Verb Root Allomorphy in Indo-Aryan Languages

PAROMA SANYAL, *Indian Institute of Technology Delhi*

ABSTRACT

This paper aims to theoretically describe the phonological basis for the systematic verb root allomorphy seen in some of the Indo-Aryan languages. To highlight the similarities and differences in allomorphy patterns, three languages, Bangla, Hindi and Odia have been compared. The paper proposes that these languages typologically choose to achieve *Paradigm Uniform*ity (Steriade 2000) within the verbal paradigm by introducing additional phonological processes, rather than by blocking the phonological processes active in the rest of the language.

1 Introduction

Natural languages tolerate allomorphy where a single lexical or syntactic item corresponds to more than one surface phonological representation. Nevertheless, within languages, such one to many mappings are restricted to small lexical sets within specific morpho-syntactic paradigms. In fact, morphological well-formedness concepts like *Paradigm Uniformity* (Kiparsky 1982, Kenstowicz 1998, Steriade 2000) have been proposed to account for the markedness of the phenomena. This has been defined in (1).

(1) Paradigm Uniformity

All output forms of α, where α is a morpheme shared by all members of a morphological paradigm P, must be identical.

In this paper, I analyze the phonological phenomenon of vowel allomorphy in the verb roots of three modern Indo-European languages, Hindi, Odia and Bangla. These languages have been selected for comparison because they share a substantial portion of the lexicon but have very distinct phonological characteristics with respect to vowels.

Hindi shares the property of vowel length distinction in non-mid vowels with other western Indo-Aryan languages. While this distinction is phonemic in non-verbs (2a), it is used to distinguish morphologically related forms in verbs (2b).

(2) Long and short vowel distinction in Hindi
a) Non-verbs

ḓi:n	'poor'	ḓin	'day'
ḓu:r	'distance'	ḓur	'bad'
ṭa:n	'string of musical notes'	ṭən	'body'

b) Non-verbs

Transitive.perf		Intransitive.perf	
pi:t-a:	'beat up'	pit-a:	'got beaten up'
lu:t-a:	'robbed'	lut-a:	'got robbed'
ka:t-a :	'cut'	kət-a:	'got cut'

Unlike Western Indo-Aryan languages, the Eastern Indo-Aryan languages have no phonemic contrast in vowel length. However, these languages exhibit distributional restrictions on the cooccurrence of vowels within the phonology of the language. In Odia, which tolerates the marked phonological context of vowel hiatus, the distributional restrictions appear in this context. In contrast, in Bangla such distributional restrictions are spread throughout the language and have been analysed as different types of vowel harmonies in preceding literature (Chatterjee 1926/1978, Dasgupta 1982, Dan 1998, Sanyal 2011). The contrast in the phonological characteristics of the vowel systems of these three languages have been schematically represented in (3).

(3) Schematic representation of Phonological characteristics
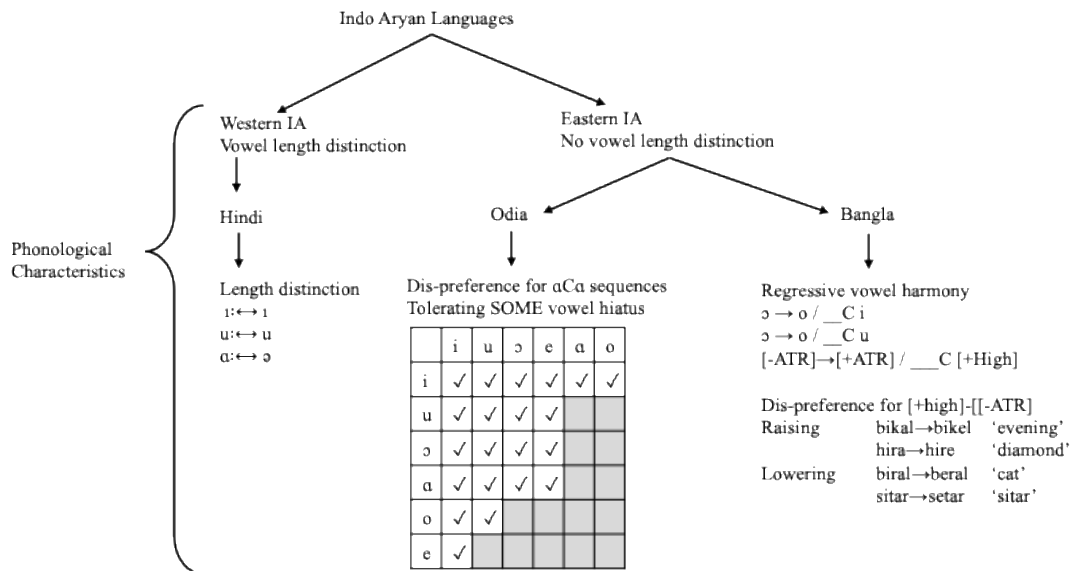
Verb root allomorphy in Hindi, Odia and Bangla involve change in the root vowel. This has been shown in (4) with the example of the verb 'sleep' which surfaces as [so] and [su].

(4) Change in root vowels in Verbs
a) Hindi
        (i) s**o:**   rəha: hũ:
             sleep prog. Be.1p
             I am sleeping.
        (ii) s**u**l-a: rəha: hũ:
             sleep-cause prog. Be.1p
             I am putting someone to sleep.
b) Odia
        (i) s**o**-uch-i
             sleep-prog.1p
             I am sleeping.

(ii) s**u**-o-uch-i
sleep-cause-prog.1p
I am putting someone to sleep.

c) Bangla

(i) s**u**-cch-i
sleep-prog.1p
I am sleeping.

(ii) s**o**-a-cch-i
sleep-cause-prog.1p
I am putting someone to sleep.

Since, vowel phonology is central to the analysis of this phenomenon, we will begin the discussion with a theoretical discussion on vowel systems in sub-section 1.1 followed by a short description of the vowel systems of the three languages in sub-section 1.2.
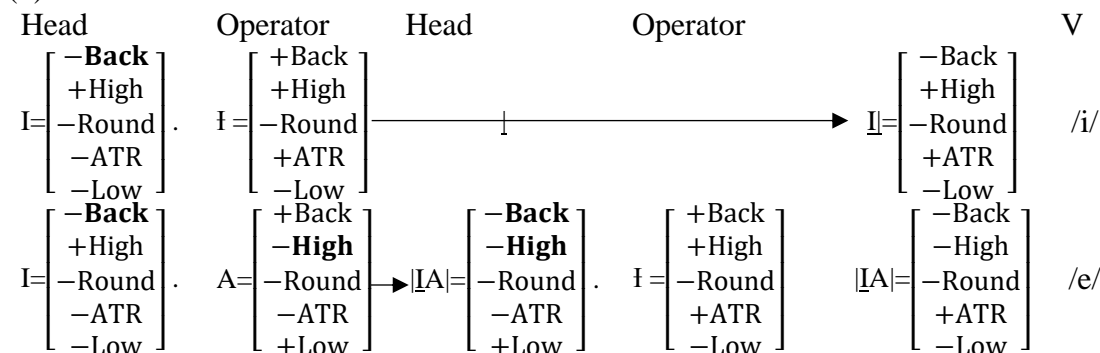
1.1 Vowel Primes

Following the theory of Government Phonology (Kaye et al. 1985, 1990, 1992, 1995 and subsequent work) we assume three Primes [I, U and A] that are the base formatives of the vocalic system each having a marked **_Hot_** feature. In addition, there is a cold vowel *v* that lacks any hot feature.

