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RESEARCH

A reanalysis of abstract contrasts and opacity in Bondu-so tongue root harmony

Jade J. Sandstedt
University of Oslo, NO
jade.sandstedt@nhm.uio.no

This paper explores a number of controversial consequences of previous abstract analyses of Bondu-so (Dogon) vowels and vowel harmony, particularly for the explanation of phonological opacity. Bondu-so has been characterised as displaying asymmetrically-patterning bidirectional harmony, a four-way [ATR] contrast on mid-vowel suffixes, and abstract [±ATR] contrasts on high and low vowels which display distinct phonological behaviours but which never surface, being absolutely neutralised (Hantgan & Davis 2012). I show that each of these unusual generalisations stems from the crucial mischaracterisation of underlying vowel contrasts and the direction of harmony in surface-ambiguous data. With a re-classification of the data, Bondu-so harmony patterns are characterisable as regular, derivationally transparent leftwards [RTR]-harmony with harmonically neutral non-contrastive high and low vowels – requiring no abstract contrasts, directional harmony asymmetries, or opacity of any kind. Following this non-abstract reanalysis, Bondu-so is revealed to be typologically and theoretically fully consistent with other harmony languages. This review of Bondu-so vowel patterns represents therefore an important contribution to the “abstractness controversy” – revealing important analytical and methodological issues in abstract approaches to phonological opacity.

Keywords: abstract contrasts; absolute neutralisation; opacity; vowel harmony; Dogon

1 Introduction

This paper explores various typologically and theoretically contentious claims that have recently been made about the vowel inventory and tongue root vowel harmony system of Bondu-so, a Dogon language spoken in Mali. Bondu-so has been analysed as displaying three typologically- and theoretically-rare characteristics: 1) a complex bidirectional tongue root harmony system with a rare bleeding relationship between leftwards and rightwards harmony, 2) a four-way [ATR] contrast on mid-vowel suffixes (i.e. suffixes which are [+ATR], [–ATR], underspecified, or underspecified with a floating [+ATR] autosegment), and 3) abstract or covert [±ATR] contrasts on high and low vowels which are phonologically active but which never surface, resulting in widespread opaque phonological patterns (Hantgan & Davis 2012; Heath 2014; Green & Hantgan 2019).

In this paper, I pursue the implications of these generalisations for broader phonological theory with particular focus on the use of abstract contrasts for the explanation of phonological opacity.[1] I show that previous analyses of Bondu-so opaque harmony patterns,

[1] In this context, derivational opacity should be distinguished from what is sometimes called “harmony opacity;” that is, where some segment or environment blocks the harmony procedure from applying to some potential target further downstream (i.e. a segment or environment which is *opaque* to harmony). In this paper, “opacity” always refers to derivational opacity resulting from a non-bleeding/non-feeding interaction between two processes and not harmony blocking. Somewhat ironically, as pointed out by Kiparsky & Pajusalu (2006: 218, fn. 3), harmony opacity results in derivational transparency while harmony transparency (skipped or non-visible segments) results in derivational opacity.

which incorporate phonologically active abstract contrasts with absolute neutralisation, are neither falsifiable nor independently motivated – suggesting that the locus of explanation lies elsewhere. I posit that all of the unusual generalisations made about Bondu-so are products of the mischaracterisation of a select set of data. Specifically, the direction of harmony is ambiguous in certain surface data (e.g. [dɔ̀gɛ̀] 'leave (it)'-PERF.). While previous analyses have all interpreted these ambiguous cases as involving rightwards harmonic spreading from roots to suffixes, I pursue the alternative – that tongue root harmony in Bondu-so is always suffix-controlled. I show that the incorrect generalisation of harmony triggers/targets in this class of data has important implications for broader Bondu-so vocalic phonology. This simple correction of Bondu-so surface generalisations eliminates all of the theoretically and typologically controversial issues raised in previous analyses; Bondu-so requires no abstract or quarternary contrasts, asymmetrically patterning bidirectional harmony, or derivational opacity of any kind. I demonstrate following these revisions that Bondu-so vowel harmony is perfectly systematic and theoretically and typologically fully consistent with other well-documented tongue root harmony systems.

This paper which contrasts competing "concrete" and "abstract" analyses of a set of ambiguous data provides an important contribution to the "abstractness controversy" literature (e.g. Kiparsky 1968; 1973; Hyman 1970; 1988; 2003; Crothers 1971; Baković 2009). The abstractness controversy in phonology relates to how closely phonological representations reflect surface sound patterns, and whether language learners posit underlying segments which are not realised phonetically. The terms "concrete" and "abstract" in this context can be misleading, as both necessarily involve degrees of abstraction. To illustrate this point, I provide examples of "concrete" and "abstract" phonological representations in Figure 1. On the left in Figure 1a, we observe examples of "concrete" /k g/ phonemic distinctions with observable [k g] surface contrasts. Figure 1a also implies some rule-driven [k g] alternations which may represent something like word-final devoicing where /g/ surfaces as [k] word-finally, but as [g] elsewhere. This kind of generalisation involves abstraction – i.e. two surface variants [k g] are derived from a common, underlying phoneme /g/ – but crucially all phonemic contrasts have transparent, "concrete" surface correlates in some environment: e.g. contrastive non-word-final [k] vs. [g]. By comparison, Figure 1b on the right illustrates /k g/ contrasts which are universally neutralised to [k] on the surface. This means that there are two kinds of *k* in this language with unique phonological properties: for example, k_1 (/g/) may behave as if specified for voicing while k_2 (/k/) does not. In this case, all *k*'s are phonetically indistinguishable, but an "abstract" contrast is motivated by dissimilar phonological patterning.

Traditional "concrete" phonological representations as in Figure 1a reduce complexity through phonological generalisations (e.g. word-final devoicing) and do not posit more underlying contrasts than are observed on the surface, but concrete analyses may struggle to explain why a given segment *k* displays multiple distinct phonological patterns in some language, such as opaque vowel lengthening: e.g. [a:k_1] vs. [ak_2].

(a) "Concrete" /k g/ contrasts. **(b)** "Abstract" /k g/ contrasts.

Figure 1: Abstract and more abstract representations in phonology.

Concrete analyses will be forced to shift the explanation of these divergent patterns to lexical storage: i.e. /aːk/ vs. /ak/. By contrast, more "abstract" representations as in Figure 1b posit more complex sound inventories than what actually surfaces but can capture generalisations where surface-identical segments (e.g. k_1 and k_2) display apparently contradictory phonological behaviours. Both types of representations in Figure 1 are therefore *abstract*, but the degree of "concreteness" or "abstractness" of a given representation has to do with the derivational transparency of the contrast. Abstract representations always involve some form of opacity, counterbled by the absolute neutralisation of the abstract contrast: e.g. vowel lengthening triggered by word-final voiced consonants with subsequent neutralisation in /ag/ → {aːg} → [aːk] vs. /ak/ → [ak]. In other words, "the process ensuring that the abstract element does not surface intact *fails to bleed* any process that takes crucial advantage of the element's abstract property" (Baković 2009: 10, emphasis in original). Opaque vowel harmony patterns have commonly been used as evidence for abstract or covert contrasts, but this paper's review of Bondu-so vowel patterns questions the validity of abstract approaches to phonological opacity.

Opacity via absolute neutralisation lacks independent motivation (circularity); that is, the neutralisation of /g k/ contrasts cannot be observed independent of vowel lengthening patterns (the sound pattern the abstract contrasts should explain). Abstract analyses of this form therefore rely on their conclusion (i.e. that phonetically indistinguishable k_1 and k_2 display unique phonological patterning) to prove their premise (that there are abstract /g/ (k_1) and /k/ (k_2) contrasts which undergo absolute neutralisation) rather than a transparent surface contrast /aːk/ vs. /ak/ as proposed by a competing concrete analysis. These analytical shortcomings draw into question the validity of abstract accounts of apparent phonological opacity and emphasise the importance of adequate, independent motivation and hypothesis falsifiability as essential metrics for evaluations of competing abstract and non-abstract analyses of ambiguous linguistic data.

1.1 Background and basic generalisations

In this section, I summarise the core generalisations which are common to previous studies of Bondu-so vowels and vowel harmony (see chiefly Hantgan & Davis 2012; Heath 2014; Green & Hantgan 2019). Though these studies vary in theoretical framework, their overall focus and principal surface assumptions regarding Bondu-so vowels and vowel harmony are in general the same. I therefore do not differentiate between them in this summary except where explicitly indicated.

The most important characteristics of Bondu-so vowel harmony are summarised by the data in (1). Roots are assumed to be contrastive for [ATR] and trigger harmony on suffixes, as illustrated by the perfective: e.g. [+ATR] [nòj-è] vs. [–ATR] [dɔ̀g-ɛ̀].[2] But Bondu-so also features non-harmonising suffixes which determine the [±ATR] value on roots – displaying both dominant suffix-controlled [+ATR] harmony (e.g. the infinitive /dɔg-iloŋ/→[dòg-ílòŋ]) as well as dominant suffix-controlled [–ATR] harmony (e.g. the mediopassive /noj-ijɛ/→[nɔ̀j-íjɛ́]).[3] High and low vowels are non-alternating and are harmonically transparent on the surface: e.g. non-local [–ATR]-harmonic [nɔ̀j-**í**jɛ], not *[nɔ̀j-ɪ́jɛ] in (1).

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[2] Advanced and retracted tongue root – commonly abbreviated as ATR or RTR – describes the relative retraction of the tongue root during the pronunciation of vowels; see Ladefoged & Maddieson (1996: pp. 300–06) for an overview. When relevant I underline the harmony trigger or feature-donor environment.

[3] The patterning of Bondu-so tones is not entirely clear, and I therefore do not represent tonal specifications in underlying representations.

(1) *Bidirectional [+ATR] and [–ATR] harmony in Bondu-so*

	UR of root	Underspecified (perfective)	[+ATR] suffix (infinitive)	[–ATR] suffix (mediopassive)
[+ATR] root	/noj-/ 'sleep'	[nòj-è]	[nój-ílòŋ]	[nɔ̀j-íjɛ́]
[–ATR] root	/dɔg-/ 'leave (it)'	[dɔ̀g-ɛ̀]	[dòg-ílòŋ]	[dɔ̀g-íjɛ́]

According to the generalisations in (1), Bondu-so displays a number of rare characteristics. First, the data may be interpreted as evidencing an equipollent, ternary [ATR] contrast on mid-vowel suffixes, distinguishing [+ATR] /-(i)loŋ/, [–ATR] /-ijɛ/, and Ø /-E/ (i.e. underspecified for [ATR]).[4] These representations capture the dichotomy between featurally specified [±ATR] /-(i)loŋ, -ijɛ/ – which trigger harmony and never undergo harmony alternations – and featurally underspecified Ø /-E/, which cannot trigger harmony but instead must get its [ATR]-specification from preceding roots, resulting in bidirectional harmony (e.g. root-controlled [nòj-è, dɔ̀g-ɛ̀] vs. suffix-controlled [nój-ílòŋ, nɔ̀j-íjɛ́]).

