Vowel Harmony in Phuthi

A Challenge for Nevins (2010)?

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1 Introduction

Vowel harmony is in principle an assimilation process whereby "a certain feature specification [...] on a vowel triggers a systematic alternation in vowels which are in direct neighbourhood [...] with the result that the involved vowels look alike with respect to the active feature" (Krämer, 2003, p. 3). But not always are the affected vowels in direct (linear) neighbourhood to each other. There are of course often consonants between the vowels, there are vowels that stand between two other harmonising vowels and do not take part in the harmonisation and there are intervening vowels between two vowels that prevent that these two harmonise. The notion of "neighbourhood" or "locality/closeness" must thus stretch beyond that of simple linear one-dimensional distance. Nevins (2010) argues that locality in vowel harmony should be computed just as it is in syntactic long-distance dependencies, namely not as absolute but as relativized distance. He aims to show that this basic principle is "universal across seemingly different levels of linguistic structure" (Nevins, 2010, p. 11). Thus, he develops an account of vowel harmony that employs a minimal search and copy algorithm driven by the need to eliminate configurations that are uninterpretable at the interface to the subsequent module of the grammar. His framework is shown to account for a whole range of different harmony patterns from a variety of languages.

One language that is not covered in his book but manifests two patterns of vowel harmony is Phuthi. In this essay, I will try to give an account of them in terms of the Nevinsonian framework to examine whether they challenge or contradict his endeavour. Therefore, section 1 presents firstly a short overview of the relevant phonological properties of Phuthi and secondly its two harmony patterns. The functioning of Nevins' (2010) harmony process is laid out in more detail in section 3. In section 4, his framework is applied to the Phuthi harmony patterns and encountered problems as well as potential solutions are discussed. Finally, section 5 summarises and concludes the essay.

2 Phuthi

2.1 Relevant aspects of Phuthi phonology

Phuthi is a Southern Bantu language of the Nguni branch[1] and is predominantly spoken in southern Lesotho and the neighbouring regions of South Africa. Due to close contact with the non-Nguni language Sotho over an extended period of time it has heavily borrowed therefrom in all areas of grammar, including the lexicon, morphology, phonology and syntax. What is particularly interesting for the present paper is the acquisition of the superclose vowels [i̹] and [u̹] or more precisely of the phonological feature [±ATR] yielding the vowel inventory in (1), where the superclose high vowels [i̹, u̹] and the high mid vowels [e, o] differ from their respective high [i, u] and low mid [ɛ, ɔ] counterparts in that the former are [+ATR] (tense) and the latter [−ATR][2] (lax). The remaining relevant distinction between high, mid, and low vowels can be captured by the binary features [±high] and [±low].

(1) *Phuthi vowel inventory* (Donnelly, 2009, p. 66, featural make-up added by me)

i̹	u̹	superclose high	[+ATR, +high, −low]
i	u	high	[−ATR, +high, −low]
e	o	high mid (tense)	[+ATR, −high, −low]
ɛ	ɔ	low mid (lax)	[−ATR, −high, −low]
a[3]		low	[(−ATR), −high, +low]

Donnelly (2009) notes that the superclose vowels almost exclusively appear in lexical items stemming from Sotho or are induced via harmony with such items (see section 2.2). Furthermore he mentions the nearly complete predictability of the tense/lax distinction in the mid vowels [e, ɛ] and [o, ɔ] showing that the occurence of the lax counterparts is conditioned by a second harmony process. Hence, they – in contrast to the superclose vowels – seem to be allophones of /e/ and /o/, respectively. The two harmony patterns themselves are not borrowed from Sotho but are, as claimed by Donnelly (2009), innovations made possible by the introduction of the contrast in tongue root position, viz. the distinctive feature [±ATR].

[1] Classification according to Donnelly (2009). There are alternative (and mainly older) classifications which are discussed in detail in chapter 1.1.7 of his dissertation.