(5) Primes

$$
\text{a)}\quad I = \begin{bmatrix} -\textbf{Back} \\ +\text{High} \\ -\text{Round} \\ -\text{ATR} \\ -\text{Low} \end{bmatrix}
\quad \text{b)}\quad A = \begin{bmatrix} +\text{Back} \\ -\textbf{High} \\ -\text{Round} \\ -\text{ATR} \\ +\text{Low} \end{bmatrix}
\quad \text{c)}\quad U = \begin{bmatrix} +\text{Back} \\ +\text{High} \\ +\textbf{Round} \\ -\text{ATR} \\ -\text{Low} \end{bmatrix}
\quad \text{d)}\quad \textit{Ɨ} = \begin{bmatrix} +\text{Back} \\ +\text{High} \\ -\text{Round} \\ +\text{ATR} \\ -\text{Low} \end{bmatrix}
$$

The Primes can combine with one another to form complex primes through the operation of combining a Head and an Operator. The resultant complex copies in the Hot feature of the Head and the remaining feature values from the Operator.
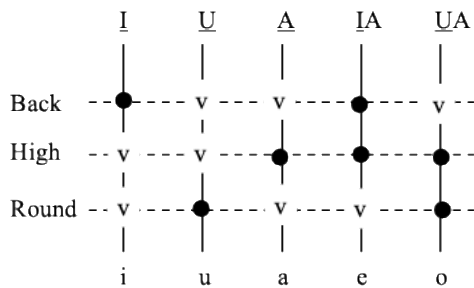
(6) Prime correlates to vowels

Head	Operator	Head	Operator		V

$$
I = \begin{bmatrix} -\textbf{Back} \\ +\text{High} \\ -\text{Round} \\ -\text{ATR} \\ -\text{Low} \end{bmatrix}.
\quad Ɨ = \begin{bmatrix} +\text{Back} \\ +\text{High} \\ -\text{Round} \\ +\text{ATR} \\ -\text{Low} \end{bmatrix}
\longrightarrow Ɨ
\quad \underline{I} = \begin{bmatrix} -\text{Back} \\ +\text{High} \\ -\text{Round} \\ +\text{ATR} \\ -\text{Low} \end{bmatrix} \quad \text{/i/}
$$

$$
I = \begin{bmatrix} -\textbf{Back} \\ +\text{High} \\ -\text{Round} \\ -\text{ATR} \\ -\text{Low} \end{bmatrix}.
\quad A = \begin{bmatrix} +\text{Back} \\ -\textbf{High} \\ -\text{Round} \\ -\text{ATR} \\ +\text{Low} \end{bmatrix} \blacktriangleright |\underline{I}A| = \begin{bmatrix} -\textbf{Back} \\ -\textbf{High} \\ -\text{Round} \\ -\text{ATR} \\ +\text{Low} \end{bmatrix}.
\quad Ɨ = \begin{bmatrix} +\text{Back} \\ +\text{High} \\ -\text{Round} \\ +\text{ATR} \\ -\text{Low} \end{bmatrix}
\quad |\underline{I}A| = \begin{bmatrix} -\text{Back} \\ -\text{High} \\ -\text{Round} \\ +\text{ATR} \\ -\text{Low} \end{bmatrix} \quad \text{/e/}
$$

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The Hot features also form autosegmental tiers on which the phonemes can be plotted. These tiers can have fused exponence in the vocalic systems of particular languages with the consequence that the primes associated with the fused tiers primes cannot combine to form a complex sound. This has been demonstrated in (7) with a respect to a toy grammar with a five-vowel vocalic system.

(7) Vocalic systems with Fused tiers
a) Distinct Tiers   b) Fused Tiers
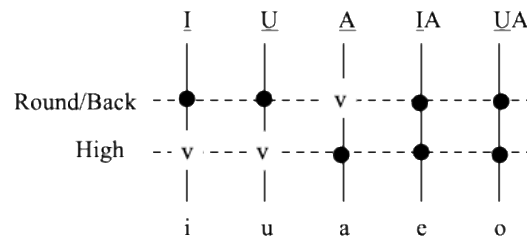
In the following section, the vowel repertoire of the three Indo-Aryan languages, Hindi, Odia and Bangla have been characterized using this formulation.

1.2 Vowel Primes in Hindi, Odia and Bangla

Hindi has a basic repertoire of three short and seven long vowels[1]. Among the long vowels there is optionality between the diphthongs /ɛe/ and /ɔo/, with the monophthongs /ɛ:/ and /ɔ:/ respectively. Leaving out these two long vowel phonemes, the rest of the long vowels have a distribution of primes identical to the one demonstrated in (7b). The Prime and (syllable) Rhyme based representation of the vocalic phonemes of Hindi are shown in (8).
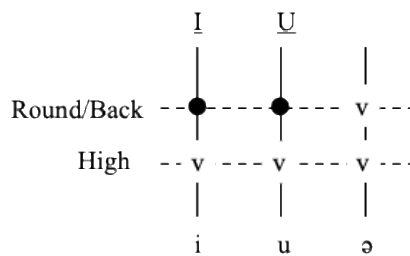
(8) Vowel phonemes in Hindi

Representations→   Prime-based   Rhyme-based
a) Short vowels

mil-na: 'to find'
juḍ-na: 'to join'
cəl-na: 'to walk'