If this account is correct, then the data in (1) raise a number of difficult, broader phonological questions. First, these generalisations constitute a significant challenge for privative feature theories. This is so because the generalisation of Bondu-so suffix-controlled harmony requires both symmetric [+ATR] *and* [–ATR] feature values since both underlying [–ATR]- and [+ATR]-specified roots /dɔg-, noj-/ undergo harmony alternations in their infinitive and mediopassive forms, respectively (i.e. [dòg-ílòŋ] and [nɔ̀j-íjɛ́]). Second, Bondu-so vowel harmony is directionally asymmetric; [αATR]-root and [-αATR]-suffix harmony in theory overlap in forms such as INF. /dɔg-iloŋ/ → [dòg-ílòŋ] and MED. PASS. /noj-ijɛ/ → [nɔ̀j-íjɛ́]. In these cases, both roots and suffixes are potential harmony triggers and targets, oppositely specified for the harmony feature, but suffix-controlled harmony always wins out. In other words, leftwards harmony bleeds rightwards harmony, changing the root featural specification before it can trigger harmony on the suffix. This is true regardless of the feature values involved; a [+ATR] suffix can advance a [–ATR] root, and a [–ATR] suffix can retract a [+ATR] root. This shows that neither [+ATR] or [–ATR] is dominant. According to the assumptions in (1), Bondu-so vowel harmony is inherently directionally asymmetric, and its harmony feature must be equipollent.[5] A third reported complication of Bondu-so vowel harmony is that it is not always surface true. Bondu-so displays only seven surface vowels: [±ATR]-paired [e ɛ o ɔ] and unpaired [i u a] – lacking *[ɪ ʊ ə] on the surface. High and low vowels are unpaired for the tongue root feature and therefore do not display harmony alternations; that is, they are *harmonically neutral* or non-undergoers of harmony (e.g. [dòg-ílòŋ] vs. [dɔ̀g-íjɛ́], not *[dɔ̀g-ɪ́jɛ́]). Though the behaviour of harmonically unpaired segments in target positions is predictably neutral, in harmony trigger positions high and low vowels behave unpredictably. Despite not being overtly contrastive for the harmony feature, there appear to be

[4] Bondu-so additionally displays a fourth type of suffix such as imperative [-o, -a] which alternate like the perfective /-E/ but which nevertheless trigger uniform [+ATR] harmony on roots like [+ATR] /-(i)loŋ/ suffixes. These alternating but triggering suffixes have been analysed as /-[+ATR]A/ by Hantgan & Davis (2012: §2.4); that is, underspecified for the harmony feature – undergoing root-controlled alternations – but which come with a floating [+ATR] autosegment, triggering [+ATR] harmony on roots: e.g. /dɔg-[+ATR]A/ → {dɔg-[+ATR]a} → [dóg-á] 'leave (it)'-IMP. For the sake of simplicity, I currently ignore these suffixes in this introduction, but see sections 3.1 and 3.4 for a full analysis of these unique patterns.

[5] Though they assume the same surface generalisations outlined here, it should be pointed out that Green & Hantgan (2019) in actuality advocate a privative analysis of Bondu-so with marked [ATR] vs. unmarked non-ATR. They achieve this, however, by separating the harmony mechanism into two separate processes: [ATR]-*spreading* in ATR harmony environments and [ATR]-*delinking* to account for RTR harmony. Regardless of the theoretical particulars, all existing analyses of Bondu-so assume the symmetric (non-dominant) ATR and RTR harmony generalisations summarised in (1).

[+ATR] and [–ATR] high and low root-vowel stems which trigger [+ATR] and [–ATR] harmony on harmonising suffixes, respectively, as illustrated by the harmonising perfective suffix in (2). This results in opaque harmony patterns such as [gìj-ɛ̀] or [bàr–è], where [±ATR]-harmony appears to have applied but without any obvious motivation, resulting in surface disharmony.

(2) *Distinct high/low vowel [±ATR]-harmony in Bondu-so*

[+ATR] root			[–ATR] root		
/bij-/	[bìj-è]	‘lay down’-PERF.	/gɪj-/	[gìj-ɛ̀]	‘kill’-PERF.
/sug-/	[sùg-è]	‘go down’-PERF.	/ʤʊg-/	[ʤùg-ɛ̀]	‘recognise’-PERF.
/bər-/	[bàr–è]	‘help’-PERF.	/pag-/	[pàg-ɛ̀]	‘tie’-PERF.

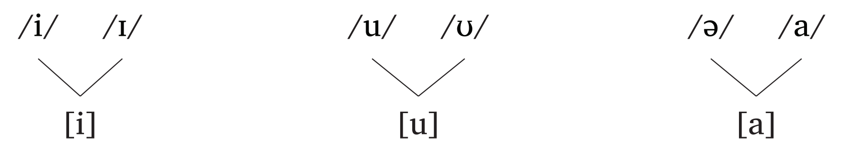
It was shown in (1) that the perfective suffix /-E/ receives its [±ATR] specification from preceding roots – e.g. [nò̱j-è] ‘sleep’-PERF. vs. [dɔ̱̀g-ɛ̀] ‘leave (it)’-PERF. If this is correct, then high and low vowels must genuinely trigger both [±ATR] harmony in (2) and therefore must be underlyingly contrastive for the harmony feature, even if they do not appear to be on the surface. This would be an example of “abstract” or “covert” contrasts which are universally neutralised in Bondu-so, as represented in Figure 2.

Abstract segments, in comparison to “concrete” or “plain” segments, represent a set of phonemes with distinct phonological behaviour – in this case /ɪ ʊ ə/ – but which for whatever reason are not permitted to be realised phonetically and undergo absolute neutralisation after other phonological processes have applied (counterbleeding opacity). An example of the assumed abstract interaction between tongue root harmony and the neutralisation of tongue root contrasts in Bondu-so is provided in (3).

(3) /gɪj-E/ → {gɪj-ɛ} → [gij-ɛ]

In the first step of the derivation in (3), an underlying [–ATR] /ɪ/ spreads [–ATR] to an underspecified suffix /-E/, but [–ATR, +high] vowels are not permitted to surface in Bondu-so, neutralising abstract /i ɪ/ contrasts to [i] which produces surface disharmonic forms such as [gìj-ɛ̀] ‘kill’-PERF. This abstract interplay between tongue root harmony and contrast neutralisation results in opaque harmony, where the suffix has acquired a [–ATR]-specification but with no obvious [–ATR] feature source on the surface. Given the covert nature of underlying tongue root contrasts on high and low vowels in (2, 3), Green & Hantgan (2019) call these “displaced contrasts,” since the tongue root distinctions on high and low vowels are only revealed indirectly by their phonological effects on other segments – in other words, the contrast has been “displaced” from the root to the suffix.

The advantage of abstract or covert approaches like (3) is that apparent exceptional data such as disharmonic [gìj-ɛ̀] can be reconciled as phonologically regular. In Bondu-so, both



(a) “Abstract” /i ɪ/ contrasts. **(b)** “Abstract” /u ʊ/ contrasts. **(c)** “Abstract” /ə a/ contrasts.

Figure 2: Abstract tongue root contrasts on high and low vowels in Bondu-so.

harmonic [bij-è] 'lay down'-PERF. and apparent harmony exceptions such as [gìj-ɛ̀] 'kill'-PERF. can be construed as predictable products of the interleaving interaction between harmony and contrast neutralisation. In other words, both forms are harmonic at some abstract level: e.g. pre-neutralisation {gɪj-ɛ} in (3). Following this abstract account, [gìj-ɛ̀] is therefore not a genuine exception to the harmony rule. In fact, this analysis posits that no forms with harmonically neutral high or low vowels in Bondu-so are true harmony exceptions. With enough abstraction, any surface disharmonic form can be construed as harmonic at some level with the subsequent neutralisation of the harmony trigger (or target) contrasts, like in (3).

To summarise the received story, Bondu-so features 1) a bidirectional tongue harmony system which is directionally asymmetric; leftwards harmony bleeds rightwards harmony. 2) Bondu-so displays equipollent featural distinctions on mid-vowel suffixes – [+ATR], [–ATR], and underspecified Ø – which are not obviously compatible with privative or monovalent feature theories. 3) Bondu-so vowel harmony is commonly not surface true, with widespread harmony opacity. This has been interpreted as evidence of abstract tongue root contrasts on high/low vowels which are phonologically active but which never surface. Finally, as I explore in greater detail in section 3.5, the implications above in combination with the treatment of other inflectional categories in Bondu-so requires additional phonological processes and contrasts, such as opaque vowel raising which motivates a fourth contrast on mid-vowel suffixes; that is, underspecified vowels with floating [+ATR] autosegments which undergo root-controlled harmony but simultaneously trigger regressive vowel harmony on roots. Each of these individual characteristics are not necessarily suspicious on their own, but altogether they make Bondu-so a theoretically and typologically highly unusual segmental phonological system. In this paper, I illustrate crucial analytical problems in this analysis of Bondu-so and illustrate how each of these unusual characteristics stems from the simple misinterpretation of a specific class of surface-ambiguous data. Specifically, in section 2, I examine the assumed opaque interaction between tongue root harmony and the neutralisation of tongue root contrasts in greater detail. Here I demonstrate how the assumption of abstract contrasts to explain apparent harmony exceptions lacks independent motivation (circularity) and by definition admits no potential counter-evidence (non-falsifiability). I show that there is one alternative way of interpreting the surface harmony patterns in Bondu-so in section 2.1 which has been previously overlooked. I explore the detailed implications of this alternative analysis for Bondu-so neutral harmony patterns in section 3, revealing important missed generalisations in previous studies. This reanalysis demonstrates that Bondu-so is both theoretically and typologically fully consistent with other well-studied harmony languages and requires no abstract contrasts, bidirectional harmony asymmetries, or opacity. Bondu-so involves a straightforward, systematic, and fully derivationally transparent case of unidirectional (leftwards or anticipatory) tongue root harmony with harmonically transparent non-contrastive high and low vowels, akin to countless other harmony languages. Using Bondu-so vowels and vowel harmony as a case-study, this "concretist" analysis provides strong, principled arguments against the explanation of opaque or exceptional phonological data via abstract contrasts and absolute neutralisation. An overall summary of the problems I have taken up in this paper and their solution is provided in section 4.

2 The problems with abstract analyses

Previous abstract analyses of Bondu-so like (3) involves a case of *counterbleeding opacity* (cf. Kiparsky 1973; Baković 2009; 2011). As illustrated below in (4), given the proposed ordered relationship between vowel harmony and neutralisation, /ɪ ʊ ə/ can trigger harmony but can never surface, being subsequently neutralised. If the two processes were ordered the other way around, neutralisation would eliminate tongue root contrasts on high and low vowels before they could trigger distinct harmony patterns (a *bleeding* relationship), but instead neutralisation always fails to bleed harmony (*counterbleeding*), resulting in harmony opacity wherein harmony appears to have applied in [gìj-ɛ̀] 'kill'-PERF. or [bàr–è] 'help'-PERF. but without any overt trigger on the surface – an example of counterbleeding opacity via absolute neutralisation.

(4) *Bondu-so harmony opacity via neutralisation*

	/bij-E/	/gɪj-E/	/pag-E/	/bər-E/
HARMONY	bij-e	gɪj-ɛ	pag-ɛ	bər-e
NEUTRALISATION	–	gij-ɛ	–	bar-e
	[bìj-è] 'lay down'-PERF.	[gìj-ɛ̀] 'kill'-PERF.	[pàg-ɛ] 'tie'-PERF.	[bàr-è] 'help'-PERF.