[2] Donnelly (2009) employs the privative features [ATR] (advanced tongue root) and [RTR] (retracted tongue root) instead of the binary [±ATR] for conceptual reasons elucidated in footnote 71 on page 94. Nevins (2010) makes use of binary features as I will do here as well. The difficulties posed by privative features will be considered in section 4.2.2.

[3] Donnelly (2009, footnote 16) notes that phonetically the low vowel is closer to [ɑ] than [a].

Apart from the two harmonies there are a bunch of other segmental processes such as affrication, labialisation, strengthening and nasalisation. These do not, as far as I see it, interact with vowel harmony and are therefore not presented in detail here.[4]

As is common for Bantu languages, Phuthi also has lexical and morphological tone. The inventory consists of two contrastive tones, high and low, giving rise to six surface patterns: level high, falling high, rising high, rising falling high, low-ish and low (Donnelly, 2009, p. 67–68). The tonal patterns do not interact with or influence the harmony patterns, at least as far as I can see.

And finally, Phuthi shows a process of vowel lengthening that targets the penultimate syllable of the prosodic phrase thereby signalling the right edge of this phrase at least for tone purposes. In some cases this edge will be different for harmony processes.

2.2 The harmony patterns

Phuthi exhibits two harmony patterns which do not interact: a progressive one affecting the high and superclose vowels [i, u, i̹, u̹] and a regressive one affecting the height of the mid vowels [e, o, ɛ, ɔ]. The exact patterns and triggering conditions are presented in the following section.

2.2.1 Progressive supercloseness harmony

The first pattern is a straightforward stem-controlled left-to-right harmony. High vowels in suffixes but not in prefixes are required to be tense (superclose) if the stem's rightmost vowel is a tense high (superclose) vowel. The harmony spans all adjacent suffixes (2-a) unless they contain a non high vowel, which is opaque and blocks further rightward harmonisation (2-b).

[4] For a detailed presentation and discussion of the processes see Donnelly (2009).

(2) *Supercloseness harmony* (Donnelly, 2009, p. 85–86, stems underlined by me)

a. kú-bí̹t-í̹si̹i̹s-a — to call intensively
kú-dzin-ísiis-a — to dress intensively
kú-bí̹t-ú̹l̩ːl-a — to be disrespectful to one's name
kú-dzin-úl̩ːl-a — to get undressed
kú-thú̹s-í̹si̹i̹s-a — to help intensively
kú-gubh-isíis-a — to dig intensively
bá-thú̹s-ú̹ú̹wɛ — they have been helped
tí-kgújh-uuwɛ — they have been dug up

b. bá-ya-bí̹t-él-iis-a — they help call for
bá-ya-bí̹t-án-iis-a — they help call each other
bá-ya-thú̹s-él-iis-a — they cause to help for
bá-ya-thú̹s-án-iis-a — they cause each other to get help

If the stem contains a mid or low vowel no supercloseness in the suffix is observed even though the mid vowel is tense (3).

(3) *No harmony with non-high stem vowels* (Donnelly, 2009, p. 88)

kú-yét-iis-a — to make, do
tí-yét-uuwɛ — they have been made
kú-khókh-íís-a — to help take out
bá-khókh-úúwɛ — they have been taken out
kú-val-íis-a — to help close
tí-val-úuwɛ — they have been closed

In featural terms, this pattern requires all suffix vowels to harmonise with the rightmost stem vowel for the feature [±ATR] under the conditions that both be [+high] and the suffix vowel be preceded by a [+high] vowel[5] (either that of the stem or that of another suffix). Thus, the supercloseness harmony is parasitic on height.

2.2.2 Regressive tenseness harmony

The second pattern is a bit more complicated than the first. It is a right-to-left tenseness harmony that is not triggered by any specific morpheme but by a specific position, the right edge of the word (thus called *edge-controlled harmony* in Donnelly, 2009). Mid vowels at

[5] It is not possible to empirically decide whether the harmony requires that (i) the suffix must be [+ATR] if the stem is [+ATR] or that (ii) the suffix must bear the same value as the stem for [±ATR] since Donnelly (2009) gives no examples of combinations of high-vowel stems with inherently superclose-vowel suffixes, probably because such suffixes do not exist. The approach to be presented in this essay provides an answer on conceptual ground, as will become clear in section 4.1.

this edge have to be lax and require all leftwards adjacent mid vowels to be lax as well (4) unless a non-mid vowel intervenes (6).