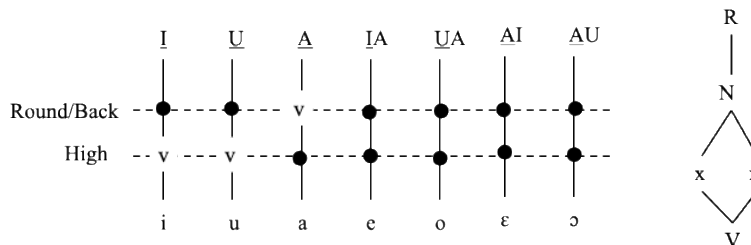
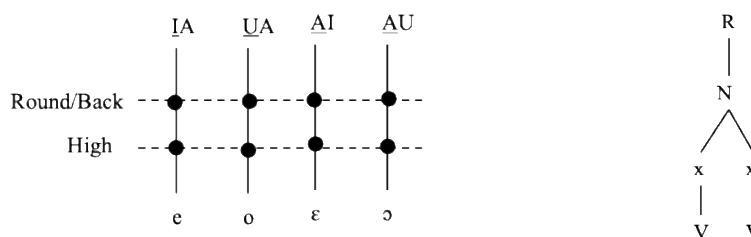[1] The long vowels can also have oral and nasal counterparts. (Think about it)

b) Long vowels

pi:ʈ-na: 'to beat up'
lu:ʈ-na: 'to loot'
cʰa:p-na: 'to print'
ḍe:kʰ-na: 'to see'
kʰo:l-na: 'to open'
bɛ:ʈʰ-na: 'to sit'
ḍɔ:ḍ-na: 'to run'

c) Diphthongs

bɛeʈʰ-na: 'to sit'
ḍɔoḍ-na: 'to run'

Hindi has word final phonetic lengthening, where the word final vowel is always a long vowel. Since the vowel schwa [ə] does not have a long counterpart, it fails to appear word finally. In section 2.1 we argue that this is the reason CV verb roots do not surface with the vowel schwa.

Unlike Hindi, where vowel length plays an important role in the phonological distribution, in the Eastern Indo-Aryan languages, all vowels are generally pronounced as phonetically long without any phonemic length distinction. The Prime and Rhyme based representation of the Odia vowels are shown in (9).
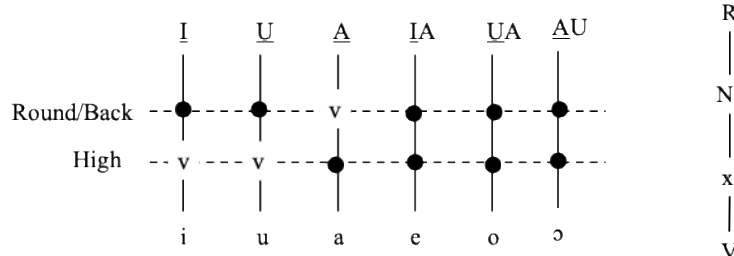
(9) Vowel phonemes in Odia

Representations→   Prime-based   Rhyme-based

piʈ   'beat up.imp'
luʈ   'loot.imp'
ḍak   'call.imp'
ḍekʰ   'see.imp'
kʰol   'open,imp'
bɔs   'sit.imp'
ḍɔ:ḍ   'to run'

With respect to the vowel repertoire, Bangla differs minimally from Odia by having one phoneme more than the latter. However, the vowel allomorphy patterns in verb roots of these two sister languages differ from each other substantially as will be seen in section 2.2 and 2.3. In Bangla verb roots, the vowels [i, u] never appear in the same morphological paradigm with the vowels [ɛ, ɔ], though these form minimal pairs in the non-verbal domain. So, in (10) I am using non-verb examples to showcase the vowel repertoire of Bangla.

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(10)   Vowel phonemes in Bangla

Representations→   Prime-based   Rhyme-based

ḍin   'day'
ḍul   'earring
ḍan   'given object'
ṭel   'oil
kol   'lap'
d̤ʰɛn   'attention'
kɔl   'tap'

In the following section I show how these vowels of Hindi, Odia and Bangla show systematic patterns of alternation in different morpho-syntactic contexts.

2 Verb Root Allomorphy

Unlike languages like English that form lexical causatives (11a), many of the Indo-Aryan languages form systematic morphological causatives (11b-d).

(11)   Lexical vs Morphological causatives

Lexical Causative	a) English [eat]↔[feed]	[see]↔[show]
Morphological Causative	b) Hindi [kʰaː-naː]↔[kʰil-aː-naː]	[d̤ekʰ-naː]↔[d̤ikʰ-aː-naː]
	c) Odia [kʰa-i-ba]↔[kʰu-o-i-ba]	[d̤ekʰ-i-ba]↔[d̤ekʰ-o-i-ba]
	d) Bangla [kʰa-wa]↔[kʰa-wa-no]	[d̤ɛkʰ-a]↔[d̤ɛkʰ-a-no]

Despite the overt morphological marking of causatives, the verb roots of causatives in all three languages form a sub-paradigm within which the vowel of verb roots gets modified. In Odia, this is the only environment for systematic allomorphy in CV verb roots. Hindi shows identical patterns of verb root allomorphy in causative and intransitive contexts. Thus the unaccusative and causative forms of transitive verb roots in Hindi have identical allomorphic forms. The same phonological pattern is seen in the causative forms of unergative and ditransitive verbs in Hindi as well. Unlike these two, the Bangla allmomorphy pattern is slightly more complex as it can be divided into three phonological sub-paradigms that correspond to five distinct morphological environments. The following sections 2.1, 2.2 and 2.3 discuss these correspondences between the phonological and morphological contexts for allomorphy in Hindi, Odia and Bangla respectively.

2.2 Patterns of verb root allomorphy in Hindi

In Hindi transitive verbs can be morphologically derived to form the corresponding unaccusative verb by systematically modifying the vowel in verb roots. This has been shown in (12).

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(12) Transitive-Unaccusative alternation in Hindi
      Transitive   Unaccusative   Causative
      piːʈ-naː   piʈ-naː   piʈ-waː-naː   'to beat up'
      ḍeːkʰ-naː   ḍikʰ-naː   ḍikʰ-aː-naː   'to see'
      gʰis-naː   gʰis-naː   gʰis-waː-naː   'to rub'
      luːʈ-naː   luʈ-naː   luʈ-waː-naː   'to loot'
      kʰoːl-naː   kʰul-naː   kʰul-waː-naː   'to open'
      bun-naː   bun-naː   bun-waː-naː   'to knit'
      cʰaːp-naː   cʰəp-naː   cʰəp-waː-naː   'to print'
      ʈəl-naː   ʈəl-naː   ʈəl-waː-naː   'to fry'

Each of the long vowel from the transitive verb root changes to a short vowel in the corresponding unaccusative and causative verb root. Similar changes take place in deriving the causative forms for unergative verbs as well, shown in (13).