Vaux (2008: 32) argues such opaque interactions are learnable; the two processes simply need to be independently motivated in transparent contexts. For example, in (5) we have a hypothetical language with the palatalisation of /t/→[ʧ] before front vowels and vowel deletions in vowel hiatuses. Crucially, palatalisation and vowel deletions occur transparently in independent contexts: e.g. /te/→[ʧe] and /to-u/→[tu]. This means that language learners observe independent environments which provide non-ambiguous evidence for the existence of both processes. We can analyse palatalisation independently of vowel deletions and vice versa. In certain circumstances, a form may satisfy the conditions for both palatalisation (/**ti**-u/) and vowel deletions (/t**i-u**/). In this case, either the first vowel in the hiatus will be deleted –/ti-u/→[tu] – removing the triggering environment for palatalisation (transparent bleeding), or vowel deletion will fail to bleed palatalisation /ti-u/→{ʧi-u}→[ʧu], resulting in counterbleeding opacity. The language in (5) displays the latter outcome. In [ʧu] palatalisation appears to have applied, producing a palatalised [ʧ], but without any palatalising front vowel on the surface, having been counterbled by the vowel deletion rule. This is just like vowel harmony in Bondu-so [gìj-ɛ̀], where [–ATR] harmony appears to have applied, but without any [–ATR] trigger on the surface.

(5) *Hypothetical counterbleeding opacity with independent motivation*

		/te/	/to-u/	/ti-u/
PALATALISATION	t→ʧ / { _i, _e }	ʧe	–	ʧi-u
DELETION	V→∅ / _V	–	tu	ʧ-u
		[ʧe]	[tu]	[**ʧu**]

Following serial, rule-based models of phonology like Vaux (2008), language learners should be able to recover the simple counterbleeding interaction in (5) because the two processes are independently motivated. Language learners have sufficient independent evidence of both palatalisation and vowel deletions in distinct contexts and therefore should be able to work backwards from opaque forms like [ʧu] to underlying representations like /ti-u/ which satisfy the conditions for both processes.

As very conservatively put by Baković (2009: 11), this requirement of independent motivation is however an unfortunate "handicap for abstract analyses" like that which we have seen for Bondu-so in section 1 (cf. Hantgan & Davis 2012; Heath 2014; Green &

Hantgan 2019). This is so because the assumed absolute neutralisation of abstract tongue root contrasts in Bondu-so cannot be independently motivated. Absolute neutralisation cannot be observed independently of its effects on orthogonal processes, such as vowel harmony. This is illustrated by bare verb stems in Bondu-so recently presented by Green & Hantgan (2019), such as [mín] wait in (6). Before looking at what other suffixes this stem takes, it is impossible to say what the underlying value of this vowel should be: /mín-/ or /mɪ́n-/? In other words, the interpretation of neutralisation in Bondu-so is crucially *dependent* on vowel harmony, as illustrated by the neutralised stem /mɪn-/ 'swallow' in (6). Unlike the independent patterning of palatalisation and vowel deletions above in (5), there is no environment where we can examine or motivate neutralisation independent of its interaction with vowel harmony in Bondu-so.

(6) *Neutralisation in Bondu-so is not independently motivated*

	/gɔm-E/	/m?n-/	/mɪn-E/
Harmony	gɔm-ɛ	–	mɪn-ɛ
Neutralisation	–	??	min-ɛ
	[gɔ́m-ɛ́] 'reek'	[mín-] 'wait'	[mín-ɛ́] 'swallow'

This shortcoming of abstract analyses has important analytical implications. The lack of independent evidence for the neutralisation of tongue root contrasts in Bondu-so means that there is no possible way to confirm or disprove abstract /i ɪ u ʊ ə a/ contrasts. The abstract segments by definition cannot be observed (otherwise they would be concrete or plain segments), and they do not figure in any other linguistic pattern in Bondu-so. Abstract contrasts are thus only evidenced by the distinct harmony patterns in (7), repeated from (2), which they are supposed to explain. In other words, in (7) we observe [-e, -ɛ] alternations which imply underlying root-vowel abstract /i ɪ u ʊ ə a/ contrasts which in turn should derive [-e, -ɛ] suffixal alternations – the analysis relies on its conclusion (i.e. that high and low vowels are harmonic triggers) to prove its premise (i.e. that there are unobservable abstract ATR/RTR contrasts on high and low vowels).

(7) *Distinct high/low vowel [±ATR]-harmony in Bondu-so*

[+ATR] root			[–ATR] root		
/bij-/	[bìj- è]	'lay down'-PERF.	/gɪj-/	[gìj-ɛ̀]	'kill'-PERF.
/sug-/	[sùg-è]	'go down'-PERF.	/ʤʊg-/	[ʤùg-ɛ̀]	'recognise'-PERF.
/bər-/	[bàr–è]	'help'-PERF.	/pag-/	[pàg-ɛ̀]	'tie'-PERF.

In addition to the above circularity, this analysis ignores important typological insights from harmony neutrality in other languages. Non-alternating vowels in harmony languages such as /i u a/ in Bondu-so may or *may not* trigger harmony. We cannot simply assume /i u a/ trigger harmony in Bondu-so because other vowel classes do; this needs to be evidenced for each non-participating vowel. This distinction between triggering and non-triggering neutral segments is clearly demonstrated in language families with widespread vowel harmony. For instance, 5V Bantu languages commonly display height harmony with alternations between paired [+high] /i u/ and [-high] /e o/ vowels while low /a/ is neutral or non-alternating: e.g. Chewa [phík-il-a] 'cook'-APPL.-FV. vs. [tsék-el-a] 'close'-APPL.-FV (Downing & Mtenje 2017). Across Bantu languages, we observe variation in the behaviour of neutral low vowels. For example, non-alternating low vowels trigger harmonic lowering in languages such as Mbunda (K.15, Gowlett 1970) or Pende (L.11/K.52, Niyonkuru 1978; Hyman (1999: 242–43) – e.g. Mbunda [kwat-el-a], not *[kwat-il-a] 'hold'-APPL.-FV. – while non-alternating low vowels do *not* trigger harmony in languages like Chewa (N.31, Downing & Mtenje 2017) or Shona (S.10, Beckman 1997): e.g. Chewa [vál-il-a], not *[vál-el-a] 'get dressed'-APPL.-FV.[6] The vowel systems and harmony patterns in these languages are otherwise essentially identical, demonstrating a basic dichotomy in vowel harmony systems – neutral (non-alternating/non-participating) segments may act as harmony triggers or not. Thus, when faced with non-alternating vowels like /i u a/ in Bondu-so, the language learner needs to determine which of the two kinds of neutral segments her language features: harmony triggering neutral vowels like in Mbunda/Pende or non-triggering neutral vowels like in Chewa/Shona. In the data we have observed so far, /i u a/ do not obviously trigger harmony on the surface in Bondu-so, co-occurring with both advanced [e o] and retracted [ɛ ɔ] vowels in word-medial (1) as well as word-initial positions (7) – a textbook example of non-triggering transparent segments. Given the typological dichotomy between triggering and non-triggering neutral vowels in harmony languages, there is no obvious evidence against a non-triggering transparent analysis and no non-circular argument for assuming that /i u a/ are covertly contrastive and active in Bondu-so tongue root harmony.

A further complication of the lack of independent evidence for absolute neutralisation in Bondu-so is that there are no data which could falsify an abstract account of neutral /i u a/ vowel patterns in Bondu-so. There can be no counter-evidence (e.g. exceptions to the harmony rule) because any seemingly exceptional form involving non-harmonising /i u a/ vowels can be construed as involving any number and any nature of abstract contrasts which apply or participate in harmony but subsequently are neutralised everywhere: e.g. /gɪj-E/ → {gɪj-ɛ} → [gɪ̀j-ɛ̀] 'kill'-PERF. or /noj-ijɛ̱/ → {nɔj-ɪjɛ̱} → [nɔ̀j-íjɛ̱́] 'sleep'-MED.PASS. All surface-disharmonic /i u a/ are by definition harmonic at some abstract level, and the analysis admits no possible counter-evidence. Finally, in addition to the above problems of circularity and non-falsifiability, we have previously seen that this analysis implies quite a number of otherwise rare characteristics: 1) directionally asymmetric bidirectional harmony, 2) equipollent, quaternary featural contrasts on suffixes, and 3) abstract contrasts which do things in the phonology, but which can never actually be transparently observed. Altogether these complications strongly suggest that there must be some other explanation for the peculiar vowel patterns in Bondu-so.

2.1 Where have we gone wrong?

Let us return to our original data in (8), repeated from (1). In this data-set there is really only one variable up for interpretation: the proposed underlying representation of the root vowels (and by consequence the direction of harmony in the perfective, as we shall see below). Playing with this variable allows for a non-abstract or "concrete" alternative analysis of Bondu-so vowels and vowel harmony which avoids the complications outlined in the previous section.

[6] Many languages even display multiple classes of neutral segments which feature both types of harmony neutrality simultaneously, such as Old Norwegian (Germanic) which displays similar height harmony with neutral blocking (non-triggering) lax mid vowels but harmonic blocking (triggering) low vowels (Sandstedt 2018). Standard Yoruba (Atlantic-Congo) illustrates a cognate case involving tongue root harmony similar to Bondu-so with neutral blocking (non-triggering) high vowels but harmonic blocking (triggering) low vowels (Ọla Orie 2001; 2003).

(8) *Bidirectional [+ATR] and [–ATR] harmony in Bondu-so*

	UR of root		Underspecified (perfective)	[+ATR] suffix (infinitive)	[–ATR] suffix (mediopassive)
[+ATR] root	/noj-/	‘sleep’	[nòj-è]	[nój-ílòŋ]	[nɔ̀j-íjɛ́]
[–ATR] root	/dɔg-/	‘leave (it)’	[dɔ̀g-ɛ̀]	[dòg-ílòŋ]	[dɔ̀g-íjɛ́]

The basic issue with the interpretation of the data in (8) is a correlation-does-not-imply-causation problem. We know that the vowels in [nòj-è] and [dɔ̀g-ɛ̀] are correlated for the harmony feature and that there is vowel harmony between mid vowels, but it is initially unclear which vowel is the harmony trigger and which is the target. Since the existing analyses posit that harmony spreads both from roots to suffixes and suffixes to roots in Bondu-so, both of the options in (9) are technically possible.

(9) *Harmony directional ambiguity in Bondu-so*
a. root-controlled: /dɔ̱̀g-E/→[dɔ̱̀g-ɛ̀]
b. suffix-controlled: /dOg-ɛ̱̀/→[dɔ̀g-ɛ̱̀]

The question comes down to where the underlying [ATR] contrast is: on the root or on the suffix? Since mid vowels are always valid harmony triggers and targets, the patterns in (9) are ambiguous and both analyses in (8) are compatible with these data. We would only be able to unambiguously discriminate the underlying contrast in forms where harmony fails to apply – e.g. cases with harmonically neutral vowels, which cannot undergo harmony. Typically, in harmony systems, the trigger or feature-donor environment should preserve the underlying contrast while a harmonically neutral (non-alternating) target fails to display harmony alternations. By comparison, when we have non-triggering neutral segments in trigger positions, harmony targets (feature-recipients) typically surface with some unmarked or default value (cf. Nevins 2010: §3.3; Sandstedt 2018: §2.2). Neutral harmony contexts thus reveal the underlying contrast and the source of harmony – either suffixes will display minimal contrasts with neutral root vowels, or roots will display minimal contrasts with neutral vowel suffixes. The right neutral harmony contexts for this kind of contrastive analysis of Bondu-so are provided by high/low vowel roots and suffixes in (10) below.

