Glossa a journal of general linguistics

Green, Christopher R. and Abbie E. Hantgan. 2019. A feature geometric approach to Bondu-so vowel harmony. *Glossa: a journal of general linguistics* 4(1): 35. 1–29, DOI: https://doi.org/10.5334/gjgl.793

RESEARCH

# A feature geometric approach to Bondu-so vowel harmony

Christopher R. Green[1] and Abbie E. Hantgan[2]

[1] Syracuse University, Syracuse, NY, US

[2] CNRS, LLACAN, Villejuif, FR

Corresponding author: Christopher R. Green (cgreen10@syr.edu)

Bondu-so (Dogon; Mali) vowel harmony exhibits both typologically and theoretically interesting properties. The language's vocalic system displays surface patterns that implicate a ten-vowel system with an underlying [ATR] contrast at three vowel heights that is not immediately apparent given only mid vowels maintain an [ATR] contrast on the surface. The current paper presents previously unaccounted for data that show alternations associated with Bondu-so vowel harmony correlate not only with the [ATR] specification of a given root vowel, but also with properties of the root-final consonant. We appeal to a combination of featural and prosodic licensing to analyze these outcomes and do so in a modified version of the *Parallel Structures Model* of feature geometry. The PSM framework has been employed in studies of consonant assimilation and consonant-vowel interaction, but to our knowledge, the current paper is the first to extend it specifically to the analysis of vowel harmony.

**Keywords:** vowel harmony; ATR; Dogon; Parallel Structures Model; feature geometry

## 1 Introduction

The Dogon language Bondu-so is spoken at the north-western edge of the Bandiagara escarpment in eastern Mali. The language exhibits several vowel alternations attributed to tongue root harmony, some of which have been earlier discussed by Hantgan & Davis (2012). Lacking details that might be elucidated, for example, via ultrasound, as to the precise phonetic correlates of this harmony, we follow these authors in describing the involved phenomena relative to the feature [Advanced Tongue Root] or [ATR].[1]

Hantgan & Davis (2012) show that Bondu-so exhibits two types of [ATR] vowel harmony (henceforth, VH).[2] The first type they describe as being root-controlled; roots lexically-specified for some value of [ATR] spread their feature to suffixes that are lexically underspecified for [ATR].[3] The second type of VH is suffix-controlled or *dominant-recessive* harmony; suffixes lexically-specified for some value of [ATR] spread their value onto a preceding root, essentially overriding the root-vowel's [ATR] value.

Given the presence of both types of VH in Bondu-so, Hantgan & Davis (2012) argue that both roots and suffixes can spread either [±ATR] value (if so specified), with only the

[1] Preliminary vowel plots show that one phonetic correlate of a vowel's [ATR] specification relates to F1, as one might expect; see the supplemental data for more details.

[2] Other Dogon languages such as Tommo So (McPherson 2013; McPherson & Hayes 2016) display height and backness harmony; in Bondu-so, there are remnants of height harmony in the formation of Imperative and Imperfective stems (see Section 7).

[3] We use the term *root* to refer to the string that is the lexical origin of features and to align this behavior with what has been called *root-controlled* VH. However, in the simplest of instances, a root also functions as a base, and, in conjunction with inflectional suffixes, it forms a stem.

latter doing so in a "feature-changing manner." Inherent in their analysis, and particularly in the suffix-controlled outcomes, is that [ATR] must be binary. Both [+ATR] and [–ATR] must also be equivalent, with neither value being dominant over the other, because a Bondu-so root specified for [ATR] will spread its value to a suffix underspecified for the feature, but a suffix lexically specified for [ATR] will override the [ATR] specification of the root.[4]

Hantgan & Davis's (2012) analysis of Bondu-so VH elegantly formalizes and describes the data for the five noun and verb contexts that they present, but in this paper, we bring to bear additional data from the Bondu-so Perfective and Chaining stems that were not reported in their study. Despite the VH patterning in these newly introduced contexts being somewhat more complex, our analysis departs from Hantgan & Davis by illustrating that Bondu-so VH need not be predicated on [ATR] binarity and instead can be adequately accounted for with privative [ATR]. More importantly, our approach shows that these newly analyzed data cannot be explained by appealing only to the role played by vocalic features in dictating tongue root harmony patterns, but, rather, featural characteristics of root-final consonants also influence the observed VH alternations.

These additional data further show that vocalic alternations between *harmonic counterparts* involve vowels belonging to different heights (e.g., [ɛ] vs. [i]) as in (1a) or that sometimes have a zero alternant (e.g., [ɛ] vs. [Ø]), as in (1b). Such outcomes are unusual given that the otherwise expected harmonic counterpart of [ɛ] is [e], as in (1c).

(1) a. gɔ̀m-ɛ́ɛ̀ 's/he had reeked' vs. gòm-îì 's/he had removed'
b. gɔ́m-ɛ́ 'reek' vs. gǒm 'remove'
c. dɔ̀g-ɛ́ɛ̀ 's/he had abandoned' vs. nòj-éè 's/he had slept'

We show that these suffixal alternations depend on the nature of the root-final consonant, and namely whether this consonant is an obstruent, liquid, or nasal. With details presented in Section 4, we illustrate that roots ending in an obstruent exhibit a [ɛ]~[e] alternation, while some with a root-final liquid instead exhibit a [ɛ]~[i] alternation, and, finally, those with a root-final nasal exhibit a [ɛ]~[Ø] alternation.

Our analysis of Bondu-so shows that VH patterns are indeed driven by the presence of [ATR] but are also subject to combination of featural and prosodic licensing conditions. We frame our analysis in a modified version of the feature geometric *Parallel Structures Model* (Morén 2003a; b; 2006; 2007), henceforth PSM. The PSM is one of several *substance-free* approaches to phonology (see Blaho 2008 for an overview) that propose a separation between phonological features and their phonetic interpretation. Following tenets of the PSM, our approach to Bondu-so VH assumes that the geometries of the language's vowels and sonorant consonants are formed by some combination of three privative vowel manner (V-Manner) features. The phonetic interpretation of these featural combinations in Bondu-so is consistent but may differ from how such combinations are interpreted in other languages. That said, we take care to point out both similarities and differences between proposed featural combinations and their behavior in Bondu-so compared to other languages for which a PSM-style approach has been explored.

Morén's PSM proposes that V-Manner features are [closed], [open], and [lax], but we have replaced [lax] with [ATR]. We have done so to capture that the presence of [ATR] and its ability to spread is "active" in Bondu-so. In addition, our approach more

[4] Hantgan & Davis's (2012) autosegmental approach is derivational and augmented by the proposal of a floating [+ATR] feature to explain what they refer to an example of parasitic harmony. As defined by Cole & Trigo (1988), in parasitic harmony, both the harmony trigger and target are linked to the same feature. In Hantgan & Davis's (2012) analysis of Bondu-so, the feature is [-LO].

substantively departs from the standard PSM architecture to capture correlations between [closed] and [ATR] that we observe in Bondu-so. We posit an additional [height] node under V-Manner that has [closed] and [ATR] as its branches. This modification is typologically supported and also echoed in other research on vocalic feature geometry. For example, Odden's (1991) vowel geometry includes an analogous [height] node whose branches are [high] (=our [closed]) and [ATR]; the higher-level node whose branches are *height* and [low] (=our [open]) is called *Vertical Movement*.

Our PSM analysis proposes that root-final sonorants, by virtue of having V-Manner features, influence the spread of [ATR] between root and suffix and do so in ways that depend on the unique featural combinations that they exhibit. Root-final obstruents, on the other hand, have no V-Manner features and therefore cannot influence spreading in the same ways.

The remainder of this paper proceeds as follows: in Section 2, we provide brief background on Bondo-so, and then, in Section 3, a summary of its basic root-controlled VH patterns. We then present previously unaccounted for data in Section 4 that illustrate a more complex set of suffixal alternations related to root-controlled VH. We offer a feature geometric analysis in Section 5 that accounts for both the transparent and more complex VH data. Section 6 then discusses instances of suffix-controlled VH for which we offer an analysis based on featural licensing. In Section 7, we propose an extension of our analysis to certain more problematic instances of VH in two additional stem types and take up the issue of an unusual "null" alternant that sometimes arises in the formation of the Chaining stem. We conclude with a few words on issues of descriptive, typological, and theoretical relevance.

## 2 Background

### *2.1 Bondu-so and Dogon language overview*

Bondu-so has two primary dialects—Kindige and Najamba—which have been described only in unpublished work by Hantgan (2013) and Heath (2017), respectively. The language has several properties that differentiate it from the other estimated 20 Dogon languages. Verb stems in all Dogon languages are agglutinative; while there are no prefixes, derivational and inflectional suffixes extend typically monosyllabic verb roots to multisyllabic stems; suffixes underspecified for [ATR] are susceptible to tongue root harmony from a root vowel. "Dominant" suffixes may instead impose their [ATR] value on the root vowel.

There is also evidence for a synchronic ten-vowel system in Bondu-so despite such a system being unattested elsewhere in Dogon. That is, [ATR] VH is attested within uncompounded stems among all the known Dogon languages, but Heath (2014: 2) argues that only the mid vowels participate in the harmony process while [a] and [i, u] are "…extra-harmonic (or neutral) in the sense that they may co-occur with vowels of either harmonic set" (p. 2). Another disparity to consider between Bondu-so and some Dogon languages such as Tommo So (McPherson 2013; McPherson & Hayes 2016) is that the latter display height and backness harmony; in Bondu-so, there are remnants of height harmony in the formation of Imperative and Imperfective stems.

Our analysis of Bondu-so VH differs from McPherson & Hayes's (2016) analysis of Tommo So VH in several ways, and markedly in our assumption concerning the lexical shape of a given verb. McPherson & Hayes assume that Tommo So verbs are lexically CVCV; the addition of a vowel-initial suffix involves a hiatus resolution rule, and alternations in what they consider to be a stem-final vowel are attributed to ablaut. We instead consider Bondu-so verbs to be lexically CVC. Accordingly, instances of hiatus resolution are fewer, and we assume that word-final vowels that arise in the Chaining and Past stems discussed below are epenthetic. In addition, we consider the vocalic alternations that

McPherson & Hayes treat as ablaut to be another reflex of vowel harmony. An advantage to approaches appealing to ablaut is that the alternations witnessed are phonologically unpredictable; however, we would argue that these alternations are in fact predictable if one takes into consideration featural properties shared between vowels and sonorant consonants and the ability of their manner features in particular to spread from the stem vowel. We also note that Green & Dow (2017) independently arrive at a similar conclusion concerning lexical stem shape in Najamba, the second dialect of Bondu-so that is most closely related to Kindige, which we describe here.

In addition, Bondu-so has a nominal class system with alliterative agreement patterns that are far more elaborate than those found in neighboring Dogon languages. Nominal class marking is expressed through encliticization, which has no effect on the noun root in terms of VH, and a vocalic suffix which does influence the [ATR] value of the stem. Specific examples of suffix-controlled nominal stems are in Section 3.1.

### 2.2 Methodology

Our data are from primary fieldwork with Bondu-so Kindige-speaking consultants in Mali from 2008–2010; the second author has longstanding familiarity with the language, having spoken it in the US Peace Corps from 1998–2000. Fieldwork was done in collaboration with the NSF-funded Dogon and Bangime Linguistics Project under the direction of Principal Investigator Jeffrey Heath (U-Michigan). The majority of the data in this paper were elicited in recording sessions with one consultant and thus do not represent all varieties of the language or genres. We encourage readers to explore resources at the project website for more information. All recordings used are available here: supplemental data and resources.

## 3 Basic vowel harmony patterns

To fully appreciate the complexities of Bondu-so VH, we first establish basic properties of the language's vocalic system, including its inventories of underlying vs. surface vowels. Establishing these facts is non-trivial. The data in Section 3.1 summarize basic vowel alternations attributed to [ATR] harmony, as analyzed by Hantgan & Davis (2012). We begin by discussing the Perfective stem. In these stems, suffixal vowels alternate based on the [ATR] value of the root and therefore provide evidence for the underlying ten-vowel inventory. We present limited data for expository purposes and refer the reader to the aforementioned paper for further details.