(4) *Edge-controlled tenseness harmony* (Donnelly, 2009, p. 93)

bá-yέέt-ε	they should make
kú-yeet-a	to make
bá-khɔ́ɔ́kl-ε	they should take out
kú-khóókh-a	to expel

However, there are three suffixes which seemingly do not count as part of the word for the harmony process. These are the diminutive "-nyana", the augmentative "-kati" and the hedging relative "-ákga"[6] (5).

(5) *Mismatching domain-edges* (Donnelly, 2009, p. 95)

sí-kɔ́lɔ́-nyaana	tiny school
sí-kɔ́lɔ́-kaati	huge school
í-kέrέkέ-nyaana	tiny church
í-kέrέkέ-kaati	huge church

When augmented/diminished words are further suffixed by the locative "-eni", optionality of tenseness in mid vowels results.

(6) *Optional harmony* (Donnelly, 2009, p. 96–97)

é-kérék-eeni	in/on/at a church
έ-kέrέkέ-nyán-eeni	in/on/at a tiny church
é-kéréke-nyán-eeni	in/on/at a tiny church
έ-kέrέkέ-kát-eeni	in/on/at a huge church
é-kéréke-kát-eeni	in/on/at a huge church

There is thus a misfit between the prosodic word right-edge (signalled by the lengthening of the penultima) and the harmonic domain right-edge which is not uncommon as Donnelly (2009) under reference to van der Hulst and van de Weijer (1995) remarks.

In featural terms, a mid-vowel at the right edge of the harmony domain (in most cases the prosodic word) and all mid-vowels adjacent to its left has to bear the feature [−ATR].

[6] Donnelly (2009) provides no data for the hedging relative suffix. Hence, the examples here lack data for this suffix as well.

3 Nevins' (2010) approach to vowel harmony

Nevins (2010) proposes a quite interesting approach to vowel harmony phenomena that is inspired by the Agree operation known from e.g. verbal agreement in Minimalist syntactic theory (Chomsky, 2000, and following publications). The Agree operation holds between a probe that searches a value for a feature (e.g. the verb) and a goal that provides this value (e.g. the argument) and allows for the probe to copy the goal's value into its own feature matrix. In analogy to verbal agreement, a vowel might bear an unvalued and hence uninterpretable phonological feature (e.g. [_ATR]) thus being a probe and start searching for a value in the adjacent vowels (the possible goals). Once it has found an appropriate value (e.g. +) it copies it to its unvalued feature (e.g. [+ATR]) and surfaces as a tense vowel. In this view, vowel harmony is a target centric process in that the recipient initiates it by means of having an unvalued feature, whereas in feature spreading based approaches harmony is source-centric. Nevins (2010) calls this Agree-like process *Harmonize*. A crucial assumption for *Harmonize* is the strict ordering of segments in a word: either segment *a* precedes segment *b* or vice versa. The actual process takes place in two steps.

(7) *Harmonize* (Nevins, 2010, p. 26)

a. Find: x = the closest τ to the recipient y in direction δ

b. Copy: the value of F on x onto y, where x, y are segments, F is a feature, τ is predicate over segments.

This Search algorithm walks left- or rightwards through the string of segments and inspects each potential goal for an appropriate feature-value and, if found, copies it onto the probe. The value is always copied from the closest goal that fulfills certain conditions (i.e. that has certain properties that make it part of the search domain).

(8) *Definition of* closer (Nevins, 2010, p. 26)
Given *a*, *b*, *c*: *b* is *closer* to *a* than *c* if either (i) *a* precedes *b* and *b* precedes *c* or (ii) *b* precedes *a* and *c* precedes *b*, where *a*, *b*, *c* are segments.