(10) *Neutral segments reveal ATR/RTR contrasts on suffixes but not on roots*

Position	Contrast	
	ATR	RTR
Suffix	bìj-**è**	gìj-**ɛ̀**
Root	b**è**l-áà	unattested

Here we have clear near minimal pairs such as [bìj-è] ‘lay down’-PERF. and [gìj-ɛ̀] ‘kill’-PERF. which provide transparent evidence that the suffix is contrastive for the harmony feature. By comparison, there are no RTR roots preceding neutral segments in word-final suffixes: e.g. [bèl-áà], *[bɛ̀l-áà] ‘edible leaves (cooked)’-SG.[7] Moreover, all non-suffixed bare roots surface are non-RTR as well: e.g. [góm] ‘remove’, [mín] ‘wait’, and [pór] ‘let escape’ (Green & Hantgan 2019: 13). This stark asymmetry in ATR/RTR contrasts is a

[7] See section 3.2 for a full analysis of this markedness asymmetry in neutral harmony contexts.

significant problem for root-controlled harmony analyses of Bondu-so, which predict contrastive roots and derived suffixes. The simple contrastive analysis in (10) rules out root-controlled analyses like (9a) and suggests that Bondu-so roots are non-RTR by default and undergo [RTR]-harmony preceding [RTR]-/ɛ ɔ/ vowels. In other words, Bondu-so perfectives involve suffix-controlled harmony, just as every other morphophonemic environment in (8): i.e. /dog-ɛ̲̀/ → [dɔ̀g-ɛ̲̀]. In sum, the interpretation of root vowel contrasts in previous analyses in (8) ignores the neutral harmony insights in (10) and is inconsistent with the distribution of surface tongue root contrasts in Bondu-so.

3 A "concrete" alternative analysis

3.1 Preview and implications

The crux of the reanalysis is thus the revised representation of underlying root vowel contrasts and the direction of harmony in the perfective, as in (11). As these data illustrate, my alternative analysis suggests that both verbal roots /noj-/ and /dog-/ are underlyingly equally [+ATR] (or non-RTR). This is evidenced by bare stems in Green & Hantgan (2019) which are all non-RTR, and the fact that roots are all non-RTR preceding non-alternating and non-triggering neutral suffixes. The crucial difference between the verbs in (11) is that these roots belong to separate inflectional classes which take an advanced /-e/ and retracted /-ɛ/ perfective suffix, respectively. These distinct perfective suffixes trigger advanced and retracted tongue root harmony on the root vowels, respectively, resulting in dissimilar [+ATR] [nòj-è̲] and [–ATR] [dɔ̀g-ɛ̲̀]. Though this morphological reinterpretation of the data may seem initially less intuitive, I demonstrate in this section that a non-abstract, morphological account crucially makes falsifiable and non-circular predictions, eliminates all of the unusual theoretical and typological generalisations outlined in the preceding sections, captures a wide range of important missed generalisations, and is fully consistent with what else is known about Bondu-so morphophonology.

(11) *Harmony variation across Bondu-so verbal classes*

	UR of root		perfective	infinitive	mediopassive	Imperative
Class A	/noj-/	'sleep'	[nòj-è̲]	[nój-íl̲ò̲ŋ]	[nɔ̀j-íjɛ̲́]	[nój-ó̲]
Class B	/dog-/	'leave (it)'	[dɔ̀g-ɛ̲̀]	[dòg-íl̲ò̲ŋ]	[dɔ̀g-íjɛ̲́]	[dóg-á̲]

Here I will provide a brief preview of the important evidence for and implications of this reanalysis. A more detailed examination of the evidence is presented in the following sections. In the way of a short overview, I argue Bondu-so features a simple, non-abstract 7V inventory with a straightforward case of unidirectional, suffix-controlled [RTR] harmony. Non-contrastive /i u a/ vowels are simply harmonically transparent, skipped by the harmony procedure, as outlined in the summary data in (12). The analysis of this simple harmony system requires no particular theoretical assumptions and assumes no harmony directional asymmetries, abstract contrasts, or derivational opacity.

(12) *Bondu-so [RTR]-harmony and high/low vowel transparency*

a.	/kedʒ-ilo̲ŋ/	[kédʒ-ìlò̲ŋ]	'cut'-INF.	i		u
b.	/kedʒ-ijɛ̲/	[kɛ́dʒ-íjɛ́]	'cut'-MED.PASS.	e		o
c.	/sem-andʒ-e̲/	[sém-ándʒ-è̲]	'slaughter'-IMPERF.-2.PL.	ɛ		ɔ
d.	/sem-andʒ-ɛ̲ɛ̲/	[sɛ́m-ándʒ-ɛ̲́ɛ̲̀]	'slaughter'-IMPERF.-3.PL.		a	

There are three main motivations for the above reinterpretation of Bondu-so vowels and vowel harmony. First, we know that there is suffix-controlled harmony in Bondu-so as evidenced by root harmony alternations: e.g. INF. [nój-ílòŋ] vs. MED.PASS. [nɔ̀j-íjɛ́]. By contrast, there are no clear or unambiguous cases of root-controlled harmony in Bondu-so; every case that has been previously interpreted as root-controlled harmony is ambiguous on the surface as in (9) and can be reinterpreted exactly as the perfective type above. Second, it has been previously recognised that Bondu-so displays distinct inflectional classes with differing harmony behaviours (see, for example, nominal class distinctions in Hantgan & Davis 2012: 8–10; Green & Hantgan 2019: 8–9). The verbs in (11) evidence additional verbal class distinctions. For example, in addition to the distinct perfective [-e, ɛ] endings in (11), these verbs also display distinct imperative suffixes [-o, -a] whose distribution is not phonologically predictable and particularly difficult to analyse in previous studies: e.g. [nój-ó] 'sleep!' but [dóg-á] 'leave (it)!' (cf. the near-minimal pairs [gíj-á] 'kill!' but [súg-ó] 'go down!'). See section 3.5 for a detailed look at exceptional imperative [-o, -a] and parallel nominal singular [-oo, -aa] allomorphy in Bondu-so. Third, like the minimal contrast on perfective suffixes in (11), personal endings in Bondu-so demonstrate that affixes are minimally contrastive for the harmony feature and that tongue root contrasts on suffixes can define important morphological distinctions while triggering distinct harmony patterns on preceding syllables: e.g. [ʤóŋ-ónʤ-è] vs. [ʤɔ́ŋ-ɔ́nʤ-ɛ́ɛ̀] 'heal'-IMPERF.-2.PL./3.PL. The reanalysis I advocate therefore crucially does not introduce any new assumptions; I simply posit that the data evidence a greater number of distinct inflectional classes than has previously been recognised and that the location of underlying tongue root contrasts and therewith the direction of harmony has been misinterpreted in specific cases.

With this re-characterisation of the morphology, all of the typologically and theoretically controversial aspects of Bondu-so vowels and vowel harmony outlined in the preceding sections go away. First, there is no directional asymmetry in Bondu-so vowel harmony but only unidirectional, suffix-controlled harmony; in previous studies, it seemed like leftwards harmony bleeds rightwards harmony because there is in fact no rightwards harmony. This rare bleeding relationship is simply an artefact of the misinterpretation of the direction of harmony in perfective-type environments and provides further evidence against the root-controlled harmony analysis outlined in section 1. Second, the data do not require equipollent, ternary featural contrasts on mid-vowel suffixes (i.e. [+ATR] /-(i)loŋ/, [–ATR] /-ijɛ/, and Ø /-E/). Following this reanalysis, perfective suffixes are harmony triggers, just as any other mid-vowel suffix, which are therefore consistent with a simpler monovalent contrast between [RTR] /-ijɛ/ and /-ɛ/ vs. (non-RTR) /-(i)loŋ/ and /-e/. These representations are fully compatible with any feature theory. Third, there are no abstract tongue root contrasts on high/low vowels (e.g. /bij-E/ vs. /gɪj-E/). According to this paper's "concrete" reanalysis of the data, there are only plain, unpaired /i u a/, which being non-contrastive for the harmony feature, universally fail to undergo or trigger harmony. The data that were previously interpreted as evidencing abstract contrasts are simply neutral suffix-controlled harmony, belonging to separate advanced and retracted inflectional classes, as shown in (13). In other words, high and low vowels simply fail to undergo harmony, regardless of following harmony triggers. In a similar vein there is no harmony opacity via neutralisation (i.e. /gɪj-E/ → {gɪj-ɛ} → [gìj-ɛ̀]) but rather simply transparent harmony neutrality: e.g. /gij-ɛ/ → [gìj-ɛ̀]. In other words, there is an active harmony trigger on the suffix but no viable harmony target vowel on the root, resulting in no root-vowel (target) alternations.

(13) *Non-contrastive high/low vowels are harmonically neutral non-targets of tongue root harmony*

ATR class /-e/			RTR class /-ɛ/		
/bij-e/	[bìj-è]	'lay down'-PERF.	/gij-ɛ/	[gìj-ɛ̀]	'kill'-PERF.
/sug-e/	[sùg-è]	'went down'	/ʤug-ɛ/	[ʤùg-ɛ̀]	'recognise'-PERF.
/bar-e/	[bàr–è]	'help'-PERF.	/pag-ɛ/	[pàg-ɛ̀]	'tie'-PERF.

In summary, all of the aforementioned controversial generalisations hinge upon the misinterpretation of the direction of harmony and underlying representation of root vowels. Reinterpreting the direction of harmony in ambiguous cases such as [dɔ̀gɛ̀] eliminates all of the typological and theoretical issues that have been raised by studies of Bondu-so vowels and vowel harmony. In contrast, I posit that Bondu-so displays a simple 7V-inventory /i, e, ɛ, a, ɔ, o, u/ – both on the surface and underlyingly – with a fully systematic, non-opaque, and non-abstract tongue root harmony system, theoretically and typologically fully consistent with other well-documented tongue root harmony languages.

This paper's revised interpretation of Bondu-so harmony patterns and vowel contrasts has especially important implications for our understanding of the behaviour of neutral harmony segments (i.e. high/low vowels) and the morphological distribution of tongue root contrasts in Bondu-so. In the following sections, I explore each of these subjects in much greater detail. I also show how this reanalysis resolves a number of more problematic data that have yet to receive a coherent explanation in existing analyses. I illustrate specifically that the harmony patterning of [RTR] non-contrastive high/low vowels is fully consistent with typological expectations and that my re-categorisation of Bondu-so morphological classes captures important missed generalisations in the distribution of tongue root and other vocalic contrasts.

3.2 High and low vowel harmony neutrality

An obvious first question for this revised analysis is that if high/low vowels do not trigger harmony (e.g. not /gɪj-E/ → {gɪj-ɛ} → [gɪ̀j-ɛ̀]), then what is their actual behaviour? According to this paper's non-abstract reanalysis, high and low vowels' harmony patterning is far simpler than previously assumed. As illustrated by the data in (14), high and low vowels in Bondu-so are simply harmonically neutral; non-participants in tongue root harmony. Harmony spreads from word-final suffixes across intervening high and low vowels to potential harmony targets further downstream. Essentially, high and low vowels do not enter the harmony equation; they are like consonants, non-contrastive and invisible to tongue root harmony.

(14) *Bondu-so high and low vowel transparency*

a. /dog-iloŋ/ [dòg-ílòŋ] 'leave'-INF.
b. /dog-ijɛ/ [dɔ̀g-íjɛ́] 'leave'-MED.PASS.

c. /sem-anʤ-e/ [sém-ánʤ-è] 'slaughter'-IMPERF.-2.PL.
d. /sem-anʤ-ɛɛ/ [sɛ́m-ánʤ-ɛ́ɛ̀] 'slaughter'-IMPERF.-3.PL.

