

## **Assamese Nasals Blocking Vowel Harmony**

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Assamese has an inventory of eight vowels of which some are subject to both ATR and height harmony. Interestingly, vowel harmony is blocked by intervening nasal consonants under circumstances where the mid back vowel /ɔ/ is followed by a nasal. The special feature of Assamese is that there is a positional restriction also: a nasal immediately preceding the potentially triggering vowel always block harmony. We propose that in order to avoid a sequence of wide pharyngeal opening – narrow opening – wide opening, harmony is blocked whenever there is an /ɔ N i/ sequence, showing that a pharynx in a narrower state is preferred to a transition from a wider pharynx to a narrow pharynx for the nasal.

### **1 Introduction**

With respect to assimilation and dissimilation processes, the following issues are usually considered relevant in phonology: (i) defining exactly which segments can be triggers, (ii) which elements can be targets, (iii) which elements can block harmony, and (iv) defining the domain in which these processes occur. In this paper we will concentrate on the triggers and targets of vowel harmony, the elements that may block harmony and the domain of vowel harmony in the Indian language Assamese.

Vowel harmony is a long distance process in which vowels within a particular prosodic or morphological domain become more alike, for instance in the property roundness. Here, we will examine vowel harmony processes which involves the movement of the tongue root in the pharynx and which can be blocked by the intervention of particular segments in its domain of application. In particular, we discuss examples from Assamese where high vowels trigger so-called ‘Advanced Tongue Root’ (or ATR) harmony in mid vowels and where intervening segments may block harmony.

The structure of this paper is as follows. We will first discuss earlier theories of vowel harmony and theories that try to explain how segments may block vowel harmony. We will then present some examples of vowel harmony in Assamese and we show that locality issues are more substantive and grounded in phonetics than they have been given credit for in current theoretical analyses of vowel harmony. Also, we show that blocking phenomena as encountered in Assamese may be a result of articulatory properties.

### **2 Vowel harmony**

Vowel harmony is a phenomenon in which the presence of one triggering vowel induces featural changes in neighbouring vowels. Consider in this respect the following examples from the African language Pulaar (Paradis 1992, Krämer 2001; 2003) where [-ATR] vowels in the stem are realised as [+ATR] vowels when a suffix follows that contains a [+ATR] vowel:

## (1) Pulaar stems and class markers (Paradis 1992)

stem-suffix	stem-class marker	gloss
[+ATR]	[-ATR]	
a. sof-ru	cɔf-ɔn	'chick'
b. ser-du	cɛr-kɔn	'rifle butt'
c. <sup>m</sup> beel-u	<sup>m</sup> bɛɛl-ɔn	'shadow'
d. peec-i	pɛɛc-ɔn	'slits'
e. dog-oo-ru	dɔg-ɔ-w-ɔn	'runner'

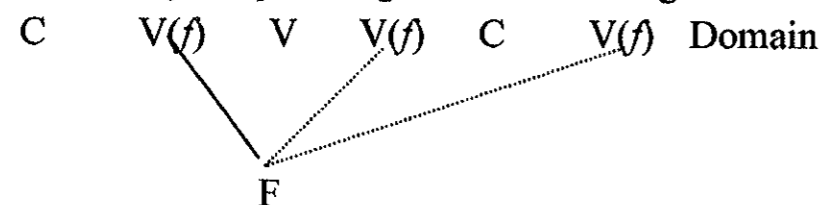
As in most languages displaying ATR harmony, the low vowel /a/ does not participate in vowel harmony as it lacks a harmonic counterpart and it behaves as an opaque segment prohibiting the spread of harmony:

## (2) Vowel /a/ blocks ATR harmony in Pulaar (Paradis 1992)

a. bɔɔt-aa-ri	*bootaari	'lunch'
b. pɔɔf-aa-li	*poofaali	'breaths'
c. nɔdd-aa-li	*noddaali	'call'
d. <sup>ɔ</sup> gɔr-aa-gu	* <sup>ɔ</sup> goraagu	'courage'

Different representational mechanisms have been assumed in linear as well as non-linear theories to explain segment skipping in vowel harmony domains. Clements (1980) and Goldsmith (1976), for example, propose that segments which undergo a change under harmony are possible targets because they can bear the harmonizing feature. Segments that do not show any featural change under vowel harmony do not have any corresponding features and may therefore emerge unaffected by the process. Schematically, such assumptions can be represented as in (3) below where the harmonizing feature F propagates only to those segments that are the 'legitimate feature bearers' or (f) in a vowel harmony domain (prosodic word, morphological word, foot, etc).