(13) Unergative-Causative alternation in Hindi
      Unergative   Causative
      ciːkʰ-naː   cikʰ-waː-naː   *cikʰ-naː   'to scream'
      leːʈ -naː   liʈ-aː-naː   *liʈ -naː   'to lie down'
      gir-naː   gir-aː-naː   'to fall'
      cʰuːʈ-naː   cʰuʈ-waː-naː   *cʰuʈ-naː   'to escape'
      boːl-naː   bul-waː-naː   *bul-naː   'to say'
      sun-naː   sun-aː-naː   'to listen'
      maːŋ-naː   məŋ--waː-naː   *məŋ-naː   'to print'
      cəl-naː   cəl-aː-naː   'to fry'

The phonological pattern of change in these modifications involves two changes. First, there is a reduction at the segmental tier where a binary branching nucleus changes to an unbranched one with just one segmental position, shown in (14a). Secondly, there is a loss in the prime |A| in the root vowels which contain the prime |A|. Thus, the two complex long vowels |IA| and |UA| reduce to short |I| and |U|, and the long vowel |A| with a single prime loses its hot feature to become the reduced vowel schwa that surfaces without any hot feature. This has been schematically represented in (14b) as the delinking of the root vowel segments from the [High] tier resulting in the loss of |A|.

(14) Phonological changes in Hindi Verb roots
      (a) Change in skeletal tier

(b)   Change in Primes
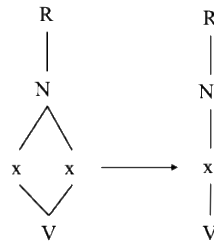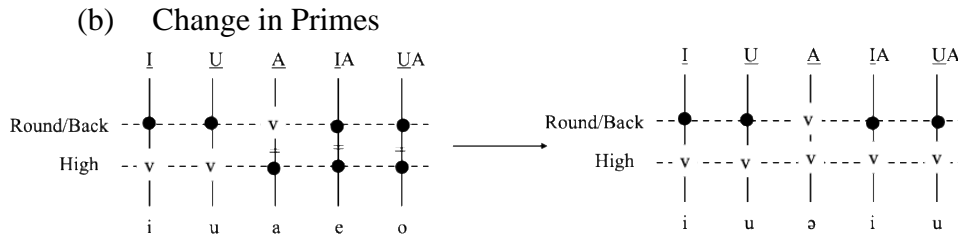
The complex vowels |AI| and |AU| that show optionality between dipththong and long monophthong surface realization also tend to show lexical variation with respect to this vowel reduction as seen in (15).
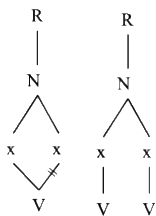
(15)   Vowel reduction in Diphthongs

| Unergative	Causative		
bɛeʈʰ-na: ~ bɛ:ʈʰ-na:	bɛeʈʰ-a:-na: ~ biʈʰ-a:-na:		'to sit'
ʈɛer-na: ~ ʈɛ:r-na:	ʈɛer-a:-na:	*ʈir-a:-na:	'to swim'
ḍɔoḍ-na: ~ ḍɔ:ḍ-na:	ḍɔoḍ-a:-na:	*ḍuḍ-a:-na:	'to 'run'
cɔ̃õk-na: ~ cɔ̃:k	cɔ̃õk-a:-na:	*cũk-a:-na:	'to shock'

Whether a native speaker is able to reduce the root vowel in causatives depends on whether they interpret it as a monophthong or a diphthong. For those cases where the vowel is categorized as a diphthong by the individual speaker, there is no reduction. This confirms that the change in segmental tier is though the delinking of the doubly linked V (16a), rather than the change of the branching nucleus to a non-branching one. Were it the latter case (16b), all long vowels including diphthongs would have shown the same reduction process in causatives.

(16)   Delinking within the skeletal tier
 a) Only Monophthongs get reduced   b) All long vowels get reduced
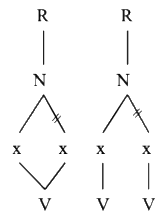
In case of Hindi, there is no phonological motivation for this vowel reduction. Such vowel reduction in lexical vowels is not seen anywhere else in the language as well. This reduction, in fact results in accidental neutralization of the lexical distinction within the causative paradigm, as shown in (17).

(17)   Neutralization of lexical distinction in causatives

Verb root	Causative verb root	
kʰa:-na:	kʰil-a:-na:	'to eat'

| kʰel-na: | kʰil-a:-na: | 'to play' |
| kʰil-na: | kʰil-a:-na: | 'to bloom' |

Hindi tolerates such lexical neutralization in verb roots in order to create a distinct paradigm of morphologically derived unaccusatives that differ from their transitive counterparts without additional suffixation. There is a semantic commonality between the transitive-causative and transitive-unaccusative derivation, because both cases involve a change in the theta role of the transitive verb .

2.3 Patterns of verb root allomorphy in Odia

In Odia verb root allomorphy is restricted to the CV roots. Further, among the CV roots *Paradigm uniformity* is restricted to the Causative paradigm. This means that in the non-causative morphological contexts the CV verb roots could surface with more than one allomorph depending on the phonological context and the resulting non-uniformity within the paradigm is tolerated. Unlike Hindi, the allomorphy pattern in Odia is partly phonologically motivated as it avoid illicit sequences of vowel hiatus. This has been shown in (18).

(18)   Neutralization of lexical distinction in causatives
   a)   Non-causatives

	hab.1p	hab.2p	prog.1p	perf.1p	
	-e	*-ɔ*	*-u-cʰi*	*-i-cʰi*	
pi	pi-e	pi-ɔ	pi-u-cʰi	pi-i-cʰi	'to drink'
cʰũ	cʰũ-e	cʰũ-ɔ	cʰũ-u-cʰi	cʰũ-i-cʰi	'to touch'
ḍe	**ḍi-e**	**ḍi-ɔ**	**ḍo-u-cʰi**	ḍe-i-cʰi	'to give'
so	**su-e**	**su-ɔ**	so-u-cʰi	so-i-cʰi	'to sleep'
kʰa	kʰa-e	kʰa-ɔ	kʰa-u-cʰi	kʰa-i-cʰi	'to eat'
nɔ	nɔ-e	nɔ-ɔ	nɔ-u-cʰi	nɔ-i-cʰi	'to bend'

        b)   Causatives

|	hab.1p	prog.1p	perf.1p	
	-a-e	*-o-u-cʰi*	*-e-i-cʰi*	
pi	pi-a-e	pi-o-u-cʰi	pi-e-i-cʰi	'to drink'
cʰũ	cʰũ-a-e	cʰũ-o-u-cʰi	cʰũ-e-i-cʰi	'to touch'
ḍe	**ḍi-a-e**	**ḍi-o-u-cʰi**	**ḍi-e-i-cʰi**	'to give'
so	**su-a-e**	**su-o-u-cʰi**	**su-e-i-cʰi**	'to sleep'
kʰa	**kʰu-a-e**	**kʰu-o-u-cʰi**	**kʰu-e-i-cʰi**	'to eat'
nɔ	**nu-a-e**	**nu-o-u-cʰi**	**nu-e-i-cʰi**	'to bend'

The causative paradigm of Odia is phonologically more complex than Hindi, as there are distinct vowels that appear as the causative morpheme in the habitual, progressive and perfect contexts which are also vowel-initial suffixes. Phonologically, all the scenarios of verb root allomorphy, save one [ḍo-u-chi] involve delinking of the [High] feature and the consequent erasure of the prime |A| from the CV roots. This is schematically shown in (19).