The Search algorithm may skip a segment during its progression through the string even if that segment is the closest one to the recipient and bears a valued feature that might act as a source for copying. This is achieved by requiring that the relevant feature must either be contrastive on the goal segment in this position (i.e. there must exist in the language a segment that may appear in the same position and that differs from the goal segment only in the value of the relevant feature) or must bear the marked value of this feature. Nevins (2010) claims that these two options are the only empirically needed and conceptually plausible ones. In this way of excluding segments from the search domain the *Harmonize* process is able to account for transparent vowels (segments) that seem to be "invisible" for vowel harmony (i.e. that do not themselves harmonise but nevertheless allow further harmonisation of following segments). What kind of transparency a language instantiates (none, contrastive, marked) is a matter of its parametric setting.

The gist of the process is that it is strictly local (i.e. values are always copied from the closest source) while at the same time this locality need not be computed in absolute terms. Rather, it is computed relatively in the sense that segments may be excluded from the search domain because they do not fulfill certain criteria (i.e. the three possible conditions mentioned above). In the same way, the probe of the *Agree* mechanism does not search for the surficially and linearly but for the structurally closest goal.

Opaque blocking elements are modelled in a slightly different way. They are still part of the search domain and the algorithm will try to copy the needed value from them. But in order for the copying to be successful, the blocking segment must fulfill an additional requirement *R*. If it fails to do so it is defective and the *Harmonize* process will stop even though there might be an appropriate source after the defective element. There is no second chance after the Search algorithm fails once. By means of additional requirements, Nevins (2010) is furthermore able to account for parasitic harmony as well. Since this property of the algorithm is relevant for the analysis of both Phuthi harmony patterns, the exact formulation of the procedure is given in (9).

(9) *Parameterized single-pass search with conditional requirements* (Nevins, 2010, p. 129)
τ is either {all values of f_i, contrastive for f_i, marked for f_i}
myVals *V*
myPosition *P*
myFeatsneeded *F*
myConditionalRequirements(F) = R

while *F* is not empty:
· Go in direction δ and update *P*
· **if** *P* of type τ for any f, $f \in F$:
· · **if** *R* is true of *P*:
· · · Copy Val(P, f) to V
· · · Remove f from *F*
· · **else**:
· · · **exit**

4 *Harmonize* in Phuthi vowel harmony

The Phuthi vowel harmony patterns provide a further testing ground for the proposed *Harmonize* process. In the following sections I will examine if the Phuthi data pose possible problems for Nevins' (2010) proposal. As will be shown, the first, progressive pattern fits neatly into this account. But problems arise for the second, regressive harmony due to it, firstly, being edge-controlled and, secondly, exhibiting a clear optionality of application in certain admittedly quite narrow circumstances.

4.1 Progressive harmony and *Harmonize*

The first pattern is a relatively clear case of progressive ATR-harmony that is parasitic on height. The tenseness of a suffix vowel is dependent on the tenseness of the rightmost stem vowel if both are [+high]. Acting as the recipient in this case, the relevant suffix vowels must bear an unvalued feature [_ATR] that initiates a leftwards search for an appropriate value. The additional requirement here is that the donor segment bears the value [+high]. Thus the relevant suffixes (e.g. intensive, causative, and basically all suffixes containing a high vowel) initiate the Search algorithm as in (10).

(10) *Phuthi high-vowel suffixes must:*
ATR-Harmonize: δ = left, F = [±ATR & R = +high]

As soon as one of these suffixes is added to the stem, the leftwards search begins. Every segment is checked for whether it can provide a value for [_ATR] or not. Once such a segment is encountered, the algorithm checks if it also bears a [+high] feature. If this is the case, the respective value of [ATR] on this segment will be copied onto the suffix vowel, if not, the algorithm will stop and a default value for [ATR] will be inserted on the needy segment. Since it is the value of the first encountered appropriate segment that is copied and the search proceeds leftwards from the suffix, only the rightmost stem-vowel can be a source. Non-high stem-vowels would halt the search even if a high vowel existed further to the left. And if there were more than one high vowel in the stem, it would be the rightmost one that would act as the source since it is closer to the searching segment. Intervening non-high suffixes halt the algorithm since they bear a value for the feature [ATR] but do not fulfill the additional requirement of being [+high] which explains the data in (2-b). All high-vowel suffixes that appear to the right of a non-high-vowel suffix are lax, thus, the default value for [ATR] must be "–".