### 3.1 Contrast and root-controlled harmony

Alternations in the Bondu-so Perfective suffix following obstruent-final roots provide insight into the language's vocalic system. In Section 4, we discuss alternations following sonorant-final roots, as these often differ markedly from those following obstruent-final roots. The examples we present first in (2) reveal that tongue root values are harmonic across stems containing only mid vowels; a surface [ATR] contrast is clear in comparing [ɛ] vs. [e] and [ɔ] vs. [o].

(2) a. nòj-éè 's/he had slept'
b. bèdʒ-éè 's/he had buried'
c. dɔ̀g-ɛ́ɛ̀ 's/he had abandoned'
d. kɛ́dʒ-ɛ̀ɛ̀ 's/he had cut'

Hantgan & Davis (2012) attribute the alternations between [-ee] and [-ɛɛ] to root-controlled [ATR] harmony; [+ATR] mid vowels occur after a root with a vowel of the same value, as in (2a–b), while [–ATR] mid vowels occur after [–ATR] root vowels, as in (2c–d). Hantgan

& Davis propose that the lexical form of the Perfective third person singular suffix is a front, mid vowel that is underspecified for [ATR], namely /-EE/.[5]

These same suffixal alternations also emerge following roots with high and low vowels, as in (3), despite the fact that the surface root vowels exhibit only a single tongue root value. Examples (3b, d, e) illustrate stems disharmonic for [ATR], though they pattern exactly like those in (2) with mid vowels. That is, some roots with high and low vowels exhibit a [+ATR] suffixal vowel while others exhibit the [–ATR] value.

(3) a. íb-éè 's/he had caught' /ib-/
b. nìŋg-ɛ́ɛ̀ 's/he had shut' /nɪŋg-/
c. kúmb-èè 's/he had held' /kumb-/
d. gùb-ɛ́ɛ̀ 's/he had hung up' /gʊb-/
e. áb-èè 's/he had agreed' /a̹b-/
f. dʒàŋg-ɛ́ɛ̀ 's/he had studied' /dʒaŋg-/

Hantgan & Davis (2012) take this paradox in disharmonic stems as evidence of an underlying [±ATR] contrast in vowels at all three heights. They attribute the surface neutralization of the underlying [ATR] contrast in low and high vowels to phonetically-based *grounded constraints* (Archangeli & Pulleyblank 1994) on the featural combinations *[–ATR]/[+HI] and *[+ATR]/[–HI].[6] As a result of these constraints, they argue that the underlying ten-vowel system in Bondu-so is neutralized to seven values on the surface, with the [ATR] contrast maintained only in mid vowels.

Although Bondu-so words are often disharmonic for [ATR], via VH, the contrastive [ATR] value of the root is displaced and therefore maintained on the suffix in contexts like the Perfective. The outcomes are opaque, with VH appearing to have overapplied on suffixes following roots with high and low vowels.

Similarly opaque alternations arise throughout Bondu-so, such as in the nominal class system, where evidence for the underlying [ATR] value of the root vowel is reflected only on singular and plural suffixes. Like in the Perfective, the noun class 2 suffix alternates between both [ATR] values depending on the value of the vowel of the root to which it attaches. Transparent instances of noun stems undergoing VH are in (4), whereas the contrast is lost on the root if the root vowel is high or low as in (5) and (6), respectively.[7]

(4) a. ól-òò 'house'
b. ól-èè 'houses'
c. bɔ́ŋg-ɔ̀ɔ̀ 'belly button'
d. bɔ́ŋg-ɛ̀ɛ̀ 'belly buttons'

(5) a. gìr-óó 'eye'
b. gìr-éé 'eyes'
c. sìdʒ-òó 'line'
d. sìdʒ-èé 'lines'
e. ùdʒùp-ɔ̀ɔ́ 'road'

[5] There is a difference in the length of the Perfective suffix between the Bondu-so dialects, Kindige and Najamba, which are long and short, respectively.

[6] We are grateful to both Laura Downing and Sharon Rose for pointing out similarities in the featural behavior of root and suffix in Bondu-so and those between root and prefix in Hyman's (1988) paper on Esimbi; both accounts involve feature transfer from root to affix with subsequent featural neutralization on the root itself.

[7] Another possibility in light of the featural analysis that we motivate below is that the featural specification of the plural is derived from the singular. That is, one could argue that the singular suffix is underspecified for some feature (e.g., [front] or [labial]), as well as [ATR], and that the addition of one of these features is entailed in inflection for number. We set this matter aside for future research.

f. ùdʒùp-ɛ̀ɛ́ 'roads'
g. tìm-ɔ́ɔ̀ 'tree'
h. tìm-ɛ́ɛ̀ 'trees'

(6) a. dág-ò-n 'medication, remedy'
b. dàg-éé 'medications, remedies'
c. dán-àà 'head'
d. dán-ɛ̀ɛ̀ 'heads'

Hantgan & Davis (2012) propose that such disharmony results when a root's [ATR] feature is delinked via one of two *clean up* rules, represented here in Figure 1a, b. They invoke these rules in order to satisfy the phonetically-based grounded constraints referenced above.

We, too, attribute such disharmony to featural incompatibility, yet we attribute delinking to constraints on surface well-formedness. Roots with antagonistic feature combinations delink [ATR], but crucially after [ATR] has spread from the root vowel to a suffix vowel that is unspecified for the feature. The resulting stem is disharmonic but does not violate well-formedness restrictions on "tense low" and "lax high" vowels.

In Section 6.1, we discuss further Bondu-so suffixes that are specified for [ATR] and, as such, yield different outcomes.

### *3.2 Summary*

In this section, we presented data representing Bondu-so's basic root-controlled VH patterns and accordingly discussed the motivations underlying Hantgan & Davis's (2012) analysis. To summarize their analysis: i) the feature [ATR] is binary; ii) neither value of [ATR] is dominant; and iii) a suffix underspecified for [ATR] receives this feature via spreading from the root vowel.

The data we present in the next section also concern root-controlled VH in Bondu-so but go beyond those discussed by the aforementioned authors. While [ATR] remains a key factor in alternations seen among these additional data, we illustrate that roots ending in sonorants intervene in featural spreading, resulting in disparate suffixal alternants after obstruent-final vs. liquid-final vs. nasal-final roots. We propose a feature geometric analysis that relates these outcomes to the presence vs. absence of particular vowel manner (V-Manner) features in the geometry of a given type of consonant that ultimately affect the outcomes of VH. Our analysis accounts not only for these new data, but also easily accounts for all data presented in Hantgan & Davis (2012), including those that were somewhat more problematic and led to the additional invocation of floating features.

## 4 New data

### *4.1 Divergent alternations*

Vocalic alternations arising from VH following sonorant-final roots differ from the basic patterns shown in Section 3.1. There, we saw that Bondu-so suffixal mid vowels alternate under the influence of root-controlled VH between two expected pairs of harmonic counterparts: [ɛ] vs. [e] and [ɔ] vs. [o]. In Section 4.1.1, we first revisit the Perfective

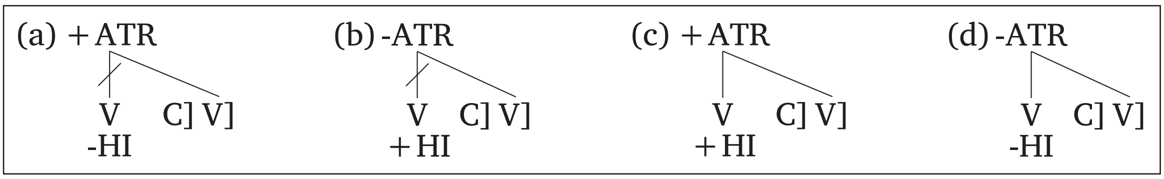


**Figure 1:** Spreading and delinking (Hantgan & Davis 2012).

stem and bring to light new data that illustrate markedly different alternations following liquid-final and nasal-final roots. We show that, in the Perfective, suffixal alternations following liquid-final roots are identical to those observed following obstruent-final roots (i.e., [ɛ] vs. [e]) but that alternations following nasal-final roots are different (i.e., [ɛ] vs. [i]). We then turn to data from the Chaining stem that diverges even further from these patterns; we introduce instances in which [ɛ] alternates with [Ø] (i.e., null). These alternations call into question an analysis based solely on [ATR] underspecification of suffixal vowels.

#### 4.1.1 Sonorant-final Perfective stems

In this section, we illustrate that [ATR] harmonization interacts with sonorant segments in the formation of Bondu-so Perfective stems. The alternations that we present first pertain specifically to nasal-final stems, but we later illustrate that stem-final sonorants often pattern as a class.

In Section 3.1, we showed that the formation of Perfective stems entails root-controlled harmony which results in an alternation between two allomorphs of the Perfective suffix, [-ee] and [-ɛɛ]. This outcome obtains in obstruent-final roots but not in all sonorant-final roots.

Following liquid-final roots, vocalic alternations in the Perfective suffix are identical to those following obstruent-final roots, as in (7). The suffix [-ee] follows a "tense" root while [-ɛɛ] follows a "lax" root.

(7) a. pór-èè 's/he had let (someone) escape'
b. bɛ̀l-ɛ́ɛ̀ 's/he had picked fruit'
c. mùl-éè 's/he filled'
d. íl-ɛ̀ɛ̀ 's/he ascended'
e. nàl-éè 'she gave birth'
f. ámbíl-ɛ̀ɛ̀ 's/he reduced'

This alternation pattern is different following nasal-final roots, as in (8); after nasals, suffix vowels in the Perfective stem are [-ii] following "tense" roots, as in (8a, c), while they are [-ɛɛ] following "lax" roots, as in (8b, d), irrespective of the height of the root vowel.

(8) a. dʒèn-îì 's/he had took away'
b. sɛ́m-ɛ̀ɛ̀ 's/he had slaughtered'
c. gòm-îì 's/he had removed'
d. gɔ̀m-ɛ́ɛ̀ 'it had reeked'
e. mìn-îì 's/he had waited'
f. mìn-ɛ́ɛ̀ 's/he had swallowed'

The standing analysis of Bondu-so Perfective stems asserts that the Perfective suffix is a front mid vowel underspecified for [ATR]. The alternations witnessed in nasal-final roots, however, suggest that there must be some additional feature present, either belonging to the suffix, or contributing to the suffix, that yields [-ii] after "tense" nasal roots, rather than simply [-ee], as found elsewhere. Furthermore, we must consider why sonorants pattern differently from one another, with liquids patterning with obstruents and nasals behaving differently. In Section 5, we propose a feature geometric analysis of these outcomes.

#### 4.1.2 The Chaining stem

Suffixal vowel alternations deviate even further in the Chaining stem. Verbs in this category are interesting to us because even their suffixal alternants in obstruent-final roots differ from the expected harmonic patterns seen, for example, in the Perfective stems in (2) and (3). All sonorant-final roots in the Chaining stem also pattern as a group.[8]

The Chaining stem is formed by a verb root suffixed by a single vowel, followed by the auxiliary verb [**dʒá-mbò**] '(s/he) is able (to perform action X).' The third person singular Chaining stem is used in Dogon descriptions and dictionaries as the citation form stem of a verb, and we follow suite here with our examples in (9).

(9)
a. bédʒ-í 'bury' /bedʒ-/
b. dʒóg-i 'have' /dʒog-/
c. íb-í 'catch' /ib-/
d. kúmb-í 'hold' /kumb/
e. áb-í 'agree' /a̘b-/
f. kɛ́dʒ-ɛ́ 'cut' /kɛdʒ-/
g. dɔ́g-ɛ́ 'abandon' /dɔg-/
h. níŋg-ɛ́ 'shut' /nɪŋg-/
i. gúb-ɛ́ 'hang up' /gʊb-/
j. dʒáŋg-ɛ́ 'study' /dʒaŋg-/

There are three possibilities in forming the Chaining stem. Examples (9a–e) show that obstruent-final roots with "tense" root vowels are followed by [-i] whereas those with "lax" root vowels are followed by [-ɛ]. Despite the fact that the verb roots in (9) end in obstruents, the Chaining Stem in these examples is reminiscent of the outcomes following nasal-final roots in the Perfective stem shown in (8).