High and low vowels are in other words phonologically *inactive* and *invisible* – non-targets and non-triggers (transparent segments), which are skipped by the harmony procedure. High and low vowels in Bondu-so thus do not affect any change on other segments – either preceding or following – nor can they undergo harmony effects of harmony triggers – either preceding or following. These neutral harmony insights provide two crucially overlooked, clear diagnostics for the direction of harmony in Bondu-so. First, as was discussed above, neutral segments fail to undergo harmony in target positions; for example, we observe no alternations on high/low vowels in word-medial positions in (14). Where harmony fails to apply, the trigger environment will preserve the underlying contrast on the surface while target environments will display no contrasts or alternations. This is illustrated in (10, 13) above, where we observe overt, minimal contrasts on suffixes – e.g. [bìj-è] 'lay down'-PERF. vs. [gìj-ὲ] 'kill'-PERF. The presence of ATR/RTR contrasts on suffixes following neutral root vowels suggests that tongue root harmony is suffix-controlled in Bondu-so.

A second diagnostic of harmony directionality is provided by neutral vowel vowels in harmony trigger positions. While neutral *targets* should reveal minimal contrasts on *trigger* environments, we expect the opposite asymmetry when dealing with neutral segments in trigger positions. Since neutral segments should not affect any change on harmony targets, the prediction is that targets should surface unchanged preceding neutral /i u a/, revealing the unmarked or "default-value" of underlying harmony targets (cf. Nevins 2010: §3.3; Sandstedt 2018: §2.2). Where we find this kind of markedness asymmetry – on roots or on suffixes – reveals the true direction of harmonic spreading – from suffixes or roots, respectively. This expectation is borne out by the data in (15). These forms reveal that high/low vowels in harmony trigger positions (suffixes) – being both phonologically *inactive* and *inert* (non-specified for the harmony feature) – affect no change on preceding vowels. Roots surface therefore unchanged as default non-RTR [e o] (e.g. /bel-aa/ → [bel-aa]). Roots are **always** non-RTR preceding word-final /-i, -u, -a/ suffixes.

(15) *Low/high vowel non-triggers reveal markedness asymmetries on roots*

a.	/bel-aa/	[bèl-áà]	*[bὲl-áà]	'edible leaves'-SG.
b.	/ob-aa/	[òb-áà]	*[ɔ̀b-áà]	'liana branch'-SG.
c.	/ʤoŋ-onʤ-oji/	[ʤóŋ-ónʤ-ójì]		'heal'-IMPERF.-1.PL.
d.	/sem-anʤ-oji/	[sém-ánʤ-ójì]	*[sέm-ánʤ-ójì]	'slaughter'- IMPERF.-1.PL.

Under root-controlled harmony analyses, the stark asymmetry in (15) where mid vowels are always non-RTR preceding /-i, -u, -a/ suffixes is highly unexpected. If the roots in (15) are the harmony triggers and have no dependency on following neutral high/low vowel segments as has been argued by Hantgan & Davis (2012) and Green & Hantgan (2019), then we would expect to find an equal number of forms with underlying [–ATR] root vowels such as hypothetical /bɛl-aa/ → [bɛ̀l-áà] as well as [–ATR] bare stems like *[gɔm] or *[pɛr], but these are apparently wholly lacking in the language. Furthermore, as we have observed in (13) above, there is no such markedness asymmetry in the opposite direction – we do find roughly an equal number of underlying [RTR] /ɛ ɔ/ and non-RTR /e o/ contrasts on suffixes following neutral /i u a/ root vowels. This is a fundamental problem for earlier accounts of Bondu-so vowel harmony and provides clear counter-evidence to root-controlled harmony analyses.

The marked/unmarked or featurally specified/non-specified asymmetry we observe in (15) further reveals by deduction that Bondu-so harmony involves active tongue root *retraction* or [RTR]-spreading, and underlying harmony targets are advanced or non-RTR /e o/ by default. Only [RTR]-paired segments participate in Bondu-so vowel harmony. Therefore, despite being seemingly dissimilarly phonetically advanced and retracted on the surface, high /i u/ and low /a/ are equally non-contrastive for the harmony feature and therefore co-occur with the same default non-RTR class of vowels in trigger positions (e.g. /ʤóŋ-ónʤ-ójì̲/ → [ʤóŋ-ónʤ-ójì̲] and /bèl-á̲à̲/ → [bèl-á̲à̲], *[bɛ̀l-á̲à̲]). This parallel behaviour of high and low vowels is expected and fully consistent with their mutual non-contrastivity for the harmony feature, but this clear [RTR]/non-RTR asymmetry and identical behaviour of high/low vowel suffixes is ignored in previous studies and coincidental according to a root-controlled analysis of Bondu-so vowel harmony (cf. Hantgan & Davis 2012; Heath 2014; Green & Hantgan 2019). Contrary to previous claims, Bondu-so vowels and vowel harmony are thus not only compatible with privative or monovalent features, but the data reveal exactly the kinds of marked/unmarked ([RTR]/non-RTR) asymmetries predicted by privative feature theories in neutral harmony contexts. While these data are of course also compatible with binary features, the asymmetries observed in (15) would require some additional marking statements/prohibitions or redundancy rules specifying default/non-default or marked/unmarked binary values (cf. Archangeli 1988; Calabrese 1995; 2005; Nevins 2010; Dresher 2014).

In addition to being internally consistent and coherent, the behaviour of neutral segments in Bondu-so is also fully regular when compared with the typology of harmony languages. The patterns displayed by high/low vowels in (14, 15) are in fact cross-linguistically the most common behaviour for non-contrastive segments in harmony systems, and there are countless cross-linguistic parallels to harmony-transparency-via-non-contrastivity like this observed in Bondu-so (cf. typological surveys in Nevins 2010; Rose & Walker 2011; Sandstedt 2018). Close parallels of tongue root harmony languages with non-contrastive, transparent neutral segments are provided, for example, by Dengese (C.81; Hulstaert & Goemaere 1984; Leitch 1996) or Ifẹ Yoruba (Ọla Orie 2001; 2003). According to this paper's revised empirical generalisations, Bondu-so vowels and vowel harmony are thus typologically and theoretically fully consistent with other well-studied tongue root harmony systems and are easily compatible with the assumptions of any established harmony framework.

In summary, Bondu-so high and low vowels 1) are harmonically transparent – that is, phonologically inactive and invisible to tongue root harmony (e.g. [sém-ánʤ-è̲] vs. [sɛ́m-ánʤ-ɛ̲́ɛ̲̀] 'slaughter'-IMPERF.-2./3.PL.; 2) reveal markedness asymmetries in the harmony feature between [RTR]-specified /ɛ ɔ/ vs. non-specified (non-RTR) /e o/ (e.g. /bèl-á̲à̲/ → [bèl-á̲à̲], *[bɛ̀l-á̲à̲]), providing clear positive evidence for suffix-controlled harmony and privative or monovalent features; and finally 3) are theoretically and typologically fully consistent with other harmony languages and require no special explanation via abstract contrasts or derivational opacity. Tongue root non-contrastive segments in Bondu-so are simply harmonically transparent.

3.3 Inflectional classes and harmony variation

The second important implication of this paper's reanalysis of Bondu-so vowels and vowel harmony is that the distribution of tongue root vowel contrasts on suffixes (harmony trigger positions) is interpreted as morphological rather than phonologically derived. In this section, I demonstrate that this prediction is fully consistent with the broader evidence presented in previous studies, and I outline the nominal and verbal classes evidenced in the published data.

First, the assumption of distinct inflectional classes in Bondu-so is not controversial. Hantgan & Davis (2012) and Green & Hantgan (2019) have already demonstrated distinct inflectional classes which trigger differing harmony patterns on preceding roots. Examples from nominal inflections are presented in (16). Here we observe two classes of nouns which we may label class A and B for the time being. These classes take identical plural suffixes but dissimilar singular allomorphs {-ɔɔ, -aa} with correspondingly dissimilar harmony patterns on roots: e.g. class A [kɔ́b-ɔ̲̀ɔ̲̀] and class B [kób-á̲á̲]. In class A nouns, we have uniformly [RTR]-specified suffixes [-ɔɔ, -ɛɛ] which trigger [RTR]-harmony on preceding roots. Class A nouns with harmonising mid vowels are therefore always uniformly [RTR]. Among class B nouns, by contrast, we have a mixture of [RTR]-specified [-ɛɛ] and phonologically inactive [-aa] suffixes, with resulting harmony and neutral harmony alternations on preceding roots, respectively: i.e. harmonising plural /kob-ɛɛ/ → [kɔ́b-ɛ́ɛ́] but harmonically neutral singular /kob-aa/ → [kób-áá].

(16) *Distinct noun classes in Bondu-so*

	Sing.	Plur.	
Class A	kɔ́b-ɔ̀ɔ̀	kɔ́b-ɛ̀ɛ̀	'sheath'
	nɛ̀nd-ɔ̀ɔ̀	nɛ̀nd-ɛ̀ɛ̀	'tongue'
Class B	kób-áá	kɔ́b-ɛ́ɛ́	'brick mold'
	cénd-àà	cɛ́nd-ɛ̀ɛ̀	'heart/liver'

In addition to important class differences, Hantgan & Davis (2012) and Green & Hantgan (2019) have also demonstrated minimal [RTR] contrasts on suffixes which define important morphological distinctions. Examples of such minimal contrasts are provided by personal endings on verbs in (17). Here 2nd and 3rd person plural suffixes differ specifically with regard to their [RTR]-specifications and initiate distinct [RTR] and non-RTR harmony on preceding syllables: e.g. [RTR] /ʤoŋ-onʤ-ɛɛ/ → [ʤɔ́ŋ-ɔ́nʤ-ɛ́ɛ̀] vs. (non-RTR) /ʤoŋ-onʤ-e/ → [ʤóŋ-ónʤ-è] 'heal'-imperf.-3.pl./2.pl.

(17) *Person and number inflections in Bondu-so: 'heal'-imperf.*

	Sing.	Plur.
1.	ʤóŋ-ónʤ-òm	ʤóŋ-ónʤ-ójì
2.	ʤóŋ-ónʤ-òò	ʤóŋ-ónʤ-è
3.	ʤóŋ-ónʤ-ò	ʤɔ́ŋ-ɔ́nʤ-ɛ́ɛ̀

In sum, this suffix-controlled harmony reanalysis does not introduce any new assumptions. Everyone is in agreement that suffixes are minimally contrastive for the tongue root feature in Bondu-so and that there are distinct inflectional classes with correspondingly distinct harmony patterns on preceding syllables. It is only the number and shape of these classes which are in question. In their conclusion, Hantgan & Davis (2012: 24) raise the following objective:

> We leave it as a challenge as to whether the full range of vowel harmony data considered in this article can be accounted for just as insightfully without positing abstract vowels or the ternary use of [ATR].

To show that this is indeed possible, I have recorded the full range of data provided by Hantgan & Davis (2012) in a CSV file, available online at http://dx.doi.org/10.17613/p0sp-yj29. I have reorganised the data according to the principle that suffixes are underlyingly specified for the tongue root feature (or in other words, assuming there is only suffix-controlled harmony). In this data frame, I provide each form's morphological parsing, gloss, example number in Hantgan & Davis (2012), and a unique class number for every unique combination of inflectional endings. A sample of these data in this revised layout are presented in (18). As may be observed from Hantgan & Davis' original example numbers in (18), re-organising the data by lexemes allows for a much easier study of Bondu-so morphological patterns than in their original organisation.