The question mentioned in footnote 5 – whether the suffix vowel must be [+ATR] if the rightmost stem vowel is [+ATR] or whether it must simply have the same value for [ATR] as the latter – can be clearly answered in Nevins' approach. The harmony requires that the suffix vowel bear the same value for [ATR] as the stem vowel. That means that its ATR-value will also depend on that of the stem-vowel if the latter is "−" (unless, of course, there is an intervening non-high vowel). Under the assumption made above, that all high-vowel suffixes need to value their [ATR], the approach correctly derives that no superclose-vowel suffixes are found on stems that do not themselves include at least one superclose vowel.

To conclude, the progressive harmony found in Phuthi poses no problems whatsoever for Nevins' (2011) proposal. On the contrary, all its aspects are captured by the *Harmonize* operation in a simple and natural manner.

4.2 Regressive harmony and *Harmonize*

The regressive harmony in Phuthi is quite different from the progressive one. Mid-vowels at the right edge of a word and all uninterruptedly adjacent mid-vowels are lax, that is [−ATR]. The main difference is that in the progressive harmony, the harmonic feature [±ATR] is independently and invariably present on the stem and might spread or be copied (depending on the respective theoretical framework that is employed) to the harmonising vowels. In the regressive harmony instead, no such source feature exists. Rather, the relevant harmonic feature [ATR] of the mid-vowels somehow changes its value depending on their position or that of neighbouring mid-vowels.

4.2.1 Problems for Harmonize

This behaviour is not straightforwardly explainable for Nevins' approach. Vowels that undergo a harmonisation are modeled as defective items in the sense that they are missing a value for a specific feature. This feature must be valued in order for the segment to be articulated at all. It thus initiates a search to find a copyable value on one of the other surrounding segments. In the same way, the mid-vowels that undergo a harmony process would have to be modeled as lacking a value for their ATR-feature, thereby starting a search. Following this rationale there are then two possibilities which I will discuss in detail below: (i) the search progresses rightwards or (ii) leftwards.

For the rightwards search there are again two potential scenarios:

1. The search finds no value because it encounters no ATR-value source between the needy vowels and the right word-edge. This would be the case for mid-vowels directly at that edge but also for those that are separated from it by one or more consonants or by a mixture of consonants and equally unvalued vowels. The result of a failed search would normally be the insertion of a default value. Mid-vowels at the right edge would thus, contrary to the evidence, obtain the same ATR-value as mid-vowels separated from it by consonants or the above mentioned mixture.

2. The search finds a value, which is copied onto the mid-vowels. In a form like *bá-yeet-a* the mid-vowels should then be lax, because [a] is [−ATR], which is obviously not the case.

A rightwards proceeding search would thus not be able to account for the found harmony pattern.

For the leftwards search there are the same two scenarios as mentioned above:

1. The search finds no value, whereupon a default is inserted. Since nearly all examples for the regressive harmony[7] given in Donnelly (2009) have a non-mid vowel prefix, there are only few data for this case: *-nɛɛkɛ* (nine), *-kghɔ́ɔpɔ́* (cruel) and *cɛɛcɛ́* (grandmother) (Donnelly, 2009, p. 93). These imply that the default must be [−ATR]. However, there are also the optional forms in (6) above where both [−ATR] and [+ATR] seem to be possible defaults.
2. The search finds a value that is then copied onto the needy vowels. In this case, all mid-vowels would turn out to have the same value for [ATR] as the closest preceding non-mid vowel (in most cases the prefix vowel), which is disproven by the forms *kú-yeet-a* and *kú-khóókh-a* where the prefix vowel is [−ATR] while the following mid-vowels are [+ATR].

