DIRECTIONALITY AND LOCALITY IN VOWEL HARMONY

With special reference to vowel harmony in Assamese

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DIRECTIONALITY AND LOCALITY IN VOWEL HARMONY

With Special Reference to Vowel Harmony in Assamese

Directionaliteit en Lokaliteit in Vocaalharmonie
Met speciale aandacht voor vocaalharmonie in het Assamees
(met een samenvatting in het Nederlands)

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Promotor:

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15th September 2007

Chapter 1

General Introduction

1 Goals of this dissertation

In phonological systems, it is commonly observed that a segment requires greater similarity to a neighbouring segment or segments with respect to a certain feature. Examples of phonological patterns exhibiting such requirements for vowels abound in natural languages, involving a wide cross-section of phonological features, resulting in processes known as vowel harmony (a long distance process where all vowels in a word agree with regard to a certain feature), metaphony (a process of vowel raising in the presence of following unstressed vowels), and umlaut (vowel raising with simultaneous changes with regard to backness and roundness). This dissertation will concentrate on vowel harmony processes and try to uncover certain fundamental characteristics of some vowel harmony languages. In unearthing these characteristics, this dissertation's aim is to contribute to an ongoing discussion within phonological theory, in this case the framework of Optimality Theory (henceforth OT, Prince and Smolensky 1993/2004) of how the notions of 'directionality' and 'locality', which typically emerge in discussions of harmony processes, should be handled.

Empirically, this dissertation leans to a large extent on facts of vowel harmony in Assamese. The various problems and challenges which were encountered in the analysis of Assamese vowel harmony that is presented in this dissertation, led to the identification of these two factors as utterly relevant to current phonological theorising. This will be further explained in the next few pages.

Assamese (less commonly known as Asambe or Asamiya) is spoken in Assam, one of the north-eastern states of India. The variety described here is representative of colloquial Assamese, spoken in the eastern districts of the state of Assam. With a majority of the total population using the language, Assamese is the major language of the state (with an estimated 20 million native and non-native speakers according to the most recent census of 2001).

Among the language-specific empirical issues concerning Assamese vowel harmony, I will show that Assamese displays iterative regressive vowel harmony, which was so far not assumed to exist in this language. I will show that as outputs of harmony, the vowels [e] and [o] are allophonic in the language. These vowels are present only in the surface inventory of the language, as a result of the vowel harmony process (which is triggered by /i/ and /u/ vowels). Furthermore, I explore the phonological status of the vowel /ʊ/, and show that the way /ʊ/ participates in vowel harmony is important to its phonological characterisation. I will also offer data obtained from an acoustic experiment to establish that /ʊ/ is a [+high, +back, -ATR], a finding that contradicts those of Ladefoged (1996, 2001). My experimentally obtained results confirm the phonological characterisation of all Assamese vowels, including /ʊ/.

In addition to these details concerning vowels and vowel-inventory related patterns in Assamese vowel harmony, this dissertation addresses a number of issues of considerable theoretical significance, in relation to a variety of different aspects of vowel harmony in Assamese, and to a lesser extent the geographically and typologically close languages of Bengali and Tripura Bengali. It is to a description of these that I now turn, taking up the discussion of the theoretical goals that were briefly announced at the beginning of this chapter, represented by the notions of 'directionality' and 'locality'.

Recent work on vowel harmony claims that directionality is not an independent parameter for which vowel harmony languages differ. It has been shown that harmony can be unidirectional (root to prefix) only in root-outward systems, but bi-directional (root to suffix and prefix) both in root-controlled systems and in dominant-recessive systems (Baković 2000, Krämer 2003). Harmony is obligatorily bidirectional in dominant-recessive systems because of the dominance of a phonological feature. However, the question of directionality in harmony systems is far from settled, as shown by the directional systems of Karajá and Pulaar, as a novel contribution in this dissertation, Assamese. Karajá, a ‘Macro-Jê’ language spoken in Central Brazil, has strictly regressive [ATR] vowel harmony (Ribeiro 2001, Hansson 2002). It therefore shares two features with Assamese: leftward directionality and [ATR] harmony. Along with Assamese and Karajá, I will also discuss Pulaar, and show how directionality can be obtained in languages other than Assamese. Pulaar and Fulfulde are the language-internal names for the varieties spoken in Senegal, Mauritiana and Mali. While Futankoore Pulaar is spoken in Mauritania, Maasinankoore is spoken in Maasina, the north-west of Mali. (For more information, see Paradis 1992, and Breedveld 1995). Pulaar also demonstrates regressive harmony, where /i/ and /u/ regressively trigger harmony on the preceding [-ATR] vowels. Therefore, Pulaar works in many ways like Assamese, as it also exemplifies leftward regressive [ATR] harmony.

I will show that harmony is exclusively unidirectional in Assamese. The [ATR] vowels /i/ and /u/ regressively trigger harmony on the preceding [-ATR] vowels, /ɔ/ /ɛ/ and /ʊ/ (except /ɑ/). This unidirectioanlity is not the result of a root-outward system, but rather that of a precedence relation, in which a marked sequence of vowel features is prohibited. I argue that assimilatory agreement in Assamese is the result of contextual neutralisation, which can be expressed in OT terms as a sequential markedness constraint, where the occurrence of a feature value [-F] is marked if it is followed by a [+F] value. The sequence which needs to be avoided is the result of the constraint *[-ATR][+ATR], which in effect drives regressive [+ATR] harmony. Similar circumstances obtain in Karajá, Pulaar and Bengali, as will be briefly explained below.

The theoretical significance of a proposal involving contextual markedness is that it shows that regressive harmony only involves contextual neutralisation and does not need any further appeal to positional factors. The application of positional faithfulness constraints renders the featural contents of a particular position (with phonological or morphological significance) inalterable as against other positions which will be subject to neutralisation. In regressive harmony, the triggering position is a non-initial vowel, which is normally without any phonological or morphological relevance (may often belong to a suffix). Sequential markedness constraints show that agreement involves a certain prohibition on the marked order of vowels without invoking constraints requiring suffixal faithfulness or faithfulness to other non-prominent positions.

The second important goal of this dissertation is to show that harmony involves so-called local agreement (see also McCarthy 2004, Wilson 2006). Harmony processes of the languages of the world are usually assumed to be long distance processes, embracing entire words and phrases. One of the major theoretical assumptions of this dissertation, however, is that harmony proceeds iteratively; the ensuing locality of such a seemingly non-local processes emerges from the way in which blocking of these processes works. In Assamese, locality is apparent from the blocking of harmony by a nasal segment only in the immediate vicinity of the trigger (chapter 6). It has been assumed in the phonological literature on vowel harmony that the vowels in a harmony domain share some vocalic feature only if the intervening consonant also does so (Ní

Chiosaín and Padgett 1997, 2004, Walker 1998). However, in this work I claim that consonants are able to bear a vowel feature in a vowel harmony language only if they are not potential undergoers. This is shown very clearly by nasals blocking harmony in Assamese. Only when nasals are immediately adjacent to the triggering vowel, are they able to block the spread of vowel harmony. Nasals in any other position do not block the spread of harmony. I propose that this behaviour is related to the sonority of the nasal, which makes it possible for such a segment to license the local vocalic agreement relation. If all consonants in all positions were able to bear vocalic features originating from a triggering vocalic segment, then languages like Turkish, Nawuri and Assamese, where vowel harmony is blocked by intervening consonants, would not be able to exist.

Locality is also plays a clear role in exceptional triggering by morphemes, where the exceptional occurrence is again confined to the immediately adjacent segment (chapter 7).

A somewhat different kind of locality is shown to occur in Bengali and Tripura Bengali where harmony is simply bounded. I argue that this follows from the requirement that agreement in the two dialects of Bengali is possible only with [+high, +ATR] vowels; simply a [+ATR] specification is not sufficient to induce harmony. In the linear order, the harmonised mid vowel has lost obeying this criterion, hence harmony does not spread beyond this vowel. This is in effect the manifestation of contextual neutralisation, which is relevant to all cases of harmony discussed in chapter 5. (See discussion of the contents of this chapter in section 3 below.)

In the next section I briefly describe the languages that will be discussed extensively in this dissertation. After that, section 3 is a complete overview of the individual chapters.

2 Languages discussed in this dissertation

The empirical underpinnings of this dissertation will hinge primarily on Assamese (chapter 4). Assamese harmony is important for a variety of reasons, primarily because vowel harmony has not been recorded as an areal feature for Indo-Aryan languages and some of the properties of [ATR] vowel harmony described here are not characteristic of vowel harmony in many other familiar language groups, for instance in the Niger-Congo language groups, or the West African languages. In most of these languages, [ATR] harmony is either dominant-recessive or root/stem controlled. Assamese vowel harmony does not abide by the definition of a dominant-recessive system, and it is not in the least a root/stem controlled system. [ATR] harmony systems are mostly assumed to be of these types.

Assamese has a surface eight-vowel inventory, which is asymmetrically paired with regards to the [+high -ATR] vowel /ʊ/ and the low vowel /ɑ/. This inventory of eight vowels is highly uncommon in the [ATR] vowel harmony systems of the world (unlike nine-, seven- and five-vowel inventories which are supposed to be widely attested in the most common [ATR] languages; such systems will be discussed in greater detail in chapter 2, section 2.2). Assamese also displays a unidirectional harmony pattern distinct from that found in dominant-recessive systems, where the presence of the dominant vowel can trigger harmony on either side of the triggering vowel. Along with Assamese, I will also discuss a small number of other regressive systems in chapter 3, namely the systems of Pulaar and Karajá, and show how directionality can be obtained in languages other than Assamese. Varieties of Pulaar (also known as Fulfulde) are spoken in Senegal, Mauritiana and Mali (see Paradis 1992, and Breedveld 1995). Just as Assamese (per this dissertation), Pulaar demonstrates regressive harmony, where /i/ and /u/ regressively trigger harmony on the preceding [-ATR] vowels. There are in this language, however, a small number of non-high suffixal morphemes which trigger harmony. I assume that apart from sequential markedness constraints (recall my preview of Assamese harmony), a so-called indexed faithfulness constraint (Pater 2006a) is operative in Pulaar. Karajá also operates in a way very similar to Assamese as it only requires sequential markedness.

Bengali is discussed here to enable highlighting non-iterative harmony in a language closely related to Assamese. Bengali is spoken by around 150 million people, primarily in India and Bangladesh. Bengali has a seven-vowel inventory like most [ATR] harmony languages, consisting of /i, u, e, o, ɛ, ɔ, ɑ/. In this dissertation I consider standard colloquial Bengali (*Cholit Bhasha*), spoken in and around Kolkata and its suburbs, which is often contrasted with literary Bengali (*Sadhu Bhasha*). I also discuss Tripura Bengali, spoken in the Indian state of Tripura. These varieties of Bengali are important in this dissertation in order to demonstrate a case where harmony is completely local or non-iterative. I argue that this non-iterativity is the result of the non-availability of complete featural correspondence with neighbouring segments, *beyond* the one in the immediately following syllable. Thus, the difference between iterative and non-iterative systems can be reformulated as a difference of more elaborate featural requirements in triggers and targets in non-iterative harmony systems such as Bengali, as against simpler constraints in an iterative system like Assamese.

3 Overview of the dissertation

In chapter 2, I present a broad overview of features, triggers and targets that are usually assumed to be involved in vowel harmony. In section 1 of that chapter I show that the 'definitions' of harmony offered in previous literature are inadequate, since they do not make it possible to limit harmony to only those processes that are word-based and bidirectional. Harmony processes can be limited to domains smaller than words and also be unidirectional. Consequently, I show that vowel harmony must be considered the result of agreement among neighbouring vocalic elements so that the phenomenon can have both apparently iterative and non-iterative manifestations. It turns out to be an unattainable goal to try and consistently predict domains and directionality in vowel harmony. This observation is immediately linked to one of the goals of this dissertation, i.e. to show that this unpredictability implies both a regressive directional system such as that of Assamese, and a regressive non-iterative system such as that of the two dialects of Bengali. Systems like these also reinforce the theoretical claim of this dissertation that these regressive systems actually involve the neutralisation of a marked order of vowels. Before further discussing this theoretical aspect in chapter 3, in this section, I describe some other characteristics of vowel harmony languages, their organisation into inventories and features which may be responsible for the domain and directionality of spreading. I also present some of the substantive linguistic factors which are crucial in vowel harmony, namely preference for the vowel quality of the root, featural restrictions, and preference for the unmarked feature value in the output. Finally, I highlight some of the distinguishing characteristics of umlaut and vowel harmony, and explain why - in my view - they do not form separate categories of vocalic agreement.

In chapter 3, I present some of the mainstream theoretical approaches to vowel harmony, including rule-based approaches, and metrical and autosegmental approaches. The rest of the chapter deals with OT approaches to harmony, as the OT framework has been chosen as the tool for theoretical explanation in this dissertation. After showing which aspects of vowel harmony any OT approach will minimally have to deal with, I move on to discuss some influential phenomenon-specific approaches to vowel harmony within this theoretical mode. This implies a review of Syntagmatic Correspondence, Stem Affix Faithfulness, Alignment, Spread, Featural Agreement, Optimal Domains Theory and Span Theory. I conclude this chapter with a detailed schema of so-called sequential markedness Constraints, and discuss their ability to handle regressive iterative and non-iterative harmony.

In chapter 4, I provide a description of harmony patterns in Assamese. Assamese has an eight vowel surface inventory —/i, u, ʊ, e, o, ɛ, ɔ, ɑ/[1], and this system contrasts the [+ATR] set /i/ /u / [e] [o] with the [-ATR] set of vowels /ʊ, ɛ and ɔ/. While /ɑ/ is opaque to harmony, a following /i/ and /u/ trigger harmony in the preceding [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/, resulting in the vowels [e] [o] and /u/ respectively (data in 1 and 2).

(1) Assamese Harmony

	Noun	Suffix	Adjective	Gloss
(a)	tɛz	-i	tezi	'strong'
(b)	bɔl	-i	boli	'strong'
(c)	zʊr	-i	zuri	'strong'

(2) Assamese harmony is only regressive, not progressive.

	Root	Gloss	Suffix	Derivation	Gloss
(a)	kin	'buy'	ɛ	kinɛ	'buy' (3Person Present)
(b)	p^hur	'travel'	ʊ	p^hurʊ	'travel' (1Person Present)
(c)	b^hut	'ghost'	ɛ	b^hutɛ	'ghost' (ergative)

In chapter 5, I argue that vowel harmony in Assamese, and the two related languages of Bengali and Tripura Bengali, as well as Pulaar and Karajá (which are completely

[1] I consistently refer to the surface phonetic inventory of Assamese which I suppose, also consists of [e] and [o]. The underlying inventory consists of the six vowels /i u ʊ ɛ ɔ ɑ/ and [e] and [o] do not occur in the underlying inventory of the language. In more traditional approaches, allophonic segments would probably not feature in the surface inventory as such, but [e] and [o] are more than allophonic in Assamese - they occur in some non-allophonic contexts as well. Though these occurrences can very well be called exceptional (chapter 4 and chapter 7), the moot point is that [e] and [o] displays gradient phonological behaviour by occurring in allophonic as well as non-allophonic environments. These reasons contributed to my assessment of [e] and [o] to be at an intermediate stage between allophony and non-allophony and also deserving consideration as one of the vowels in the surface inventory.

unrelated) can be shown to be the result of sequential markedness constraints. Regressive directionality in these languages emerges from the OT markedness constraint *[-F][+F] (Pulleyblank 2002, Hansson 2002). It is proposed that both iterative and non-iterative harmony result from such contextually motivated markedness constraints. In non-iterative harmony, the context for neutralisation needs additional featural requirements, which do not exist beyond the immediately adjacent neutralised segment. So while iterative processes like those of Assamese, Karajá and Pulaar are satisfied with *[-F][+F], the non-iterative cases require constraints of the type *[-F][+F +G]. I also show that Pulaar can be analysed simply using sequential markedness constraints, without relying on the so-called INTEGRITY constraints (Krämer 2003) which result in the reversal of ROOT FAITH ≫ SUFFIX FAITH (all else being equal, root features will be faithful and affix features not).

In chapter 6, I offer a unified account of all the facts of blocking encountered in Assamese. Canonical vowel harmony is expected to spread from vowel to vowel without affecting or being affected by intervening consonants. But blocking can interrupt this flow, and this chapter deals with three kinds of blocking encountered in Assamese: blocking by the [+low -ATR] vowel /ɑ/ (exemplified in (3)), blocking by the nasals /n/ /m/ and /ŋ/ (4), and blocking by consonants in a moraic position (5).

(3) Blocking by /ɑ/
(a) mɔdɑhi ‘drunkard’ *modahi

(4) Blocking by nasals
(a) sɛkɔni ‘strainer’ *sekoni

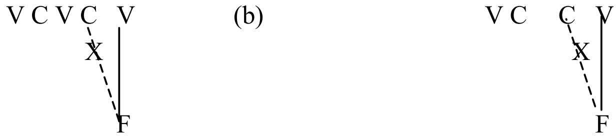
(5) Blocking by coda consonants
(a) bɔn.ti ‘lamp’ *bon.ti

The goal of this chapter is to show that local intervention (6a) by both vowels and consonants is driven by the same principle: high sonority. Non-local blocking (6b), i.e. intervention by segments which are not segmentally adjacent, is the result of prosodic requirements only.