(18) *Bondu-so sample database*

	Form	Morph.	Gloss	Ex.No	Class
a.	kéʤ-ìlòŋ	infinitive	‘cut’	6	1
b.	kéʤ-á	imperative	‘cut!’	9	1
c.	kɛ́ʤ-íjɛ́	mediopassive	‘be cut’	7	1
d.	kɛ̀ʤ-ɛ̀	perfective	‘s/he cut	1	1
e.	gí-ílòŋ	infinitive	‘kill’	6	1
f.	gíj-á	imperative	‘kill!’	9	1
g.	gìj-è	perfective	‘s/he killed’	1	1
	…				

When the data are re-organised as in (18), four verbal and three nominal inflectional classes emerge, whose inflectional suffixes are outlined in Tables 1–2 below. Hantgan & Davis (2012) have unfortunately only provided 104 inflected forms and do not always provide complete paradigms. The data are therefore incomplete for certain lexemes and certain classes. Specifically, we do not know the mediopassive and/or imperfective forms for what I have labelled class 3 and 4 verbs. For this reason, a number of verbs with incomplete paradigms which I have categorised as class 1 may actually belong to class 4 since they have identical infinitive, perfective, and imperative inflections.

The morphological classes in Tables 1–2 reveal consistent and coherent inflectional patterns in nominal and verbal inflections. In contrast to abstract phonological analyses, this morphological account of suffixal contrasts in Bondu-so is independently motivated – evidenced by overt inflectional contrasts between lexemes which are not phonologically predictable. Moreover, this account makes concrete and transparent predictions about Bondu-so inflectional patterns which can be falsified and corrected by further data collection. Finally, this revised analysis of Bondu-so morphology straightforwardly clarifies several existing problems which have previously resisted explanation, which I explore in the following sections.

Table 1: Nominal classes in Bondu-so.

	Class 1	**Class 2**	**Class 3**
Sing.	/-oo/	/-ɔɔ/	/-aa/
Plur.	/-ee/	/-ɛɛ/	/-ɛɛ/

Table 2: Verbal classes in Bondu-so.

	Class 1	**Class 2**	**Class 3**	**Class 4**	**Personal endings**	
Perf.	/-e/	/-ɛ/	/-e/	/-e/	1.sg	/-om/
Inf.	/-(i)loŋ/	/-(i)loŋ/	/-(i)loŋ/	/-(i)loŋ/	2.sg	/-oo/
Imp.	/-o/	/-a/	/-a/	/-o/	3.sg	/-o/
med.pass.	/-ije/	/-ijɛ/		/-ijɛ/	1.pl	/-oji/
Imperf.	/-onʤ-/	/-anʤ-/			2.pl	/-e/
					3.pl	/-ɛɛ/

3.4 "Concrete" vs. "abstract" morphological and phonological features

As outlined in the preceding section, previous studies have ascribed Bondu-so vowel alternations to an intricate combination of phonological and morphological factors. For instance, root-vowel ATR/RTR alternations like [dòg-ílòŋ, dɔ̀g-íjɛ́] 'leave (it)'-INF./MED.PASS. unambiguously demonstrate suffix-controlled vowel harmony while nominal inflectional variation such as [kɔ́b-ɔ̀ɔ̀] 'sheath' -SG. vs. [kób-áá] 'brick mold'-SG. is universally accepted as non-phonological allomorphy (see section 3.3). Between these cases, there is a class of data whose grammatical status is less clear; that is, forms which display suffixal alternations but without transparent phonological motivation on the surface: e.g. [sùg-è] 'go down'-PERF. vs. [ʤùg-ɛ̀] 'recognise'-PERF. Complex cases like these may admit a variety of analyses depending on the analyst's assumed division of labour between phonological and morphological computation (cf. Bermúdez-Otero 2012). Hantgan & Davis (2012) and Green & Hantgan (2019) posit phonological interpretations using opaque interactions between tongue root harmony and the neutralisation of abstract contrasts: e.g. /ʤʊg-E/ → {ʤʊg-ɛ} → [ʤùg-ɛ̀]. By comparison, a morphological account prioritises transparent derivations and non-covert representations in exchange for novel morphological class features: e.g. /sùg-[CLASS:1]/ vs. /ʤùg-[CLASS:2]/. In both accounts, an underlying contrast must be specified on the root, and a reviewer asks whether the use of morphological class features is not equally *abstract* as earlier covert phonological approaches. The short answer is no. In (19) I compare competing opaque phonological and transparent morphological interpretations of perfective suffixal alternations, which highlights important similarities and dissimilarities. Instead of abstract [±ATR]-specifications on root vowels which derive [-e, -ɛ] suffixal alternations with subsequent neutralisation as in (19a), roots must be lexically specified with some morphological class features which select alternative {-e, -ɛ} suffixes which in turn trigger regressive vowel harmony in (19b). A reanalysis of Bondu-so perfective patterns as non-phonological allomorphy therefore avoids phonological opacity, abstract contrasts, and neutralisation, but at the expense of enriching the morphology. These competing accounts thus involve a similar number of "steps", and both must account for some underlying contrast between stems with advanced and retracted suffixes. The fundamental difference comes down to the transparency of that underlying contrast.

(19) *Abstract phonological vs. morphophonological derivations*

a) **Harmony + absolute neutralisation of abstract [±ATR] contrasts**

	/sug-E/	/ʤʊg-E/	/dɔg-E/
HARMONY	sug-e	ʤʊg-ɛ	dɔg-ɛ
NEUTRALISATION	——	ʤug-ɛ	——
	[sùg-è]	[ʤùg-ɛ̀]	[dɔ̀g-ɛ̀]

b) **Inflectional classes + harmony**

	{sug-[CLASS:1]}	{ʤug-[CLASS:2]}	{dog-[CLASS:2]}
SUFFIX ASSIGNMENT	sug-e	ʤug-ɛ	dog-ɛ
HARMONY	——	——	dɔg-ɛ
	[sùg-è]	[ʤùg-ɛ̀]	[dɔ̀g-ɛ̀]

As I showed already in Figure 1 in section 1, both "concrete" and "abstract" representations involve *abstraction*, as any theoretical generalisation does, but there is a crucial difference in the transparency or opacity of morphological class features and abstract contrasts in (19). The morphological class features above have "concrete", transparent surface realisations in contrasting [-e, -ɛ] perfective suffixes. I assume the language learner posits class features whenever faced with non-phonologically generalisable surface contrasts on inflectional suffixes, as in the near-minimal pairs [sùg-è] 'go down'-PERF. vs. [ʤùg-ɛ̀] 'recognise'-PERF. or [bìj-è] 'lay down'-PERF. vs. [gìj-ɛ̀] 'kill'-PERF.[8] The constellation of suffixes defines the relevant class (i.e. classes are emergent and transparent). "Abstract" or what Green & Hantgan (2019) have called "displaced" contrasts such as /u ʊ/ in (19a) have no such transparent ("concrete") realisation. In other words, there are no surface contrasts that directly relate to the abstract or covert representations; covert contrasts can only be discerned *indirectly* on other segments by the opaque interaction of vowel harmony and absolute neutralisation, which I have shown in section 2 is not an independently motivated process in Bondu-so. In summary, the two analyses are not equally "abstract" in the technical sense; both involve abstraction, but morphological class features have transparent (non-opaque) realisations on contrasting inflectional suffixes – that is, they can be identified, falsified, and corrected independently of orthogonal morphophonological processes. By comparison, covert phonological contrasts are "abstract" or "covert" in the technical sense – that is, they can only be inferred indirectly via phonological effects on other segments, and because of absolute neutralisation covert/abstract phonological representations are by definition opaque and can never be transparently realised anywhere in the language.

3.5 Competing phonological and morphological solutions to problem cases

In this paper, I have compared phonological accounts invoking abstract or covert contrasts with absolute neutralisation like (20a) with a morphological account with class features as in (20c). Another reviewer has raised a third possibility, using floating autosegments on roots which spread to suffixes (20b). A similar approach has been employed by Noske (1996; 2000) to account for a similar bidirectional tongue root harmony system with harmonising and non-harmonising suffixes in Turkana (Eastern Nilotic). This kind of analysis has the advantage of avoiding the need for abstract contrasts and absolute neutralisation, however like other root-controlled harmony analyses, this approach faces considerable complications in Bondu-so inflectional patterns whose distribution is not phonologically predictable from the roots' feature specification or floating autosegment.

(20)		[sùg-è]	[ʤùg-ɛ̀]	
	a.	/sug/	/ʤʊg/	(absolute neutralisation)
	b.	/sug $^{[+\text{ATR}]}$/	/ʤug $^{[-\text{ATR}]}$/	(floating autosegment)
	c.	/sug $^{[\text{class:1}]}$/	/ʤug $^{[\text{class:2}]}$/	(inflectional classes)

Initially, a floating autosegment analysis like (20b) is cognate to existing abstract approaches. Following a floating feature analysis, the verb /sug-/ 'go down' and the verb /ʤug-/ 'recognise' have a [+ATR] and [–ATR] floating autosegment, respectively, triggering advanced and retracted harmony on suffixes as in (20) – i.e. [sùg-è, ʤùg-ɛ̀]. The advantage of the floating feature analysis is that no abstract /u ʊ/ contrasts or absolute neutralisation are required, avoiding the opaque interaction between harmony and the neutralisation of abstract contrasts. In this respect, an approach incorporating floating autosegments may well be favourable to other root-controlled analyses. However, the non-transparent perfective data are not the only apparent cases of opaque vowel assimila-

[8] This is not to say that phonological opacity is impossible or unlearnable; the two interacting processes in an opaque derivation must simply be independently motivated, as I outline in section 2.

tions in Bondu-so, and a floating featural analysis does not remedy other more problematic data.

In the way of an example, there are two imperative suffixes in Bondu-so on the surface: [-o, -a]. These suffixes pattern similarly (though crucially not identically) to perfective suffixes [-e, -ɛ]. Like with the perfective data, a morphological account treats imperative suffixal differences as simple allomorphy, reflecting distinct inflectional classes since their distribution is not clearly phonologically generalisable: e.g. [nój-ó] 'sleep!' but [dóg-á] 'leave (it)!' (cf. the near-minimal pairs [gíj-á] 'kill!' but [súg-ó] 'go down!'). However, since the distribution of imperative [-o, -a] suffixes is fairly similar to perfective [-e, -ɛ] suffixes, earlier root-controlled analyses posit a separate raising process triggered by [+ATR] stems, raising /-a/ to [-o] (Hantgan & Davis 2012: §2.4; Green & Hantgan 2019: §7.1). This is illustrated by the data below in (21), reproduced from Hantgan & Davis (2012: 11). Like earlier abstract accounts, the floating [+ATR] autosegment in (20b) could analogously trigger vowel raising in the imperative suffix: i.e. /sug $^{[+ATR]}$-A/ → [súg-ó] 'go down'-IMP. but /ʤug $^{[-ATR]}$-A/ → [ʤúg-á] 'recognise'-IMP. This raising process is more limited than tongue root harmony, as the distribution of imperative suffixes is not entirely predictable from other alternating suffixes: e.g. [+ATR] [bàr-è] but [–ATR] [bár-á], not *[bár-ó] 'help'-PERF/IMP as would be expected following [+ATR]-triggered raising. Currently, we can derive this exceptional pattern by limiting vowel raising to [+ATR, -low] vowels (Hantgan & Davis 2012: §2.4; cf.Green & Hantgan 2019: §7.1).