## (3) Vowel Harmony as spreading of a harmonizing feature F



In contrast to approaches in which the intervening segments are regarded as non-participants in the vowel harmony process (see 3 above), Walker (1998), Ní Chiosain and Padgett (1997, 2001) and others see spreading of features as strictly and segmentally local, i.e., according to them, harmony affects the intervening segments as well, even though this may not have an audible effect. However, here we do not address the issue of feature spreading to all elements within a certain domain. Rather, we discuss the relatively surprising role that non-vocalic elements have in Assamese; namely as blockers of harmony. In other words, even though most consonantal elements allow harmony to permeate from one element to the other, there in fact appear to be some consonants that stop harmony from spreading. A central aspect of

our discussion is that, in section 6, we argue that in Assamese, the consonants that block harmony share an articulatory gesture with their surrounding vocalic elements.

Apart from segments blocking spreading of features, we also find that spreading may be arrested by prosodic boundaries. Grijzenhout (1990), for example, shows that so-called "u-umlaut" in Icelandic is triggered by the vowel /u/ and affects the preceding vowel /a/ only within a foot. In an unstressed position, the low vowel /a/ becomes [u] and in a stressed position it is realised as the low-mid vowel [œ] (spelled as <ö>); /a/ → [œ]/ --- /u/. The process affects an immediately preceding vowel within a foot (4a-b), or a vowel in an adjacent foot (4c), but it does not cross the foot-boundary (see 4d):<sup>1</sup>

(4) Icelandic *u-umlaut* within a foot

	stem	suffix	gloss		gloss
a	tala	-um	'to speak'	(tölum)	'we speak'
b	barn	-um	'child'	(börnum)	'child' (dat)
c	bakar	-um	'baker'	((böku)rum)	'baker' (dat)
d	almanak	-um	'almanac'	(alma)(nökum)	'almanac' (dat)
				*(ölmü)(nukum)	

We show in section 4 that a similar restriction applies in Assamese. First, however, we introduce the Assamese vowel inventory.

## 3 Assamese vowel inventory and co-occurrence restrictions

Assamese is an Indo-European language spoken in North-eastern India and some parts of Bangladesh. Its eight-vowel system is presented in the table below.

## (5) Assamese Vowel Chart

		Front	Back
High	+ATR	i	u
High-Mid	-ATR		ɐ <sup>2</sup>
Low-Mid	+ATR	e	o
Low-Mid	-ATR	ɛ	ɔ
Low	-ATR		ɐ

All the eight vowels are distinctive in Assamese, as the following minimal pairs show:

## (6) Minimal pairs for the eight vowel phonemes in Assamese

- a. [bɛl] 'a kind of fruit'      e. [bɔl] 'strength'

<sup>1</sup> In the examples below, we indicate foot boundaries by rounded brackets.

<sup>2</sup> In a UCLA phonetic database, it is proposed that this vowel is a round low central vowel (ɐ). However, our data show that the vowel is actually higher than /ɔ/ (see example 7 below).

- b. [bel] ‘bell’  
 c. [bɛl] ‘child’  
 d. [bɔl] ‘colour’  
 f. [bol] ‘let’s go’  
 g. [bul] ‘a proper name’  
 h. [bil] ‘a small lake’

The two high vowels /i/ and /u/ are pronounced with an advanced tongue root (indicated in phonological representations by the feature [+ATR]) as are the mid vowels /e/ and /o/. The mid vowels /ɛ/ and /ɔ/ are slightly lower than /e/ and /o/ and are not realised with an advanced tongue root, i.e. they are specified as [-ATR]. The high-mid central vowel /ə/ and the low central vowel /ɐ/ are also specified as [-ATR]. Note that this system lacks the low [+ATR] vowel /a/ and the high [-ATR] vowels /ɪ/ and /ʊ/. The system has a round high-mid vowel which is central. An acoustic study of this vowel /ə/ and the low-mid back vowel /ɔ/ with the help of PRAAT using 3 subjects, 4 sets of words and 3 iterations shows the following formant frequencies.

- (7) First formant frequencies of two [-ATR] round vowels in Assamese

		ə	ɔ
F1	(Hz)	411	647

These frequencies indicate that /ə/ is higher than /ɔ/. Also, phonologically the vowel /ə/ behaves as a [+high] vowel in that it alternates with /u/ in vowel harmony despite the fact that it is a central vowel rather than a back vowel.