Diagrammatic representation of local and non-local blocking

(6) Local intervention Non local intervention

(a) (b)



Recent phonological theory has shown that one of the problems that agreement based models within OT face while dealing with opaque segments is that they fail to account for partial harmony when an opaque segment intervenes (McCarthy 2004, Wilson 2006). This situation arises in examples like /sɑpɔr/ ‘bend’ +/i/ → /sɑpori/ ‘to bend’ instead of */sɑpɔri/ and */sopori/ where all the vowels are either [-ATR] or [+ATR]. I deal with this problem by bringing into the scene Harmonic Serialism (McCarthy 2006, 2007). Harmonic Serialism involves stepwise evaluation of candidates instead of parallel evaluation. By incorporating a locality convention which ensures that constraints will only apply in a ‘minimal string’, it is shown that partial harmony when a blocking segment intervenes can be taken care of.

In chapter 7, I discuss certain deviant occurrences of harmony in the derivational morphology of Assamese, which are not predicted by the constraint hierarchy proposed in the previous chapters. The deletion of the morpheme /i/ and subsequent surfacing of [e] and [o] without the presence of a following high vowel, are analysed to be the result of a constraint NOHIATUS$_{L}$, which demands exceptional hiatus resolution in the verbal morphology.

chapter 7 is also concerned with a discussion of some surprising characteristics of vowel harmony in Assamese and Bengali. In Assamese, a morpheme expresses itself on the otherwise non-participating vowel /ɑ/. I propose to analyse this exceptionality with the aid of a lexically indexed constraint. The constraint indexation approach proposed by Pater (2006a, to appear) is chosen as the most suitable because it involves locality restrictions in the application of indexed constraints, and as a result makes the correct predictions in this exceptional case of harmony.

In chapter 8, I make an attempt at probing into the functional motivation for regressive harmony as exhibited by Assamese. I show that, although Assamese looks like the metaphonic systems of Romance (recall the notion of 'metaphony' from earlier in this introduction), where the high vowel in the weak position determines harmony, the reason for regressiveness cannot lie in an analysis based on the perceptual attenuation of a high vowel. I discuss other work concerning the perceptual qualities of high vowels, and arrive at the conclusion that this behaviour of the high vowel is indeed related to articulatory factors rather than any perceptual threat to high primary vowels like /i/ and /u/.

4 Symbols and data collection

		[−BK]		[+BK]		
[+HI]	[+ATR]	i	y	ɯ	u	
	[−ATR]	ɪ	ʏ		ʊ	
[−HI]	[+ATR]	e	ø	ɤ	o	
	[−ATR]	ɛ	œ	ʌ	ɔ	[−LO]
	[+ATR]	æ		ɐ		
	[−ATR]	a	ɶ	ɑ	ɒ	[+LO]
		[−RD]	[+RD]	[−RD]	[+RD]	

Chart I
(Diagram reproduced from Baković 2000)
Finally, let me point out that in the transcriptions in this dissertation of Assamese and Bengali material, I will consistently rely on International Phonetic Association symbols and diacritics, unless otherwise noted. The following is the IPA vowel chart, revised to 1993. The shaded cells in the chart above indicate vowels which are not attested.

Furthermore, being a native speaker of Assamese, many facts of Assamese in this dissertation are my own impressionistic judgements. Being aware of the perils of such a biased approach, I recorded assimilated and unassimilated sequences in Assamese. Formant changes showed distinct differences in harmonised words versus non-harmonised words (Appendix II of this dissertation). In order to increase our understanding of the intriguing phenomenon of Assamese vowel harmony, it will definitely be useful to enhance our knowledge conducting further experiments. This is left for future research, however.

Chapter 2

Vowel harmony: background and a new perspective

1 Introduction

The aim of this chapter is to familiarise the reader with the concept of vowel harmony, and present some of the novel assumptions about the phenomenon that will be pursued in the rest of the dissertation.

This chapter is organised as follows. Section 1 explores the extant definitions of harmony and points out their inadequacies. These inadequacies lie in the characterisation of vowel harmony as a process which would always be word based, as well as stem-controlled if harmony is progressive, but bi-directional if the system displays dominant-recessive harmony. This section shows that such a characterisation totally eclipses directional regressive systems like Assamese from the scenario of vowel harmony. Section 2 discusses harmony-like phenomena occurring in natural languages following the basic requisites of their organisation into feature inventories and domains. Section 3 deals with various domains, defined in terms of phonological and morphological factors, which have been known to constrain occurrences of vowel harmony. Section 4 attempts to arrive at a consistent and coherent classification of metaphony (a process of vowel raising in the presence of following unstressed vowels) and to a lesser extent umlaut (vowel raising with simultaneous changes with regard to backness and roundness) and shows that both, especially so-called metaphony, are comparable processes, and the only difference lies in the factors which constrain them.

1.1 Definitions of harmony

The topic of this dissertation is vowel harmony and a characterisation of the process is therefore indispensable for our purposes. It is no easy task, however, to define the wide variety of processes encountered within the scope of the blanket term ‘vowel harmony’. There have been some attempts to reduce vowel harmony to only those cases which abide by a few select principles as against some others which do not meet these criteria. To reduce these often divergent cases to a few defining characteristics is indeed a mammoth undertaking, but I would like to explore these characteristics for an understanding of the phenomenon at hand. The principles below were proposed to characterise harmony by Ultan (1973), and then by Clements (1977a):

1.2 Principles of vowel harmony

(7) Ultan presents five defining characteristics of vowel harmony:
   (a) The triggering element is always a vowel.
   (b) The triggering vowel is a root or stem vowel.
   (c) The domain of vowel harmony is the phonological or morphological word.
   (d) Vowel harmony systematically affects all grammatical classes.
   (e) There must be at least two alternating classes of vowels in any vowel harmony system.

Clements presents a set of five properties, some which are closely related to the ones noted by Ultan. Clements regards the combination of these properties as falling out of the general principles of 'autosegmental phonology' (Goldsmith 1976, 1979, to be discussed in chapter 3).

(8) Clements' (1977 a) general principles of harmony:
   (a) Vowel harmony involves the spreading of a phonetically definable feature.
   (b) Vowel harmony is root controlled.
   (c) Vowel harmony is a bidirectional process. It affects both suffixes and prefixes.
   (d) Vowel harmony applies in an unbounded manner.
   (e) Root controlled vowel harmony is not optional.

Implicit in both (7) and (8) is the notion that vowel harmony must spread from the root and also be unbounded. In a response to these definitions, Anderson (1980) seeks out to outline the general criterial properties of vowel harmony, but rejects *all* of the properties identified by Clements, arguing that none of the characteristics are sufficient to capture the diversity among vowel harmony languages, so as to distinguish them from other phenomena like umlaut and metaphony. According to Anderson, harmony does not always involve phonetic motivation. In Uralic and Altaic systems, historical change take the place of phonetic motivatedness. For instance, in Buriat Mongolian, the original diphthongs /oy/ and /ay/ shifted to /œ/ and /ö/ respectively. Since these vowels were originally back vowels, they behave like other back vowels in synchronic vowel harmony as well. Unboundedness is also not sufficient to describe vowel harmony – e.g. Icelandic umlaut which can sometimes affect the initial syllable as a result of both umlaut and reduction[2]:

(9) /banan+um/ → /banönum/ → /bönunum/ 'banana' DATIVE PLURAL

Counterexamples were found to exist for each and every principle of vowel harmony. Anderson concluded that a proper definition of vowel harmony is elusive, though the phenomenon itself may be straightforward, and there are no principles as such to establish these distinctions convincingly. However, phonologists generally hesitate to accept metaphony and umlaut-like systems within the domain of harmony, which may be guided by Clements' influential observations.

One of the themes of this chapter is that vowel harmony refuses to be constrained by the bounds of typologies defined by Clements and Ultan. Definitions fail to describe the range of vocalic agreement phenomena noticed in the world's languages: as long as vocalic assimilation exists, a language may be said to possess vowel harmony. The only criteria that may play a role is the presence of two alternating sets of vowels in the inventory. When one set induces the other to change, vowel harmony exists in that language. Therefore, I conclude that it is not a worthwhile theoretical persuasion to analyse 'vowel harmony' and 'assimilation' as two separate processes: they are artefacts of the same motivation, i.e. agreement, and by compartmentalising the two into separate categories, one overlooks the generalisation that agreement occurs in both (see also section 4 in this chapter for more discussion in favour of this position). Ample evidence for this approach comes from two closely related languages, Assamese and Bengali that play an important role in this dissertation: whereas harmony is iterative and regressive in Assamese, it is non-iterative in Bengali. Going back to the definitions offered by

[2] This is not to mean that umlaut in Icelandic unbounded. See Grijzenhout (1990) and Gispen and Ringen (2000) Ringen and Heinamaki (1999) and the relevant references therein for analysis of the bounded nature of Icelandic. This example only shows how umlaut can also 'show up' as unbounded because of some combined processes.

Clements and Ultan, neither of these languages would have qualified as harmonic, as Assamese demonstrates regressive harmony where /i/ and /u/ trigger harmony only in the preceding vowels, and is therefore not bi-directional, root-controlled, or word-based at all, while in Bengali /i/ and /u/ affect only one preceding vowel and, therefore defiantly contravening all laws of harmony. Time and again in this dissertation, I will stress the point that both Assamese and Bengali are vowel harmony languages, because theoretically speaking, there is no reason to have different mechanisms to analyse the two languages or even to assume that they are two different processes. I will now move to section 2, where I discuss important factors regulating assimilatory behaviour, e.g. concernng features, morphological and phonological domains, etc.

2 Conditions on harmony

In this section, I will discuss various factors which can potentially demarcate vowel harmony, such as those involving direction and domains. The factors which limit of the scope of harmony in a language may be related to features, prosodic factors like stress, positional factors and/or universal markedness factors. Restrictions on the sequential arrangement of marked feature values provide the context for directionality in strictly directional systems, just as the direction is demarcated in morphologically conditioned systems by constituents like the root/stem or by the dominant value in phonologically controlled systems.

Features interact in harmony systems in myriad ways and feature geometries over the years have tried to reflect the wide array of harmony properties. Although there are many feature groups involved in assimilatory alternations in the world's languages (see van der Hulst and van de Weijer 1994, and Krämer 2003, for an extensive overview), in order to capture interactions among some phonological features which are frequently encountered in vowel harmony languages, I will discuss feature dependencies in two groups of harmony languages. These can be broadly (and simplistically) classified as the rounding harmony and [ATR] harmony groups. Further, it will also be useful to characterise [ATR] harmony early in the discussion as Assamese, a language that will be discussed extensively, i.e. will be shown to demonstrate [ATR] harmony. Section 2.1 is an introduction to [ATR] harmony in general, while section 2.2 elaborates on directionality and domains in [ATR] harmony systems.

2.1 ATR harmony

The phonetic correlate of the feature [ATR] is the advancement of the tongue root. Articulatory correlates of [ATR] may consist of the expansion of the pharyngeal cavity along with laryngeal lowering (Lindau 1975). The [ATR] distinction was traditionally thought to be synonymous with the tense/close or lax/open. Stewart (1967, 1971) however, argued that the category of tongue root position provided a simple explanation for phenomena like vowel harmony in languages in West Africa. These systems could be accounted for by the use of [+ATR] as a feature contrasting with [-ATR], as the high, mid and low vowels in these languages, contrast phonologically along the lines of [±ATR], and not height. Work by Ladefoged (1964), and Ladefoged *et al* (1972), showed that tongue root position is an important factor of phonetic description as well as phonological alternation. ATR harmony, as shown by Hall *et al*, is not confined to West African languages, such as, Yoruba, Wolof, Fula and Diola Fogni. Such harmony systems are also found in the Nilotic languages of East Africa. The Nilotic languages studied in Hall *et al,* are Southern Nilotic (Kalenjin and Pakot) Eastern Nilotic languages (Lutoko and Maasai), Western Nilotic (Acoli, Luo, Dinka-Nuer and Shilluk). [ATR] systems are also found in the Niger-Congo language branches of Gur, Kwa, Adamawa-Eastern, Mande and Benue-Congo. Hall *et al* also report [ATR] harmony in other language families like the Afro-Asiatic family, (mainly in Somali) etc.

2.2 ATR systems – vowel inventories and domains

Interestingly, Stewart, following Greenberg (who first noticed that African vowel harmony systems are typically reduced), observed that languages which exhibit [ATR] vowel harmony in its fullest form tend to have five positional distinctions, which can be divided into two non-overlapping sets, so that each set has an alternating counterpart in the other set, differing only where the harmony triggering feature value is concerned.

(10)	[+ATR]	[-ATR]
	i u	ɪ ʊ
	e o	ɛ ɔ
	a	ɑ

However, most languages with tongue root distinctions lack the distinction in the low vowel, leaving a nine-vowel system. Furthermore, he observed that in most commonly occurring vowel harmony systems, the distinctions between the high vowels merge too (/i/ with /ɪ/, and /u/ with /ʊ/), creating seven-vowel systems. Most [ATR] harmony systems follow these inventory related predictions of Stewart, but they still do not enable us to predict assimilatory relationships. Triggers, targets and directionality do not necessarily fall out from the inventory, and even identical ten vowel inventories displaying [ATR] harmony can be subject to different behaviour. As already explained, ten vowel systems consist of all the vowels that form, in principle, a complete [ATR] inventory. Consider a ten-vowel [ATR] harmony system in Twi (Berry 1957). Inside a root, [+ATR] or [-ATR] vowels may co-occur, but not both. Consider the following examples:

(11) [ATR] harmony in Twi

(a) [biri]	'black'
(b) [bɪrɪ]	'red'
(c) [firi]	'to lend'
(d) [fɪrɪ]	'to fail

Affixes agree with the advanced tongue-root feature of the root vowel. Examples are given below:

(12) [ATR] alternation in Twi

(a) mɪ.bɛ.firɪ.ɪ	mibefirii	'I will borrow it'
1P .FUT.	borrow. it	
(b) mɪ.bɛ.fɪrɪ.ɪ	mɪ.bɛ.fɪrɪɪ	'I will miss it'
1P.FUT.	miss. it	
(c) ɔ.biri	o.biri	'It is black'
3P.	black	
(d) ɔ.bɪrɪ	ɔbɪrɪ	'It is red'
3P.	red	

In Twi, harmony appears to be bidirectional, which need not be stipulated in any account, as it falls out from the fact that harmony is always triggered by the root initial syllable and it can affect suffixes and prefixes equally.

Variations in a vowel harmony language with a ten-vowel inventory can be much more than what meets the eye. Take for instance Kalenjin, by now a standard example of dominant-recessive (or cross-height) harmony. In Kalenjin, any [+ATR] vowel can trigger vowel harmony, regardless of the vowel's morphological affiliation.

(13) Dominant-recessive harmony in Kalenjin

par	'kill'		
kɪabarɪn	'I killed you'		
kɪ-	a-	par	ɪn
Distant past	I	kill	you (sg)

In Kalenjin, if there is a [+ATR] vowel in a word, whether in the root or in the affix, then all recessive vowels become [+ATR]. For example, in the root /ke:r/ 'see' the [+ATR] vowel triggers vowel harmony.

(14) Harmonic words in Kalenjin

kiageri:n	'I saw you'		
kɪ	a-	ke:r	ɪn
Distant past	I	see	you (sg.)Object

(15) kiagere 'I was shutting it'

kɪ	a-	ker-	e
Distant past	I	non-completive	3rd (sg.) object

In the examples above, if a dominant affix such as the non-completive suffix /-e/ is added to a [-ATR] root as /kɛr/ 'shut', then it too triggers vowel harmony:

However in Vata, which also has a ten vowel inventory words may be either [+ATR] or [-ATR]. Vata has ten-vowels, five [+ATR] and five [-ATR]. The instrumental-locative suffix /lɛ/ is realised as [le] after [+ATR] stems and as [lɛ] after non [-ATR] stems, as shown below:

(16) Vowel harmony in Vata

(a)	pi	+ lɛ	pile	'prepare with'
(b)	ɓlɪ	+ lɛ	ɓlɪlɛ	'sing in'

Vata also has a process which spreads [+ATR] optionally leftwards across word boundaries.

(17) Optional harmony in Vata
(a) ɔ̀ nɪ sakápì 'he did not cook the rice'
(b) ɔ̀ nɪ sakʌ́pì

The word /saka/ 'rice' assimilates its second vowel to the following /pì/. If the sequence of vowels is [-ATR] in a word, then the assimilation may non-obligatorily spread to the leftmost syllable:

(18) Optional harmony in Vata
(a) ɔ̀kázapɪ 'he will cook food'
(b) ɔ̀kázʌpɪ
(c) ɔ̀kʌ́zʌpɪ
(d) òkʌ́zʌpɪ

In Vata, there is [+ATR] spreading to [-ATR] vowels. Whereas [+ATR] spreads optionally to all vowels in the stem as well as to affixes in Vata, in Twi and Kalenjin, there is only one process and it is obligatory. All these languages have no constraints regarding their triggers and targets: each language has the option to spread [-ATR] or [+ATR] in a word, but the domains and processes they choose are different and, at first glance, totally arbitrary (at least from an informal point of view).

Thus [ATR] vowel harmony shows clearly that inventories may employ different strategies to obtain harmony. As the preceding examples with a complete ten-vowel inventory show, harmony can proceed in any direction irrespective of the fact that the inventories are exactly similar. Most languages with tongue root distinctions lack a distinction in the low vowels, leaving a nine-vowel system. Akan, a Kwa language of Niger Congo, has nine vowels, grouped into two sets according to their specification for the feature [ATR]. An Akan-like language introduces the possibility of an unpaired vowel blocking vowel harmony.

(19) Akan vowel inventory

[+ATR]		[-ATR]	
i	u	ɪ	ʊ
e	o	ɛ	ɔ
		ɑ	

Akan's vowel harmony system is similar to that of Vata, except that [ɑ] is opaque. In words which do not contain low vowels, all vowels must be either [+ATR] or [-ATR].