Data representative of sonorant-final roots forming Chaining stems in (10a–c) reveal a third possibility, namely that the Chaining stem requires no suffixal vowel at all when following sonorant-final roots with a "tense" vowel. Following similar roots with a "lax" vowel like (10d–f), however, we observe that the addition of [-ɛ] is required to form the Chaining stem.

(10)
a. góm 'remove' /gom/
b. mín 'wait' /min/
c. pór 'let escape' /por/
d. gɔ́m-ɛ́ 'reek' /gɔm/
e. mín-ɛ́ 'swallow' /mɪn/
f. bɛ́l-ɛ́ 'pick fruit' /bɛl/

### *4.2 Data summary*

The behavior of Perfective stems with sonorant-final roots, as well as all Chaining stems, brings to light several issues that must be resolved in any analysis of Bondu-so VH. In sonorant-final roots, we see that beyond the expected [-ee] and [-ɛɛ] allomorphs of the Perfective, a third allomorph [-ii] emerges following nasal-final (but not liquid-final) roots. An analysis based on [ATR] underspecification and root-controlled spreading alone cannot predict the emergence of the [-ii]. As such, some other property, ostensibly due to or stemming from the nasal, appears to intervene and affect harmonization.

The outcomes in Chaining stems are different; a root can be followed either by [-ɛ], [-i], or by no vowel at all. We would like to propose that these outcomes arise due to two interacting factors. To begin, the fact that a vowel is absent following some roots suggests

[8] The Chaining stem is segmentally identical to the Past stem; both exhibit identical segmental alternations resulting from VH. The two contexts differ tonally, however, in that root-initial voiced consonants in the latter contribute tonal depressor effects on an adjacent vowel.

to us that perhaps the stem-final vowel in these verbs is epenthetic, rather than being associated with the realization of some morphological exponent of these verb contexts. If we are correct, it would therefore appear that the quality of the epenthetic vowel is (like the suffixal vowel of the Perfective stem) determined by the featural properties of the segments that precede it, but only partially by the [ATR] specification of the root vowel. The subsidiary distinction between obstruent-final roots and sonorant-final roots once again shows that other factors are involved in the stem-final vowel's quality.

A second issue relates specifically to sonorant-final roots and the conditions governing whether they require an epenthetic vowel or not. We take up this issue in Section 7.3.

With these new patterns of root-controlled VH established, we next turn to formalizing these relevant outcomes. In Section 5, we offer an analysis inspired by the principles and representations proposed in the *Parallel Structures Model* of feature geometry (Morén 2003a; b; 2006; 2007). We illustrate that two modifications of this model allow us to transparently capture not only the more straightforward outcomes of Bondu-so VH discussed in earlier work, but also certain more complex alternations, like those introduced in this section. In Section 7, we extend this analysis to other contexts that were analyzed using floating features by Hantgan & Davis (2012).

## 5 The Parallel Structures Model

The *Parallel Structures Model* (PSM) of feature geometry (Morén 2003a; b; 2006; 2007) proposes that all segments are composed of parallel Consonantal and Vocalic Place and Manner nodes within which an identical and limited set of features are employed in various combinations to yield a language's consonant and vowel inventories. The approach combines components from a number of feature theories; we refer the reader to Morén (2006) for details concerning the combinatory construction of the framework. In addition, the PSM is one of several approaches to phonology that are widely referred to as *substance-free*; Blaho (2008) provides an excellent comparative survey of these approaches and their tenets. For the purposes of our analysis of Bondu-so VH, it is important to recognize that substance-free approaches to phonology, generally speaking, assume no direct correlation between phonological features and their phonetic interpretation. Rather, the ways in which features are interpreted in a given language must be established by identifying contrasts and patterns of alternations.

More broadly, feature geometric approaches like the PSM aim to model cross-linguistically attested operations such as feature spreading, feature co-occurrences, and co-articulation, among others, with a maximally economic feature set. Thus far, the PSM has not been widely applied outside of Morén's work just cited and theses by Youssef (2006; 2013) and Iosad (2012). However, even among these few works, the PSM has been employed to capture a variety of phenomena, though mostly involving consonant assimilation and consonant-vowel interactions, in a typologically-diverse array of languages (e.g., Serbian, Cairene Arabic, Hawaiian, Buchan Scots, and several Celtic languages). We illustrate in this section that such a model can successfully capture the distribution of underlying vs. surface vowels in Bondu-so, as well as the various VH phenomena observed in the language.

Other assumptions inherent in the PSM approach are important for our analysis. One of these is feature privativity: a feature is either associated with a given segment, or it is not. Binary featural distinctions do not figure into this model, nor in standard versions of Feature Geometry itself (e.g., Clements 1985). There has certainly been longstanding scholarly debate on the nature of phonological features, concerning whether they are privative (F vs. Ø), binary (+F vs. –F), or equipollent (+F vs. –F vs. Ø), as well as whether the phonological grammar should allow these characteristics to vary by feature in a given language. For competing viewpoints see Goldsmith (1985), Goldsmith (1987), Archangeli (1988), Rice (1992), Baković (2000), and Walker (2011), but also many others. It is not our intent to delve deeply into this debate, but rather, our goal is to illustrate that the PSM offers an economical means by which to account for Bondu-so's complex VH phenomena in a principled way and does so based on a limited set of well-motivated privative features. We nod to an argument raised in Rice (1992) that featural privativity should be assumed unless there is evidence for binarity. Our analysis illustrates that binary (±) specifications, though assumed by Hantgan & Davis (2012), need not be invoked to account for the Bondu-so VH patterns.

Another assumption of the PSM is that terminal features and nodes can spread, just as they have been proposed to do in other feature geometric approaches, and notably in Clements (1985; 1991). As Clements outlines, features may spread in an assimilatory fashion from node to node, but also a node and its constituent features often spread as the result of a phonological rule provided that there is no crossing of association lines. Our main concern will be with the role of Manner features, though the Place feature [dorsal] will be invoked to account for the behavior of "front" vs. "back" vowels.

Representations illustrating the basic structural premise of the PSM are in Figure 2. In the PSM, consonant place (C-Place) and vowel place (V-place) are determined by a combination of the features [labial], [dorsal], and [coronal]. Correspondingly, consonant manner (C-Manner) and vowel manner (V-Manner) are determined by a combination of [closed], [lax], and [open].[9] A given segment may possess or lack one or more of these features; for example, obstruents lack V-Manner features (and, thus, a V-Manner node, altogether), while sonorant consonants may instead possess one or more V-Manner features under the V-Manner node. However, a segment possessing at least one V-Manner feature must necessarily have a dominating C-Manner node. A given node, if present, need not be saturated. However, as we shall see, there is evidence for implicational relationships between some features in Bondu-so, and in other instances, a feature may be associated or else delinked in order to satisfy phonological constraints on surface well-formedness.

These figures illustrate a dependency between C- features and V- features that is motivated by appealing to various instantiations of featural spreading and asymmetries between the spreading of consonantal vs. vocalic features. Important to our interests here is that

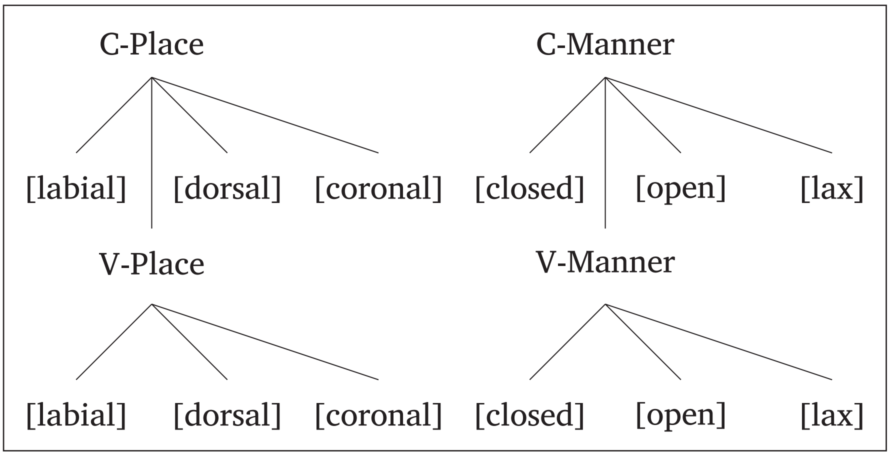


**Figure 2:** Basic PSM specifications for vowels and consonants.

[9] We thank an anonymous reviewer for reminding us of the sentiment raised in Morén (2006) that C- and V-nodes are more organizational than substantive, as consonants can exhibit features in a V-node, and vowels may have features resident in a C-node.

vocalic features (whether individually or in some combination) often (but not always) can spread without being influenced by certain intervening consonants. The PSM assumes that this arises because certain consonants lack relevant vocalic features that might affect or influence vowel-to-vowel spreading. However, the spreading of consonantal features is comparatively rare owing to the fact that a given vowel necessarily possesses both C- and V- nodes that intervene and potentially mediate consonant feature spreading.

In summary, there are three key factors to keep in mind pertaining to the PSM. First, the PSM makes use of a limited inventory of phonological features. Second, these features are either present or absent in a given segment; they are privative. Lastly, and to quote Morén (2006: 1209): "…the mapping from a given feature specification to a phonetic realization is determined on a language-by-language basis, based on a combination of contrasts and behavior. Therefore, a given phonetic transcription can correspond to different feature specifications in different languages." Thus, the limited inventory of phonological features assumed in the PSM can be implemented (to some degree) in language-specific ways.

From a practical standpoint, this last factor means that a given segment like [l] is not unambiguously assumed to be [+lateral, +approximant, +coronal, +voice, etc.] in all instances for all languages. Rather, the PSM assumes that [l] might be characterized by the presence of the V-Manner feature [open] in one language, while it may be lacking this feature altogether in another language. The presence vs. absence of [open] would be established based upon the way that [l] behaves or patterns relative to other segments in the language. One could argue that such stipulations are reasonable alongside other well-attested phenomena related to segments of different types that have language-specific implementations. For example, this might include language-specific differences in the relative sonority of certain segments (for a fairly recent survey, see Parker 2002). This could also be applied to coda conditions of different types, such as those in Japanese (Ito 1986) or Axininca Campa (Payne 1981) where nasals, but no other sonorants, can appear in syllable codas due to their underspecification for place features. Also applicable would be approaches to syllabification that are predicated on structural properties of segments, rather than sonority, as discussed in van der Torre (2003). For further discussion on cross-linguistic differences in the patterning of liquids and nasals, see Mielke (2005).

### 5.1 Modifications to the PSM

We propose two modifications to the standard PSM approach. First, we assume, following other models of vowel geometry, that [ATR], as opposed to [lax], suitably captures vocalic behavior cross-linguistically (Odden 1991; Vaux 1996; Halle et al. 2000, among others). This is more of a conceptual modification, rather than one that affects the architecture of the model itself. A second modification that we propose is more substantive but nonetheless grounded in cross-linguistic vocalic tendencies discussed elsewhere. That is, our data suggest that the V-Manner features [closed] and [ATR], rather than being independent of one another, instead pattern together in notable ways. This fact becomes is particularly apparent in that the feature [ATR] is licensed in surface representations only alongside [closed].

Thus, we propose that [closed] and [ATR] form a constituent or node under V-Manner but separate from [open]. This supposition is far from unexpected; the features [closed] and [ATR] tend to cluster together cross-linguistically, prompting Odden (1991), for example, to propose that they function as two features branching under a *height* node. This is also supported by typological perspectives offered in different frameworks, such as in Archangeli & Pulleyblank (1994), which form the basis for the *grounded* constraints on incompatible height/[ATR] combinations that Hantgan & Davis (2012) employed in their earlier analysis of Bondu-so VH.