Basing ourselves on the considerations mentioned immediately above, we assume the following set of distinctive features for Assamese vowels:

- (8) Set of distinctive features for Assamese vowels

	/i/	/e/	/ɛ/	/ə/	/u/	/o/	/ɔ/	/ə/
[high]	+	-	-	-	+	-	-	+
[low]	-	-	-	+	-	-	-	-
[ATR]	+	+	-	-	+	+	-	-
[front]	+	+	+	-	-	-	-	-

Note that in the following examples are cases in which all vowels within the word are [-ATR].

- (9) a. tɛtɔ ‘thirteen’  
 b. bɛtɔn ‘salary’  
 c. bɛsɔn ‘powdered pulse’  
 d. bɛlɛɟɛ ‘differently’  
 e. ɔt<sup>h</sup>ɔsɔ ‘though’  
 f. ɔnɔntɔ ‘infinite’  
 g. ɔpɔrɛd<sup>h</sup> ‘crime’  
 h. kɛrɔn ‘reason’  
 i. xɛtɔrɔ ‘seventeen’

There is an interesting distributional restriction in the occurrence of /e/ and /o/: they do not occur in word-final syllables. The underived words presented below end in a high vowel and the preceding vowels all agree in their [+ATR] specifications. There are no words like those in (11).

- (10) a. beli ‘sun’  
 b. pelu ‘worm’  
 c. teteli ‘tamarind’  
 d. leteku ‘a kind of berry’  
 e. boroxun ‘rain’

Now note that there are co-occurrence restrictions on sequences of two [+ATR] mid vowels, when there is no following high [+ATR] vowel (\*e/-e/, \*o/-o/, \*e/-o/ and \*o/-e/). Thus, the examples in (11) constitute impossible words in Assamese:<sup>3</sup>

- (11) Non-existing Assamese words

- a. \*tero  
 b. \*beton  
 c. \*beson  
 d. \*belege  
 e. \*othoso  
 f. \*ononto  
 h. \*opored<sup>h</sup>  
 g. \*kɛrɔn  
 i. \*xutoro

We showed in section 2 that all the vowels in Assamese are distinctive. However, in words of two or more syllables, [ɔ] and [e] do not occur unless they are licensed by a following [+high] vowel (i.e. either /i/ or /u/).

The next section considers Assamese [+ATR] harmony in more detail.

#### 4 Assamese ATR-harmony

As the vowel chart in (5) above shows, the ATR contrast is limited to the mid vowels only. The high vowels /i/ and /u/, and the low vowel /ɐ/ do not have a [-ATR] or [+ATR] counterpart, respectively. In the absence of their harmonic counterparts, these vowels do not undergo harmony.

Examples of vowel harmony are presented below. In (12), the first person suffix /i/ triggers a change in the mid vowel:

- (12)
- |    | verbal stem      | inflection | inflected form     | gloss                         |
|----|------------------|------------|--------------------|-------------------------------|
| a. | lɛk <sup>h</sup> | -i         | lɛk <sup>h</sup> i | write, 1 <sup>st</sup> Pres   |
| b. | sɛp              | -i         | sɛpi               | squeeze, 1 <sup>st</sup> Pres |

In (13), the infinitival suffix -i is added to the root (which may surface as the imperative form of the verb)

<sup>3</sup> There are a few exceptions in the lexicon like /bɛzɛ/ ‘useless, unimportant’ and /pɛrɛ/ ‘a sweet prepared from whole milk’. The numbers of exceptions are very low and are recent borrowings from neighbouring languages like Bengali.

(13)	verbal stem	inflection	inflected form	gloss
a.	pər	-i	puri	to burn
b.	səʂɔr	-i	susori	to crawl
c.	pət	-i	puti	to dump
d.	pɔr	-i	pori	to fall
e.	kɔr	-i	kori	to do

Vowel harmony is not only caused by an inflectional suffix, but also by derivational endings, as the following examples illustrate. In (14) the adjectival suffix *-i* is added to nominal stems and in (15) the feminine marker *-iCə-* is added to the base form of the noun (where *C* is any consonant from the base).