(20) Opaque [ɑ] in Akan
(a) ebuo 'nest'
(b) ɛbʊɔ 'stone'

The low vowel /ɑ/ co-occurs with either set.

(21) /ɑ/ occurs with both the [ATR] values
(a) bisɑ 'to ask'
(b) pʊrɑ 'to sweep'

Prefix and suffix harmony are controlled by the first and last root vowel respectively:

(22) Affixal harmony in Akan
(a) o-bisa -ɪ 'he asked'
(b) o-ninsɛn -ɪ 'she became pregnant'

Akan shows dominant-recessive harmony and the vocalic inventory can be divided into two sets, one [–ATR] and the other [+ATR.] The process of vowel harmony determines that in a phonological word only vowels of the same set may co-occur.

The exposition above shows that a perfect ten-vowel inventory has no restrictions on triggers and targets in [ATR] vowel harmony. All vowels bear the [±ATR] value of the vowel in the root. But a nine-vowel root controlled inventory has to pay the price of lacking a low vowel by tolerating sequences of [ATR] mismatches in words.

Further, it has been observed that in many common vowel harmony systems, the distinctions between the high vowels merge too (/i/ with /ɪ/, and /u/ with /ʊ/) creating a seven-vowel system. More complex interactions result in vowel harmony systems where there are only seven vowels. In these systems, [ATR] interaction is confined mostly to the four mid vowels, or the high vowels contrasting in [±ATR]. A language of this type is Ogori (an Eastern Kwa language of Nigeria; Chumbow, 1982) where there are seven vowels /i, u, e, o, ɛ, ɔ, a/. In a word there is bidirectional [ATR] agreement from the root outwards, such that the mid vowels /e o/ occur only with themselves or the other two high vowels /i u/.

(23) Ogori vowel harmony

(a) à- á-bɛ̀mɔ́	è-é-ré-mú
He incl. beats me	It inc. hurt me
'He is beating me'	'It is hurting me'

(24) *à-á-bɛ̀-mu *à-á-ré-mɔ

In short, Ogori belongs to the expected type of root-outwards harmony without any further complications.

Keeping in mind the sorts of variations (mainly root-outward and bidirectional) possible, it is now interesting to see that Pulaar shows another dimension of variation - here harmony is regressive.

(25) Pulaar mid stem vowels and harmony: Pulaar dominant *e* and *o*

(a) lef-ol		'ribbon' CLASS
(b) lef-el	lɛf-ɔn	'ribbon' DIMSG/DIMPL
(c) keer-ol		'boundary' CLASS
(d) keer-el	kɛɛr-ɔn	'boundary' DIMSG/DIMPL
(e) paɗ-el	paɗ-ɔn	'shoe' DIMSG/DIMPL

(Paradis 1992: 87)

Yoruba, is a Niger-Congo language of Nigeria (Archangeli and Pulleyblank, 1996). Standard Yoruba has seven vowels [i u e ɛ o ɔ a] and there is a surface [ATR] contrast in mid vowels. ATR spreading applies between stems and prefixes but not between stems and suffixes.

(26) Yoruba vowel harmony

Harmony after nominalising prefixes		Verb	
(a) ɔdɛ	'hunter'	dɛ	'hunt'
(b) èrò a	'thought'	rò	'think'
(c) ɛ̀rɔ	'machine'	rɔ	'fabricate'
(d) ɔta	'person who is a good shot'	ta	'shoot'
(e) òkú	'corpse of person'	kú	'die'

Here again, though the three languages have the same inventory, their interactions show a number of complexities. In Pulaar, suffixes trigger harmony, whereas in Yoruba harmony is root outward, affecting only prefixes.

This elaborate discussion on features, inventories and directionality illustrates that most of the time there is nothing inherent either in the inventory or the features involved in harmony which leads to differences in the patterning of vowel harmony systems[3]. There are numerous parameters of variation that are possible within each and every type of harmony. The point that a reader shouldn't miss is that every slight change in any factor brings along a multitude of possibilities, with regard to variation in the assimilatory nature. That being said, languages with very similar inventories may also display wide dissimilarities in harmony.

3 Possible determining factors in vowel harmony

It would be an unfair assessment of harmony to deny that there are no substantive principles in a linguistic system which sometimes determine the direction of a vowel harmony process. In 3.1 below, I briefly discuss two such determinants of harmony, namely independently governed morphological and phonological processes.

3.1 Morphological factors

In some languages in which harmony is morphologically conditioned, the status of the triggering morpheme as a root/stem or suffix is of primary importance. In Finnish, for instance, the illative singular morpheme agrees to the root vowel. Finnish has the

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[3]Though see Casali (1990) for some inventory related predictions relating to [ATR] processes.

following vowels: /i ü u e ö o ä/. The non-neutral vowels /ü u ö o ä/ harmonise for front/back values within a word. Consider the following examples (Anderson 1975:79):

(27) Finnish Illative Suffix:

(a)	maa+han	'land'
(b)	tuo+hon	'that'
(c)	jo+hon	'relative pronoun'
(d)	tähän	'this'
(e)	mihin	'what'

3.2 Phonological factors : emergence of the unmarked

Baković shows that in languages with dominant recessive [ATR] harmony the value [+ATR] is always the unmarked value.

> "The essence of the dominant-recessive pattern of vowel harmony is the fact that the assimilation is to a particular value of the harmonic feature. …the theory of markedness within OT…make the strong prediction that this 'particular value' of the harmonic feature is the *unmarked* value. So, for the dominant-recessive harmony systems of Kalenjin and Diola Fogny to be properly analysed as assimilations to the unmarked, the 'dominant' [+ATR] value of the harmonic feature [ATR] must be the unmarked one". (Baković 2000: 53)

Though this is an interesting result it should not be accepted without a necessary caveat. A dominant-recessive system like that of Nez Perce has [+ATR] as the active value (see also Vata (above)).

3.3 Positional factors

In Shona (Fortune 1955, Beckman 1997, 1998) vowel harmony, it is the initial syllable which triggers harmony.

(28) Height harmony in Shona verbs

(a) pera	'end'	per-era	'end in'
sona	'sew'	son-era	'sew for'

	vereŋga	'count'	vereŋg-eka	'be numerable'
(b)	ipa	'be evil'	ip-ira	'be evil for'
	bvisa	'remove'	bvis-ika	'be easily removed'
	bvuma	'agree'	bvum-isa	'make agree'

Shona vowel harmony has been shown to be dependent on the positional factor of the root initial syllable, which determines the vowel height quality of all the following vowels. More discussion on Shona and positional faithfulness will ensue in the next chapter.

Features shape harmonic groups of languages by restricting the scope of harmony. For instance, there are languages exhibiting multiple feature harmonies. In these languages the harmonic dimension is constrained by the condition that agreement is in terms of more than one feature. This means that in these languages, the target vowels are only those that can alternate according to both dimensions (see also Akinlabi 1997).

3.4 Featural restrictions - rounding harmony

In Turkish, which belongs to the Uralic-Altaic group of back-round harmonising systems, there are two harmony processes: backness harmony where all vowels in a word agree with regard to backness, and rounding harmony where all high vowels agree with the roundness of the stem vowels.

(29) The Turkish vowel inventory

	round		non-round	
	front	back	front	back
high	ü	u	i	ɨ
non-high	ö	o	e	a

(30) Standard Turkish vowel harmony (from Clements and Sezer 1982)

	Nom Sg.	Gen.Sg	
(a)	ip	ip-in	'rope'
(b)	kɨz	kɨz-ɨn	'girl'
(c)	yüz	yüz-ün	'face'
(d)	pul	pul-un	'stamp'

The important fact is that the [high] suffixal vowel in the examples given above is fully harmonic: it always agrees in terms of [back] and [round] with the stem vowel. Kaun (1995) considers a typology involving ten different patterns and finds that in rounding harmony systems, height is an important factor. high vowels are preferred targets of rounding harmony and non-high vowels are preferred triggers of this type of harmony. If there is any mismatch in terms of height between the trigger and target, rounding harmony fails to take place. van der Hulst and van de Weijer (1995) discuss rounding harmony (dubbed palatal harmony by them) in some Turkic languages where rounding harmony is dependent on the front quality of the trigger. This shows that the vowels in these vowel harmony systems may very well be constrained by factors such as an additional requirement on the featural quality of the vowel to which it will alternate, as well as a condition on the target.

3.4.1 Featural restrictions: ATR harmony

Phuthi (a Bantu language spoken in southern and eastern Lesotho, Donnelly 2000), has the following vowel inventory: /ị ụ i u e o ɛ ɔ a/ (five vowel heights, including superclose vowels). It has two harmonies: (i) Left-to-right superclose harmony (ii) Right-to-left mid harmony. For superclose vowel harmony, all successive high vowels also have to be high.

(31) Superclose harmony in Phuthi

kú-bịt-ịs-a	'to help/make call'	ku-bịt-a	'to call'
kú-bịt́-ịśịs-a	'to call intensively'		
kú-thụ́s-ịś-a	'to cause to help'	ku-thụs-a	'to help'
kú-thụ́s-ịśịs-a	'to help intensively'		

The causative suffix /-is/ and the intensive suffix /-isis-/ do not appear with the superclose value when they attach to non-high vowel roots. This again shows that harmony requires the presence of an additional feature apart from [high], so that occurrences of vowel harmony are constrained by the presence of these features at a time.

Thus, languages choose harmony domains and directions quite independently (at least most of the time), and issues related to these intriguing questions can only be resolved by examining the general linguistic principles (like stem/root faithfulness or unmarked vowel spreading or even positional faithfulness). Morphological and positional factors, etc. can play a role but there are also boundless variations which are also possible within each and every type of harmony. I have already discussed variation in domains and directions within canonical harmony systems. In the next section, I will discuss some other variants of vowel harmony before gauging their place in vowel harmony systems.

4 Metaphony, umlaut and non-iterative harmony

Before concluding this chapter I briefly discuss umlaut and metaphony and try to throw some light on my presupposition that they are also types of vowel harmony and there is no formal distinction between them. Maiden (1991) describes metaphony as a process of raising mid and low stressed vowels, in the environment of a following unstressed high non-mid vowel /i/ or /u/. Maiden discusses varieties of metaphony which depend on three major parameters: (a) height of the triggering vowel, (b) stressed syllable structure; (c) frontness of the triggering vowel. Maiden also analyses metaphony as an exclusively morphologically conditioned process.

Hualde (1989) gives examples of stress-conditioned harmony in a number of dialects of northwestern Spain (in Asturias and Cantabria). The trigger of harmony is a word-final high vowel. Metaphony induces vocalic change in all the vowels between the stressed vowel and the trigger. In other cases, only the stressed vowel is affected, leaving all the intervening vowels unaffected. In Tudanca all the vowels in the stressed foot upto the stressed vowel are affected:

(32) Harmony within the stressed foot in Tudanca

(a)	θéra	‘wax’	(θirî)ya	‘match’
(b)	séka	‘dryness’	(sikú)ra	‘thirst’
(c)	merendár	‘to have a snack’	(mirjén)da	‘medium’
(d)	molér	‘to grind’	(muljén)da	‘grinding’

In Tudanca again, high unstressed vowels cause centralising harmony in all vowels upto the stressed syllable.

(33) Centralising harmony in Tudanca

(a)	sɛ́kʊ	'dry'(masc)	séka	'dry' (fem)
(b)	kɛ́sʊ	'cheese'	késos	'cheeses'
(c)	bjʊ́dʊ	'widower'	bjúda	'widow'
(d)	θʊ́rdʊ	'left-handed' (sg.masc)	θúrdos	'left-handed' (sg.plural)

In Lena Bable, the vowels in between the trigger and stressed vowel remain unaffected, as shown below:

(34) Harmony in Lena Bable

(a)	górdos	gúrdu	'fat'	(m pl/m sg)
(b)	kordéros	kordɪ́ru	'lamb'	(m pl/m sg)
(c)	(Spanish, gato)	gɔ́tu	'cat'	(m sg)
(d)	(Spanish, blanco)	blɔ́nku	'white'	(m pl/m sg)

The examples above show that stress is one of the delimitative factors along which harmony is constrained in a metaphonic domain, but apart from this prosodic factor there is no crucial point of difference with vowel harmony.

Umlaut (Saussure 1915, Sapir 1921, Kiparsky 1971) and metaphony have been known to be assumed to be related to each other as both involve morphologisation of a phonological process. Germanic umlaut involves adjustments for backness and roundness whereas metaphony only involves raising. I will not discuss Germanic umlaut in this dissertation, but suffice it to say that there is no clear line of distinction between all these processes. Future work will have to determine whether these processes can be analysed with the mechanisms that will be developed in this dissertation.

4.1 Opaque and transparent vowels

4.1.1 Blocking vowels

Opaque vowels are commonly observed in harmony languages. While Stewart observes how in [ATR] harmony systems /a/ always emerges as the opaque vowel because of constraints inherent in the inventory, metaphonic systems, too, involve similar restrictions in agreement. In Salentino, a southern Italian dialect, there are seven vowels /i, u, e, o, ɛ, ɔ, a/. While /i/ triggers harmony in the preceding syllable, /a/ is not affected at all.

(35) Blocking in Salentino

	Sing.	Plural	
(a)	paréte	parı́ti	‘wall’
(b)	mése	mísi	‘months’
(c)	ngrése	ngrísi	‘English’

4.1.2 Transparent vowels

Metaphony in Lena Bable shows transparency. Stressed mid vowels become high in metaphonic contexts and stressed low vowels become [ɔ]. In words with antepenultimate stress, a penultimate vowel is unaffected by harmony.

(36) Transparency in Lena

	Masc. Sg.	Masc. Pl	Fem. Sg.	Gloss
(a)	burwı́banu	burwébanos		‘wild strawberry’
(b)	péšaru	pášaros	pášara	‘bird’
(c)	kékabu	kákabos		‘wreck’
(d)	kéndanu	kándanos		‘dry branch’
(e)	sébanu	sábanos	sábana	‘sheet’
(f)	trwı́banu	trwébanos		‘beehive’

Transparency, too, is therefore, not limited to vowel harmony systems like Finnish and Hungarian alone. Metaphonic systems may show the same complications that ‘proper’ vowel harmony systems demonstrate in agreement. The point that I want to make is that theoretical straight jacketing of harmony, metaphony and/or umlaut do not reflect in the relationships that these systems demonstrate in their triggers and targets and harmonic environment.

4.2 Domains in harmony, umlaut and metaphony

Van der Hulst and van de Weijer (1995) propose that the domain of harmony should be considered to occur at some level of the morphological word. Such an approach does not exclude metaphony from the realm of vowel harmony systems. The primary reason that metaphony and umlaut-like systems have not been regarded as vowel harmony proper, but only as some kind of assimilation, is fundamentally because vowel harmony is an unbounded phenomenon whereas umlaut and metaphony are not. Harmony systems are said to be word-based in the sense that the harmonic feature percolates to all the syllables in a word, whereas metaphony/umlaut are not word-based. However, this bounded versus non- unbounded conundrum is also not borne out in its entirety either by the metaphonic or other canonical vowel harmony systems, as some metaphonic languages are word-based (for example, Andalusian). It will be shown in this dissertation that the emergence of crosslinguistically common properties in vowel harmony languages is not dependent on the inventory, but more a random application of some universal constraints (for. eg. *[-ATR][+ATR], to be discussed in chapter 5). Thus, the exposition of this chapter shows that differences in domains and directions among languages exhibiting harmony can only mean that various constraints which apply to harmony domains cannot be predicted. Consequently, one of the major goals of this dissertation will be to show that Optimality Theory is a theoretical framework eminently suited to capture these observed similarities and variation.

5 Conclusions

In this chapter I showed in section 1 that the definitions and classifications of canonical harmony leave out harmony phenomena in regressive vowel harmony like Assamese and stress based phenomena like metaphony. Thereafter, in section 2 I argued why agreement phenomena in strictly regressive systems and metaphony etc. are not very different from restrictions in canonical harmony languages exhibiting progressive stem-controlled harmony. Restrictions on harmony domains, and other properties of vowel harmony like vowel transparency, vowel opacity and language-specific restrictions on trigger and target are not confined to root/stem harmonic systems. Metaphonic systems and strictly regressive vowel harmony systems also demonstrate smilar complications. In sections 3 and 4, I present some common properties observed across vowel harmony languages.

Finally therefore, newly presented data from a strictly directional system like Assamese and a strictly non-iterative harmony system like Bengali, should not lead to the conclusion that they should be considered exceptional cases of harmony, but it should be deemed desirable for a theory of vowel harmony to be able to understand and analyse them.

Chapter 3

Theoretical approaches to vowel harmony

1 Introduction

The aim of this chapter is to present a very broad overview of the various theoretical approaches to vowel harmony in general and to Optimality Theory in particular. In doing so, I will not only try to capture the differences prevalent among these approaches, but I will also try to motivate my own theoretical persuasion in this dissertation. This chapter is organised as follows: in section 2, I discuss theoretical approaches to vowel harmony, namely derivational models, autosegmental and metrical approaches, followed by an introduction to Optimality Theory in section 3. In section 3.1, I provide a sketch of the state-of-the-art of assimilation in Optimality Theory. In section 4 I take up a topical issue in contemporary phonological theory, that of directionality. In sections 4.2 to 4.7, I discuss various approaches within OT which have either adopted the approach of spreading of autosegments or featural agreement. Others, which take a slightly different stand, like that of Span Theory, are also discussed. In section 5, I provide a brief synopsis of some of the OT approaches to metaphony and umlaut. In section 6, I discuss one of the main ideas of this dissertation, where I show that iterative regressive harmony in Assamese and Pulaar, as well as non-iterative systems like Bengali and Tripura Bengali, result from sequential markedness constraints.