(21) *Root-controlled /a/-raising and imperative [+ATR] harmony*

	[+ATR]-stem			[–ATR]-stem	
a.	[némbíl–ó]	'beg'-IMP.	f.	[kéʤ–á]	'cut'-IMP.
b.	[nój–ó]	'sleep'-IMP.	g.	[dóg–á]	'leave'-IMP.
c.	[bíj–ó]	'lay down'-IMP.	h.	[gíj–á]	'kill'-IMP.
d.	[súg–ó]	'go down'-IMP.	i.	[ʤúg–á]	'recognise'-IMP.
e.	[bár–á]	'help'-IMP.	j.	[pág–á]	'tie'-IMP.

There is a significant complication for root-controlled analyses in the imperative data above. Though the imperative suffix is interpreted as an alternating underspecified /-A/ suffix like the perfective /-E/, roots nevertheless **always** surface as [+ATR] before the imperative suffix, regardless of their underlying [ATR]-specification or floating autosegments. This is shown on the right in (21f–j) where underlyingly [–ATR] stems trigger [–ATR] harmony on suffixes (or fail to trigger raising) but the stems themselves paradoxically surface as [+ATR] before the word-final [–ATR] vowel: e.g. /kɛʤ–A/ → [kéʤ–á] 'cut'-IMP. In other words, the imperative suffix is an *alternating* suffix – like the perfective [-e, -ɛ] – but which nevertheless triggers uniform [+ATR] harmony on roots – breaking the ternary suffixal typology outlined in section 1 between [+ATR] /-(i)loŋ/, [–ATR] /-ijɛ/, and underspecified (alternating) /-E/-type suffixes. The imperative suffix alternates – implying that it is underspecified for the harmony feature – but nevertheless triggers [+ATR] harmony. To get around this complication, Hantgan & Davis (2012) invoke a floating [+ATR] autosegment on the imperative suffix which attaches to the root *after* the root spreads its [ATR] specification to the suffix (another case of counterbleeding opacity), as illustrated in two steps in Figure 3. This considerably complex account posits highly opaque and, as Green & Hantgan (2019: 32) admit, rather unusual derivations; for example, both vowels in /bər-$^{[+ATR]}$A/ 'help'-IMP. are underlyingly specified [+ATR] or have a floating [+ATR] feature, but both fail to surface as [+ATR] – i.e. [bár–á] – due

(a) Root-controlled [−ATR]-harmony (non-raising).

(b) [−ATR]-delinking and suffix-controlled [+ATR] harmony.

Figure 3: Hantgan & Davis' (2012: 11–15) autosegmental analysis of harmony and raising in imperative stems and suffixes.

to the [-low] limitation on [+ATR]-raising and the neutralisation of /ə a/ to [a]. Any root-controlled analysis, regardless of whether it assumes abstract underlying contrasts as in (20a) or floating autosegments on roots as in (20b), would need to posit some similar opaque harmony/raising derivation similar to that in Figure 3.

In summary, regardless of the mechanisms involved, a root-controlled analysis of Bondu-so inflectional patterns must crucially assume two independent processes: tongue root harmony and [+ATR]-triggered low vowel raising, neither of which is entirely surface true and at least one of which necessarily involves opacity with the delinking or neutralisation of tongue root contrasts. Additionally, Hantgan & Davis' (2012) root-controlled account of Bondu-so requires a quaternary contrast on suffixes, distinguishing [+ATR] /-(i)loŋ/, [–ATR] /-ijɛ/, underspecified /-E/, and underspecified /-$^{[+\text{ATR}]}$A/ with a floating [+ATR] feature. All of these issues stem from the original mischaracterisation of the direction of harmony; a closer examination of the data reveals that roots do not determine [ATR]-specifications on suffixes. A privative suffix-controlled [RTR]-harmony analysis which treats [-o, -a] as simply non-phonologically driven allomorphy parallel to other established inflectional class differences avoids each of these issues, and there are telling asymmetries in the data which are predicted by and which confirm this analysis.

We have seen that bare unaffixed roots are always non-RTR – e.g. [góm] 'remove' and [pór] 'let escape' – and surface as non-RTR by default in neutral harmony contexts (15, 21). This is strong counter-evidence to root-controlled analyses which predict around half of roots should be underlyingly [–ATR]. [–ATR] stems should surface with retracted vowels in unaffixed forms or when attached to at least some subset of neutral or underspecified suffixes. This is not the case, and as I have discussed above in section 3.2, this stark asymmetry whereby roots are uniformly non-RTR in bare stems and neutral harmony contexts suggests that the marked (active) harmony feature is [RTR] and harmony targets (roots) are underlyingly non-RTR by default. Unpaired neutral segments /i u a/ are non-specified for the harmony feature. Therefore, in trigger positions (i.e. in suffixes like the imperative), neutral segments do not trigger any harmonic alternations on roots, which surface unchanged. In other words, imperative stems are always non-RTR in (21) for the simple reason that they either precede a non-RTR /-o/ suffix (e.g. /nój-ó/ → [nój-ó] 'sleep-IMP.), or they precede a harmonically neutral (non-triggering) /-a/ suffix and therefore surface unchanged: e.g. /keʤ–a/ → [kéʤ–á], not *[kɛ́ʤ–á].

The data in (21) are thus exact cognates to nominal harmony patterns below in (22). If we focus on the singular suffixes in the top half of the data-set (22a–c; g–i), we observe the exact same pattern where root vowels surface as non-RTR preceding non-RTR suffixes like /-oo/ as well as when preceding neutral (non-specified) suffixes like /-aa/, as predicted by a suffix-controlled [RTR]-harmony analysis with transparent /i u a/ vowels: e.g. /ol-oo/ → [ól-òò] 'house'-SG. and /kob-aa/ → [kób-áá] 'brick mold'-SG.

(22) *Non-RTR roots before low and non-RTR suffixes in nouns*

	Class 1			Class 3	
a.	[ól-òò]	'house'-SG.	g.	[kób-áá]	'brick mold'-SG.
b.	[gómbór-óò]	'mountain'-SG.	h.	[bèl-áà]	'edible leaves'-SG.
c.	[gùnʤò gùnʤ-óò]	'hunched back'-SG.	i.	[cènd-àà]	'heart/liver'-SG.
d.	[ól-èè]	'house'-PL.	j.	[kɔ́b- ɛ́ɛ]	'brick mold'-PL.
e.	[gómbór-éè]	'mountain'-PL.	k.	[bɛ̀l-ɛ́ɛ̀]	'edible leaves'-PL.
f.	[gùnʤò gùnʤ- éè]	'hunched back'-PL.	l.	[cɛ́nd-ɛ̀ɛ̀]	'heart/liver'-PL.

Though there are striking parallels in (21, 22), non-RTR nominal stems with [-oo, -aa] inflectional differences have *not* been analysed as instances of vowel raising in earlier studies. As I outlined earlier in section 3.3, the singular allomorphy in (22) has been correctly identified as reflecting inflectional class differences with suffix-controlled harmony (Hantgan & Davis 2012; 8, 10–11; Green & Hantgan 2019: §3.1). This is apparently because Bondu-so nouns display a third type which more clearly demonstrates that the variation in (22) is not phonologically motivated. The data in (23), repeated from (16), illustrate near-minimal pairs contrasting class 2 and class 3 noun inflections. Contrary to root-controlled analyses of imperative suffixes in (21), the singular data in (22, 23) cannot be analysed as an underlying low-vowel suffix /-$^{[+ATR]}$aa/ with a floating [+ATR] autosegment which raises to [-oo] following [+ATR] stems because [–ATR] stems like [kɔ́b-] 'sheath' and [nɛ̀nd-] 'tongue' surface with excepional mid and retracted [-ɔ̀ɔ̀] suffixes, not *[-aa] as predicted by a raising analysis. This three-way inflectional contrast between [-oo, -aa, -ɛɛ] is not derivable from tongue root harmony and [+ATR]-triggered low vowel raising and is therefore recognised as reflecting distinct inflectional classes. I argue the imperative data in (21) should be analysed in the same way.

(23) *Distinct noun classes in Bondu-so*

	SING.	PLUR.	
CLASS 2	kɔ́b-ɔ̀ɔ̀	kɔ́b-ɛ̀ɛ̀	'sheath'
	nɛ̀nd-ɔ̀ɔ̀	nɛ̀nd-ɛ̀ɛ̀	'tongue'
CLASS 3	kób-áá	kɔ́b-ɛ́ɛ́	'brick mold'
	cénd-àà	cɛ́nd-ɛ̀ɛ̀	'heart/liver'

In the way of an interim summary, this exploration of more complex mid and low vowel data illustrates significant complications for root-controlled analyses, which do not admit a unified phonological account. Following a root-controlled analysis, the verbal and nominal data in (21–23) require opaquely intervening tongue root harmony and vowel raising, abstract contrasts with absolute neutralisation, as well as distinct nominal inflectional categories. By comparison, all the data in (21–23) are fully consistent with the expectations of our working transparent unidirectional reanalysis of Bondu-so vowel harmony assuming suffixes are underlyingly contrastive for the harmony feature. There is no need for additional vowel raising, opacity, abstract contrasts, or floating [ATR] autosegments, and this revised account unifies the treatment of otherwise exceptional imperative [-o, -a] and parallel singular [-oo, -aa] allomorphy.

The problematic imperative data above sharply contrast root- and suffix-controlled analyses, but these are not the only aberrant suffixes which root-controlled analyses have struggled to explain. We observe parallel exceptions in other inflectional categories. The final example I explore in this paper is the exceptional behaviour of mediopassive suffixes. It was previously assumed that the mediopassive suffix is always non-alternating /-ijɛ/ – cf. (1, 8, 11) – but this has left unexplained a significant class of non-RTR mediopassive forms, as illustrated in (24). The distribution of these exceptional [+ATR] mediopassive suffixes is not phonologically predictable; for example, the [+ATR] stems /nembil-/ 'beg' and /noj-/ 'sleep' take identical perfective suffixes [nèmbìl-è, nòj-è]; infinitival suffixes [némbíl-lòŋ, nój-ílòŋ]; and imperative suffixes [némbíl-ó, nój-ó]; but have dissimilar mediopassive forms, [nèmbìl-íjé] and [nɔ̀j-íjɛ́].