(14)	noun	suffix	adjective	gloss
a.	tɛz	-i	tezi	strong
b.	bɛg	-i	begi	fast
c.	zɛr	-i	zuri	strong

(15)	noun	infix	fem. noun	gloss
a.	lɛk <sup>h</sup> ɔk	-iCə-	lɛk <sup>h</sup> ikə	writer (fem)
b.	g <sup>h</sup> ɛxɔk	-iCə-	g <sup>h</sup> uxikə	announcer (fem)

In (16) the suffix *-uwə* triggers a change in the mid vowel /ɔ/:

(16)	Stem	suffix	noun	gloss
	bɔtɔrɛ	-uwə	botoruwə	someone who brings news

The examples above show that the surface realization of [e], [o] (and sometimes [u]) is dependent on the presence of a following [+high, +ATR] vowel.

Example (13b) shows that vowel harmony spreads leftward throughout a polysyllabic stem. Now consider the fact that in sequences of more than three syllables where the triggering vowel is final, harmony affects only the syllable immediately preceding the trigger (17c-e) and not syllables that occur further to the left.

(17)	a.	(be.li)	‘sun’
	b.	((le.te).ku)	‘a kind of berry’
	c.	(pɔ.tɛ).(so.ri)	‘queen consort’
	d.	(bɔ.xɔ).(bor.ti)	‘submissive’
	e.	(kɔl.pɔ).(to.ru)	‘a mythical tree’

This reminds us of Icelandic u-umlaut in that Assamese ATR-Harmony seems to be restricted to the foot domain as well:

(18)	a.		b.	
		Foot	Foot	Foot
		/ \ \	/ \	/ \
		s w \	σ σ	σ σ
		\	pɔ tɛ	so ri
		σ σ σ	[-ATR]	[+ATR]
		su so ri		
		[+ATR]-domain		

We can tentatively describe Assamese vowel harmony as follows:

- (19) a. /ɛ/ and /ɔ/ harmonize to [e] and [o], respectively, under the influence of a following [+high, +ATR] vowel.  
 b. /e/ alternates with [u] in the presence of a triggering [+high, +ATR] vowel.  
 c. ATR Harmony is restricted to the foot domain.

This, however, is not the entire story. As in many other languages, vowel harmony in Assamese can be blocked not only by a prosodic boundary such as the foot-boundary, but also by certain segments. We now investigate the elements that may block ATR Harmony in Assamese in more detail.

## 5 Assamese opaque segments

In Assamese, the low [-ATR] vowel /ɛ/ does not have a [+ATR] counterpart. As in Pulaar, Akan, Kwa and other languages, the lowest vowel in Assamese also behaves as an opaque segment prohibiting the spread of harmony. Examples are presented below:

(20)	a.	səwəli	‘girl’	(*suwəli)
	b.	zəgəli	‘apprentice’	(*zugəli)
	c.	ɛpəsi	‘a corn basket’	(*ɛpəsi)
	d.	heməhi	‘irresponsibility’	(*heməhi)
	e.	bepəri	‘a businessman’	(*bepəri)
	f.	meg <sup>h</sup> ɛli	‘a common name’	(*meg <sup>h</sup> ɛli)
	g.	gɔrɛki	‘owner’	(*gɔrɛki)
	h.	d <sup>h</sup> ɛməli	‘light enjoyment’	(*d <sup>h</sup> ɛməli)

As a more precise alternative to the formulation in (19), we may say that a segment specified as [+ATR, -low] triggers harmony in segments that are [-low].

An intervening [+low] segment is not affected by harmony and introduces a new domain, or, to put it differently, [+low, -ATR] blocks harmony. In this respect, Assamese Vowel Harmony is not special; it has often been observed that harmony may be blocked by certain segments within a word and this segment is often a vowel that lacks the harmonizing counterpart. The special feature of Assamese is that there are also other segments that may block the spread of the feature [ATR], namely nasal consonants. It is to this phenomenon that we now turn.

### 5.1 Nasals blocking harmony in Assamese

Vowel harmony is sometimes blocked by intervening nasal consonants. In (13)-(16), all vowels in the word are [+ATR], whereas in (21a-g) vowels in words may differ in their ATR-specification when a nasal consonant intervenes.