(19)   Phonological change in Odia Causative verb roots
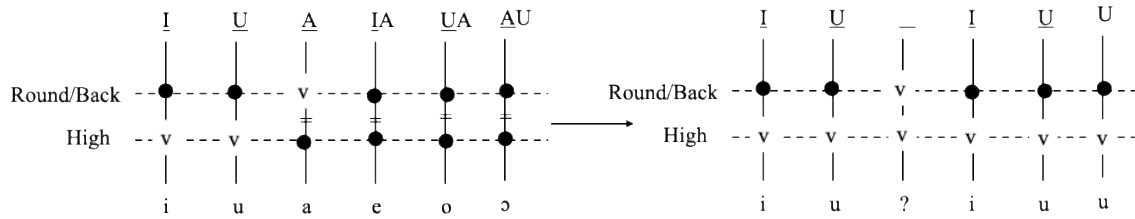
While Odia is similar to Hindi in delinking the associations with the [High] tier as part of the Causative morphology, it differs from the latter in the realization of the vowel without any hot feature. Unlike Hindi which has a phoneme schwa to corresponds with the cold feature set, Odia does not have any output representation that matches this description. To surface in a structure preserving manner (Kiparsky 1985) this underspecified form must now acquire the characteristics of the default epenthetic vowel for the language. In Odia, this vowel is [ɔ] with the primes |AI|. Once characterized as [ɔ] it follows the same delinking and reduction process that takes place for underlying cases of |AI|. This derivational route has been shown in (20).

(20)   Process of reduction of |A| to |U| in Odia Causatives
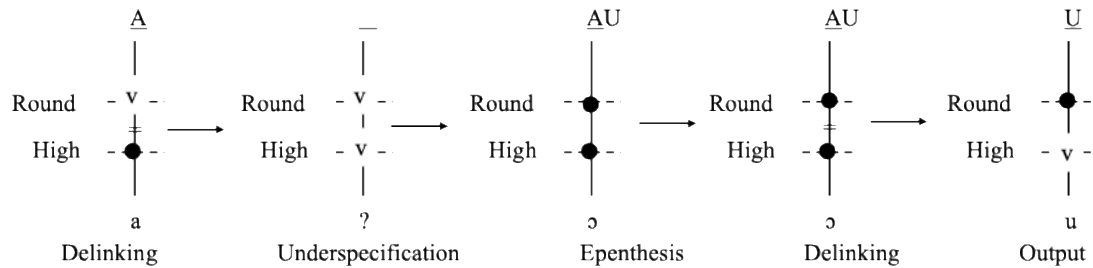
Independent phonological evidence supporting the analysis in (20) can be found at two different places within the Odia lexicon. The first is the case of delinking an underlying [a] from the [High] tier when it is followed by another [a] in the consecutive syllable. This is found in both verbs as well as non-verbs, but in non-verbs it becomes apparent only when the forms are compared to cognates in other Indo-Aryan languages. This has been shown in (21).

(21)   Dis-preference for consecutive [a] vowels in Odia
        a)   Verbs
                    hab.1p   Caus.hab.1p   Caus.prog.1p   Caus.perf.1p
        ɖak   ɖak-e   **ɖɔk**-a-e   **ɖɔk**-o-u-cʰi   **ɖɔk**-e-i-cʰi   'to call'
        b)   Non-Verbs
                    Odia   Hindi   Bangla
                    cʰɔṭa   cʰa:ṭa: cʰaṭa   'umbrella'
                    ɔṭa   a:ṭa: aṭa   'flour'

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In the case of (21a) and (21b), the second sequence of delinking from (20) does not take place since the output forms with [ɔ] followed by [a] with an intervening consonant is not a marked sequence that requires repair. In case of the causative form of verbs, the phonological change is overapplied across all the causative forms of the lexical item to maintain *Paradigm Uniformity*.

The second evidence comes from the distributional restriction on the vowel [o] in different dialects of Odia. While Katki Odia, spoken around the east central region of the state restricts [o] to initial syllables, Sambalpuri Odia, spoken along the western flank prefers to restrict it to the final syllable (Guru and Nayak, 2024). A comparison of cognates between the two dialects reveals that the underlying [o] surfaces as [u] in prosodic positions where the former is not licensed. This has been shown in (22).

(22)   Reduction of [o] to [u] in Odia dialects

				UA	UA	U
UR	seo 'apple'	gora 'fair'				
Delinking			Round	−●−	Round −●−	Round −●−
SR			High	−●−	High −●−	High −v−
Sambalpuri	seo	**gura**		o	o	u
Katki	**seu**	gora		Intput	Delinking	Output

2.4 Patterns of verb root allomorphy in Bangla

Bangla has two distinct processes of vowel harmony that could have potentially made the verbal paradigm non-uniform. These two processes are listed in (23).

(23)   Phonological processes in Bangla

a) Regressive harmony

ɟɔj	'victory'	ɟoj-i	'victor'
poʈʰ	'path'	poʈʰ-ik	'traveller'

b) Prosodic misalignment adjustment

bikal~bikel	'evening'	biral~beral	'cat'	biʃal	'huge'
ɟuʈa~ɟuʈo	'shoe'	ɖukan~ɖokan	'shop'	ʃikar	'hunt'
piʈɔl~peʈol	'brass'	ʃikɔr~ʃekor	'root'	iʃʃɔr	'god'

In (23a) when the mid lax vowel [ɔ] is followed by the vowels [i] or [u] in the following syllable, the former raises to [o]. Except for a handful of prefixes, this process applies throughout the lexicon. The second one (23b), is analyzed as a case of prosodic misalignment by Sanyal (2011). I observe that there is a distinct dis-preference for disyllabic lexical strings where a [+high] vowel is followed by a [-ATR] one, and often

results in alternative pronunciations that address this context by either lowering the first vowel or raising the second one. In Sanyal (2011) I argue that this dis-preference is caused by prosodic mis-alignment where the stresses initial syllable contains vowels with lowest sonority and its corresponding unstressed second syllable contains the maximally sonorous vowels.

In the lexical domain of verb roots, both these phonological processes could have potentially induced phonologically conditioned allomorphy. In (24) I demonstrate this point using the hypothetical verb root template [kvl], where [v] is replaced with the seven vowels or the repertoire, with actual inflectional markers from Bangla.