(24) *Exceptionally advanced* MED.PASS. [-íjé]

RTR [-íjɛ́]		ATR [-íjé]	
[kɛ́ʤ-íjɛ́]	'cut'	[nèmbìl-íjé]	'beg'
[dɔ̀g-íjɛ́]	'leave (it)'	[sòŋg-íjé]	'curse'
[jàmb-íjɛ́]	'cover'	[dàŋ-íjé]	'be stuck'

Hantgan & Davis (2012: 9, fn. 8) attempt to explain away these problematic [+ATR] [-ije] suffixes by positing that the nasals in the roots in (24) contribute to [+ATR] realisations on the mediopassive suffix, but this too admits exceptions – e.g. [jà**m**b-íjɛ́] 'cover'-MED.PASS. – and we have no reason to believe that nasals motivate [+ATR] in other morphophonological contexts either: e.g. [tì**m**-ɔ́ɔ̀/-ɛ́ɛ̀] 'tree'-SG./PL., [**n**ɛ̆**n**d-ɔ̀ɔ̀/-ɛ̀ɛ̀] 'tongue'-SG./PL., [ì**n**-ɔ̀ɔ́/-ɛ̀ɛ́] 'tooth'-SG./PL., and [ʤɔ́**ŋ**-ɔ́**n**ʤ-ɛ́ɛ̀] 'heal'-IMPERF.-3.PL. The cause of these non-RTR [-ije] suffixes remains unclear following Hantgan & Davis' (2012) and Green & Hantgan's (2019) strictly phonological accounts. However, according to the morphological re-categorisation of the data in Tables 1–2, these "exceptions" are not exceptional at all but may rather evidence important sub-regularities between inflectional classes. For example, as illustrated in (25), there are patterns to labial and tongue root contrasts across the inflectional classes: e.g. class 1 (non-RTR [-e, -ije] / labial [-o, -onʤ-]) vs. class 2 (RTR [-ɛ, -ijɛ] / non-labial [-a, -anʤ-]). In other words, non-RTR [-ije] suffixes are not exceptional but align with broader inflectional patterns across class 1 and class 2 verbs. However, take notice that class 3 & 4 verbs do not have this kind of alignment of [RTR] and [labial] suffixes (Table 2), which shows that the pattern is not phonologically motivated in Bondu-so.

(25) *Class 1–2 regular correspondences*

	Class 1	Class 2
PERF.	-e	-ɛ
MED.PASS.	-ije	-ijɛ
IMP.	-o	-a
IMPERF.	-onʤ-	-anʤ-

In summary, this reanalysis provides a promising initial correction to the organisation of the published data in Hantgan & Davis (2012). In this section, I have highlighted a range of problematic data and used these to contrast competing analyses which incorporate 1) abstract contrasts with absolute neutralisation, 2) floating root and suffix [ATR] autosegments, and 3) a suffix-controlled harmony account with distinct inflectional classes. I have shown that there are telling asymmetries in imperative and mediopassive suffixal alternations which are not straightforwardly predicted in earlier root-controlled accounts, and which require a considerable increase in the grammatical machinery to work in a root-controlled interpretation of Bondu-so vowel harmony. Specifically, exceptional imperative [-o, -a] alternations introduce the need for a novel vowel raising process triggered by [+ATR, -low] vowels on an underlyingly [ATR]-underspecified suffix with a floating [+ATR] autosegment in Hantgan & Davis' (2012) account. Second, the patterning of non-RTR mediopassive [-ije] has never been adequately explained. I argue that each of these complications follow from the original mischaracterisation of the direction of harmony in Bondu-so, which is avoided in a suffix-controlled analysis. First, I have shown that a unidirectional, privative [RTR] harmony process predicts exactly the kinds of [RTR]/non-RTR asymmetries observed in the imperative and mediopassive data, and I have demonstrated clear parallels in [-oo, -aa] nominal inflections, which are already universally recognised as non-phonological allomorphy with suffix-controlled harmony. This account predicts that the distribution of advanced, retracted, and non-specified suffixes – being the underlying source of contrast – are not phonologically motivated and that roots (harmony targets) should predictably surface as unmarked non-RTR by default in bare stems and neutral harmony contexts. Second, while a suffix-controlled analysis requires us to assume distinct inflectional classes, existing analyses have already demonstrated that we need these morphological distinctions anyway for parallel nominal inflections (Hantgan & Davis 2012: §2.2; Green & Hantgan 2019: §3.1). Moreover, a morphological account correctly recognises that the distributions of imperative [-o, -a] and mediopassive [-ije, -ijɛ] suffixes like nominal [-oo, -aa] inflections are not (easily) phonologically generalisable, but in fact reveal coherent patterns in Bondu-so inflectional classes – explaining recalcitrant exceptions in earlier accounts.

The ambiguities and remaining gaps in inflectional classes outlined in this paper can be cleared up with additional data collection in cooperation with Dogon specialists. To summarise, I have demonstrated clear evidence for the following aspects of Bondu-so morphophonology: 1) Bondu-so displays distinct inflectional classes, which have long been accepted in nominal data (e.g. class 2 [kɔ́b-ɔ̀ɔ̀] 'sheath'-SG. vs. class 3 [kób-áá] 'brick mold'-SG.), 2) suffixes are minimally contrastive for the tongue root feature (e.g. non-RTR [ʤóŋ-ónʤ-è] vs. [RTR] [ʤɔ́ŋ-ɔ́nʤ-ɛ́ɛ̀] 'heal'-IMPERF.-2.PL./3.PL.), and 3) there are regularities in some inflectional patterns in the data which clarify existing exceptions which have otherwise defied a coherent explanation (e.g. class 1 ATR [-e, -ije] and labial [-o, -onʤ-] vs. class 2 RTR [-ɛ, -ijɛ] and non-labial [-a, -anʤ-]). In contrast with the existing abstract phonological accounts of Bondu-so vowels and vowel harmony, the morphological classes outlined in this section are independently motivated and have transparent ("concrete") surface realisations. A suffix-controlled account assuming non-phonologically driven inflectional allomorphy takes heed of the important neutral harmony insights presented in section 3.2. This analysis makes concrete, testable predictions, such as the predicted non-RTR realisation of root mid vowels in neutral harmony contexts and unaffixed stems. Finally, this revised interpretation of Bondu-so morphophonology captures a wide variety of previously missed generalisations and provides a unified solution to the apparent exceptional and unique behaviour of nominal singular and verbal imperative and mediopassive suffixes.

4 Conclusions and discussion

Bondu-so has been previously analysed as displaying 1) a directionally asymmetric tongue root harmony system with a rare bleeding relationship between leftwards and rightwards harmony; 2) a quaternary contrast on mid-vowel suffixes, distinguishing [+ATR], [–ATR], underspecified, and underspecified suffixes with a floating [+ATR] autosegment; 3) abstract or covert [±ATR] contrasts on high and low vowels which trigger distinct harmony patterns but which never surface; and 4) [+ATR]-triggered low vowel raising, which interacts opaquely with tongue root harmony (Hantgan & Davis 2012; Heath 2014; Green & Hantgan 2019). In addition to these theoretically and typologically irregular implications, these abstract accounts of Bondu-so vowel patterns assume additional cases of harmony counterbleeding opacity via absolute neutralisation, which by definition cannot be independently motivated or counter-evidenced. These analytical shortcomings strongly suggest that there must be some other explanation for Bondu-so vowel patterns.

I have advocated an alternative solution. Previous studies of Bondu-so tongue root harmony have ignored crucial insights from neutral harmony contexts (e.g. [bɪ̀j-è] 'lay down'-PERF. and [gɪ̀j-ɛ̀] 'kill'-PERF.) which demonstrate underlying tongue root contrasts on suffixes. This has led to the further misinterpretation of the direction of harmony and locus of underlying tongue root contrasts in harmonic surface-ambiguous cases (e.g. [dɔ̀gɛ̀] 'leave (it)'-PERF.). Following these corrected surface generalisations, Bondu-so displays a simple, non-abstract 7V inventory with a straightforward case of unidirectional, suffix-controlled [RTR] harmony. Like countless other harmony systems, non-contrastive high/low vowels are harmonically transparent, skipped by the harmony procedure, as outlined in the summary data in (26), repeated from (12). The analysis of this simple harmony system requires no particular theoretical assumptions and no harmony directional asymmetries, abstract contrasts, orthogonal vowel raising, floating autosegments, or derivational opacity – eliminating all of the theoretical, typological, and analytical issues raised in existing abstract analyses.

(26) *Bondu-so [RTR]-harmony and high/low vowel transparency*

a.	/keʤ-ilo̱ŋ/	[kéʤ-ìlò̱ŋ]	'cut'-INF.	i		u
b.	/keʤ-ijɛ̱/	[kɛ́ʤ-íjɛ̱́]	'cut'-MED.PASS.	e		o
c.	/sem-anʤ-e̱/	[sém-ánʤ-è̱]	'slaughter'-IMPERF.-2.PL.	ɛ		ɔ
d.	/sem-anʤ-ɛ̱ɛ̱/	[sɛ́m-ánʤ-ɛ̱́ɛ̱̀]	'slaughter'-IMPERF.-3.PL.		a	

This paper makes an important contribution to the "abstractness controversy" in phonology (Kiparsky 1968; 1973; Hyman 1970; 1988; 2003; Crothers 1971; Baković 2009). Analyses involving opacity via the absolute neutralisation of abstract contrasts are widespread in the phonological literature and should face the same analytical shortcomings I have demonstrated for existing analyses of Bondu-so. For example, Standard Yoruba (Atlantic-Congo) displays a 7V surface inventory with leftwards [RTR] harmony very similar to Bondu-so, but which features a number of unpredictable, lexical harmony exceptions: e.g. [e-bi̱] 'hunger' vs. surface-disharmonic [ɛ̀-bi̱] 'guilt'. To eliminate these exceptions, Ọla Orie (2001; 2003) posits abstract tongue root contrasts on high vowels which trigger distinct [±ATR] harmony but then undergo neutralisation after harmony has applied: i.e. /e-bɪ̱/ → {ɛ-bɪ̱} → [ɛ-bi̱]. Similar abstract approaches have been used to explain away the typologically rare distribution of vowel contrasts in Esimbi (Southern Bantoid), which displays four vowel height contrasts on affixes but only two on roots; for instance, labial vowels display a three-to-one contrast: [u-mu] 'drink' vs. [o-mu] 'go up' vs. [ɔ́-mu] 'sit'. Assuming that affixes should be universally less marked with respect to roots, Hyman (1988) posits widespread abstract contrasts on roots which are transferred to affixes via some abstract height transfer. After this vowel height transfer process has applied, root contrasts are assumed to be neutralised, effectively displacing underlying contrasts from roots to affixes, resulting in the unusual distribution of height distinctions on affixes and roots in Esimbi: e.g. /ú-mɔ̱/ → {ɔ́-mɔ̱} → [ɔ́-mu̱]. Each of these are examples of the same counterbleeding opacity via the absolute neutralisation of abstract contrasts we have seen for Bondu-so harmony patterns: e.g. /gɪj-E/ → {gɪj-ɛ} → [gɪ̀j-ɛ̀].

Like with abstract accounts of Bondu-so, there is no independent way to ever confirm or disprove the existence of these abstract segments in Yoruba or Esimbi nor can any surface form ever provide counter-evidence to the abstract analysis – regardless of the vowel patterns involved. Simply put, abstract contrasts do not validly explain surface opacity, and such analyses should be reviewed with the same skepticism I have given to Bondu-so vowels and vowel harmony.

Though I have shifted much of the locus of explanation for Bondu-so vowel patterns to the morphology, this is not to say that there is no abstractness in phonology or role for phonological explanations of exceptional data. As rightly put by Odden (2005: 258), "without generalizing beyond the directly observable, it would be impossible to make even the most mundane observations about any language. The question is therefore not whether phonology is abstract at all, but rather what degree of abstractness is required." In this paper, I have demonstrated clear limitations on the abstractness of phonological representations and some basic requirements in evaluating competing abstract and concrete analyses. Phonological contrasts and contrast neutralisation must be independently motivated (non-circularity), and any analysis must in principle admit possible counter-evidence (falsifiability). Until an account of abstract contrasts satisfies these requirements, I posit that segmental contrasts in phonology are "concrete".

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