We acknowledge that such a modification poses an issue concerning the "parallel" nature of the PSM. However, given that the nodes proposed in the PSM are strictly organizational in nature (Morén 2006), the introduction of another level of structure within the V-Manner node seems not to be expressly precluded. Of course, one might ask whether there is evidence for such an interrelationship between [closed] and [ATR] under C-Manner itself. Absent such an investigation, we would argue nonetheless that the introduction of a separate *height* node containing [closed] and [ATR] (at least under V-Manner) improves upon the basic architecture of the PSM approach given that it is supported both cross-linguistically and typologically. Indeed, we illustrate below that the *height* node plays an important role in our analysis of Bondu-so VH. The modified structure for Manner features that we assume is represented in Figure 3. Because Place features play no substantive role in the phenomena under consideration, we have chosen to omit C-Place/V-Place trees from the figures below.

The structure given in Figure 3 provides a means to represent the role played by the presence vs. absence of particular features in our modified PSM approach to Bondu-so VH.

### *5.2 Vowel inventories*

The limited set of features that we propose in our PSM-style analysis not only captures the vowel contrasts present in Bondu-so but also motivates the absence of certain surface vowels. In Table 1, vowels in shaded rows are part of the phonemic inventory but do not surface. In addition, the featural specifications that we propose in Table 1 make certain predictions about the surface distribution of these vowels that are supported elsewhere in the language and in the outcomes of VH.

The V-Manner features represented in Table 1 correspond to those utilized in the PSM, with the exception of the substitution of [ATR] for [lax] discussed above. While it is not of an immediate concern in our analysis, we utilize V-Place [dorsal] to differentiate "front" vs. "back" vowels as features like [round], [back], and [front] are not typically assumed in the PSM framework. Note that there is independent evidence that /a/ and /a̹/ pattern with other "back" vowels in Bondu-so; as such, we assume that the featural specification of the low vowels also includes V-Place [dorsal]. (For more on the patterning of low vowels in Bondu-so, see Section 7.)

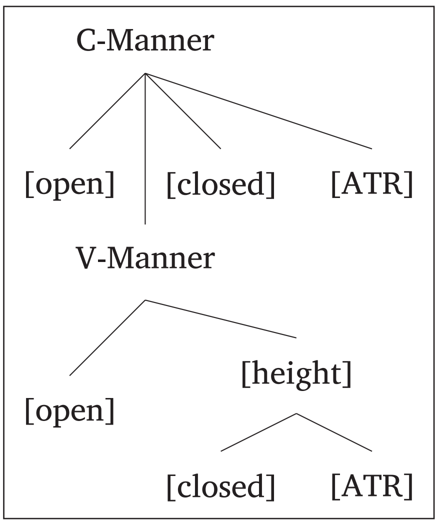


**Figure 3:** Modified PSM – Manner features.

**Table 1:** Featural specification of vowels.

| | V-Place | V-Manner | | |
|---|---|---|---|---|
| | [dorsal] | [closed] | [open] | [ATR] |
| /i/ | | ✓ | | ✓ |
| /ɪ/ | | ✓ | | |
| /u/ | ✓ | ✓ | | ✓ |
| /ʊ/ | ✓ | ✓ | | |
| /e/ | | ✓ | ✓ | ✓ |
| /ɛ/ | | ✓ | ✓ | |
| /o/ | ✓ | ✓ | ✓ | ✓ |
| /ɔ/ | ✓ | ✓ | ✓ | |
| /a̘/ | ✓ | | ✓ | ✓ |
| /a/ | ✓ | | ✓ | |

Given the proposed featural specifications for Bondu-so vowels in Table 1, we can now make several key observations. Each vowel in Bondu-so must have at least one V-Manner feature in its geometry; however, the only feature licensed to occur on its own is [open], as with [a]. Vowels with a fully-specified [height] node (i.e., containing both [closed] and [ATR]) are licensed on their own in the absence of [open], as with [i] and [u]. Vowels with a fully-specified V-Manner node (i.e., containing [open], [closed], and [ATR]) are also possible, as with [e] and [o].

We find, however, that while vowels whose only V-Manner feature is [closed] are part of the phonemic inventory, they are not licensed in surface representations in the absence of another V-Manner feature; this accounts for the absence *[ɪ] and *[ʊ]. Rather, [closed] can occur on the surface without [ATR], but only when accompanied by [open], as we find with [ɛ] and [ɔ]. The presence of [open] satisfies a higher level licensing condition that at least one V-Manner terminus must be saturated.

That [ATR] is licensed only by [closed], as in [i] and [u], which occur in the absence of [open], also speaks to the higher level licensing condition; vowels are licensed in the absence of [open] if both termini of the [height] node (and hence one branch of the V-Manner node) are filled. The opposite combination, however, is not attested. That is, [ATR] is not licensed by [open], as we see in the absence of [a̘].

Surface vocalic outcomes in Bondu-so support our proposal of a [height] node under V-Manner, with [closed] as the head, directly governing [ATR], as depicted in Figure 3. The two branches of the V-Manner node illustrate no obvious asymmetry or head/dependent relationship. As stated above, the fact that [closed] can appear without [ATR] in the presence of [open] is due to other factors. In the next section, we provide the specifics of the proposed PSM analysis of Bondu-so VH.

### 5.3 Vowel harmony with PSM V-Manner features

Hantgan & Davis (2012) analyze Bondu-so VH as involving [ATR] spreading. We agree, in principle, but differ in our assertion that spreading is due to a single, privative [ATR] feature, rather than spreading of [+ATR] vs. [–ATR], depending on the value of the root and/or suffixal vowel. We illustrate the basic components of our analysis by first returning to root-controlled [ATR] spreading in the Bondu-so Perfective stem. Our privative approach assumes that the Perfective suffix is *un*specified for [ATR]; Hantgan & Davis

(2012) instead proposed that it is *under*specified for this feature. This subtle distinction has important consequences.

Recall that the two vowels in the Perfective suffix that emerge after obstruents and liquids are [e] and [ɛ]. The featural specifications for vowels we offer in Table 1 show that the only distinction between [e] and [ɛ] is the presence vs. absence of [ATR], with the latter lacking this V-Manner feature; see Figure 4.

Thus, the Perfective suffix, being unspecified for [ATR], has [ɛ] for its basic form. However, under the influence of a root vowel specified for [ATR], this feature spreads to the suffixal vowel. The result of spreading fills the empty terminal branch with [ATR], resulting in [e], hence the alternation between [ɛ] and [e] in Figure 5. If the root vowel is unspecified for [ATR], no spreading occurs, and the Perfective suffix exhibits its basic form, [ɛ]. Such outcomes can be seen by comparing examples given above in (3) and (4). We discuss below the third alternant of the Perfective suffix, namely [i], which occurs after nasal-final roots.

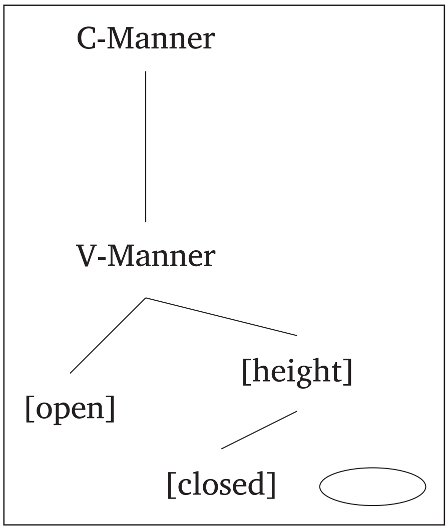


**Figure 4:** Underlying featural representation of the Perfective suffix.

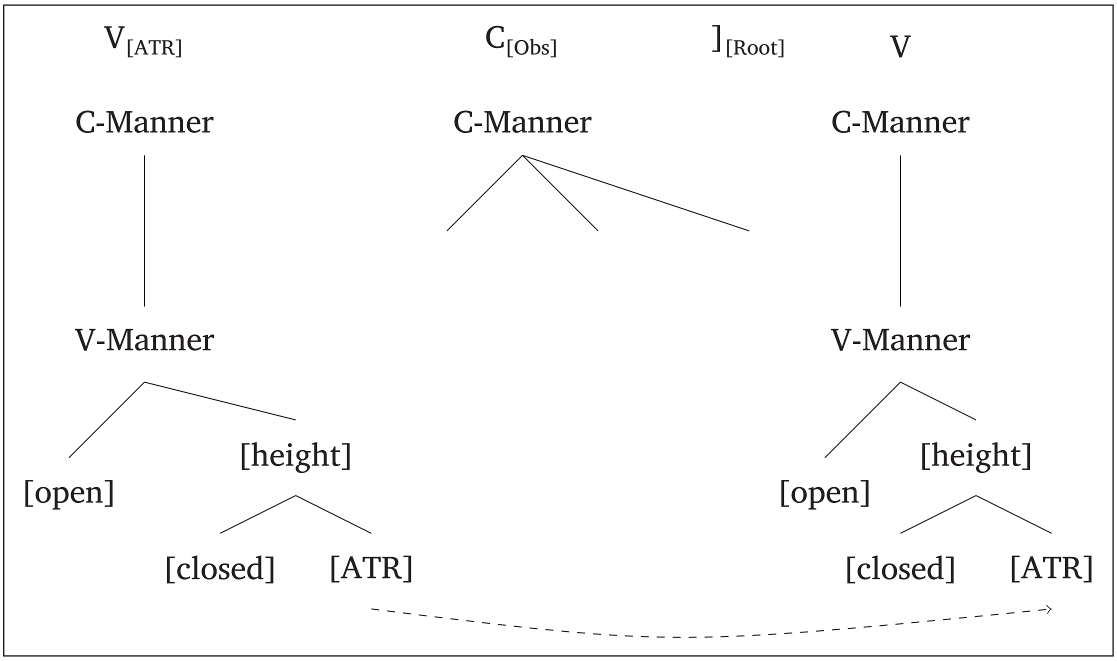


**Figure 5:** ATR spreading: Obstruent root to the Perfective suffix.

The intervening root-final obstruent appears to play no role in mediating the spreading of [ATR] from the root vowel to the suffix. We attribute this to the fact that obstruents have no V-Manner features that would support the spreading of [ATR] to the obstruent. Recall that there is no vowel, underlying or phonemic, that exhibits only V-Manner [ATR] in Bondu-so. We propose below that licensing and headedness relationships, as well as the well-formedness constraints found in Bondu-so vowels, also apply to sonorants in the language.

We would, of course, be remiss without addressing the outcomes with underlying root vowels /ɪ/, /ʊ/, and /a̹/, which have no surface counterparts in the language. Beginning with /ɪ/ and /ʊ/, these root vowels have no [ATR] feature to spread to the Perfective suffix; however, they are later assigned [ATR] due to a surface constraint on lax high vowels. Root /a̹/ is specified for [ATR] and therefore can spread this feature to the Perfective suffix; however, this vowel later loses its [ATR] feature by way of an analogous surface constraint on tense low vowels.

With these basic harmonic alternations between [ɛ] and [e] motivated, we turn to the behavior of liquid-final vs. nasal-final roots. Recall that vowels in the Perfective suffix following liquids pattern like those following obstruents, but those after nasals pattern differently. We attribute the difference to the unique combination of features in the geometry of each class of consonants, and each consonant's influence on feature spreading from root vowel to suffix.

The alternation in the Perfective suffix after nasals is between [ɛ] and [i]. We propose that this outcome arises due to the fact that Bondu-so nasals, like proposed for those in Serbian (Morén 2003a) and Bothoa Breton (Iosad 2012), exhibit V-Manner [closed] but lack V-Manner [open]. The presence of V-Manner [closed] on the nasal licenses local spreading of [ATR] from the root vowel; recall that [closed] similarly licenses [ATR] in Bondu-so vowels. The local spreading of [ATR] yields a saturated and licit V-Manner node. We propose that because combinations of [closed, ATR] are licit in Bondu-so, spreading of the entire V-Manner node to the suffixal vowel is licensed, ultimately resulting in [i]. Recall from Table 1 that the featural specification for [i] is in fact [closed, ATR]. The outcome of featural spreading in nasal-final roots is formalized in Figure 6 and seen in the examples given above in (8).