(24) Hypothetical case of phonological processes applying in the verbal domain

Root vowel	*Verb	Habitual.1p	Gerund
i	kil	kil-i→kili	kil-a→kela
e	kel	kel-i→keli	kel-a→kela
ɛ	kɛl	kɛl-i→keli	kɛl-a→kɛla
u	kul	kul-i→kuli	kul-a→kola
o	kol	kol-i→koli	kol-a→kola
ɔ	kɔl	kɔl-i→koli	kɔl-a→kɔla
a	kal	kal-i→kali	kal-a→kala

In (24) the cases of potential homophony are highlighted. Not only would these phonological processes make the verb root paradigm phonologically non-uniform, but it would produce homophonous outputs within the paradigm. To avoid this scenario, the verb roots in Bangla are divided into three phonological sub-paradigms that correspond to different syntactic contexts. These three sub-paradigms are shown in (25).
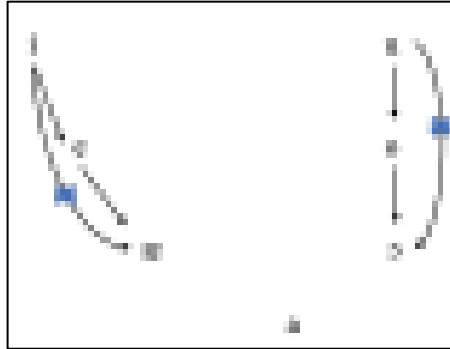
(25) Phonological sub-paradigms in Bangla verb roots

Sub-Paradigm	A	B	C	
Root Vowels	[e, o, a, ɔ, ɛ]	[i, u, a, o, e]	[i, u, o, e]	
a) CVC roots	Imperative.2p	Permissive/ (Prohibitive)	Perf.present.1p	
	lekʰ-o	likʰ-o (na)	likʰ-e-cʰ-i	'write'
	ʃon-o	ʃun-o (na)	ʃun-e-cʰ-i	'listen'
	rakʰ-o	rakʰ-o (na)	rekʰ-e-cʰ-i	'keep'
	kɔr-o	kor-o (na)	kor-e-cʰ-i	'do'
	ḍɛkʰ-o	ḍekʰ-o (na)	ḍekʰ-e-cʰ-i	'see'

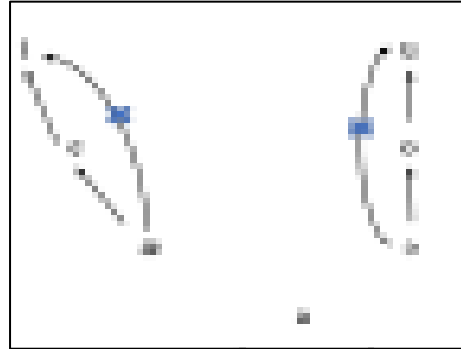| Sub-Paradigm	A		C	
Root Vowels	[o, a, e]	[i, u, e]	[i, u, e]	
b) CV roots	Imperative.1p	Permissive/ (Prohibitive)	Perf.present.1p	
	ca	ce-o (na)	ce-e-cʰ-i	'ask for'
	ʃo	ʃu-o (na)	ʃu-e-cʰ-i	'sleep'
	ne	ni-o (na)	ni-e-cʰ-i	'keep'

In (25a) CVC roots form three sub-paradigms in such a way that each verb root has two allomorphs that can be derived from the other form by chain shift lowering or raising.

(26)   Schematic representation of chain shift
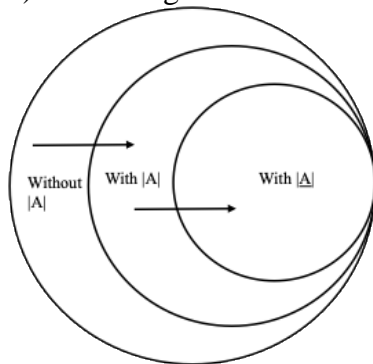   a) Lowering Hypothesis   b) Raising Hypothesis


The schematics in (26a) and (26b) both depict the patterns root vowel change between sub-paradigms A and B in (25a). Here, the vowels that undergo change can be divided into three sets: Those without |A|, those with |A| and those with |A| as head. Since the change is symmetric, we could either consider A or B as the base paradigm and derive the other. This has been shown using primes in (27).

(27)   Prime-based representation change in resonance for Root vowel
         a) Increasing Resonance   b) Decreasing Resonance
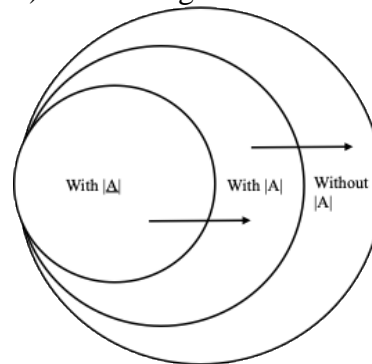
The Low vowel [a] does not participate in allomorphy between sub-paradigms A and B. However, it participates in C by failing to surface and showing a decrease in resonance, similar to B. Based on this pattern of change between A to C, I concur with preceding literature that the process in Bangla CVC verb roots could be characterised as vowel raising or decrease in sonority. To prevent homophony between items in the within the paradigm, the Sub-paradigm A, henceforth Root 1, does not contain [+high] vowels. Root 2 is derived by making a gradual change with respect to the realization of the prime |A|. In (25b) we find that with CV roots, the sub-paradigm B is missing altogether and the change is from pattern A in Root 1 to pattern C in Root 2. Further, there are only two levels of change in

the resonance of CV roots, instead of the three levels of change in the phonological system of CVC roots[2].

　　There are clear morpho-syntactic paradigms associated with Sub-paradigms B and C in Bangla where the verb roots have uniform exponence. These have been listed in (28a) and (28b) below.

(28)　　Morpho-syntactic paradigms
　　　　a)　Sub-Paradigm B

Past.1p	Past.hab.1p	Past.prog.1p	Present.prog.1p	Fut.1p	
likʰ-l-am	likʰ-t-am	likʰ-cʰi-l-am	likʰ-cʰ-i	likʰ-b-o	'write'
ʃun-l-am	ʃun-t-am	ʃun-cʰi-l-am	ʃun-cʰ-i	ʃun-b-o	'listen'
rakʰ-l-am	rakʰ-t-am	rakʰ-cʰi-l-am	rakʰ-cʰ-i	rakʰ-b-o	'keep'
kor-l-am	kor-t-am	kor-cʰi-l-am	kor-cʰ-i	kor-b-o	'do'
ḍekʰ-l-am	ḍekʰ-t-am	ḍekʰ-cʰi-l-am	ḍekʰ-cʰ-i	ḍekʰ-b-o	'see'