A leftwards search thus does not fare better than a rightwards search with respect to adequately accounting for the data.

Taken together, when pursuing a simple formulation of the regressive harmony in terms of Nevins' *Harmonize* operation the behaviour of the mid-vowels cannot be captured correctly. This is because *Harmonize* necessarily relies on there being a source segment to copy the needed value from. The Phuthi mid-vowels however seem to receive the value for their ATR-feature out of nowhere under the condition that they be adjacent to the mid-vowel at the right word-edge.

4.2.2 Potential solution

A potential solution to the problem of lacking a source would obviously be to provide such a source. Since a word-final mid-vowel is the cause for the harmonisation of adjacent mid-vowels, it would be plausible to identify it as the source. Thus one might assume a process of final mid-vowel laxing that works much like the final obstruent devoicing known from Germanic languages where the phonoligcal rule (11) ensures the voicelessness of word-final obstruents.

(11) *Final-obstruent devoicing*

$$[+\text{voice}] \longrightarrow [-\text{voice}]/[-\text{son}, \_\_]\#$$

[7] Apart from the section on vowel harmony, Donnelly (2009) uses the grapheme *e* and *o* for [e, ɛ] and [o, ɔ] respectively, thereby delimiting the clear and reliable data to only this section.

Accordingly, the rule that laxes word-final mid-vowels would be (12).

(12) *Word-final mid-vowel laxing*
[+ATR] ⟶ [−ATR]/[−high, −low, __]#

Such a rule would require that – contrary to the assumption made above – not all mid-vowels lack a value but only non-final ones whereas final ones are inherently specified as [+ATR]. Unfortunately for this idea, mid-vowels that are word-final in one word might be non-final once a suffix is added to that word. The assumption from above needs to be retained. Consequently, the rule has to be changed such that its input consists of mid-vowels with unvalued [ATR] as in (13).

(13) *Word-final mid-vowel laxing (unvalued version)*
[_ATR] ⟶ [−ATR]/[−high, −low, __]#

Whenever a mid-vowel is word-final, this rule will furnish it with the value "−" on [ATR]. Rules of that form have to be employed by Nevins[8] in one or the other way in order to assign the default value of a feature to needy vowels in case the search algorithm returns empty handed. The crucial difference between these default rules and (13) is their ordering with respect to the *Harmonize* process. The former must apply after *Harmonize* and the latter before it.

Although the introduction of the rule in (13) might seem ad-hoc and solely be made for the purpose of rescuing Nevins' (2010) approach it is needed anyway. As Donnelly (2009, footnote 14, p. 66) remarks the occurrence of lax mid-vowels is limited to the right word-edge and hamonically conditioned adjacent positions which effectively makes the lax mid-vowels allophones of their tense counterparts. Allophones need always be derived by a special rule. Thus it is plausible to assume that the behaviour of the mid-vowels in Phuthi is a result of the interaction between allophony and vowel harmony.

The *Harmonize* operation for Phuthi mid-vowels would then be as in (14).

(14) *Phuthi mid-vowels must:*
ATR-Harmonize: δ = right, F = [±ATR & R = {−high, −low}]

The mid-vowel without a value for [ATR] at the right edge of a word would be valued by the allophony rule as [−ATR] first. Then, the other unvalued mid-vowels to its left would initiate a rightwards search that finds the edge-vowel and copies its − value thus deriving the data in (4). An intervening non mid-vowel between the edge-vowel and mid-vowels further left would halt and cancel the search by not fulfilling the additional requirement R,

[8] Nevins (2010) does not explicitly formulate the means by which default values are inserted but the obvious and straightforward way, in my view, would be phonological rules.

which explains forms like *bá-khókh-él-iis-ɛ́* ("they should help take out for", Donnelly, 2009, p. 101). The default value for this case is [+ATR].