The outcomes following roots ending in liquids in the Perfective differ from those ending in nasals in that the former pattern with other obstruent-final roots in witnessing an alternation in the Perfective suffix between [ɛ] and [e]. We propose that the influence of Bondu-so liquids is different due to their unique featural specification. The patterning of Bondu-so liquids suggests that they are specified V-Manner [open, closed]. This differs from what has been suggested for other languages analyzed under the PSM, but it is far from unexpected. Pembrokeshire Welsh and Bothoa Breton (Iosad 2012) liquids are said to exhibit V-Manner [open] while liquids in Serbian (Morén 2003a) are instead V-Manner [closed]. Of course, there is no prohibition in the PSM that prevents liquids in some language from expressing both features. If vowels are uncontroversially able to exhibit both features, then the "parallel" nature of the PSM would suggest that the same would apply to relevant consonants. Indeed, the behavior that liquids have on Bondu-so VH strongly supports this assumption.

Because liquids exhibit V-Manner [closed], they also permit local [ATR] spreading from the root vowel; as in the case of the root-final nasals described above, the presence of the licit V-Manner node in liquids licenses spreading of the node to the suffixal vowel. The resulting suffixal vowel following liquids is [e], which is accordingly specified [closed, open, ATR]. The result of spreading within a stem with a root-final liquid is represented in Figure 7 and seen in words like those given above in (7). Note that the crucial difference between Figures 6 and 7 is the absence vs. presence of the feature [open] in the root-final consonant, respectively.

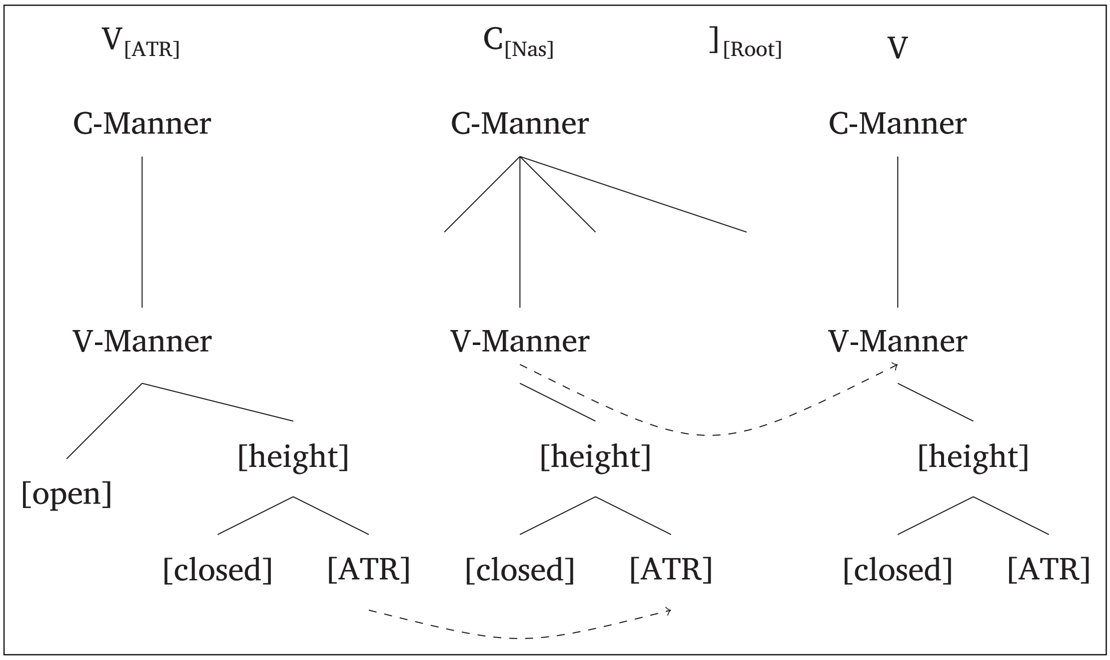


**Figure 6:** ATR spreading: Nasal root to Perfective suffix.

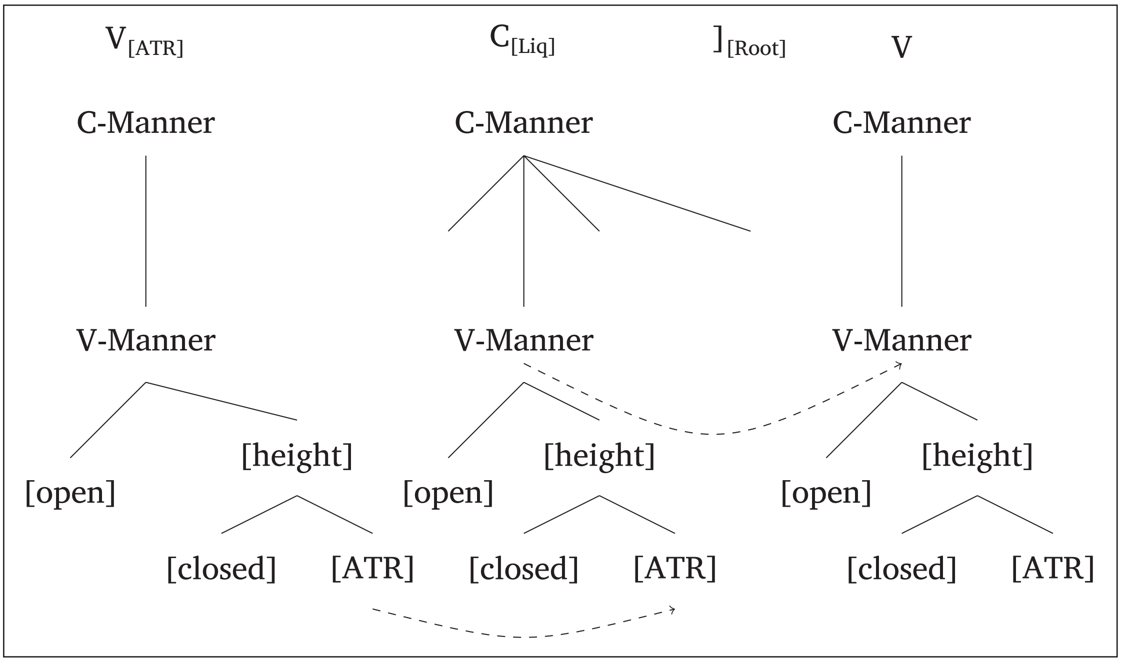


**Figure 7:** ATR spreading: Liquid root to Perfective.

Thus far, we have motivated vocalic alternations in the Perfective suffix by referencing the role played by features exhibited by root-final consonants of different types. We turn next to alternations involving epenthetic root-final vowels in the Chaining stem. We first discuss [ɛ]~[i] alternations in the Chaining stem in non-phrase final verbal contexts involving obstruent-final roots; recall that obstruent-final roots in the Perfective stem instead manifest [ɛ]~[e]. We will once again address the outcomes in reference to featural licensing but suggest that the differing outcomes in Perfective and Chaining stems arise from the featural characteristics of the Perfective suffix vs. epenthetic vowels, respectively. We will reserve discussion of the otherwise unexpected alternation between [ɛ] and [Ø] that arises after sonorant-final [ATR] roots in Chaining stems for Section 7.3.

Our analysis assumes that the Perfective suffix is unspecified for [ATR]; as such, we propose that its feature specification is V-Manner [open, closed] and that its empty [ATR] terminus is filled by spreading wherever applicable from a root vowel specified for this feature. The alternations observed in Chaining stem data, as in the examples in (9) and (10) above, however, suggest that the epenthetic vowel associated with the formation of these stems is specified only for V-Manner [closed]. This epenthetic vowel is schematized in Figure 8.

The Perfective suffix, with its V-Manner [open, closed], licenses a surface vowel, but the underlying featural specification of the epenthetic Chaining vowel does not and must be augmented by another feature in order to be realized. In the simplest of instances, namely those in which a root ends in a consonant and contains a vowel unspecified for [ATR], the epenthetic vowel receives [open]. The combination V-Manner [open, closed] results in [ɛ]. This combination appears to represent the minimal featural repair necessary to license a vowel. Although the addition of [ATR] is arguably another option, it seems not to be the preference in Bondo-so.

In those instances where the Chaining root vowel is instead specified for [ATR], two possibilities arise. For obstruent-final roots, the outcome is like that in Perfective stems. The root vowel's [ATR] feature spreads as elsewhere to the epenthetic vowel. [ATR] fills the empty [height] terminus alongside [closed] and precludes the assignment of [open], thus resulting in [i]. The spreading of [ATR] in obstruent-final Chaining stems is represented in Figure 9 and is seen in examples like those given above in (9). Sonorant-final roots whose vowels are specified for [ATR] spur different outcomes and are discussed in Section 7.3.

Our analysis of root-controlled VH in Perfective and Chaining stems of different types illustrates the importance of the root-final consonant in dictating Bondu-so VH patterns. We have captured not only transparent alternations between well-known "harmonic counterparts" but also those alternations that cross-cut vowel heights. We will take up our discussion of the curious "zero" alternation in nasal-final Chaining stems in Section 7.3 where we propose correlations between the presence of [ATR], moraic licensing, and a bimoraic minimality condition on Bondu-so verb stems. In the next section, we briefly outline a licensing approach to instances of what has earlier been analyzed as suffix-controlled harmony in Bondu-so.

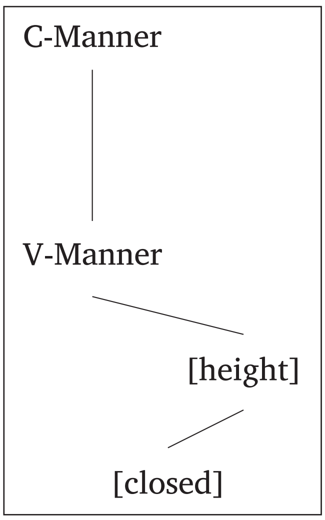


**Figure 8:** Proposed features of epenthetic Chaining/Past vowel.

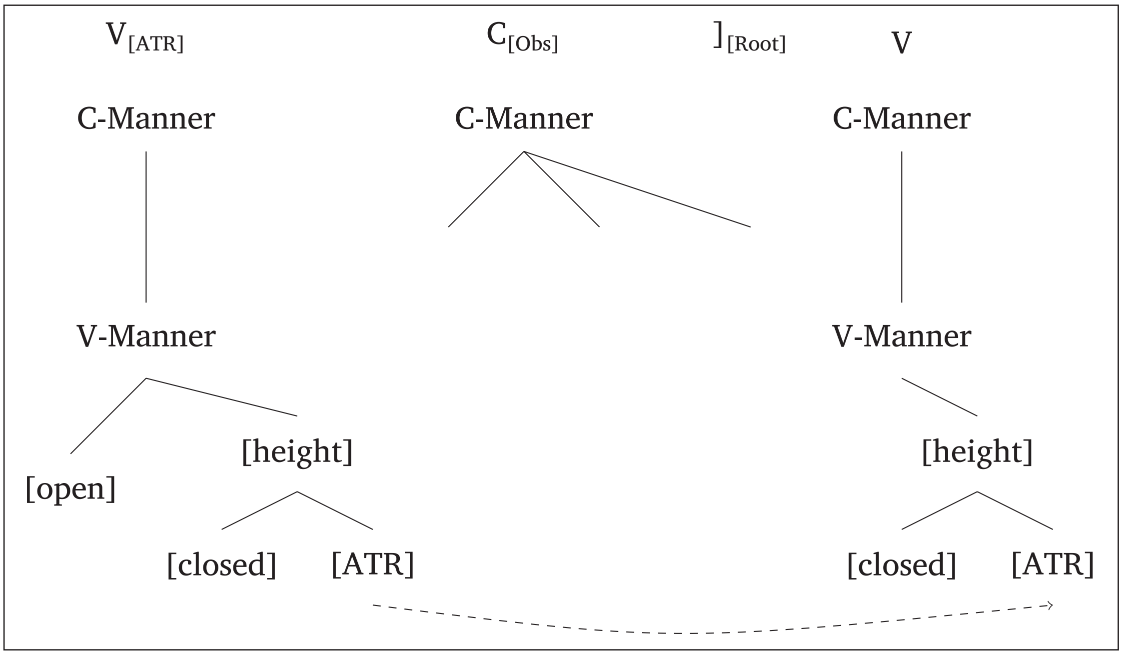


**Figure 9:** ATR spreading: Obstruent-final root to epenthetic vowel.

## 6 Suffix-controlled harmony with privative [ATR]

### *6.1 Suffix-controlled harmony*

Hantgan & Davis (2012) interpret suffixal vowel alternations in the Perfective stem and in singular/plural noun pairs as being due to root-controlled [ATR] harmony, but they also discuss other verbal and nominal contexts in which root vowels themselves alternate. Thus, root vowels alternate before suffixes that are said to be lexically-specified for some value of [ATR], leading these scholars to propose that neither the plus nor minus value of [ATR] is dominant. That is, they attribute some alternations to suffixal [+ATR] spreading, as in the formation of Bondu-so stems like the Infinitive in (11). Others, they attribute to [–ATR] spreading, as in the Mediopassive in (12).[10] The proposed underlying root forms for each example allow us to illustrate that the suffixal [ATR] value has spread onto the root, overriding its underlying [ATR] value to agree with that of the suffix.