Past.2p	Past.hab.2p	Past.prog.2p	Present.prog.2p	Fut.2p	Subjunctive.2p
likʰ-l-e	likʰ-t-e	likʰ-cʰi-l-e	likʰ-cʰ-o	likʰ-b-e	likʰ-o
ʃun-l-e	ʃun-t-e	ʃun-cʰi-l-e	ʃun-cʰ-o	ʃun-b-e	ʃun-o
rakʰ-l-e	rakʰ-t-e	rakʰ-cʰi-l-e	rakʰ-cʰ-o	rakʰ-b-e	rakʰ-o
kor-l-e	kor-t-e	kor-cʰi-l-e	kor-cʰ-o	kor-b-e	kor-o
ḍekʰ-l-e	ḍekʰ-t-e	ḍekʰ-cʰi-l-e	ḍekʰ-cʰ-o	ḍekʰ-b-e	ḍekʰ-o

Past.3p	Past.hab.3p	Past.prog.3p	Present.prog.3p	Fut.3p	Subjunctive.3p
likʰ-l-o	likʰ-t-o	likʰ-cʰi-l-o	likʰ-cʰ-e	likʰ-b-e	likʰ-uk
ʃun-l-o	ʃun-t-o	ʃun-cʰi-l-o	ʃun-cʰ-e	ʃun-b-e	ʃun-uk
rakʰ-l-o	rakʰ-t-o	rakʰ-cʰi-l-o	rakʰ-cʰ-e	rakʰ-b-e	rakʰ-uk
kor-l-o	kor-t-o	kor-cʰi-l-o	kor-cʰ-e	kor-b-e	kor-uk
ḍekʰ-l-o	ḍekʰ-t-o	ḍekʰ-cʰi-l-o	ḍekʰ-cʰ-e	ḍekʰ-b-e	ḍekʰ-uk

All non-present forms along as well as those marked with progressive aspect belong to the Sub-Paradigm B. All affixal forms that attach to the verb root are consonant-initial, with the notable example of the 2p subjunctive. The vowel of the affix has no effect on the root morpheme. The paradigm B emerges in certain CV roots.

Past.2p	Past.hab.2p	Past.prog.2p	Present.prog.2p	Fut.2p	Subjunctive.2p
ca-i-l-e	ca-i-t-e	ca-i-cʰi-l-e	ca-i-cʰ-o	ca-i-b-e	ca-o *ca-i-o
kʰe-l-e	kʰe-t-e	kʰa-c-cʰi-l-e	kʰa-c-cʰ-o	kʰa-b-e	kʰa-o

With respect to CV roots, the differences between Sub-paradigms B and C are not as clearly defined as it is in case of CVC roots, and I will not comment of this matter any further in this paper.

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[2] The vowel [ɔ] and [ɛ] do not appear word-finally in lexical words in Bangla, and also fail to occur root finally in CV verb roots.

b) Sub-Paradigm C

Perf.1p	Perf.2p	Perf.3p	
likʰ-e-cʰ-i	likʰ-e-cʰ-o	likʰ-e-cʰ-e	'write'
ʃun-e-cʰ-i	ʃun-e-cʰ-o	ʃun-e-cʰ-e	'listen'
rekʰ-e-cʰ-i	rekʰ-e-cʰ-o	rekʰ-e-cʰ-e	'keep'
kor-e-cʰ-i	kor-e-cʰ-o	kor-e-cʰ-e	'do'
ḍekʰ-e-cʰ-i	ḍekʰ-e-cʰ-o	ḍekʰ-e-cʰ-e	'see'

Past.perf.1p	Past.perf.2p	Past.perf.3p	Conjunctive participle
likʰ-e-cʰi-l-am	likʰ-e-cʰi-l-o	likʰ-e-cʰi-l-e	likʰ-e (eʃ-o)
ʃun-e-cʰi-l-am	ʃun-e-cʰi-l-o	ʃun-e-cʰi-l-e	ʃun-e (eʃ-o)
rekʰ-e-cʰi-l-am	rekʰ-e-cʰi-l-o	rekʰ-e-cʰi-l-e	rekʰ-e (eʃ-o)
kor-e-cʰi-l-am	kor-e-cʰi-l-o	kor-e-cʰi-l-e	kor-e (eʃ-o)
ḍekʰ-e-cʰi-l-am	ḍekʰ-e-cʰi-l-o	ḍekʰ-e-cʰi-l-e	ḍekʰ-e (eʃ-o)

Phonologically, Sub-Paradigm C is a specialized case of Sub-paradigm B where the root vowel [a], which is phonologically inert in B, also undergoes the same phonological transformation as other vowels with |A| head. Morpho-syntactically too, the Sub-paradigm B is the larger set containing all non-present tense forms as well as aspect markers. Similar to the phonology, the Perfect aspect, can also be considered as a specialized morpho-syntactic characterization which stands out from the general set B by forming a specialized paradigm C.

Elsewhere in the language as well, there is independent evidence that the Perfect is morpho-phonologically distinct from the regular Tense-Aspect morphology of Bangla. For example, it has a fused exponence with negation as seen in (29).

(29)   Negation in Bangla
        a) Present/Habitual

tumi	o-ke	bol-o		tumi	o-ke	bol-o	na
2p	3p-acc	tell.subj.2p		2p	3p-acc	tell.subj.2p	Neg
You tell him.				You don't tell him.			

        b) Perfect

tumi	o-ke	bol-e-cʰo		tumi	o-ke	bɔl-o	ni
2p	3p-acc	tell.perf.2p		2p	3p-acc	tell.2p	Neg.perf
You told him.				You didn't tell him.			

Finally, the remaining or elsewhere morpho-syntactic paradigm shows non-uniform phonological exponence. When the CVC verb root is immediately followed by a inflection that begins with a [+high] vowel, the environment for regressive vowel harmony, the Root 2 is surfaces in sub-paradigm B. Everywhere else, including causatives, gerund and imperative the Root appears in Sub-paradigm A. This has been shown in (30).

(30)　Elsewhere

a)　Sub-paradigm B: With [High] vowels

Habitual.1p	Habitual.1p.fam	Caus.Perf	Imp.Hon	
likʰ-i	likʰ-iʃ	likʰ-i-e-cʰi-l-o	likʰ-un	'write'
ʃun-i	ʃun-iʃ	ʃun-i-e-cʰi-l-o	ʃun-un	'listen'
rakʰ-i	rakʰ-iʃ	rakʰ-i-e-cʰi-l-o	rekʰ-un	'keep'
kor-i	kor-iʃ	kor-i-e-cʰi-l-o	kor-un	'do'
ɖek̚ʰ-i	ɖek̚ʰ-iʃ	ɖek̚ʰ-i-e-cʰi-l-o	ɖek̚ʰ-un	'see'

b)　Sub-paradigm A

Imp.2p.fam	Imp.2p	Hab.Hon	Hab.3p	Gerund
lekʰ	lekʰ-o	lekʰ-en	lekʰ-e	lekʰ-a
ʃon	ʃon-o	ʃon-en	ʃon-e	ʃon-a
rakʰ	rakʰ-o	rakʰ-en	rakʰ-e	rakʰ-a
kɔr	kɔr-o	kɔr-en	kɔr-e	kɔr-a
ɖɛkʰ	ɖekʰ-o	ɖɛkʰ-en	ɖɛkʰ-e	ɖɛkʰ-a