- (21) a. sekoni ‘strainer’ (\*sekoni)  
 b. xomoniɛ ‘a colleague’ (\*xomonie)  
 c. potoni ‘a dumping ground’ (\*putoni)  
 d. k<sup>h</sup>omir ‘a leavening agent’ (\*k<sup>h</sup>omir)  
 e. xomikk<sup>h</sup>on ‘survey’ (\*xomikk<sup>h</sup>on)  
 f. b<sup>h</sup>oŋb<sup>h</sup>oŋiɛ ‘open hearted, frank’ (\*b<sup>h</sup>oŋb<sup>h</sup>oŋie)  
 g. lowonu ‘milk cream’ (\*lowonu)

All the nasals - i.e. /n/, /m/ and /ŋ/ - block harmony in the examples above which all involve a sequence of the vowel /o/, a nasal and /i/ or /u/ (underlined for clarity). Now note that harmony is not blocked when the vowel preceding the nasal is /ɛ/. Consider in this respect the derivations in (22a-c) and the non-derived word in (22d) below:

- (22) a. premikɛ ‘lover’(fem) (from prem ‘love’)  
 b. xemeni ‘expression of embarrassment’ (from xemene-)  
 c. b<sup>h</sup>emesi ‘crooked’(fem) (from b<sup>h</sup>emesɛ ‘crooked’)  
 d. pemuwɛ ‘to cry in a piteous tone’

The special feature of Assamese is that there is also a positional restriction on the nasals which block harmony: a nasal immediately preceding the potentially triggering vowel always block harmony (i.e. if the nasal is in onset position of a syllable containing /i/ or /u/, vowel harmony will not take place; see 21a-g), whereas a nasal somewhere else in the word does not function as a blocker, i.e. if the nasal is in onset position of a syllable undergoing vowel harmony, it will not block harmony.

In (23a-c) the words end in a syllable with a high vowel and all vowels agree in [+ATR] despite the presence of a nasal within the word.

- (23) a. porinoti ‘consequence’  
 b. ponoru ‘onion’  
 c. somokit ‘frightened suddenly’

Thus, ATR-Harmony is blocked when (i) a foot boundary interferes, or (ii) the low vowel /ɛ/ intervenes, or (iii) the mid back vowel /o/ is followed by a nasal. Next, we consider a possible explanation for the Assamese nasals blocking harmony.

### 5.2 The articulatory dimension of blocking by nasals

In the production of vowels, there is vigorous vibration of the vocal cords and no major stricture in the oral cavity. The small stricture in the oral cavity is the effect of the movement of the tongue and the lips. Consider as an example the articulatory movements that are involved in the production of the Assamese vowel /i/:

- (24) Articulatory movements for /i/  
 lips: spread  
 tongue: the body of the tongue is raised ([+high])  
 and moved far forward ([+front])  
 tongue: the root of the tongue is drawn forward so that the width in the pharynx is enlarged ([+ATR])

Because the tongue body and the tongue root are moved forward, this vowel is produced with the widest space at the back of the mouth, i.e., both the fact that the tongue body is moved forward and the fact that the tongue root is moved forward result in a pharynx that is as wide as possible. This property is a harmonizing one; in other words, such a vowel triggers a wider pharyngeal opening in other vowels. The effect of vowel harmony is that all vowels within a specified domain have a wider pharyngeal opening.

- (25) sɛ sɔr +i → su so ri ‘to crawl’  
 V V V V V V  
 state of  
 pharynx: narrow narrow wide wider wider wide

Below, we present the articulatory movements for the high vowels /ə/ and /u/, respectively. Note that under vowel harmony, /ə/ is realised as [u] (e.g., 13c, 14c, 15b), i.e. the vowel which involves a relatively narrow pharyngeal opening is realised with a larger opening in anticipation of a following vowel which involves a raised tongue body and a forward tongue root:

- (26) Articulatory movements for /ə/  
 lips: round  
 tongue: the body of the tongue is slightly raised ([+high]),  
 but not moved forward ([-front])  
 tongue: root of the tongue is not drawn forward (feature [-ATR])
- (27) Articulatory movements for /u/  
 lips: round  
 tongue: the body of the tongue is raised ([+high])  
 and moved backward ([-front])  
 tongue: root of the tongue is drawn forward so that the width in the pharynx is enlarged ([+ATR])

In the production of most consonants and in the production of vowels, the velum is raised to shut off the nasal tract. In the production of nasal consonants, the velum is lowered, so that air can escape through the nasal cavity.

Now consider the sequential production of the vowel /o/ and a following nasal. For the vowel, the body of the tongue is moved downwards and backwards (contrary to the production of /ɛ/) and the root of the tongue is not drawn forward (contrary to the production of /o/) resulting in considerable narrowing in the pharynx. In fact, this vowel constitutes the narrowest pharynx compared to other vowels in Assamese. For