(11)
a. némbíl-lòŋ 'to beg' /nembil-/
b. kédʒ-ìlòŋ 'to cut' /kɛdʒ-/
c. súg-ílòŋ 'to go down' /sug-/
d. dʒúg-ílòŋ 'to recognize' /dʒʊg-/
e. bàr-lòŋ 'to help' /ba̘r-/
f. pág-ílòŋ 'to tie' /pag-/

(12)
a. pɔ̀r-íjɛ́ 'let escape' /por-/
b. dɔ̀g-íjɛ́ 'left' /dɔg-/
c. ìn-íjɛ́ 'went' /in-/
d. ìr-íjɛ́ 'be forgotten' /ɪr-/
e. jámb-íjɛ́ 'be covered' /ja̘mb-/
f. dàg-íjɛ́ 'be locked' /dag-/

[10] Heath (2017) describes the Mediopassive suffix-final vowel in Najamba as being underspecified and thus harmonizing with that of the adjoining root. The behavior in Kindige that we consider here differs in that the suffix appears to be specified and therefore spreads its feature to the root.

The approach we adopt below instead assumes privative [ATR] and that the presence of [ATR] is dominant. In doing so, we account for instances of suffix-controlled, dominant harmony by appealing to morphological and prosodic asymmetries between certain *dominant* suffixes and the root itself. Though not necessarily a novel approach, by appealing to Positional Licensing (e.g., Ito 1986; Goldsmith 1990; Steriade 1994; Lombardi 1995; Ito & Mester 1999; Walker 2004), we assert that only stems headed by a suffix specified for [ATR] license the retention of [ATR] on their root.

As in other instances of suffix-controlled harmony, like those discussed by Casali (2008), we assume that there is a structural asymmetry between dominant affixes and a preceding root. Under the approach that we propose here, suffix-controlled harmony arises in Bondu-so word formation in those instances where a suffix projects a new prosodic word (PWd). In doing so, the affix becomes both the morphological and prosodic head of the resulting word, with some of its features percolating (Lieber 1980) and subsequently trickling down to structurally lower PWds. If such a dominant affix is specified for [ATR], the feature will override the [ATR] specification of a PWd that comes before it, even if this PWd is the root. We envision such an outcome being structurally represented as in Figure 10.

Such a structural approach to suffix-controlled VH can account for what Hantgan & Davis (2012) analyze as [–ATR] dominance, without appealing to featural binarity. If an affix such as the Bondu-so Mediopassive seen in (12) is unspecified for [ATR] but structurally higher than the preceding root, the absence of the [ATR] feature on this morphological and prosodic head fails to license the retention of this feature on lower PWds. This, thereby, results in the loss of the feature and an apparent regressive harmonization for "lax" vocalic values. We schematize this outcome in Figure 11.

In the next section, we illustrate that by combining our PSM-style analysis and the Positional Licensing approach proposed above, we can successfully account for certain more problematic cases of Bondu-so VH discussed by Hantgan & Davis (2012), and namely those alternations involved in the formation of Imperative and Imperfective stems. The former involves yet another pair of harmonic alternants, namely [a] and [o], which led these authors to posit that a floating [+ATR] feature to capture observed outcomes. Our PSM-style approach requires no such machinery. The Imperfective stem presents an additional challenge in that it appears to involve both root-controlled and suffix-controlled VH. We show that our approach adequately accounts for these outcomes as well.

## 7 Extension to problematic cases

Our analysis has proposed a modified version of Morén's PSM to treat instances of Bondo-so tongue root harmony reported by Hantgan & Davis (2012) that involve alternations between the expected harmonic counterparts [ɛ]~[e] and [ɔ]~[o]. In addition, however,

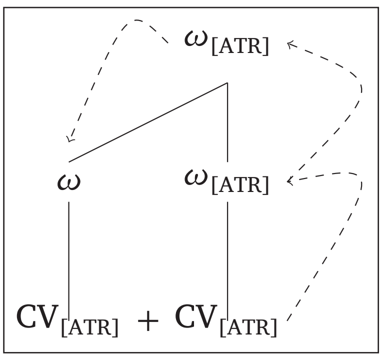


**Figure 10:** [ATR]-dominant suffix-controlled harmony.

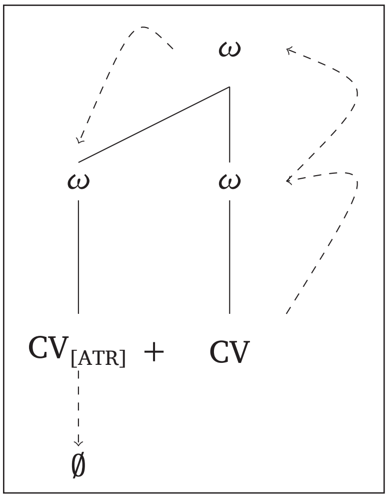


**Figure 11:** [ATR]-dominant suffix-controlled harmony.

we have illustrated how such an analysis can be applied to new data that exhibit more divergent alternations across different height categories. In doing so, we have appealed to a combination of featural and prosodic licensing to address various outcomes. In this section, we extend our analysis to two additional cases, one of which presented a challenge to Hantgan & Davis's (2012) autosegmental analysis of [ATR] harmony, subsequently requiring them to posit the presence of floating features to motivate the observed alternations. Last in this section, we propose an analysis of the "null" alternant observed after some nasal-final roots in the formation of the Chaining stem.

### *7.1 Imperative stems*

The Imperative stem involves suffixation of a short vowel that alternates between [o] and [a]. The examples in (13) illustrate that the former arises after [ATR] roots, with the exception of roots with /a̩/, which take [a]. The latter is found in all instances after roots whose vowel is unspecified for [ATR], like those in (14), despite the fact that root vowels, including mid vowels, other than /a/, surface "tense."

(13) a. némbíl-ó 'beg!' /nembil-/
b. nój-ó 'sleep!' /no-/
c. bíj-ó 'lie down!' /bi-/
d. súg-ó 'go down!' /sug-/
e. bár-á 'help!' /ba̩r-/

(14) a. kédʒ-á 'cut!' /kɛdʒ-/
b. dóg-á 'leave!' /dɔg-/
c. gíj-á 'kill!' /gɪ-/
d. dʒúg-á 'recognize!' /dʒʊg-/
e. pág-á 'tie!' /pag-/

The challenge presented by the Imperative stem is two-fold. One issue is in the behavior of suffixal vowels which alternate between [a] and [o]. We have not yet witnessed such an alternation elsewhere in Bondo-so. A second issue is that all vowels except [a] surface "tense," irrespective of the root vowel specification for [ATR]; this is reminiscent of what we saw above with suffix-dominant harmony, as in the Infinitive, though the vowels of the Infinitive suffix itself did not alternate. The analysis that we propose below stems from principles we have established thus far for other verb contexts.

Crucially, our analysis assumes that the Imperative suffix is specified V-Manner [open, ATR] but unspecified for V-Manner [closed], as represented in Figure 12. As we have shown elsewhere, this featural combination is disallowed on the surface though it is arguably part of the phonemic inventory, given evidence for roots with underlying /a̧/.

For the non-low verb roots specified for [ATR], such as those in (13a–d), we propose that root vowels are specified as V-Manner [closed, ATR]. We further suggest that [closed] spreads (as [ATR] has elsewhere) to fill the empty terminus in the suffixal vowel's geometry, yielding [o], as in Figure 13. The [ATR] feature need not spread because it is already specified in the suffixal vowel geometry.

Verb roots like example (13e) are specified V-Manner [open, ATR], as is the Imperative suffixal vowel. Thus, there is no opportunity for spreading of [closed]. In both instances, this disallowed featural configuration is resolved to [open] on the surface, as it has been elsewhere in the language. A similar outcome arises in examples like (14e) where the root

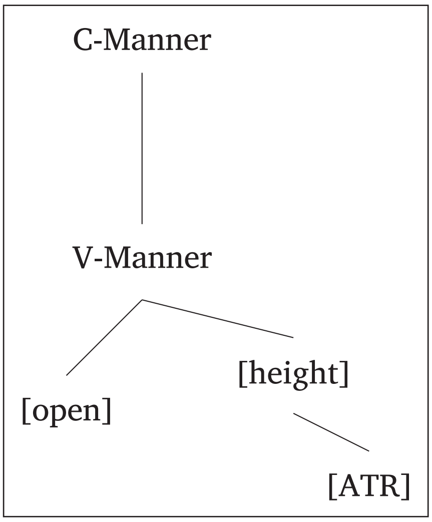


**Figure 12:** Proposed features of Imperative suffix.

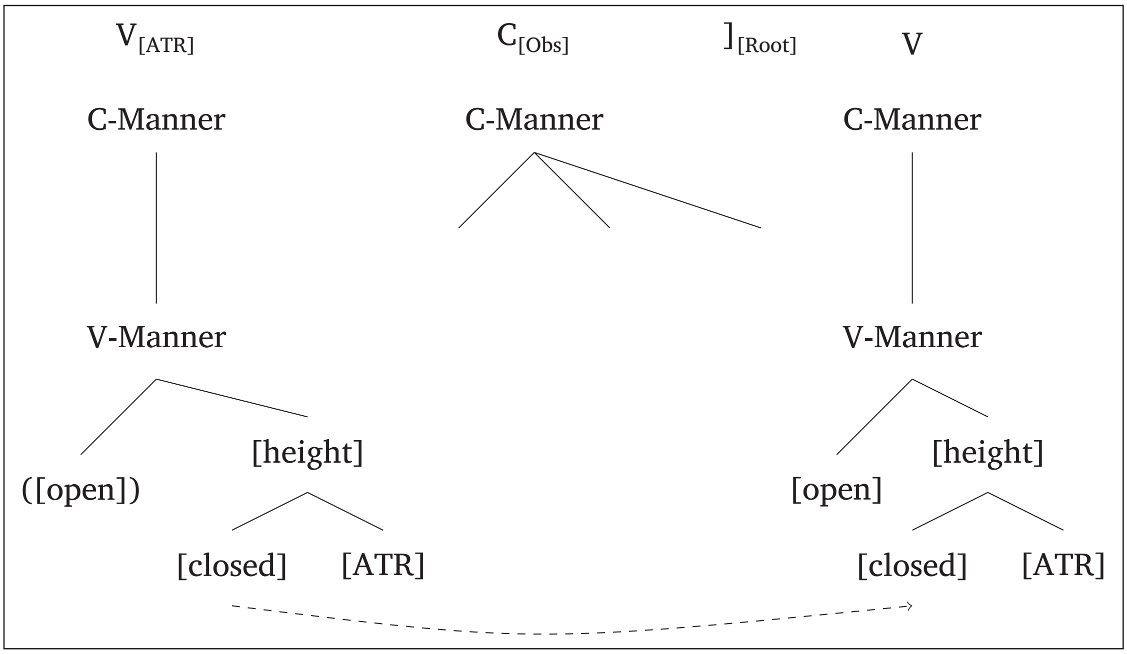


**Figure 13:** [closed] spreading to Imperative.

vowel is specified only as V-Manner [open]; again, there is no opportunity for [closed] spreading. Roots like those in examples (14a–d) are specified underlyingly for V-Manner [closed]; however, it appears that [closed] cannot spread in the absence of [ATR], as we have seen elsewhere in Bondu-so. The suffix vowel is [a].