Caus.1p	Caus.prog.1p	Caus.past.1p	Caus.prog.past.1p	
lekʰ-a-i	lekʰ-a-c-cʰ-i	lekʰ-a-l-am	lekʰ-a-c-cʰ-i-l-am	'write'
ʃon-a-i	ʃon-a-c-cʰ-i	ʃon-a-l-am	ʃon-a-c-cʰ-i-l-am	'listen'
rakʰ-a-i	rakʰ-a-c-cʰ-i	rakʰ-a-l-am	rakʰ-a-c-cʰ-i-l-am	'keep'
kɔr-a-i	kɔr-a-c-cʰ-i	kɔr-a-l-am	kɔr-a-c-cʰ-i-l-am	'do'
ɖɛkʰ-a-i	ɖekʰ-a-c-cʰ-i	ɖɛkʰ-a-l-am	ɖekʰ-a-c-cʰ-i-l-am	'see'

Summarizing this sub-section on Bangla verb root allomorphy, we see that the pattern for vowel alternation cannot be simply stated with respect to either a single phonological or morphological context. The morphology of the language, cognizant of the phonological well-formedness requirements of Bangla, conspires to create phonological sub-paradigms A and B that bleed away the context for phonological rule application.

3　Discussion

In this paper we have seen that all the three Indo-Aryan languages Hindi, Odia and Bangla show vowel umlaut in verb roots. In each one of the contexts, the prime |A| plays a central role in the phonological description of the allomorphic pattern. Further, in each of the patterns the vowel repertoire gets restricted in the marked morphological environments. The "marked" morphological context, literally works to set the paradigm distinctively apart from the rest of the inflectional morphology in the verbal paradigm.

This "marking out" is witnessed clearly in the case of Hindi and Odia causatives where the umlaut simply doubles up as an additional morphological factor in a context that is already marked by a causative inflection.

(31)　Double Morphological marking

	sleep.Non-fin	sleep.causative. Non-fin
Hindi	so:-na:	sul-a:-na:
Odia	so-i-ba	su-e-i-ba

These two languages also differ in the extent of such marking out within the verbal lexicon. Hindi, which has no other systematic vowel cooccurrence restrictions, applies this across the board to the morphological causatives of all verbs, while Odia which has phonological restrictions on vowel hiatus contexts, applies the umlaut to only those verbs roots CV and CaC ones, that would have undergone phonological modification anyway. In that way, Odia and Bangla are similar as the latter also uses umlaut as a means to avoid irregularity within "marked out" paradigms. Also, similar to Bangla, Hindi could have easily avoided surface homophony in the "marked" morphological paradigms by avoiding the short vowels in the non-causative and non-accusative verb roots. This would have optimized the morphological "marking out" of these paradigms even better as the transitive and unaccusative forms of all verbs would be distinct. At present the ones with the short vowels become homophonous on the surface.

(32)   Hindi transitive-unaccusative homophony

Transitive					Unaccusative			
rəvi	səmo:se:	ʈəl	rəha:	tʰa:	səmose	ʈəl	rəhẽ:	tʰẽ:
ravi	samosa.pl.	fry	prog.M	be.past.M	samosa.pl	fry	prog.pl	be.past.pl
Ravi was frying the samosas.					The samosas were being fried.			

Unlike Hindi and Odia, Bangla phonology places more restrictions on vowel cooccurrence, so there is a greater need to optimize the verbal lexicon. So, the language has removed vowels without |A|, [i, u], from the phonological sub-paradigm A altogether. Most of the verbal morphology falls into sub-paradigm B where the complex vowels with |A| head fail to surface in verb roots. This group includes all morphological paradigms where the post-verbal inflection begins with a [High] vowel, as well as all the consonant-initial inflections. It also includes subjunctives though they are vowel initial and do not begin with [High] vowel. In Sanyal (2017), I argue that the subjunctives are included in the allomorphic paradigm to avoid surface homophony with the imperatives. So, we see that Bangla avoids homophony not just between lexemes within a paradigm, but also between the outputs of distinct paradigms.

(33)   Homophony avoidance in Bangla

do.imperative (Sub-paradigm A)   do.subjunctive (Sub-paradigm B)
    kɔr-o   kor-o

Finally, as part of the concluding remarks a word about the distinct patterns between CVC and CV verb roots is warranted. Most of the verb roots in all Indo-Aryan languages are CVC monosyllables with a handful of CV and disyllabic roots. Ideally, CVC roots should not have much phonological issue with morphological suffixation as the final C will get syllabified tauto-syllabically and hetero-syllabically with C-initial and V-initial suffixes. In case of Hindi, this is not a major concern as most inflections are independent clitics and not suffixes. In Bangla the verbal inflections are all suffixes and could be either C-initial

or V-initial. All the C-initial suffixes fall into the same morphological sub-paradigm, but the V-initial ones show divergence.

CV verb roots in all three languages have non-uniform morphological paradigms. In Odia, this non-uniformity in verb root exponence is restricted to non-causatives, but in Bangla and Hindi all paradigms of CV are somewhat irregular.

(34)　Irregularities in CV paradigms
　　　a)　Hindi　kʰaː-naː 'to eat'　　kʰil-aː-naː:　'to feed'　　*kʰəl-a:-naː:
　　　　　　　　　gaː-na: 'to sing'　　gə-waː-naː:　'to make sing' *gil-a:-naː:
　　　b)　Bangla　kʰa-wa 'to eat'　　kʰe-ʈ-am　　'eat.past.hab' *kʰa-t-am
　　　　　　　　　ga-wa 'to sing'　　gai-ʈ-am　　'sing.past.hab' *ge-ʈ-am

Disyllabic verb roots are those with a morphological causative built into it. For example, the Hindi verb root [bula:-na:] 'to call', has not non-causative root [bul-na:]. In Bangla, such forms usually surface with two possible pronunciations and have been discussed extensively in Dasgupta (2018).

(35)　Alternative pronunciations for denominal verbs in Bangla
　　　kor-a-no ~ kur-o-no　'to lift from the ground'
　　　ceb-a-no ~ cib-o-no　'to chew'

In conclusion, the key task is to imagine a theory of morpho-phonological interface where morphological well-formedness factors such as Paradigm Uniformity and Anti-Homophony are being balanced with core phonological distributional restrictions to arrive at Optimal Paradigms. This paper is just a small step in that direction.

Acknowledgements

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