2 Rule-based, Autosegmental and Metrical approaches

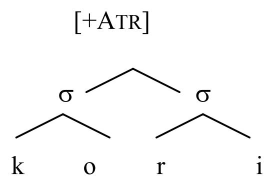
In standard derivational theory of the SPE type (Chomsky and Halle 1968), a rule of vowel harmony would be formulated as below:

(37) $V \rightarrow \quad [+F] \quad / \quad [+F] \; C_0$ ___

Rule based phonology works in a stepwise manner by configuring the structural changes that an underlying representation undergoes in each and every step of the derivation[4].

During the 70's and 80's (beginning with Clements 1979) there were two representational approaches which were fuelled to a large extent by vowel harmony: a) Metrical b) Autosegmental. According to the metrical theory of harmony, metrical structure needs to be built in order to adequately account for harmony processes in stress languages. This kind of metrical representation for vowel harmony systems was proposed by Halle and Vergnaud (1981). Metrical theory proposes that elements within a phonological representation are dominated by branching structures. By assigning feet to harmony spans, vowel harmony phenomena were analysed in ways close to stress, tone, etc. In a standard metrical analysis, it is assumed that the harmony feature is represented at a level higher than that of the segments, which make up the harmonic word. The feature percolates to the head of the syllable, and then to the head of the harmonic foot. The percolation principle in metrical theory was proposed to characterise limitations on syllable structure as also to explain all instances of vowel and consonant harmony. The following example shows how an Assamese word will be implemented in metrical harmony, where a branching tree is erected over all [ATR] vowels in the word.

(38) Metrical analysis of harmony



Root nodes which dominate other terminal nodes determine their feature labelling. Any relabelling of the root node also results in change in the terminal nodes.

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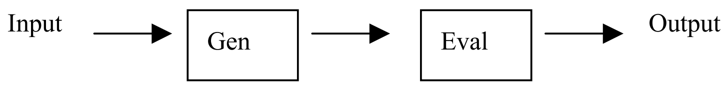
[4] A recent work adopting a rule-based approach is Nevins (2004) which proposes a target-centric approach to harmony instead of the more ubiquitous trigger-oriented approaches. In this framework, harmony is driven by a target's search for 'valuation' and the search ends at the closest possible 'source' where the target can receive its valuation. For details regarding this proposal, readers are referred to Nevins (2004).

The most fundamental characteristic of Autosegmental theory (as well as Metrical harmony) is that phonological representation can be postulated paradigmatically. In Autosegmental theory various features of the phonological process (tone, nasalisation process, harmony, etc.) are represented on independent tiers and parallel to the segmental tier. These independent tiers have autosegments that are related to the segmental tier by a set of conventions that preserve well-formedness throughout the course of phonological derivations. Phonological rules may apply to the elements of one level to the exclusion of elements of another level. But unlike Metrical harmony, the spreading features are represented at a lower level than that of the segments. These features recur in neighbouring segments as a result of phonetic feature spreading. The notion of 'spreading' as executed in autosegmental theory has retained its influential status even though the heydays of proto-typical autosegmental theory are long over. The idea of spreading has survived and perpetuated in various ways in much of the Optimality Theory work on assimilatory processes (see sections 4.5 and 4.6 in this chapter). Ever since Optimality Theory (Prince and Smolensky 1993/2004) came into circulation, it has been perceived by a considerable number of generative phonologists worldwide, as perhaps the currently most promising framework of analysis. The theoretical framework of this thesis is that of OT, mainly because of OT's ability to capture universal properties and select outputs in a manner which reflect crosslinguistic tendencies as well as predict typological variations. OT's way of capturing generalisations is through conflicting constraints, and an OT grammar of a language is expressed in the ranked order of violable constraints. This architecture of OT will be used to great advantage throughout the rest of the dissertation. Therefore, I will present a brief overview of the theoretical apparatus of OT, but without delving into very complex problems. I will only deal with those aspects of the framework which have a direct bearing on the problems addressed in this thesis.

3 Optimality Theory

An OT grammar of a human language is defined by a particular ranking of a universal set of violable constraints in a strict dominance hierarchy; a conflict between any two constraints over the selection of a given input-output pairing is resolved by favouring the higher-ranked of the two constraints. Constraints in OT are restrictions that are generally expressed by two types of constraints: *markedness constraints*: (i.e. favouring unmarked structures) and *faithfulness constraints* (favouring preservation of inputs). The function of the grammar is then to resolve conflicts depending on the preferred choices of individual languages. Apart from CON (i.e the set of ranked constraints), OT assumes two other constructs, namely, GEN (Generator) and EVAL (Evaluator). The following diagram from McCarthy (2002) gives one an idea of the basic working of OT.

(39) Basic OT architecture



3.1 State-of-the-art of OT in assimilation

OT´s yardstick of evaluating input-output disparities is primarily through faithfulness constraints, so that any deviation from the input to the output is laid threadbare in faithfulness violations. In the case of assimilation, this faithfulness violation is enforced by a higher ranking markedness constraint, which is satisfied by the assimilated candidate but violated by the candidate without assimilation.

Faithfulness Constraint
(40) IDENT[F]
Input-Output segments have the same value for the feature [F]

Markedness Constraint
(41) AGREE[F]
Adjacent segments have the same value for the feature

The relevant faithfulness constraint IDENT [F] and the markedness constraint AGREE[F] will be ranked AGREE[F] ≫ IDENT [F] in order to result in assimilation. The schematic tableau below shows how this ranking achieves featural assimilation in vowel harmony. The ranking of the markedness constraint above the faithfulness constraint is obligatory to drive assimilation in OT.

(42) Schematic tableau

I:[-F][+F]	AGREE[F]	IDENT[F]
a. [-F][+F]	*!	
b.☞ [+F][+F]		*

The tableau below shows a real life example from Assamese where the verbal root /kɔr/ 'do' undergoes harmony under the influence of the inflectional marker /-i/.

(43) Vowel harmony tableau

I:/kɔr/+/i/	AGREE[ATR]	IDENT[ATR]
a. [kɔri]	*!	
b.☞ [kori]		*

The resultant surface output /kori/ undergoes assimilation to the feature [ATR] at the expense of violating the faithfulness constraint IDENT [ATR]. There are numerous approaches to the relevant markedness constraint within OT (see sections below), but the ranking of Markedness ≫ Faithfulness is necessary in order to capture any process of assimilation within OT. This basically surmises OT's approach to assimilation. However, I have not discussed in the tableau above why there is no assimilation to the [-F] feature. Assimilation to the [-F] feature would result in the output candidate with a [-F][-F] featural composition. This involves progressive assimilation, and in the tableau in (43) we do not have any constraint to forbid this competing output candidate. Directionality needs to be tackled with additional constraints within OT. In this dissertation I will show that directionality need not be the result of additional constraints, but with the employment of a constraint which prohibits linear occurrence of a marked order of vowels, directionality can be successfully accounted for. This is another topic which will be taken up for discussion in the following sections and the constraint responsible for directional harmony will be discussed extensively in section 4. Therefore, with this exposition, I will now proceed to provide an overview of some of the mainstream approaches and their implementation of the problem of directionality in OT. However, the discussion on directionality in all the sections below will only provide a telescopic view of the more general issues on directionality in order to keep the thread of argumentation relevant to the theme of this dissertation, which is vocalic assimilation.

4 Taking stock of directionality in OT

It will be shown in the following sections that it is a widely prevalent view that when a triggering vowel is morphologically determined, directionality need not be stipulated. On the other hand, in a language like Assamese where the triggering [+high +ATR] vowel asymmetrically triggers harmony in vowels only to its left, and therefore exclusively *phonologically* determined, do we need to stipulate directionality? In rule-based approaches, directionality is simply a matter of incorporating the direction into the rule itself. In autosegmental approaches, the association line referring to the direction of the association is one of the conditions of the environment which govern the process. In the next section I discuss the approach to directionality that is followed in this dissertation.

4.1 A discussion of sequential markedness constraints

In this dissertation, regressive iterative directionality in three languages (Assamese, Pulaar and Karajá - see Hansson 2002 for the original analysis of Karajá)) is shown to be the result of the sequential markedness constraint *[-ATR][+ATR]. This constraint can be violated only when the featural composition of the vowels in question are in the marked sequence. Therefore a constraint *[-F][+F] is not violated by [-F][-F] or by [+F][-F] sequences. The candidates which are in the sequential order [-F][-F] and [+F][-F] vacuously satisfy the constraint, because they do not provide the right context for the application of the constraint.

These sequential markedness constraints can also be seen as sub-components of the AGREE constraint of the agreement family of constraints (Baković 2000, Beckman 1998, Butska 1998, Lombardi 1996ab, 1999).

(44) AGREE[F]

Adjacent segments must have the same [αF] value of the relevant feature.

However, there are some important differences between AGREE and sequential markedness. An agreement constraint is violated every time there is an alteration of the value of the relevant feature.

(45) Unbounded assimilation in AGREE

I: [-F][-F][+F]	AGREE-F	IDENT[+F]	IDENT[-F]
a. [-F][-F][+F]	*!		
b. [-F][+F][+F]	*!	*	
c. ☞ [+F][+F][+F]			**
d. [-F][-F][-F]		*!	

AGREE[F] is also a contextual neutralisation constraint, but its symmetrical nature prevents it from giving us the right results in strictly directional systems. It only favours total agreement, thereby creating a pressing need for higher positional constraints which determine the direction of agreement. A constraint like AGREE is capable of showing the right result only when unbounded iterative assimilation is the predicted outcome. AGREE fails while evaluating input candidates like [-ATR][+ATR][-ATR] (this kind of data is discussed in the next chapter), where the desired output is one with regressive hsrmony and not total agreement of the flanking [-ATR] vowels on both sides. The asymmetric trigger [+ATR] can only lead to an output candidate with regressive agreement, resulting in a sequence of [+ATR][+ATR][-ATR] vocalic features. In this scenario, AGREE would predict only the wrong results, favouring outputs which conform to total assimilation, i.e, either [-ATR][-ATR][-ATR] or [+ATR][+ATR][+ATR]. In the persistently regressive harmony of Assamese where there is no substantive positional relevance of the trigger, other theoretical devices like positional faithfulness and local conjunction also prove to be redundant.

(46) AGREE fails in the absence of total harmony[5]

I:[-F][+F][-F]	AGREE-F	IDENT[+F]	IDENT[-F]
a. [-F][+F][-F]	*!		
b.✭ [+F][+F][-F]	*!		*
c. 💣 [+F][+F][+F]			**
d. [-F][-F][-F]		*!	

[5] Throughout this dissertation a pointy finger indicates a selected output, an unhappy smiley indicates an actually occurring output which fails to win in the evaluation, and a bomb indicates the wrongly selected candidate.

The tableaux shows that in the absence of any reliable morphological or prosodic motivation, AGREE by itself does not lead us to regressive or progressive directionality. In the proposed analysis, I proceed to disentangle the behaviour of AGREE from its inherently asymmetric nature to a more specific constraint which identifies the marked sequence of features. These sequences specify the marked sequences of feature values, saving it from unwarranted agreement violations. Consequently, if AGREE[F] is broken up into the following sub-constraints, then Universal Grammar has to choose one of the specific markedness constraints:

(47) Sequential markedness constraints

*[+F][-F] – Assign a violation mark to [-F] segments preceded by [+F] segments.

*[-F][+F] – Assign a violation mark to [+F] segments preceded by [-F] segments

Applying the constraint *[-F][+F] to the offending input of (46) [-F][+F][-F] we arrive at the right result in (48) below:

(48) *[-F][+F] in partial assimilation

I: [-F][+F][-F]	*[-F][+F]	IDENT[+F]	IDENT[-F]
a. [-F][+F][-F]	*!		
b. ☞[+F][+F][-F]			*
c. [+F][+F][+F]			**!
d. [-F][-F][-F]		*!	**

Apart from handling directionality, these sequential constraints can also competently account for non-iterativity in Tripura Bengali and Bengali, languages closely related to Assamese. The AGREE [F] constraint favours total agreement by demanding iterative local agreement among all the adjacent vowels. With such a constraint it would be impossible to account for harmonic neutralisation when it is strictly contextually driven and therefore not iterative. In Tripura Bengali, high vowels can trigger a change only in the vowel feature of the preceding vowel, not any further, because harmony is absolutely dependent on both the values [+high] and [+ATR]. There is no way of expressing this kind of neutralisation with an AGREE [ATR] or AGREE [high] constraint which would demand obliteration of [ATR] or [high] contrasts in all the vowels of a word. This kind of neutralisation can be analysed when harmony is viewed as autosegmental spreading instead of featural agreement. Spreading will demand association of the triggering segment to the licensed vowel. Contextual markedness can capture the fact that licensing is not the issue in the facts at hand:

(49) Harmony in non-iterative assimilation

I: [-F -G][-F-G][+F+G]	*[-F][+F, +G]	IDENT[F]	IDENT[G]
a. [-F-G][-F-G][+F+G]	*!		
b.☞[-F-G][+F-G][+F+G]		*	
c. [+F-G][+F-G][+F+G]	*!	**	

I will demonstrate the actual implementation of sequential markedness constraints in OT in chapter 5. In chapter 5 I will show that this type of a markedness constraint presents a neat account of regressive harmony, without bringing in morphology into question or requiring a reversal of FAITH ROOT ≫ FAITH AFFIX (McCarthy and Prince 1995). This will be effectively shown to be the case in Assamese, Pulaar and Karajá (see Hansson 2002 for the original analysis of Karajá). Apart from being a suitable tool in the analysis of iterative harmony, these constraints will be also applicable to non-iterative harmony, essentially validating the claim that I have defended in this dissertation that such systems are nothing but variations of a single motivation, and that is agreement. The discussion below presents some precedents in the use of sequential markedness constraints in the OT literature.

Archangeli and Pulleyblank (1994) noted that feature spreading depends on the well-groundedness of the trigger: [+high +ATR] are well-matched features articulatorily, and their physical compatibility also leads to the groundedness of the vowels /i/ and /u/ which bear this feature combination. This attribute of the trigger implies that it is the most harmonic. Smolensky (1993) proposed the use of ‘cross-positional’ and ‘within featural’ constraints, where a [+high +ATR] source is well-grounded and therefore prohibits neighbours which would surface with unassimilated feature combinations i.e., *[-ATR][+ATR] and *[+high -ATR]. Essentially, this kind of featural prohibition constraint forbids disharmony in vowel sequences. In a similar vein, Pulleyblank (2002), proposed the following constraints in order to compel [ATR] vowel harmony:

(50) *<u>ATR</u>-C0-RTR: Ignoring consonants, an ATR segment may not be immediately followed by RTR.
*RTR-C0-ATR: Ignoring consonants, an ATR segment may not be immediately preceded by ATR.

Pulleyblank further elaborates these constraints, to account for transparency in vowel harmony languages as well.

(51) Proximal vs. distant sequential prohibitions
<u>Distant:</u> *RTR-∞-ATR<u>:</u> An ATR segment may not be preceded by RTR.
*<u>ATR</u>-∞-RTR: An ATR segment may not be followed by RTR.

In its most local manifestation, the sequential prohibition would disallow any immediately adjacent sequence of differing tongue root specifications. Pulleyblank shows that sequential markedness constraint applied to long-distance environments generates transparency in vowel harmony languages.

Pulleyblank also puts forward the view that these constraints are functionally motivated because articulatory settings prefer minimal changes in their configuration during articulation. Featural markedness constraints prohibiting sequences of features facilitate articulatory economy by favouring minimal movement of articulatory mechanisms. However, in the approach presented in this dissertation I only consider sequential markedness constraints which can evaluate sequences of features locally and not distally. Further, this dissertation concentrates exclusively on regressive harmony and claims that the constraint *[-ATR][+ATR] gives rise to regressive [ATR] harmonies only and the reverse of that process is predicted not to occur – i.e, *[-ATR][+ATR] alongwith the appropriately ranked featural markedness constraints will result in the emergence of [+ATR][+ATR] and not its reverse, [-ATR][-ATR].

Having shown my approach of sequential markedness to directionality in vowel harmony, in the following subsections, I will present a portrayal of the treatment of both harmony and corresponding directionality in some mainstream approaches to OT. The aim of this presentation is to show that various degrees of shortcomings will be encountered in the use of these proposals in the analysis of strictly regressive vowel harmony of the Assamese type.

4.2 Positional Faithfulness

Beckman (1997, 1998) analyses vowel harmony to be an effect of positional faithfulness with markedness. Positional faithfulness ensures that a vowel in a prominent position triggers harmony. Markedness constraints are violated when features spread to non prominent positions. Beckman illustrates this with height harmony in Shona. Vowels following the initial vowel agree in height with the first vowel of the word. The vowel /a/ never alternates. The following example, using a standard tableau is from Shona which allows the mid vowels /e/ and /o/ only in the prominent position:

(52) Pos Faith in Shona harmony

I: /per-ira/	IDENT σ_1	*Mid	*high	IDENT (high)
a. perira		*	*!	
b. ☞ perera		*		*
c. pirira	*!		*	*

The positional identity constraint IDENT σ_1 permits mid vowels if they are in the root-initial syllable. It leads to the preservation of underlying contrasts over markedness violations which otherwise serve to rule out mid vowels. This exemplifies that faithfulness constraints can prevent some unfaithful elements from surfacing. Neutralisation and allophony processes require restrictions on possible outputs. Therefore allophonic neutralisation in prominent positions must be the consequence of markedness constraints specific to those positions. Vowel harmony has been shown to be controlled by a vowel in a strong position (*qua* Beckman and others). Positional Faithfulness constraints only preserve contrasts in strong positions and do not enforce any specific kind of unfaithfulness. Therefore, positional faithfulness of the initial syllable would not characterise Assamese vowel harmony alterations at all.

