speakers of the language. If our argumentation is correct, the process directly bears on a debate in the literature regarding the empirical status of noniterativity and regarding the degree of permissiveness of the right phonological theory. Our finding challenges Kaplan's 2008 hypothesis that true noniterativity does not exist in natural language. It therefore weakens the argument that rule-based phonology overgenerates unattested noniterative patterns and that basic OT is properly restrictive in this regard.

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