As we alluded to above, on their own, the underlying features of the Imperative suffix (i.e., /a̙/) cannot license a surface vowel and must be adjusted in order for a vowel to be expressed. One possibility, the delinking of [ATR], is widely-attested in the language. The other option is the addition of [closed], which we have proposed occurs via spreading from the root vowel, wherever possible. Thus, this accounts for the suffixal alternation between [o] and [a].

There are at least two possibilities to address the alternations seen in roots lacking an underlying specification for [ATR] in (14). One possibility is to invoke the perspective we motivated in Section 6 concerning the behavior of [ATR] in structurally-dominant suffixes. The Imperative stem would behave like the Infinitive and Mediopassive stem in that the underlying [ATR] specification of its suffixal vowel comes to be distributed over preceding material in the stem due to a combination of structural dominance and licensing, despite the feature being later removed to satisfy a constraint on well-formedness. This approach would require an arguably uncontroversial series of two rules: one involving a morphophonological rule of [ATR] percolation/trickling and a second to satisfy a surface well-formedness constraint. Both these rules are independently attested elsewhere in Bondu-so.

Another possibility would be to propose that the Imperative stem entails a context-specific rule that generalizes the constraint that we have elsewhere seen applied to /ɪ/ and /ʊ/ that disallows vowels specified only for [closed] in the absence of either [ATR] or [open]; these vowels would alternate to [i] and [u] by the addition of [ATR] to their geometries. If this rule were generalized to mid vowels, it might require *any* vowel underlyingly specified for [closed] (regardless of whether [open] is present or absent in the geometry) to acquire [ATR]. Thus, all mid vowels under influence of this rule would surface [e] or [o]. This possibility, too, has a precedent in the behavior of lax high vowels elsewhere in the language. Future research will be necessary to tease apart which of these options best captures the otherwise unusual behavior of mid vowels in the Imperative, which surface "tense" despite being underlyingly unspecified for [ATR] while also being followed by a suffixal vowel that is also (underlyingly) unspecified for this feature.

In any event, both of these possibilities present independently-motivated mechanisms by which to derive the alternations observed in the Bondo-so Imperative without having to invoke the presence of floating features, as proposed by Hantgan & Davis (2012).

### *7.2 Imperfective stems*

Another context that Hantgan & Davis (2012) deem somewhat problematic is the Imperfective stem. Formation of the Imperfective stem involves two suffixes following the root (an aspectual Imperfective suffix, and one of several suffixes marking person/number). We illustrate below that the alternations in these affixes follow transparently from the principles we have outlined and motivated above. In fact, we view the examples of the Imperfective stem formed from [ATR] roots in (15) and those formed from roots whose vowel is unspecified for this feature in (16) to be strongly in support of our analysis. These examples illustrate a combination of progressive harmonization via spreading but also reveal that the two suffixes following the root are structurally quite different from one another and thereby entail different alternations.

(15) a. dʒóŋ-óndʒ-òm 'I was healing'
b. dʒóŋ-óndʒ-òò 'you were healing'
c. dʒóŋ-óndʒ-ò 'he/she/it was healing'
d. dʒóŋ-óndʒ-ójì 'we were healing'
e. dʒóŋ-óndʒ-è 'you (PL) were healing'
f. dʒɔ́ŋ-ɔ́ndʒ-ɛ́ɛ̀ 'they were healing'

(16) a. sém-ándʒ-òm 'I was slaughtering'
b. sém-ándʒ-òò 'you were slaughtering'
c. sém-ándʒ-ò 'he/she/it was slaughtering'
d. sém-ándʒ-ójì 'we were slaughtering'
e. sém-ándʒ-è 'you (PL) were slaughtering'
f. sɛ́m-ándʒ-ɛ́ɛ̀ 'they were slaughtering'

We propose that the Imperfective suffix vowel is underlyingly specified for the same features as the Imperative, namely V-Manner [open, ATR] (see Figure 12). This motivates the primary alternation between [a] and [o]. One alternant, [a], follows "lax" roots after the underlying featural specification of the suffix has been adjusted (via the removal of [ATR]) to satisfy surface well-formedness. The second alternant, [o], arises after "tense" roots due to [closed] spreading from the root vowel. We address the third vocalic alternant, [ɔ], below. While generally resulting in the same alternations as the Imperative, the Imperfective suffix differs in that it appears to behave structurally like other "weak" suffixes, such as the Perfective, that do not project a PWd.

We attribute the paradigmatic oddity of forms inflected for the third person plural to the fact that person/number suffixes are structurally higher than the Imperfective suffix in that they project a PWd; we proposed the same to be true of the Infinitive and Mediopassive suffixes. By virtue of being structurally higher, an [ATR] licensing constraint dictates the specification for this feature on all preceding vowels. Importantly, however, the data reveal that all person/number suffixes other than the third person plural are associated with [ATR] (like for the Infinitive); the third person plural is unspecified for this feature (like for the Mediopassive), resulting in [ɔ] in (15f). Again, because *[a̹] is not licensed on the surface, the Imperfective suffix is realized [a] in (16a–e).

We have illustrated that an analysis of Bondu-so VH within the PSM that appeals to licensing not only accounts for relatively straightforward cases of transparent harmonization but also accounts for those with more complex interactions between roots and suffixes where underlying featural specifications are obscured.

### *7.3 Moraic minimality*

Thus far, we have set aside discussion of the alternations that arise in the formation of the Chaining (and Past) stem that result in [Ø]. We introduced above that in forming the Chaining stem, all roots whose vowel is unspecified for [ATR], regardless of whether they end in an obstruent or sonorant, surface with an epenthetic [-ɛ], as in (17f–j) and (18d–f). Obstruent-final roots whose vowel is specified for [ATR], like those in (17a–e), instead surface with an epenthetic [-i] while sonorant-final roots with an [ATR] vowel, like in (18a–c) instead require no epenthetic vowel.

(17) a. bédʒ-í 'bury' /bedʒ-/
b. dʒóg-í 'have' /dʒog-/
c. íb-í 'catch' /ib-/
d. kúmb-í 'hold' /kumb/

e. áb-í 'agree' /a̧b-/
f. kɛ́dʒ-ɛ́ 'cut' /kɛdʒ-/
g. dɔ́g-ɛ́ 'abandon' /dɔg-/
h. níŋg-ɛ́ 'shut' /nɪŋg-/
i. gúb-ɛ́ 'hang up' /gʊb-/
j. dʒáŋg-ɛ́ 'study' /dʒaŋg-/

(18) a. góm 'remove' /gom/
b. mín 'wait' /min/
c. pór 'let escape' /por/
d. gɔ́m-ɛ́ 'reek' /gɔm/
e. mín-ɛ́ 'swallow' /mɪn/
f. bɛ́l-ɛ́ 'pick fruit' /bɛl/

We motivated epenthetic [-ɛ] and [-i] featurally in our PSM-style analysis, and in this section, our aim is to account for the third, null alternant. Given that this null outcome is limited to sonorant-final roots with an [ATR]-specified vowel, we would like to propose that this outcome relates to a well-formedness condition predicated on moraic minimality.

Given what we have observed in Bondu-so, we propose that root-final sonorants, by virtue of exhibiting V-Manner features, are licensed to receive [ATR] and do so via spreading from a root vowel specified for this feature. The presence of [ATR] on these segments, in turn, licenses the projection of a mora. This relates to the [-ɛ]/[-i]/[Ø] alternation in that once these coda sonorants project a mora, they contribute to the satisfaction of a bimoraic minimality condition in Bondu-so on prosodic word well-formedness. Roots ending with a moraic sonorant achieve bimoraicity, which accordingly precludes epenthesis. Such minimality requirements are common cross-linguistically (Hayes 1995). While preliminary, the perspectives that we offer here are generally in line with research exploring correlations between [ATR] and "tensed" sonorants found in Carnie (2002) for Irish and between [ATR] and fortis sonorants found more recently in Uchihara & Báez (2016) for Quiaviní Zapotec.

Root-final sonorants in Bondu-so that do not receive [ATR] from the root vowel fail to license a mora and therefore require epenthesis to achieve bimoraicity. Of course, additional research will be necessary to substantiate certain details of this proposal, particularly regarding any phonetic correlates that distinguish moraic sonorants from their non-moraic counterparts. Preliminary measurements of the Past stem, however, indicate that the length of [l] following a root with a "tense" vowel is slightly longer than that following a "lax" vowel.

## 8 Concluding thoughts

There has been a great deal of research, notably in a series of papers by Casali (2003; 2008; 2016), concerning the characteristics of [ATR] harmony systems from both theoretical and typological perspectives. Our analysis of Bondu-so [ATR] harmony adds substantively to this work given that Casali primarily discusses cases that have been analyzed with contrasts based on binary [±ATR]. One exception to this is his mention of analyses that propose two opposing privative features, [ATR] and [RTR]. Our privative analysis assumes only [ATR] (and not [RTR]) and illustrates that binarity is not necessary to account for the complex VH phenomena that the language exhibits.

Interestingly, Bondu-so's vocalic system is typologically rare. Casali (2003) notes that languages with a full ten vowel system /i ɪ e ɛ a a̧ ɔ o ʊ u/ that retain a surface [ATR] contrast are relatively few in number; examples include Akposso (Anderson 1999) and Degema (Fulop et al. 1998; Archangeli & Pulleyblank 2007; Kari 2007). Although such situations are not discussed in Casali's work, Bondu-so is especially unique in that evidence substantiating its phonemic [ATR] contrast at three heights is opaque, being seen only in suffixal alternations and then only in the behavior of mid vowels. As such, the language maintains its [ATR] contrast covertly via feature spreading.

The fact that Bondu-so maintains a surface [ATR] contrast only in mid vowels aligns with typological predictions borne out in binary systems. For example, our data show that the presence of [ATR] is dominant in this ten-vowel system; Casali's (2003) survey analogously illustrates that [+ATR] is dominant in languages that maintain an [ATR] contrast in high vowels. Bondu-so maintains this contrast, albeit underlyingly, which would arguably be in line with this prediction.

Concerning directionality of harmony, Casali (2008) states: "Although there are interesting cases in which roots change their ATR value to agree with affixes, the far more common case is that affixes alternate in their ATR values to agree with roots." Bondu-so is indeed an interesting case, but one that is more complex than his statement suggests. Bondu-so affixes do alternate in their [ATR] value to agree with roots, but only in the direction of becoming "tense"; we argue that this alternation indicates the addition of [ATR] to a suffixal vowel that is unspecified for the [ATR] feature. [ATR] spreading is rendered opaque, however, by surface constraints on featural co-occurrence. As we have shown, high and low vowel roots are neutralized in their [ATR] specification, resulting in the generalization of [ATR] dominance not being immediately clear.

Bondu-so roots also change their [ATR] values to agree with affixes in some instances, but this is only borne out in certain morphological contexts. That is, only upon the addition of what we have proposed to be a *dominant suffix* can the root [ATR] specification be changed; interesting, however, is that the [ATR] specification can be changed in two directions, either adding or removing [ATR] to/from the root vowel. There is no clear, independent evidence elsewhere in Bondu-so for [–ATR]; therefore, we cannot assert that the behavior triggered by certain dominant suffixes in rendering root vowels "lax" is due to spreading of this value.

This outcome in Bondu-so is particularly unusual given that Casali (2008) asserts that so-called dominant affixes are "invariantly [+ATR]," suggesting therefore that suffixes defined as [–ATR], "lax," or unspecified for [ATR] and behaving in a dominant way are rare (or perhaps unattested?). We introduced above that we attribute such outcomes to a licensing condition by which only those roots structurally dominated by a PWd specified for [ATR] are licensed to express [ATR]. If a root lexically specified for [ATR] is structurally dominated by a suffix lacking [ATR], root [ATR] is not licensed and therefore removed. However, if a root lexically unspecified for [ATR] is structurally dominated by a suffix specified for [ATR], the root can and must express [ATR]. This is yet another manifestation of [ATR] dominance.