4.3 Harmony as Correspondence : Stem-Affix Faithfulness

Baković (2000) argues for a model of assimilation which employs stem-affixed form of faithfulness in stem controlled systems like Turkish by employing cyclic derivation. For the stem-controlled systems it is argued that between two candidates, the one most faithful to the feature value of the stem of affixation decisively wins. In other words, the feature value of a vowel in the stem of affixation is more faithful, as opposed to that of a vowel in the affix. In such an approach, the vowel of the stem undergoes cyclic evaluation every time a new affix is added as against the value of the affix, and, is thus, called *stem-controlled*. In order to arrive at this, Baković employs Transderivational Correspondence Theory (TCT). TCT evaluates each stem of affixation in loops, where the entire constraint hierarchy is repeated in each cycle (Benua 1995, 1997ab). Thus, the output form of each stem of affixation is available for the next level of affixation. What is needed to derive stem-controlled vowel harmony is a special kind of faithfulness constraint preferring that the feature values of the stem of affixation remain unchanged. In TCT, there is a correspondence relation between affixed forms and their stems of affixation. Featural faithfulness constraints on this correspondence relation, called SA-IDENT [F] constraints, require correspondence between morphologically-related forms, so that they have the same feature value.

(53) SA- IDENT [F]
A segment in an affixed form [*Stem+affix*] must have the same value of the feature [F] as its correspondent in the stem of affixation [*stem*].

The importance of SA- IDENT [F] arises because AGREE [F] is equally satisfied by two candidates, one with all [-F] vowels and the other with all [+F] vowels, the choice must be made in favour of the harmony feature value of the stem of affixation. The table below in (54) shows the assimilation of the affix vowel to the root vowel, where SA IDENT [F] prefers the candidate in which the affix vowel assimilates to the root vowel rather than the candidate in which the root vowel assimilates to the affix vowel.

(54) Input: [+F].[-F] stem:[F]

	AGREE[F]	IO-IDENT[F]	SA -IDENT[F]
a. [+F].[-F]	* !		
b.☞[+F].[+F]		*	
c. [-F].[-F]		*	*!

Among the three candidates only (54) (b) does not violate SA –IDENT [F], but at the same time satisfies AGREE [F]. However, the simplicity of this hierarchy does not capture complicated situations like the existence of more than two vowels in the input.

This is called the 'majority problem' (Lombardi 1997, Baković, 2000). The majority rule problem arises if another suffix with a [-F] feature specification is attached to the stem derived in (54). Then a ranking as the one below in (55) results in candidates which equally satisfies both the candidates.

(55) Input:[+F].[-F]. [-F] stem: [+F].[+F]

	AGREE[F]	IO - IDENT [F]	SA –IDENT [F]
a.[+F]. [-F]. [-F]	*!		*
b.[+F]. [+F]. [-F]	*!	*	
c.[+F]. [+F]. [+F]		**	
d.[-F]. [-F]. [-F]		*	**

In the tableau above, AGREE [F] is dominant and it brings down the candidate set down to basically two candidates, one with all [+F] and the other with all [-F] candidates. When IO IDENT [F] is higher than SA-IDENT [F], then it will choose only that candidate which is least deviant from the input. However, in order to outwit the majority problem (where the harmony feature value happens to be better represented in the input), Baković assumes that local conjunctions of markedness constraints and the faithfulness constraints are universally higher ranked than their conjuncts. The local conjunction proposed to be active here is *[-F] & IO-IDENT [F].

One of Baković's prominent claims in the dissertation is also about directionality. He makes a strong claim that there are only two vowel harmony processes in the languages of the world - stem controlled and dominant recessive. He argues:

> "Vowel harmony is entirely dependent on the morphological structure of the language… if directionality were an independent parameter along which languages could arbitrarily differ, then one would expect to find at least the following two unattested vowel harmony patterns. The first is a left to right pattern from the initial syllable, root to prefix, the other is a right to left pattern from the final syllable, root or suffix – logically independent considerations such as morphological impoverishment aside (e.g. lack of prefixes as in Turkish, or a lack of suffixes as in Yoruba) a theory of assimilation with directionality as a theoretical primitive directly predicts the possibility of these unattested patterns. First, in languages with strictly prefixing morphology, harmony reliably

propagates from root to prefix = right to left, and in languages with both prefixes and suffixes, vowel harmony percolates both leftwards and rightwards". (Baković 2000:19-20)

However, as I will discuss throughout this dissertation, directional harmony systems are indeed attested. In Assamese, any [+ATR] trigger on the right is capable of spreading the [+ATR] feature to all the vowels in the other direction, i.e. leftwards, including the prefix.

4.4 Syntagmatic Correspondence

Baković does not address or acknowledge the existence of other schemes of organisation in the typology of harmony: specifically stress-controlled or strictly directional systems. However, Krämer addresses another type of harmony, which he dubs affix-controlled harmony. Krämer also employs correspondence, which shows that harmony emerges in satisfaction of an identity constraint on different surface representations called Surface or Syntagmatic identity by Krämer (1998, 2001, 2003)[6] (essentially the same as AGREE by Lombardi (1999), Baković (2000).

While both Krämer (2003) and Baković (2000) reject positional faithfulness, Krämer's Syntagmatic Identity constraint rejects cyclic derivation in favour of output – output correspondence at a representational level. According to Krämer, this kind of an identity relation allows for affix controlled systems, whereas SAF does not. Basing his analysis on Lamontagne & Rice (1995), Krämer postulates constraints against multiple correspondences, (INTEGRITY constraints) where features of a given underlying segment are realised only to one segment in the surface representation.

(56) Positional Integrity:
a. INTEGRITY (F) Affix

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[6] In the basic faithfulness constraint families of OT, IDENTITY says that segments in one representation should agree in feature specifications with the respective segments in another representation. The crucial difference between the approaches being that identity constraints in the sense of McCarthy and Prince refer to the identity of input and output or that of base and reduplicant, while an output-output identity constraint refers to adjacent elements in the output.

No feature of an affix in an input has multiple correspondents in the output.
b. INTEGRITY (F) Root
No feature of the root in an input has multiple correspondents in the output.

These constraints block harmony or spreading between adjacent feature bearing units 'within the same representation'. The triggering vowel has an indirect correspondence relation within target vowels (because of an input-output correspondence relation with the underlying representation). Further, in Krämer's analysis, in order to account for affix control, INTEGRITY Root has to rank above INTEGRITY Affix, while in root controlled systems INTEGRITY (F) Affix outranks INTEGRITY Root.

(57) Affix control with Integrity constraints (Krämer 2000)
a. Root control: INTEGRITY (F) Affix ≫ INTEGRITY Root
b. Affix control: INTEGRITY (F) Root ≫ INTEGRITY Affix

I will take up this ranking and the proposed affix-controlled analysis of Pulaar in chapter 5 and try to show that this radical revision may not be necessary, and harmony in Pulaar can be shown to be the effect of sequential markedness constraints as well.

4.5 Harmony in AGREE, ALIGN and SPREAD

Agreement in a lot of OT work has been seen to be the result of a featural agreement constraint. One such featural agreement constraint is AGREE [F], which is symmetric and, therefore, non-directional in its very nature, thereby compelling either regressive or progressive spreading.

(58) AGREE [F]: Adjacent segments must have the same [αF] value of the relevant feature (Lombardi 1996ab, 1999, Baković 2000)

Assuming that agreement is driven between segments by an AGREE [F] constraints, give us the result that agreement will be violated every time there is disagreement in terms of features. To break the tie in order to determine in which direction harmony will proceed, AGREE [F] is always dependent on positional faithfulness constraints (like STEM IDENT, Baković 2000). Agreement constraints are defined in such a way so as to drive assimilation locally. Thus, AGREE [F] constraints by definition allow agreement only in the adjacent segment disallowing skipping of the relevant segments.

Apart from analyses favouring featural agreement, there are also other competing analyses, which assume a correspondence approach to faithfulness. In this approach, which assume a correspondence method of analysing vowel harmony, adjacent output segments are bounded by a correspondence relation. In correspondence based agreement, apart from a correspondence constraint, another agreement constraint also needs to be functional to prohibit disagreement between features. A directional correspondence constraint was proposed by Walker (2000) whereas directional AGREE constraints have been proposed by Pater and Werle (2001).

A lot of OT analyses have adopted the autosegmental approach of phonetic spreading. In many, harmony was analysed predominantly in terms of alignment (which is also an autosegmental remnant). Alignment typically requires features to be aligned to the left or right edge of a morphological or phonological domain.

(59) Featural Alignment(Kirchner 1993)
ALIGN (F, L/R, Mcat): For any parsed feature F in morphological category Mcat (= Root, Word), F associated to the leftmost/rightmost syllable in Mcat (violations assessed scalarly).

This type of alignment constraint demands that the edge (right/left) of a feature be associated with the right/left edge of a category. Alignment approaches are typically carried over from earlier derivational and autosegmental approaches in their usage of right and left edges in order to designate the conditions under which a precise phonological phenomenon can take place. For critiques of alignment, showing how alignment can lead to unattested patterns, see Hansson[7] (2001) McCarthy (2004).
As discussed in the previous section, in output-oriented Optimality Theory, directionality should 'fall out' of universal constraints, which refer to either some form of faithfulness (cyclically, to the stem for instance) or markedness properties of the

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7 See Hansson (2002) for a critique which shows the perils of ALIGN-R and ALIGN-L if the harmony system involves rightward spreading of both values of [±back] (as argued for Hungarian, e.g., by Ringen & Vago 1998). It is shown that ALIGN-R and ALIGN-L can operate in largely equivalent ways, by generating identical output candidates.

features involved in the vowel harmony process. The distinction between regressive versus progressive assimilation has been shown to be epiphenomenal, emerging out of stem-control or emergence of the unmarked. As a result, alignment constraints have been shown to be extraneous in vowel harmony (Baković 2000, Krämer 2003, etc. discussed in sections 4.3 and 4.4). Thus, in the true spirit of OT, the search for such independent attributes and not simply an alignment constraint responsible for directionality (especially in assimilation) has emerged as a central concern.

Harmony has also been shown to be the result of spreading constraints. SPREAD[F] drives autosegmental association of the feature of the harmony trigger to all segments in a harmony domain. Simply bearing the vowel harmony feature value by two consecutive segments is not sufficient to satisfy the spreading constraint. The fundamental difference between the two approaches in which SPREAD construes harmony as 'spreading' as against featural agreement relations, can be highlighted with the schema given below:

(60) AGREE vs. SPREAD

AGREE	AGREE
[+F] [+F]	[+F] [+F]
SPREAD	*SPREAD
[+F] [+F]	[+F] [+F]

The representations show how spreading and autosegmental assumptions differ from agreement based models. AGREE is satisfied if (a) two underlying instances of a relevant feature exist in agreement, (b) agreement is the result of feature spreading from the trigger to the target. In contrast, spreading is satisfied only when underlying instances of a feature [αF] are linked to adjacent segments as a result of spreading or association. In spreading of the autosegmental variety, markedness violations are assessed by feature rather than by segment (see McCarthy & Prince 1994a, Itô & Mester 1994, Padgett 1995ab, Walker 1998b, and Alderete et al, 1999, etc). Under the said autosegmental approach to markedness, also advocated in Beckman (1995, 1997, 1998), these two representations are distinguishable by markedness constraints, which penalise individual features and not the segments. In this approach, also dubbed 'feature-driven' markedness, (60)(a) violates *[+F] twice, while (60)(b) incurs a single violation of the markedness constraint. On the other hand, proponents of agreement models put forward the view that any given markedness constraint *[+F], does not differentiate between the representations in (60), as they both violate *[+F] twice.

4.6 Optimal Domains Theory

In many ways, Optimal Domains Theory (Cole and Kisseberth 1994, 1995) reverberate many of the attributes of alignment, as it too demands alignment of features to relevant prosodic or morphological domains. However, this approach relies on abstract feature domains, where the output correspondents of inputs belong to domains which bear the relevant feature. These abstract feature domains are enforced by the EXPRESS [F] constraint which requires the expression of these features phonetically. Further, alignment in Optimal Domains Theory is of two types – Wide Scope Alignment where alignment is required to larger domains such as metrical domains or word domains. Whenever there is wide Scope Alignment, it outranks basic alignment which is merely the alignment of the segment bearing the feature association in the output.

4.7 Span Theory

Autosegmental Phonology (Goldsmith 1976a, 1976b and many others) accomplishes feature spreading by allowing it to be a phonological process that is iterative and independent of individual consonants and vowels. Span theory (McCarthy 2004) is a modification of autosegmental phonology in OT, where feature spreading segments are evaluated on the basis of their belonging to a particular 'span' for a certain feature [F]. Each segment of a word is exhaustively parsed into a structure called spans, which resembles associations borne by autosegmental features. Each span is demarcated by its segmental head and the head's value of [F]. The notion of headship is unique to Span theory, and in a way marks a departure from standard autosegmental theory[8]. In the

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[8] Another similar approach is that of Smolensky (2006) which also employs headedness, but relies on traditional alignment constraints.

theory of headed spans *A-SPAN (F) prohibits adjacent spans.

(61) *A-SPAN(F)

Assign one violation mark for every pair of adjacent spans of the feature [F].

*A- SPAN (F) is a markedness constraint that demands that each span be exclusive and not overlap with any other span. *A- SPAN (F) penalises candidates with violation marks that are equal to (x-1), x being the number of spans that the candidate has. This constraint is used instead of the traditional AGREE constraint to compel obligatory spreading. *A-SPAN (F) is different from AGREE as it does not refer to adjacent segments but to adjacent spans. AGREE favours total spreading, whereas *A-SPAN (F) is compatible to partial spreading (This is again discussed in detail in the next section). Partial spreading is robustly attested in Vowel harmony languages, as harmony blocking is a regular feature in these languages as the process of harmony itself. *A- SPAN (F) has an advantage over AGREE. Phonological opacity in Vowel harmony can be more effectively accommodated in Span Theory. In Span theory, IDENT and MAX-feature constraints are replaced by FTHHDSP(αF).

(62) FTHHDSP [αF]

If an input segment ς_I is [αF] and it has an output correspondent ς_o, then ς_o is the head of an [αF] span.

FTHHDSP [+F] is violated when (i) an input segment with the [+F] segment has an output correspondent that is not the head of a [+F] span or, (ii) an input [+F] segment correspondent is the head of a [-F] span. Markedness constraints requiring certain segments to head spans with a particular F value. Feature co-occurrence restrictions manifest as span heads in this theory.

(63) HEAD([βG, γH,…], [αF])

Every [βG, γH,…] segment heads a [αF] span.

Directionality of harmony is a consequence of constraints on the location of the head segment. As unbounded directionality is cumbersome in order to be interpreted in terms of positional markedness or positional faithfulness. Span Theory relies on the notion of the head span, which determines directionality. For instance SP HD L (+ATR) would determine that the head segment of a [+ATR] span is initial and SP HD R (+ATR) would be required if the head segment [-ATR] is final and these constraints evaluate candidates categorically, not gradiently.

Span Theory brings along with it welcome results in directionality and a means for capturing the so-called problem of 'sour grapes'. The problem of sour grapes arises because the constraint AGREE requires global evaluation, where there is no scope for the selection of candidates with partial assimilation. Partial assimilation arises in harmony systems as result of a very simple fact of iterative assimilaion: harmony spreads in the whole word or till it meets a blocking segment. AGREE fails to predict the right results whenever the output demands partial agreement. AGREE's propensity to all or nothing in agreement, can be shown with the Assamese input /sɑpɔr/+/i/, as shown in the tableaux below:

(64) AGREE's sour grapes problem

sɑpɔr+i	*[LOW +ATR]	AGREE	IDENT[ATR]
a. 💣 sɑpɔri		*	
b. ☹ sɑpori		*	*
c. sæpori	*!		

The tableau in (64) above shows that AGREE's sour grapes problem arises because it cannot distinguish between partial and complete assimilation. Span Theory has an edge over agreement with its attribute of headedness. The tableaux below shows how Span Theory averts the problem of sour grapes:

(65) /ɑ/ blocking – high ranking HD[+low-ATR] and violation of *A-SPAN allows opacity

I: /sapɔr/+/i/	FTHHDSP [+ATR]	HD [+low -ATR]	*A-SPAN [ATR]	HD_R ATR	HD_L ATR
a.☞(sɑ̲)(pori̲)			*		*
b. (sɑpɔ̲)(ri̲)		*!	*		
c. (sɑ̲pɔ)(ri̲)			*	*!	
d. (sɑ̲)(po̲ri)	*!		*	*	

The difference between the candidates (65)-a and (65)-b lies in the latter's violation of the highly ranked HD[+low - ATR]. (65)-c incurs a violation of HD_R [ATR] and, therefore, it fares badly than the most optimal candidate. Headedness therefore seemingly resolves problems that AGREE's global evaluation fails to curb.

However, Wilson (2006) shows that Span theory cannot deal with various aspects of partial spreading as it is strictly speaking does not look at local domains while evaluating outputs.

The problem of 'sour-grapes' and its proposed analysis in this dissertation is taken up in chapter 6. The problem of consonantal intervention in harmony is thoroughly discussed in chapter 5.