In section 4.1 the default value for [ATR] on reasoned to be [−ATR]. Based on this contradiction, Donnelly (2009) argues for privative features [ATR] and [RTR], because "a single feature cannot have both + and − settings as default" (Donnelly, 2009, footnote 71, p. 94). But the use of privative features is precluded in Nevins (2010). The whole *Harmonize* operation is based on valuing an unvalued feature. If a vowel had no privative [ATR] or [RTR] feature, how would it know that it needs one? And even if it did, how would it determine that it misses an [ATR]/[RTR] feature and not some other type? Sure one might posit some overarching "meta" feature such as TONGUE-ROOT-POSITION on the vowel that can be either [ATR] or [RTR] but this would be no different from a binary feature. And how would the neediness be limited to just one feature? The vowel could just as well search for more features after having found the [ATR]. Employing privative features thus brings about more problems than it solves.

On a closer look, the apparent contradiction is not even as problematic for Nevins (2010) as it is in Donnelly's (2009) view. First, the different values act as defaults in different environments, namely high-vowels for "−" and mid-vowels for "+". Second, the default values are assigned by phonological rules that can make reference to these different environments. The rules are given in (15).

(15) *Default-insertion rules for unvalued [ATR]*

a. [_ATR] ⟶ [−ATR]/[+high]

b. [_ATR] ⟶ [+ATR]/[−high, −low]

There is nothing special about these rules. Nothing inherently distinguishes them from, say, the allophony rule in (13). Thus, it is no problem to have both "+" and "−" as default values for [ATR]. It seems even more plausible when closer scrutinising the language's history. As mentioned above, most Phuthi words that contain a superclose vowel are of Sotho origin. The indigenous high vowels (the "default" if one wants) before the acquisition of the phonological feature [±ATR] were [i, u] and lax. The allophones of the mid-vowels with the more general distribution are the tense ones. The lax ones only emerged after the acquisition of [±ATR], thus the "original" Phuthi mid-vowels are the tense [e, o].

4.2.3 Mismatch and optionality

Two further aspects of the regressive harmony pattern, the mismatch between harmony domain edge and prosodic word edge and the optionality, have not yet been covered by the account developed in the last two sections. A mismatch results when one of the three exceptional suffixes "-nyana" (diminutive), "-kati" (augmentative) or "-ákga" (hedging relative) is attached to a stem ending in a mid-vowel. Contrary to the prediction of the mechanism built above, the stem-final vowel is laxened and all adjacent mid-vowels harmonise.

There are three possible ways to deal with the mismatch. First, the relevant suffixes are attached to the stem after the allophony rule has applied. This would entail that either the subsequently attached suffixes would all have tense mid-vowels even if these were word-final or that the rule and with it the whole *Harmonize* process applies iteratively. Since there are no appropriate examples in the data, a decision cannot be made. A second way is to add the three suffixes as additional contexts to the allophony rule which is in effect equivalent to postulating the three additional allophony rules in (16).

(16) *Additional laxing rules*

a. [_ATR] ⟶ [−ATR]/[−high, −low, __]-nyana
b. [_ATR] ⟶ [−ATR]/[−high, −low, __]-kati
c. [_ATR] ⟶ [−ATR]/[−high, −low, __]-ákga

This is the easiest way and at the same time the most ad-hoc one. The third and last way is based on the observation that the first vowel in all three suffixes is [a]. Since the mid-vowels before the suffixes are not word-final the allophony rule could not apply and subsequently the search algorithm would be started. It would progresse rightwards and find the [−ATR] source [a]. The value would get copied and the mid-vowels would turn out as lax. In order for this to work, the additional requirement *R* in (14) would have to be modified to only contain [−high]. Although this is an elegant way of accounting for the apparent mismatch it is disproven by the data. The so modified *R* would e.g. derive the incorrect *kú-yɛɛt-a* instead of *kú-yeet-a* (to make).

Thus, the second approach provides the clearest and most unambiguous solution even if it is the most unelegant one.