With these thoughts in mind, we would argue that this paper has made contributions to language description, to the typology of ATR harmony systems, and to theoretical approaches to the analysis of vowel harmony. We have presented data on Bondu-so [ATR] harmony that extends beyond what has yet been reported in the literature, and notably in Hantgan & Davis (2012). Bringing these more robust data to light is important, first and foremost, because Bondu-so and Dogon languages in general remain relatively understudied and are arguably endangered languages whose genetic relatedness to other African languages is yet unclear. Data from the languages have only recently come to appear in published literature, and therefore the languages' unique properties are not familiar to many scholars other than specialists on African languages.

Concerning typology, we have shown that seemingly unusual alternations that arise in Bondu-so are generally in line with what we have come to expect of ATR harmony systems cross-linguistically. Bondo-so is unique, however, in that it presents no direct evidence for ATR binarity; extant surveys of ATR systems (Casali 2003; 2008; 2016) are almost entirely predicated on binary systems, thus leaving open the question as to where languages with properties like Bondu-so's fit. Bondu-so has both root-controlled and dominant-recessive vowel harmony, but once again, the language is unique in that it appears to have dominant suffixes that are unspecified for [ATR] that fail to license the retention of this feature on preceding material.

Finally, from a theoretical perspective, we have endeavored to show that Morén's *Parallels Structures Model*, which assumes a limited set of privative features, can account for the vowel harmony patterns observed in Bondu-so. To our knowledge, our is the first work employing this model to illustrate its utility in the analysis of vowel harmony. The model makes accurate predictions about the distribution of both transparent and more opaque alternations resulting from vowel harmony as observed in a variety of verb contexts. Based on the Bondu-so data, however, we have proposed a few typologically well-supported modifications to the model's proposed Vowel Manner features that we believe strengthen it. Whether these changes hold more broadly, and whether or not they are extensible to Consonant Manner, or might have reflexes in Place features is a matter ready to explore in future research.

## Acknowledgements

We are indebted to our patient primary consultants, Hama and Issa Sangalbah, who provided the data for this research. We are also grateful to Stuart Davis, Laura McPherson, Sharon Rose, Laura Downing, Dave Odden, and three anonymous reviewers for their comments and suggestions on this work. We also acknowledge thoughtful suggestions from audience members at GLOW 41, WOCAL 9, ACAL 45, and University College London. Of course, all remaining errors and shortcomings are solely our responsibility.

## Funding Information

This research was partially funded by US National Science Foundation grant BCS-0537435, "Dogon languages of Mali" of which Jeffrey Heath is the Principal investigator.

## Competing Interests

The authors have no competing interests to declare.

## References

Anderson, Colleen G. 1999. ATR vowel harmony in Akposso. *Studies in African Linguistics* 28(2). 185–214.

Archangeli, Diana. 1988. Aspects of Underspecification Theory. *Phonology* 5. 183–207. DOI: https://doi.org/10.1017/S0952675700002268

Archangeli, Diana & Douglas Pulleyblank. 1994. *Grounded Phonology*. Cambridge, MA: MIT Press.

Archangeli, Diana & Douglas Pulleyblank. 2007. Harmony. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 353–378. Cambridge, UK: Cambridge University Press.

Baković, Eric. 2000. *Harmony, dominance, and control*. New Brunswick, NJ: Rutgers University dissertation.

Blaho, Sylvia. 2008. *The syntax of phonology: A radically substance-free approach*. Trømso, Norway: University of Trømso dissertation.

Carnie, Andrew. 2002. A note on diphthongization before tense sonorants in Irish: An articulatory explanation. *Journal of Celtic Linguistics* 7. 129–148.

Casali, Roderic F. 2003. [ATR] value asymmetries and underlying vowel inventory structure in Niger-Congo and Nilo-Saharan. *Linguistic Typology* 7. 307–382. DOI: https://doi.org/10.1515/lity.2003.018
Casali, Roderic F. 2008. ATR harmony in African languages. *Language and Linguistics Compass* 2(3). 496–549. DOI: https://doi.org/10.1111/j.1749-818X.2008.00064.x
Casali, Roderic F. 2016. Some inventory-related asymmetries in the patterning of tongue root harmony systems. *Studies in African Linguistics* 45. 95–140.
Clements, George N. 1985. The geometry of phonological features. *Phonology Yearbook* 2. 225–252. DOI: https://doi.org/10.1017/S0952675700000440
Clements, George N. 1991. Place of articulation in consonants and vowels: A unified theory. *Working Papers of the Cornell Phonetics Laboratory* 5. 77–123.
Cole, Jennifer & Loren Trigo. 1988. Parasitic harmony. In Harry van der Hulst & Norval Smith (eds.), *Features, segmental structure and harmony processes (Part II)*, 19–38. Dordrecht: Foris.
Fulop, Sean, Ethelbert Kari & Peter Ladefoged. 1998. An acoustic study of the tongue root contrast in Degema vowels. *Phonetica* 55(2). 80–98. DOI: https://doi.org/10.1159/000028425
Goldsmith, John. 1985. Vowel harmony in Khalka Mongolian, Yaka, Finnish, and Hungarian. *Phonology Yearbook* 2. 253–275. DOI: https://doi.org/10.1017/S0952675700000452
Goldsmith, John. 1987. Vowel systems. In Anna Bosch, Barbara Need & Eric Schiller (eds.), *Papers from the Parasession on Autosegmental and metrical phonology*, 116–133. Chicago: Chicago Linguistic Society.
Goldsmith, John. 1990. *Autosegmental and Metrical Phonology*. Oxford: Blackwell.
Green, Christopher R. & Michael C. Dow. 2017. The morphophonology of nouns in Najamba (Dogon). In Samuel G. Obeng & Christopher R. Green (eds.), *African linguistics in the 21st century*, 57–70. Köln: Rüdiger Köppe.
Halle, Morris, Bert Vaux & Andrew Wolfe. 2000. On feature spreading and the representation of place of articulation. *Linguistic Inquiry* 31(3). 387–444. DOI: https://doi.org/10.1162/002438900554398
Hantgan, Abbie. 2013. A grammar of Kindigué. http://dogonlanguages.org/sources/hantgan2013kindigue.
Hantgan, Abbie & Stuart Davis. 2012. Bondu-so vowel harmony: A descriptive analysis with theoretical implications. *Studies in African Linguistics* 41(2). 1–26.
Hayes, Bruce. 1995. *Metrical stress theory*. Chicago: University of Chicago.
Heath, Jeffrey. 2014. Dogon ATR harmony. Ms. University of Michigan. https://cdstar.shh.mpg.de/bitstreams/EAEA0-BEA8-9A2B-BAC9-0/a.pdf.
Heath, Jeffrey. 2017. *A grammar of Najamba (Dogon, Mali)*. Jena, Germany: Language Description Heritage Library. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/139022/Heath_Najamba_Grammar%20reduced.pdf?sequence=1&isAllowed=y.
Hyman, Larry M. 1988. Underspecification and vowel height transfer in Esimbi. *Phonology* 5(2). 255–273. DOI: https://doi.org/10.1017/S0952675700002293
Iosad, Pavel. 2012. *Representation and variation in substance-free phonology: A case study in Celtic*. Trømso, Norway: University of Trømso dissertation.
Ito, Junko. 1986. *Syllable theory in prosodic phonology*. Amherst, MA: University of Massachusetts, Amherst dissertation.
Ito, Junko & Armin Mester. 1999. Realignment. In Harry van der Hulst René Kager & Wim Zonneveld (eds.), *The prosody-morphology interface*, 188–217. Cambridge, UK: Cambridge University Press.

Kari, Ethelbert. 2007. Vowel harmony in Degema, Nigeria. *African Study Monographs* 28(2). 87–97.

Lieber, Rochelle. 1980. *The organization of the lexicon*. Cambridge, MA: Massachusetts Institute of Technology dissertation.

Lombardi, Linda. 1995. *Laryngeal features and laryngeal neutralization*. New York: Garland.

McPherson, Laura. 2013. *A grammar of Tommo so*. Berlin: de Gruyter Mouton.

McPherson, Laura & Bruce Hayes. 2016. Relating application frequency to morphological structure: The case of Tommo so vowel harmony. *Phonology* 33(1). 125–167. DOI: https://doi.org/10.1017/S0952675716000051

Mielke, Jeff. 2005. Ambivalence and ambiguity in laterals and nasals. *Phonology* 22. 169–203. DOI: https://doi.org/10.1017/S0952675705000539

Morén, Bruce. 2003a. Affricates, palatals, and iotization in Serbian: Representational solutions to longstanding puzzles. *Poljarnyj Vestnik* 6. 46–70. DOI: https://doi.org/10.7557/6.1344

Morén, Bruce. 2003b. The Parallel Structures Model of feature geometry. *Working Papers of the Cornell Phonetics Laboratory* 15. 194–270.

Morén, Bruce. 2006. Consonant-vowel interactions in Serbian: Features, representation, and constraint interaction. *Lingua* 116. 1198–1244. DOI: https://doi.org/10.1016/j.lingua.2005.04.003

Morén, Bruce. 2007. The division of labor between segment-internal structure and violable constraints. In Sylvia Blaho, Patrick Bye & Martin Krämer (eds.), *Freedom of analysis?*, 313–344. Berlin: Mouton de Gruyter. DOI: https://doi.org/10.1515/9783110198591.313

Odden, David. 1991. Vowel geometry. *Phonology* 8(2). 261–289. DOI: https://doi.org/10.1017/S0952675700001408

Parker, Stephen G. 2002. *Quantifying the sonority hierarchy*. Amherst, MA: University of Massachusetts, Amherst dissertation.

Payne, David L. 1981. *The phonology and morphology of Axininca Campa*. Dallas, TX: SIL.

Rice, Keren. 1992. Blocking and privative features: A prosodic account. *The Linguistic Review* 9(4). 359–393. DOI: https://doi.org/10.1515/tlir.1992.9.4.359

Steriade, Donca. 1994. Positional neutralization and the expression of contrast. Ms. University of California, Los Angeles.

Uchihara, Hiroto & Gabriela Pérez Báez. 2016. Fortis/lenis glides and vowels in Quiaviní Zapotec. *Glossa* 1. 1–24. DOI: https://doi.org/10.5334/gjgl.13

van der Torre, Erik Jan. 2003. *Dutch sonorants: The role of place of articulation in phonotactics*. Leiden: Universiteit Leiden dissertation.

Vaux, Bert. 1996. The status of [ATR] in Feature Geometry. *Linguistic Inquiry* 27(1). 175–182.

Walker, Rachel. 2004. Vowel feature licensing at a distance: Evidence from northern spanish language varieties. In Benjamin Schmeiser, Vineeta Chand, Ann Kelleher & Angelo J. Rodriguez (eds.), *Proceedings of the 23rd West Coast Conference on Formal Linguistics*, 787–800. Somerville, MA: Cascadilla.

Walker, Rachel. 2011. *Vowel patterns in language*. Cambridge, UK: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511973710

Youssef, Islam M. 2006. *Vocalic feature assimilation in Cairene Arabic and Buchan Scots: Contrast and phonological activity in the Parallel Structures Model of feature geometry*. Trømso, Norway: University of Trømso MA thesis.

Youssef, Islam M. 2013. *Place assimilation in Arabic: Contrasts, features, and constraints*. Trømso, Norway: University of Trømso dissertation.

**How to cite this article:** Green, Christopher R. and Abbie E. Hantgan. 2019. A feature geometric approach to Bondu-so vowel harmony. *Glossa: a journal of general linguistics* 4(1): 35. 1–29, DOI: https://doi.org/10.5334/gjgl.793

**Submitted:** 31 August 2018 **Accepted:** 13 December 2018 **Published:** 06 March 2019



]u[ *Glossa: a journal of general linguistics* is a peer-reviewed open access journal published by Ubiquity Press. **OPEN ACCESS**