5 Approaches to umlaut and metaphony

Before closing the discussion, I would like to draw attention to previous non-OT approaches to non-iterative processes like umlaut, which were shown to be contextual neutralisation (as against absolute neutralisation, see Kiparsky 1981). In OT approaches[9], there is no dominant view in analysing a non-iterative process like umlaut. Karvonen and Sherman (1997) use sympathy theory to explain cases of opacity. On the other hand, Klein (1995) analyses umlaut alternation and its morphological idiosyncrasies in German with the aid of a representational device called desiderata. Morphological classes are present in the input through desiderata. Constraint violations are then evaluated by general faithfulness constraints such as MAX-IO. Output candidates are measured by the faithfulness constraint to check whether they match the violations in the desiderata. Ringen and Heinamaki (1999) propose that Icelandic umlaut results from the COINCIDE color constraint, which requires a strong color node to belong to an affix to coincide with a root vowel. This analysis also relies on floating features of input vowels which are not surface apparent. These so-called 'ghost vowels' are realised to satisfy constraints on syllable structure. This analysis proposes that only morphologically complex forms undergo umlaut. The reason that forms such as *kaktus* 'cactus' do not undergo umlaut is that it is a morphologically simplex form without any requirement for affix to root association.

[9] Though it may be possible to offer a comparative markedness analysis of the phenomena under discussion here, no such treatment of vocalic assimilation, iterative or non-iterative, exists (as far as I am aware).

A similar approach to that of Ringen and Heinamaki has been proposed for metaphony in the recent OT literature by Walker (2006). Walker proposes to analyse metaphony with a LICENSE constraint where the vowel in the weak position alters the vowel in the strong position in order to be licensed by it. This is discussed at length in chapter 8. I'll leave this issue here and proceed to elaborate my own approach of 'Sequential Markedness Constraints' in order to evaluate iterative and non-iterative harmony systems.

5.1 Conclusion

In this chapter I have discussed the theoretical background relevant to the discussion of unidirectional regressive vowel harmony. In section 4.1, I have elaborated on the approach to directional harmony which will be employed throughout this dissertation. In the other sections from 4.2- 4.7, I have shown how other approaches which could have been potentially used in this dissertation have limitations in their ability to capture the intricacies of directional harmony, especially Assamese vowel harmony.

Chapter 4

Vowel harmony in derived and non-derived words of Assamese

1 Introduction

As I have already guaranteed in chapters 1, 2 and 3, the main arguments in this dissertation will be primarily informed by Assamese and a description of its vowel phonology is therefore indispensable. The aim of this chapter is to provide adequate descriptive information about the vowel harmony facts of the language. The organisation of this chapter is as follows: In section 1, I present the vowel phonology of Assamese in great detail. In section 2, I deal with the co-occurrence restrictions in underived words of Assamese. In section 3, the focus of interest is vowel harmony in derived words of Assamese. Having shown that derived forms behave just like the underived ones, in section 4, I present some affixes in nouns, adjectives and verbs, which can trigger iterative harmony and also lead to some interesting patterns. In section 5, I discuss exceptional lexical occurrences in this regular system of harmony.

1.1 Background to Assamese

Assamese was accorded the status of one of the official languages of the state of Assam in India (see map in the appendix I) along with English by the state's Official Language Act of 1960. The origin of Assamese goes back to the Prakrit[10] stage of the development of Indo-Aryan languages. It has incorporated various other elements into its lexicon and grammar, the Indo-Aryan element being the major shaping influence and Austric and Tibeto-Burman influences stamping their discernible mark not only in loan words but

[10] Prakrit or 'natural language' was a colloquial form of literary Sanskrit. Varieties of Prakrit were spoken in various parts of North India for more than a millennia from 600 B.C. to 1000 A.D.

also in its phonology, morphology and syntax. The variety described here is representative of colloquial Assamese spoken in the eastern districts of Assam. Assam is a North-Eastern state of India, but Assamese (also known as Asambe, Asamiya, etc.) and creoles of Assamese like Nagamese are spoken in the different north-eastern states and also in the neighbouring country of Bhutan. Assamese can be regarded as the easternmost language in the Indo-European language family.

The erstwhile pre-British kingdom of Assam was ruled by the Ahom kings from 1228 and the then capital was based in the eastern district of Sibsagar and later in Jorhat. Under British colonial rule, Christian missionaries established the first printing press in Sibsagar (1836) and these circumstances led to the acceptance of the variety spoken in Eastern Assam as the standard for all purposes. However, there is considerable amount of dialectal variation within the state. It is common among linguists to divide the dialects into three main groups Upper (spoken in Upper Assam, i.e. the upper reaches of the river Brahmaputra), Middle (spoken in areas between upper and lower Assam) and Lower (spoken in Lower Assam). Though it is said that the present standard is the variety slowly evolving out of the largest city Guwahati (which also hosts the capital of the state Dispur), there are hardly any stable and defining characteristics in the language spoken in that city, perhaps owing to the fact that it is a city of settlers from different parts of Assam as well as India. For the purposes of mass media and communication, a 'neutral' Eastern Assamese, without too many regional variation (/r/ deletion for instance, which is a robust phenomenon in some Eastern varieties) is still considered to be the norm.

I will briefly present an outline of the basic phonology of Assamese, which will be restricted to the phonology of the vowels of the language. This will be followed by an extensive discussion on all the vowel co-occurrence restrictions in the underived as well as the derived phonology of the language.

1.2 Vowel inventory

Assamese has the eight surface vowels [i, e, ɛ, ɑ, ɔ, o, ʊ, u] of the table below:
Table 1

	Front	Back	
high	i	u	+ATR
		ʊ	-ATR
Mid	e	o	+ATR
	ɛ	ɔ	-ATR
low		ɑ	-ATR

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]. Though it may appear from this table that all the eight vowels appear contrastively, there are constraints in the distribution of [e] and [o] and these constraints will be discussed extensively in this dissertation (chapters 5, 6 and 7). [e] and [o] occur only under circumstances of vowel harmony (and in some exceptional circumstances, which will be discussed in chapter 7), or in vowel clusters[11].

Thus the obvious distinctions are along the parameters of height, [ATR] and backness (except /ɑ/ and /ʊ/, as they do not have front counterparts), but harmonic alternations are restricted to the [-ATR] set of vowels. This system of eight vowels contrasts the [+ATR] set – /i, u, e, o/ with the [-ATR] set of vowels - /ʊ, ɛ and ɔ/. This distinction with the feature values for [ATR] are distributed as below:

[11] Assamese is known to have a considerable number of vowel clusters. Goswami (1966) reports that there are forty-one two vowel clusters in Assamese of which five are gemination of the same vowel. He also observes that phonemically there are no diphthongs although /i e o u/ form diphthongs in non-stressed positions. I cannot claim to have anything original to add to this apart from the fact that the final /i/ occurring in clusters does not trigger vowel harmony. The presence of all these vowel clusters is subject to debate, primarily because these instances of vowel clusters are not substantiated with examples and /e/ and /o/ do not occur in Assamese under non-harmonic circumstances.

(66) [+ATR] and [-ATR] distinctions

[+ATR]			[-ATR]	
i	u			ʊ
e	o	ɛ		ɔ
			ɑ	

The featural distribution system above shows that there is a contrast in terms of the feature [ATR], but the contrast is less than perfect. There is a gap reflected in the absence of a [-ATR] high front vowel. Assamese is therefore atypical of seven or nine vowel systems (in ATR harmony languages) where gaps are encountered only with respect to the low vowel /ɑ/.

As already mentioned, these vowels can appear 'contrastively' *only* in a restricted sense. Some of these paradigms have appeared as textbook examples of the distinctiveness of the eight vowels which appear in the Assamese inventory. An oft-cited 'contrastive' set (see eg. Goswami 1966) is given below in (67)(a):

(67) (a) minimal pairs of Assamese (b) non-minimal pairs

(i)	bɛl	'kind of fruit'	(i)	bɛt	'cane'
(ii)	bel	'bell'(from English)	(ii)	dʰet	(interjective)
(iii)	bɑl	'child'	(iii)	bʰɑt	'rice'
(iv)	bʊl	'colour'	(iv)	bʰʊk	'hunger'
(v)	bɔl	'strength'	(v)	bʰɔr	'fill'
(vi)	bol	'let's go'	(vi)	dot	'monster'
(vii)	bul	(proper name)	(vii)	buz	'understand'
(viii)	bil	'small lake'	(viii)	bʰir	'crowd'

Note that in the paradigm set in (67)(a. ii) /bel/[12] is a loan word from English, while /bol/ is not an underived word, it is an inflected form of 'go' 2P ordinary present plural. It is possible to construe another set consisting only of native Assamese monomorphemic words, as in (67)(b), which are not necessarily perfect minimal pairs. But even here /dʰet/ (interjective) and /dot/ 'monster' are members of an extremely limited set of

[12] I do not intend to discount the fact that there will be a lot of difference in the minute phonetic details of the perception and production between the Assamese /e/ and the English /e/. However, the ones borrowed from English are still [+ATR] mid vowels phonologically.

lexical items consisting of non-allophonic /e/ and /o/. Therefore I will maintain in the rest of the dissertation that words with [e] and [o] do not occur independently and their status as allophones is justified.

As far as the vowel /ʊ/ is concerned, native linguists characterised it as a rounded, high, back vowel. Goswami (1966) characterised it as 'higher mid' as he considered it to be higher than /o/, he also portrayed it as back and 'half closed'. A discussion of this vowel will be again taken up in section 1.4.

The vowel phonology of Assamese can be conclusively said to have an eight vowel inventory, where there are three high vowels, four mid vowels and one low vowel. The next section discusses a phonetic experiment aimed at verifying the phonological judgements regarding the quality of the vowels of Assamese.

1.3 An acoustic experiment of Assamese vowels

In order to confirm the distinctions among the eight vowel set of table paradigm sets exemplified in (67), an acoustic study of these vowels was conducted with the help of PRAAT (Boersma and Weenick 1993 - 2007)[13]. The experiment was conducted on 3 subjects, using 4 sets of words and 3 iterations. The experiment was controlled for some important factors like regional variation and amount of second language interference. The table below shows the formant frequencies obtained as a result of the experiment (the actual set of words used, and the conditions under which this experiment was conducted is in appendix I):

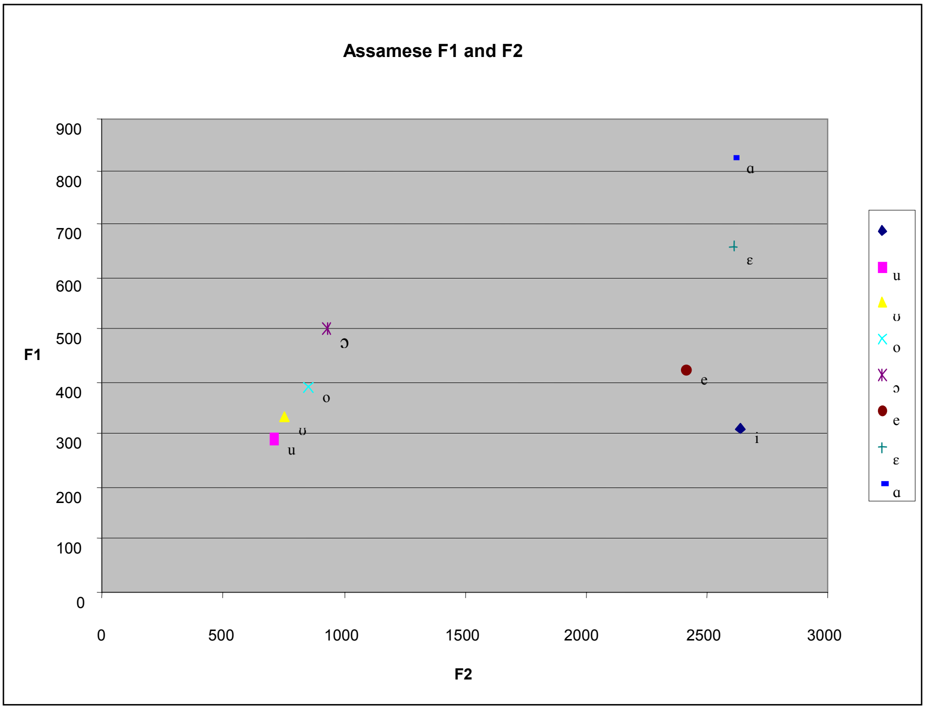
Chart I

	F_1	F_2	F_3
i	312	2642	3197
u	292	707	2891
ʊ	333	756	2637
o	390	850	2763
ɔ	501	927	2608
e	423	2418	3047
ɛ	659	2608	2953
ɑ	824	2731	2961

[13] PRAAT is a software for phonetic analysis.

The formant frequencies given above confirm the vowel system. The plot below makes use of the first and second formant frequencies only, but it shows the height and back attributes of these vowels very clearly.

Diagram 1



The plot of the vowels above shows that while /i/ and /u/ are the highest vowels, /ʊ/ is only slightly lower than /u/. The other back vowels also have significant F_1 differences. The front vowels on the other hand, are more spread out allowing for significant height differences between /i/, /e/ and /ɛ/. Among the back vowels, while /ɔ/ is the lowest and /o/ is higher than /ɔ/.

1.4 The phonetics of the Assamese high vowel /ʊ/

Among the Assamese vowels, the vowel /ʊ/, has been the subject of attention in phonetic studies in the recent past (Ladefoged 1986, 2001, 2003). The phonetic experiment discussed above shows that in keeping with Goswami's (1966) observation, the vowel /ʊ/ is higher and more rounded than /o/ (though /ɔ/ shows up as more rounded than /ʊ/). These frequencies also indicate that /ʊ/ is higher than /ɔ/. The Assamese vowel called 'low rounded /ɒ̹/' was one of the subjects of Ladefoged's (1986) inquiry in the 'Sounds of the World's languages[14]'. The phonetic experiment conducted by Ladefoged shows the qualitative differences in Assamese vowels. The following are the lexical items that Ladefoged uses in his experiment.

(68) Assamese contrastive vowels in Ladefoged (1986)

Word	Gloss	Word	Gloss
pit	'to beat'	puti	'having buried'
petu	'intestines'	poti	(girl's name)
pɛt	'stomach'	pɔt	'appearance'
pat	'to establish'	pɒ̹t	'to bury'

Ladefoged does not pay attention to the fact that the occurrence of /e/ and /o/ in his set of examples is only due to the presence of the following high vowels /i/ and /u/. Furthermore, he also overlooks the fact that his so-called "rounded low vowel" in the verbal root /pɒ̹t/ 'to bury', leads to the derivation of a high round vowel in /puti/ 'having buried', i.e. he does not take into account the systematic [ATR] harmony pattern in his own examples. He concluded that the difference lies in a paradigmatic distinction between the two vowels /ɔ/ and /ɒ̹/ (following his transcription). He shows that "the first ([ɔ]) is fairly like the IPA reference vowel [ɔ]; the second has a tongue position like that of [o], but with a lip position more like that of [u]. The first and second formants are at slightly higher frequencies for [ɔ] – an unusual situation in that higher vowels normally

[14] I am not aware of the details of the speakers and other controls that were used in this experiment. The web edition of the Sounds of the World's languages (Web edition 2001) is cited as an appendix to the phonetic material produced by the members of the UCLA Phonetics Lab. It archives some 800 possible speech sounds in the languages of the world with the aim to "present constrasting sounds so as to provide illustrations of the range of the linguistic phonetic abilities of mankind".

have lower first formant frequencies. The considerable rounding in [ɒ̜] has caused both formants to be lower as well as a sharp decrease in spectral energy immediately above the second”.

Unlike the findings reported in Ladefoged, our experiment shows that /ʊ/ is not a low vowel, but rather high and rounded (roundedness was also noted by Ladefoged). This makes it a high rounded [-ATR] vowel which alternates with the value [+ATR] as a result of harmony. In so far as phonology is concerned, the vowel /ʊ/ behaves as a [+High] vowel as it alternates to /u/ as a result of vowel harmony.

There are wide regional divergences in the Assamese spoken throughout the Assam valley, and there is no indication in Ladefoged as to the regional variety that he chose for his experiment. His findings for all other vowels by and large coincide with my experiment. Though I do not wish to dismiss Ladefoged’s findings, it has to be emphasised that it is not clear which factors were controlled for his experiment.

It must be noted that phonologically, even for the speaker(s) of the ‘dialect’ used in Ladefoged’s experiment, the vowel must be high, because it alternates to /u/ under harmony in the examples cited. To assume otherwise, would lead to a highly improbable height/round harmonic pattern where the lowest round vowel alternates with the highest round vowel skipping all the mid round vowels in between.

2 Vowel co-occurrence restrictions in underived Assamese words

This section deals with combinatorial restrictions on vowels in monomorphemic Assamese words. Sections 2.1 – 2.6 are concerned with distributional restrictions on vowels in different positions of a bisyllabic word. Section 2.7 discusses vowel co-occurrence restrictions (in much less frequently occurring) trisyllabic and quadrisyllabic monomorphemic words. Section 2.8 discusses directionality of vowel harmony in the examples we have seen so far. Section 2.9 summarises the discussion.

2.1 Collocational restrictions in simplex words of two syllables

The basic distributional facts of vowels in disyllabic Assamese words are summarised in table 2. The horizontal axis in table 2 indicates the second vowel of the disyllabic word and the vertical axis indicates the first vowel. A plus (+) indicates a sequence that occurs and a minus (-) represents a sequence that does not. Keep bearing in mind that this section deals only with monomorphemic sequences in Assamese.