It should be noted that in all attempts to solve the mismatch problem there is no need to modify or extend the actual *Harmonize* operation proposed by Nevins (2010). Rather, operation-external objects like rules and ordering relations are changed.

The issue is further complicated by the examples in (6) where mid-vowels may be either tense or lax if the word contains one of the three exceptional suffixes followed by the locative suffix "eni". Concerning this optionality, (Donnelly, 2009, footnote 76, p. 96) notes that "[t]he precise conditions of harmony are not clear here; some speakers accept the harmonic (cohering) diminutive and augmentative forms in the locative; others do not. […] they occur in regular speech with low frequency". Thus it seems that whether the mid-vowels harmonise or not in these forms is a matter of idiolectal variation. Unfortunately, there is no information about any correlation between one or the other form and e.g. social status, age or other language background. Anyway, such a form of optionality is in general a problem for every theoretical linguistic approach that strictly distinguishes only two degrees of grammaticality (either grammatical or ungrammatical). I see no elegant way in which the observed variation can be derived by the approach pursued up to this point. One might perhaps want to claim that speakers who use the forms with tense mid-vowels just do not possess the additional allophony rules in (16), whilst speakers who do the opposite do possess them. If this were indeed the case, the former should not exhibit any of the mismatches that are observed with the exceptional suffixes without the locative. Nevertheless, they do exhibit them. If the exceptional suffixes were attached after application of the allophony rule as proposed above one would wrongly expect all speakers to use the forms with lax mid-vowels. The only possible solution is to posit again another three rules that act as correction rules on those in (16) and apply directly after them.

(17) *Correctional laxing rules*

a. [−ATR] ⟶ [_ATR]/[−high, −low, __]-nyana-eni
b. [−ATR] ⟶ [_ATR]/[−high, −low, __]-kati-eni
c. [−ATR] ⟶ [_ATR]/[−high, −low, __]-ákga-eni

These rules are employed by those speaker who exhibit tense vowels in the augmentativ-locative, diminutive-locative and hedging relative-locative forms. After they have applied, the usual *Harmonize* algorithm will value the empty ATRs with the default "+".

5 Summary and conclusions

Nevins (2010) approach to modeling vowel harmony as an *Agree*-like relation between a value-seeker and a value-donor has been very successful in accounting for the Phuthi progressive ATR-harmony pattern. Especially its parasitic dependency on only [+high] vowels could be captured in a simple and elegant way. The progressive harmony in Phtuhi might thus be added to the numerous examples listed in his book that support his claim of phonology and sytax employing the same basic mechanisms.

The situation was a bit more difficult for the regressive harmony which is not controlled by the presence or absence of a certain source-segment but rather by the position of the value-seeking segment(s). The focus had to be shifted away from the actual *Harmonize* operation to the hitherto implicit assumptions that underlie it, namely the existence of rules that assign default values to features that remain unvalued by the algorithm. Once made explicit, these rules have been used to provide one positionally prominent value-seeker with a value which serves as a source in the subsequent *Harmonize* process. Accounting for the Phuthi regressive harmony pattern in this way has exemplified a further capability of Nevins' (2010) mechanism.

However, there is no way in the framework to simply and plausibly capture the observed mismatches between the right edges of the harmony domain and the prosodical word. The only possibility is the stipulation of a set of two additional rules for each exceptional suffix.

Since the optional locative forms are very low frequent and the exceptional harmonic behaviour is only found with the very small number of three suffixes I surmise that the approach nevertheless is better of with six additional rules than with some deeper ad-hoc changes of the core *Harmonize* algorithm. In this sense, the difficulties with the regressive harmony pattern in Phuthi do not in any way refute the central idea of Nevins' (2010) endeavour: that (i) a common locality principle underlies different levels of linguistic structure and that (ii) if hitherto neglected parallels between the syntactic and the phonological modules of the grammar are taken into account it is possible to model subsegmental phonological processes such as vowel harmony in Minimalist Programmatic terms.

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