(69) Table 2

V_2 →

V_1 ↓

	i	e	ɛ	ɑ	ɔ	o	ʊ	u
i	+	-	+	+	+	-	-	+
e	+	-	-	-	-	-	-	+
ɛ	-	-	+	+	+	-	+	-
ɑ	+	-	+	+	+	-	+	+
ɔ	-	-	+	+	+	-	+	-
o	+	-	-	-	-	-	-	+
ʊ	-	-	+	+	+	-	+	-
u	+	-	+	+	+	-	-	+

The table in 3 demonstrates the combinations possible only in disyllables. We will see later in Section 2.6 that restrictions in disyllables are different from restrictions in trisyllables.

Immediately below, I classify the harmonic properties observed in the table according to the height of the vowels concerned i.e. high, mid and low. Possible sequences are exemplified with at least four suitable examples. Wherever applicable, the comment 'not attested' suggests that the gap is systematic and is a regular feature of the co-occurrence patterns of the language.

2.2 high vowels - /i/ and /u/

As we have already mentioned, there are two [+high +ATR] vowels in Assamese /i/ and /u/. From the tables in 1 and 2 we can formulate the following generalisations:

(70) The high vowels /i/ and /u/ are [+ATR]

- (i) as V_1 they co-occur with everything except /e, o, ʊ/
- (ii) as V_2 they co-occur with everything except /ɛ, ɔ, ʊ/

Other things being equal[15], the distribution of [+ATR] in words containing /i/ and /u/ is

[15] 'Other things' refers to potential blockers of harmony effects in Assamese, namely, two consonants occurring together, and the nasals /n/ /m/ and /ŋ/ which block harmony in certain environments. Consonantal intervention will be discussed in detail in chapter 6.

restricted with respect to co-occurring mid vowels, in that a [+high, +ATR] vowel is permissible both to the left and to the right of some mid vowels, and also co-occurs with itself. Although it is possible to have [+ATR] mid vowels to the left of the [+ATR] high vowel and to have a [-ATR] mid vowel to the right of a high vowel, it is impossible to have a [+ATR] mid vowel to the *right* of a high vowel and a [-ATR] mid vowel to the *left*.

Distributional restrictions on high vowels always concern the feature [±ATR]. high vowels do not co-occur with all vowels, both when the high vowel is in V_1 position and when it is in V_2 position. The possible sequences are in (71), (72) and (73) (74) below and the impossible sequences in (75).

(71) Sequences of high vowels

high vowels which are [+ATR] co-occur with each other and themselves in all positions of a word.

V_1	V_2
[+high]	[+high]
[+ATR]	[+ATR]
i, u	i,u

i-initial /i-final	Gloss
iti	'end'
miri	(miri people)
tiri	'woman'
riti	'convention'

i-initial /u-final	Gloss
ritu	'season'
ripu	'darning'
bihu	'Bihu' (name of an Assamese festival)

u-initial/u-final	Gloss
buku	'chest'
uzu	'easy'

guru	'religious leader'
uru	'thigh'

(72) Sequences of [+ATR +high] vowels with mid vowels.
The [-ATR] mid vowels /ɛ/ and /ɔ/ occur to the right of the [+high, +ATR] vowels, whereas [+ATR] mid vowels occur to their left[16]

(73)

(a) V_1	V_2	(b) V_1	V_2
[+ATR]	[-ATR]	[+ATR]	[+ATR]
[+high]	[-high,-low]	[-high,-low]	[+high]
i,u	ɛ, ɔ	e,o	i u

	i-initial	Gloss	i-final
ɛ	digɛn	(proper name)	not attested

	i-initial	Gloss	i-final
ɔ	igɔl	'eagle'	not attested
	xitɔl	'cool'	
	ixɔt	'little'	
	pitɔl	'copper'	

[16] The number of /i…ɔ/ words outnumber the /i…ɛ/ ones. Underived /i…ɛ/ words are only proper names, but I consider the non-occurrence of this vowel sequence elsewhere an accidental rather than a systematic gap.

	i-initial	i-final	Gloss
e	not attested	mezi	‘bonfire’
		beli	‘sun’
		zet^hi	‘lizard’
		k^heti	‘farming’

	i-initial	i-final	Gloss
o	not attested	g^hori	‘watch’
		soki	‘chair’
		olik	‘baseless’
		bohi	‘exercise book’

	u-initial	u-final	Gloss
e	not attested	renu	‘pollen’
		d^henu	‘bow’
		pelu	‘worm’
		kesu	‘earthworm’

	u-initial	u-final	Gloss
o	not attested	soku	‘eye’
		potu	‘clever’
		bod^hu	‘wife’
		xoru	‘small’

(74) Sequences of high vowels /i/ and /u/ in combination with /ɑ/

Even though the low vowel /ɑ/ is [-ATR], it co-occurs with the [+high +ATR] vowels /i/ and /u/

(a)	V_1	V_2	(b)	V_1	V_2
	[+ATR]	[-ATR]		[-ATR]	[+ATR]
	[+high]	[+low,-high]		[+low-high,]	[+high]
	i,u	ɑ		ɑ	i,u

	i-initial	Gloss	i-final	Gloss
ɑ	itɑ	'brick'	bɑti	'bowl'
	hirɑ	'diamond'	lɑt^{h}i	'stick'
	pirɑ	'sitting mat'	kɑli	'yesterday'
	xitɑ	(proper name)	ɑli	'road'
	u-initial		u-final[17]	
ɑ	muk^{h}ɑ	'mask'	zɑru	'broom'
	ug^{h}ɑ	'to wind thread'	ɑp^{h}u	'poppy plant'
	xutɑ	'thread'	ɑŋur	'grape'
	k^{h}utɑ	'pole'	ɑtur	'thirsty'

(75) Impossible sequences of [+high, +ATR] vowels with mid vowels

(a)	*V_1	V_2	(b)	*V_1	V_2
	[-ATR]	[+ATR]		[+ATR]	[+ATR]
	[-high low]	[+high]		[+high]	[-high]
	ɛ,ɔ	i,u		i,u	e,o

Notice that these co-occurrence restrictions only apply in the vicinity of mid vowels. Mid vowels always appear with their [+ATR] specification before /i, u/ and therefore */ɛ…i/ sequences or */ɔ…i/ sequences are not possible. The same consideration is also applicable to */ɛ…u/ and */ɔ…u/ patterns. This leads to an asymmetric distribution of [+ATR] and [-ATR] mid vowels. While /o…i/ and /e…i/ sets are attested, the same is not true for */ɛ…i/ or */ɔ…i/ sequences.

2.3 The high vowel /ʊ/

The vowel /ʊ/ is like the other [-ATR] vowels in more than one respect. /ʊ/ combines with [-ATR] mid vowels and the low vowel /ɑ/ when it is both in V_1 and V_2 positions, in a manner replicating the combinatorial aspects of the mid vowels /ɛ/ and /ɔ/. But the vowel /ʊ/ with the feature set [-ATR +high] stands out as the only vowel which combines

[17] /u/-final words are less common than /i/ final words. /i/ is also one of the more frequently attested vowels in inflectional and derivational endings.

precisely these two feature values. The examples in (76) show the distribution of /ʊ/ and its implication for the inventory.

(76) /ʊ/ occurs in both positions of a disyllabic syllable

Initial	Gloss	Final	Gloss
ʊpɔr	'above'	mʊkʊt	'snake skin'

Though /ʊ/ has no positional restriction, it is subject to certain co-occurrence restrictions. The sequences in (77) (78) (79) (80) (81) show the combinatory possibilities of /ʊ/. The vowels with which /ʊ/ can combine are the mid vowels /ɛ/ and /ɔ/, the low vowel /ɑ/ and itself. However, /ʊ/ has certain restrictions in occurring with high vowels, as the examples below will show.

(77) Possible sequences of /ʊ/

V_1	V_2
[-ATR]	[-ATR]
[+high, -low]	[+high,-low]

ʊ initial/final	Gloss
zʊrʊn	(part of marriage ceremony)
k^hʊrʊŋ	'burrow'
mʊkʊt	'snake skin'
zʊpʊt	'trip'

(78) Possible sequences of mid vowels and /ʊ/

(a)	V_1	V_2	(b)	V_1	V_2
	[-ATR]	[-ATR]		[-ATR]	[-ATR]
	[+high]	[-high, -low]		[-high, -low]	[-high -low]
	ʊ	ɛ,ɔ		ɛ, ɔ	ʊ

	ʊ initial			ɛ/ɔ initial	
ɛ	zʊgɛn	(proper name)	ʊ	kɛrʊn	'fault'
	ʊrɛ	'entire'		mɛt^hʊn	(Indian bison)
ɔ	ʊk^hɔ	'tall'		xɔpʊn	'dream'
	ʊpɔr	'above'		bɔrʊ	(Bodo people)

(79) /ʊ/ also co-occurs freely with /ɑ/

(a)	V_1	V_2	(b)	V_1	V_2
	[-ATR]	[-ATR]		[-ATR]	[-ATR]
	[+high,-low]	[+low]		[+low]	[+high,-low]
	ʊ	ɑ		ɑ	ʊ

(See examples in section 1.4)

(80) Impossible sequences of /ʊ/ and [+ATR] mid vowels

(a)	*V_1	V_2	(b)	*V_1	V_2
	[-ATR]	[+ATR]		[+ATR]	[-ATR]
	[+high]	[-high,-low]		[-high, low]	[+high, low]
	ʊ	e,o		e,o	ʊ

/ʊ/ is the only [-ATR] vowel in the inventory which does not combine with /i/ and /u/ when it is in the V_2 position. The absence of /i…ʊ/ and /u…ʊ/ sequences is best considered as an accidental gap, the evidence coming from the abundant existence of /i…ʊ/ and /u…ʊ/ sequences in the derived part of the lexicon (See section 3.3).

(81) Restricted occurrences of /ʊ/ with /i/ and /u/

(a) Systematic gap

*V_1	V_2
[-ATR]	[+ATR]
[+high]	[+high,-low]
ʊ	i,u

(b) Accidental gap

V_1	V_2
[+ATR]	[-ATR]
[+high,-low]	[+high,low]
i,u	ʊ

/ʊ/ does not combine with [+ATR] mid vowels and high vowels in both V_1 and V_2 positions. But it is shown in the examples in (81) /ʊ/'s behaviour is not exceptional when it comes to combining with other [-ATR] vowels. It can thus be concluded that there are no positional restrictions on /ʊ/. Until negative evidence to the contrary presents itself, it can be safely assumed that /ʊ/ exists in the underlying inventory of Assamese.

2.4 The mid vowels / ɛ, ɔ, e, o/

The occurrences of the mid vowels [-high, -low] with high and low vowels have been discussed in the previous sections. In this section, the focus of attention will be on to thrashing out the combinatory possibilities of sequences of mid vowels. With respect to sequences of mid vowels, the values of [±ATR] must agree. That is the sequences in (82) – (91) are possible, whereas the sequences in (84) and (85) are impossible.

(82) Possible sequences of mid vowels

Sequences of [-ATR - high] vowels co-occur with each other on either side of a word.

V_1	V_2
[-ATR]	[-ATR]
[-low, -high]	[-low,-high]
ɛ, ɔ	ɛ, ɔ

In the previous sections, the discussion of co-occurrence restrictions focussed on the high vowels. This section will deal with patterns of co-occurrence among the mid vowels /ɛ, ɔ, e, o/, with each other and themselves.

(83) As V_1 /ɛ/ and /ɔ/ occur with everything else except [e], [o]

(i) As V_1 [e] and [o] do not occur with /ɛ/ and /ɔ/

(ii) As V_2 /ɛ/ and /ɔ/ do not occur with [e] and [o]

(iii) As V_2 [e] and [o] do not occur with /ɛ/ and /ɔ/

	ɛ-initial	Gloss
ɛ	bɛlɛg	‘different’
	xɛmɛk	‘damp’
	kɛrɛp	‘worry’
	sɛtɛp	‘snap’

	ɛ-initial	Gloss		ɔ-initial	Gloss
ɔ	tɛrɔ	‘thirteen’	ɛ	tɔbɛ	‘therefore’

	bɛsɔn	‘powdered pulse’	lɔkɛt	‘locket’ (from English)
	rɛsɔn	‘provisions’	pɔxɛk	‘week’
	bɛtɔn	‘salary’	kɔlɛz	‘college’ (from English)
	ɔ-initial	Gloss		
ɔ	ɔxɔm	‘Assam’		
	gɔrɔm	‘hot’		
	bɔhɔl	‘wide’		
	bɔtɔr	‘weather’		

(84) Impossible sequences of mid vowels

(a)	$*V_1$	V_2	(b)	$*V_1$	V_2
	[-ATR]	[+ATR]		[+ATR]	[-ATR]
	[-high,-low]	[-high,-low]		[-high,-low]	[-high,-low]
	ɛ, ɔ	e,o		e,o	ɛ, ɔ

(85) Impossible sequences of mid vowels and high vowels

(a)	$*V_1$	V_2	(b)	$*V_1$	V_2
	[+ATR]	[+ATR]		[+ATR]	[+ATR]
	[+high]	[-high,-low]		[-high,-low]	[+high
	i,u	e,o		ɛ,ɔ	i,u

From the possible sequences in (82) (89) (90) and (91) and impossible sequences in (84) -(85)[18] it is clear that in a word, mid vowels combine only with vowels which have corresponding [±ATR] values. Consequently, words with alternating [±ATR] specifications of mid vowels are prohibited in disyllables. In this domain, co-occurrences of similar [±ATR] values can be seen clearly, as there is no room for harmony to be blocked by intervening vocalic (or consonantal, see chapter 6) segments. We have already seen the examples of the sequences in (82) (iii) and (iv). These sequences show that mid vowels always agree to the [±ATR] specification of the vowel on the right and not vice versa. In the following paragraphs, we will discuss the

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[18] The sequences /e…e/, /e…o/, /o…e/, /o…o/ are possible *only* in the presence of a following /i/ or /u/, so they occur only in trisyllables. These sequences have been marked by (-) in the table in 2.

distribution of the mid vowels /ɛ, ɔ, e, o/ in greater detail and try to evaluate their place in the inventory.

(86) distribution of /ɛ/ in different syllabic positions

	ɛ initial	Gloss		ɛ final	Gloss
ɑ	kɛsɑ	'raw'	ɛ	bɛlɛg	'different'
	bɛkɑ	'bend'		kɔlɛz	'college'(from English)
	dɛkɑ	'youth'		pɔxɛk	'week'

(87) /ɛ/ occurs in all the positions of a word, [e] does not occur in final positions (cf (73))[19].

	e-initial	Gloss	final
i	zet^hi	'lizard'	not attested
	beli	'sun'	
	k^heti	'farming'	

The vowel [e] emerges only when there is a following high vowel. Word initial and word-medial [e] is always conditioned by the presence of a following high vowel. This means that there are restrictions on the occurrence of /ɛ/ when there is a following high vowel. In (86) and (87) above, [e] does not occur without a succeeding high vowel. Lexical items such as these assist in arriving at a finer conclusion concerning our earlier conjecture that [e] occurs only in a context preceding a high vowel.

(88) [+ATR] harmony in bisyllabic words (cf. (73))

Word	Gloss
beli	'sun'
pelu	'worm'
soku	'eye'
potu	'clever'

There is a phonotactic restriction against the occurrence of [e] and [o] in successive syllables (without a following high vowel). On the other hand, there is no such restriction in a sequence of /ɛ/ and /ɔ/.

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[19] Examples here and elsewhere are repeated from the examples in the collocational restrictions.

(89) Possible sequences of mid vowels and low vowels

	(a) V₁	V₂	(b) V₁	V₂
	[-ATR]	[-ATR]	[-ATR]	[-ATR]
	[-low, high]	[+low]	[+low]	[-high,-low]
	ɛ, ɔ	ɑ	ɑ	ɛ, ɔ

(see examples in section 1.5)

(90) Possible sequences of mid vowels and high vowels

(a) V_1	V_2
[+ATR]	[+ATR]
[-high,low]	[+high]
e, o	i,u

(see examples in section 1.2)

(91) Possible sequences of [+ATR,+high] vowels

(a) V_1	V_2
[+ATR]	[-ATR]
[+high]	[-high]
i,u	ɛ, ɔ

(see examples in section 1.2)

(92) [-ATR] harmony in bisyllabic words (cf.(82) and (86))

Word	Gloss
gɔrɔm	'hot'
bɛlɛg	'different'
pɔxɛk	'week'
bɛsɔn	'powdered pulse'

The illustrations in (88) and (92) show that the deciding factor behind the occurrence of [e] is the presence of a succeeding high vowel.

(93) Generalisations regarding [e]

(i) [e] is realised when there is a following [+high, +ATR] vowel.

(ii) /ɛ/ does not occur if there are following [+high, +ATR] vowels.

These facts show that the stem phonology of Assamese is unlikely to have an underlying [e]. In (94) (95)and 0 below are a few examples of how /ɔ/ and [o] are distributed in the inventory. Their position in a word with two syllables have been divided into syllable initial and syllable final positions.

(94) The distribution of /ɔ/

ɔ- initial	Gloss	ɔ - final	Gloss
kɔpɑl	'forehead'	pitɔl	'copper'
bɔtɑh	'wind'	rɛsɔn	'provisions'
pɔxɛk	'week'	pɑtɔl	'light'

(95) Initial and final (cf. (82))

xɔrɔl	'simple-minded'
tɔpɔt	'hot'

(96) The distribution of [o] (cf. (73))

Initial	Gloss	Final
$ok^{h}il$	'world'	not attested
soki	'chair'	
bohi	'exercise book'	
sohi	'signature'	

The relation between [o] and /ɔ/ in Assamese is not very different from what we have already seen in [e] and /ɛ/. The non-initial occurrence of [o] is strictly prohibited. In the non-final position, the occurrence of [o] is preconditioned by the presence of a succeeding high vowel. Distributionally, /ɔ/ has fewer restrictions than [o]. The following lexical items show that in a polysyllabic environment [o] needs the presence of a following [+ATR +high] vowel.

(97) [o] always needs a following [+ATR +high] vowel in polysyllabic words

Word	Gloss
porohi	‘day before yesterday’
bogoli	‘crane’
ponoru	‘onion’

The complementary distribution of /ɔ/ ~ [o] is similar to that of /ɛ/ ~ [e]. The difference in [±ATR] specifications between /ɛ/ ~ [e] and /ɔ/ ~ [o] leads to their complementary distribution. The presence of co-occurrence restrictions in the underived lexicon of Assamese and the distribution of /ɛ/ ~ [e] and /ɔ/ ~ [o] is directly related to this observation. From this section it is clear that [e] and [o] emerge only when /i/ and /u/ occur in succeeding syllables. In the presence of /i/ and /u/, /ɛ/ and /ɔ/ occur only in the following syllables. Though /ɛ/ and /ɔ/ co-occur with each other in both V_1 and V_2 positions, they never co-occur with [e] and [o].

2.5 The low vowel /ɑ/

/ɑ/ has the feature value [-ATR] and so it is able to combine with the other [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/. /ɑ/ is never subject to harmony restrictions, so it co-occurs with /i/ and /u/ as well.

(98) (i) As V_1 /ɑ/ does not regularly occur with [o] and [e]
(ii) As V_2 /ɑ/ does not regularly occur with [o] and [e]
(iii) /ɑ/ does occur with [o] and [e] in some loan words and historical remnants.

(99) (a)

	V_1	V_2
	[-ATR]	[+ATR]
	[+low]	[+high]

(b)

	V_1	V_2
	[+ATR]	[-ATR]
	[+high]	[+low]

	ɑ -initial	Gloss		i-initial	Gloss
i	ɑli	'sand'	ɑ	itɑ	'brick'
	ɑzi	'today'		zikɑ	'courgette'
	sɑri	'four'		titɑ	'bitter'
	gɑli	'scold'		biyɑ	'marriage'

	ɑ-initial	Gloss		u-initial	Gloss
u	ɑlu	'potato'	ɑ	k^hutɑ	'pole'
	ɑtur	'distressed'		ukɑ	'bare'
	tɑlu	'palate'		tulɑ	'silk cotton'
	xɑmuk	'snail'		mulɑ	'radish'

(100) (a)

V_1	V_2
[-ATR]	[-ATR]
[+low]	[+high, -low]
ɑ	ʊ

(b)

V_1	V_2
[-ATR]	[-ATR]
[+high, -low]	[+low]
ʊ	ɑ

(101) Possible sequences

	ɑ-initial		ʊ initial	
ɑ	ɑpʊn	'dear'	zʊtɑ	'shoe'
	ɑmʊl	'regime'	kʊlɑ	'lap'
	ɑmʊd	'joy'	bʊkɑ	'mud'
	ɑhʊm	'Ahom'	ʊzɑ	'exorcist'

(102) (a) V_1 V_2 (b) V_1 V_2

	(a)		(b)	
	V_1 V_2		V_1 V_2	
	[-ATR][-ATR]		[-ATR] [-ATR]	
	[+low][-low,-high]		[+low][-low,-high]	
	ɑ ɛ, ɔ		ɛ,ɔ ɑ	
ɛ pɑt^{h}ɛk	‘officer’	ɛlɑh	‘laziness’	
xɑrɛŋ	‘bird’	ɛŋɑ	‘reluctance’	
pɑlɛŋ	‘spinach’	tɛmɑ	‘container’	
p^{h}ɑtɛk	‘jail’	zɛgɑ	‘place’	
ɔ ɑsɔl	‘real’	zɔlɑ	‘hot’	
xɑgɔr	‘sea’	mɔtɑ	‘male’	
ɑtɔr	‘perfume’	bɔtɑh	‘wind’	
ɑk^{h}ɔr	‘letters’	bɔgɑ	‘white’	

(103) (a) V_1 V_2

[-ATR] [-ATR]

[+low] [+low]

ɑ ɑ

	ɑ-initial	Gloss
ɑ	ɑdɑ	‘ginger’
	ɑxɑ	‘hope’
	ɑtɑ	‘grandfather’
	dɑdɑ	‘brother’

We can conclusively say that /ɑ/ never changes its featural configuration under influence of any vowel, and there is no doubt that /ɑ/ exists in the underlying inventory.

2.6 Trisyllables/Quadrisyllables

Monomorphemic trisyllables and quadrisyllables are less common in Assamese, but longer syllables are more abundant in derived environments. They also fit into the general pattern that has been observed for disyllables. In other words, [±ATR] agreement takes place robustly in these sequences as well. Even so, longer sequences of syllables mean that many potentially different vowel features can interact and therefore words show far more varied co-occurrences. As mentioned in Section 2.1, [e]…[e] and [o]…[o] sequences[20] occur only in tri/quadrisyllables in the presence of a final high vowel. Examples are given below:

(104) occurrences of [e] and [o]

Trisyllables	Gloss
e-initial	
tekeli	'small earthen jar'
leteku	'berry'
keŋeru	'kangaroo'
zelepi	'sweet'
keseru	'tree'
bogoli	'crane'
teteli	'tamarind'
o-initial	
kotoki	'royal messenger'
korobi	'oleander'
porohi	'day before yesterday'
opheli	(proper name)

2.7 Directionality

So far it has been shown how vowels agree to the [ATR] specification of neighbouring vowels. However, to actually verify the direction from which agreement is triggered, longer words with medial /i/ and /u/ are good test words, precisely because /i/ and /u/ will trigger agreement in one or both ways. If harmony is regressive then vowels on the left side will agree with the following vowel and vice versa if harmony is progressive.

[20] It should not escape our notice that /o..e..i/, /e..o..u/ /o..o..u/ and /o..e..u/ sequences are missing here. Monomorphemic trisyllables and quadrisyllables are less common than disyllabic ones and for that reason all sequences are not found in longer words.

(105) trisyllables/ quadrisyllables with a medial /i/ or /u/

ob^{h}inɔb	'new, extraordinary'
orihɔnɑ	'contribution'
xoriyɔh	'mustard'
kolikɔtɑ	'Calcutta'

Note that in these examples, while the vowel on the left agrees with the [+ATR] feature, the vowel on the right does not. This clearly shows that vowel harmony in Assamese is a strictly leftward process. Though affixation is not an issue here, it is clear from examples like /orihɔnɑ/ above that a vowel between a potentially triggering segment /i/ and an opaque segment always agrees with the latter and not with the former.

(106) trisyllables/ quadrisyllables with a medial /ɑ/

kʊlɑhɔl	'commotion'
xɔdɑgɔr	'merchant'

Notice that there are no words with [+ATR] mid vowels on either side of /ɑ/. This shows that whenever there is agreement with the feature [-ATR], there is normally no /i/ and /u/ to the right of the [-ATR] vowels /ɛ/, /ɔ/ and /ʊ/. This directional aspect of Assamese vowel harmony will be analysed theoretically in the next chapter (chapter 5).

2.7.1 /ɑ/ with other vowels in trisyllables

It is also worth investigating whether /ɑ/ has any influence on [±ATR] harmony in trisyllables. The examples in ((107) show that /ɑ/ is the only oral vowel which can be preceded by a [-ATR] vowel and followed by a [+ATR] vowel. Some instances of 'blocking' [+ATR] spread is given below:

(107) Words with intervening /ɑ/

bɔrɑli	(type of fish)
bʊwɑri	'daughter-in-law'
bɛmɛzɑli	'disarray'
gʊhɑri	'notice'
gɔrɑki	'owner'
d^hɛmɑli	'merry-making'

The words in (107) above show that the presence of /ɑ/ word medially prevents the right peripheral [+ATR] vowel's value from agreeing with the [-ATR] value of the initial vowel, i.e., words with the vowel sequences /o..ɑ..i/, /e..ɑ..i/, /o..ɑ..u/ and /e..ɑ..u/ are not attested. Theoretical aspects of phonological blocking of harmony will be extensively discussed in chapter 6.

2.8 Conclusion

In the preceding section, it has been shown that Assamese imposes severe restrictions on the occurrence of the features [+ATR] and [-ATR] in an underived word. To sum up, the underlying vowel inventory of Assamese consists of six vowels, /i/, /u/, /ɛ/, /ɔ/, /ʊ/ and /ɑ/ in its stem phonology. Where /i/, /u/ and /ɑ/ never alternate, /ɛ/ and /ɔ/ alternate with [e] and [o], respectively, when followed by /i/ and /u/. The true status of /ʊ/ in the inventory is not so obvious in simplex morphological forms, though we can assume that /ʊ/ exists in the underlying inventory as one of the [-ATR] vowels. /ɑ/ is not subject to alternation and appears unaltered even in the presence of succeeding [+ATR] vowels /i/ and /u/.

In Assamese, all vowels in a word may be either [-ATR], but also [+ATR], depending on the presence of a following [+high, +ATR] vowel which triggers the preceding [-ATR] mid vowels to agree to its [+ATR] value. Apart from these descriptive facts, there are also other distributional restrictions on Assamese vowels (presumably not directly related to vowel harmony). The vowels /i/ and /ɛ/ were never found to combine in bisyllabic words. This accidental gap is not found in the underived inventory, this can probably be made sense of in terms of an [ATR] mismatch of the two vowels. Similarly, there was also an accidental gap in the vowels /u/ and /ʊ/. There are also other systematic phonological patterns of disharmony in the presence of the vowel /ɑ/ and in closed syllables, which will be discussed in the chapter on blocking (chapter 6).

The feature set which triggers a change is [+ATR +high] - /i/ and /u/. Direction of change is not evident in words where there is agreement in terms of the feature [-ATR]. But as already pointed out, it is only a following [+high +ATR] vowel, which can trigger a change in the preceding vowels. Actual ‘changes’ in [±ATR] specifications are visible in derived words only; the presence of featural agreement in underived words, on the other hand, can be only inferred from vowels existing in agreement with the [±ATR] specification of their neighbouring vowels. Hence the division so far in terms of ‘co-occurrence restrictions’. Final descriptive generalisations on combinatorial restrictions of Assamese vowels:

(108) Agreement in terms of the feature [±ATR]

(i) In the presence of following [+ATR +high] vowels mid vowels appear with their [+ATR] specifications.

(ii) In the presence of a [-Atr] vowel, the mid vowels appear with their [-Atr] specifications.

Whether the nature of restriction is exactly the same in complex morphological domains will be examined in the next section. At this point we can neither determine whether [ATR] ‘spread’ is a strictly leftward process and the feature [ATR] is a property of the morpheme at the left side of the word; but we will find out only from the derived morphology that a following vowel consistently imposes changes on the preceding [-ATR] vowels.

3 Agreement in the derived morphology

The goal of this section is to show how suffixes induce vowel harmony in Assamese by triggering a change in the [-ATR] specification of the vowels of the preceding syllables. Section 3 deals with collocational restrictions in derived words in a manner similar to the structure of section 2 on underived words.

3.1 Collocational restrictions in derived words

In section 2.1, I have shown that Assamese has eight surface oral vowels /ɑ, ɛ, ɔ, e, o, ʊ, i, u/, of which the vowels /ɑ, ɛ, ɔ, ʊ, i, u/ are underlying, whereas the vowels /e, o/ are not.

(109) Proposed generalisations of this chapter:

(i) All stems with the vowels /e/ and /o/ are a result of /ɛ/ ~ /e/ and /ɔ/ ~ /o/ alternation.

(ii) [+ATR, +high] vowels (i.e., /i/ and /u/) trigger changes in preceding [-ATR] vowels (i.e., /ɛ, ɔ, ʊ/ are realised as /e, o, u/ in this environment).

In this section, I will classify the harmonic behaviour of vowels in derived words according to the height of the vowels, i.e. first I discuss high vowels, then the mid vowels and finally the low vowel. The previous chapter, showed that bisyllabic words in underived environments clearly demonstrate that certain collocational restrictions are possible and others are not. In this section, I will deal with bisyllabic words in derived environments in the first section of this chapter in order to assess the possibility of similar combinations of vowels.

3.2 high vowels /i/ and /u/

The high vowels /i/ and /u/ are specified as [+ATR]. Similar to the words discussed in the underived section, it is impossible in a derived environment to have a [+ATR] mid vowel to the right of the high vowels /i/ and /u/ and a [-ATR] mid vowel to the left. Below in (110), are cases in which the stem has a high vowel in the left column and cases in which the suffix has a high vowel in the right column.

(110) Cases in which both the root/stem and the suffix contain a high vowel.

V_1	V_2
[+high]	[+high]
[+ATR]	[+ATR]
i,u	i,u

i-	Gloss	i-initial	Gloss
ziki	win(inf)	xitu	another one (tu- cl)
xiki	learn(inf)	zitu	that one (tu- classifier)
piti	beat(inf)	trixul	Shiva's spear(tri –three, xul- spear)
siɲi	tear(inf)	bipul	abundance
i/u		u-initial	Gloss
i-final		/u/-final	
puti	dump(inf)	guput	secret(from gʊpɔn-secretive')
tuli	lift(inf)	bukut	'on chest'
puri	burn(inf)	zugut	joined(from zʊg)
ruki	scrape(inf)	xuzug	opportunity(xu-good zug-

Combinations of high vowels in the stem and [-ATR] suffixal vowels occur, whereas combinations of /i/ and /u/ stem vowels followed by mid [+ATR] vowels do not. Also note that a high vowel in the suffix means that the mid stem vowel appears with a [+ATR] specification.

(111) Cases in which mid vowels combine with a high vowel.

(a) V_1	V_2	(b)	V_1	V_2
[+ATR]	[-ATR]		[+ATR]	[+ATR]
[+high]	[-high,-low]		[-high,-low]	[+high]
i,u	ɛ, ɔ		e,o	i,u

ɛ	pitɛ	ıon &3P)	not attested
	kinɛ	buy (2P hon & 3P)	
	zikɛ	win(2P hon &3P)	
	xikɛ	learn(2P hon &3P)	

[21] Loc stands for Locative case

	i-initial	Gloss	
ɔ	pitɔ	beat(2P fam)	not attested
	kinɔ	buy(2P fam)	
	zikɔ	win(2P fam)	
	xikɔ	learn(2P fam)	

	i-initial	Gloss	
ʊ	pitʊ	beat(1P)	not attested
	kinʊ	buy(1P)	
	zikʊ	win(1P)	
	xikʊ	learn(1P)	

	u-initial		Gloss
ɛ	utɛ	not attested	flow(2Phon &3P)
	xunɛ		hear(2P hon &3P)
	xuŋɛ		smell(2P hon &3P)
	buzɛ	understand(2P hon &3P)	

	u-initial		
ɔ	utɔ	flow(2P fam)	not attested
	xunɔ	hear(2P fam)	
	xuŋɔ	smell(2P fam)	
	buzɔ	understand(2P fam)	

	u-initial		
ʊ	not attested	xuŋʊ	smell(1P)
		sulʊ	touch(1P)
		xunʊ	listen(1P)
		buzʊ	understand(1P)

	i-initial	i-final	Gloss
e	not attested	keri	squinted(fem)

		eri	leave(inf)
		meli	spread(inf)
		seki	strain(v)inf)
	i-initial	i-final	
o	not attested	pori	fall(inf)
		kori	do(inf)
		gozi	grow(inf)
		poki	ripe(inf)
e	not attested	petu	pot-bellied
o	not attested	otul	incomparable
		protul	sufficient
		prosur	abundance

(112) Cases in which either the root/stem and the suffix contain /ɑ/.

(a)	V_1	V_2	(b)	V_1	V_2
	[+ATR]	[-ATR]		[-ATR]	[+ATR]
	[+high]	[+low, -high]		[+low -high]	[+high]
	i,u	ɑ		ɑ	i,u

i-initial	Gloss	i-final	Gloss
xikɑ	'teach' (2P fam)[22]	ɑki	'draw' (inf)
zikɑ	'win' (2P fam)	t^hɑki	'stay' (inf)
pitɑ	'beat' (2P fam)	pɑti	'place' (inf)
silɑ	'stitch' (2P fam)	xɑzi	'build' (inf)

u-initial	Gloss	u-final	Gloss
utɑ	'flow' (2P fam)	xɑzu	'prepare' (from xaz)
uzɑ	'go upstream' (2P fam)	zɑluk	'pepper' (from zal)
urɑ	'fly' (2P fam)	sɑlu	'wicked' (from sal)
p^hurɑ	'travel' (2P fam)	g^hɑtuk	'assassin' (from g^hat)

[22] Fam is familiar, ord is ordinary and hon is honorific. Inf indicates infinitive.

(113) Thus the following sequences are impossible:

(a) *V_1 V_2
[-ATR] [+ATR]
[-high, low] [+high]
ɛ,ɔ i,u

(b) *V_1 V_2
[+ATR] [+ATR]
[+high] [+high]
i,u e,o

The combinatorial behaviour of high vowels shows that the distributional restrictions apply only with respect to mid-vowels. Notice that there is a systematic gap in the occurrence of */ɛ…i/, */ɛ…u/, */ɔ…i/ */ɔ…u/ */ʊ…i/ and */ʊ…u/ sequences. Recollecting the restrictions on high vowels in underived words, the following generalisations hold in Assamese:

(114) Generalisations regarding high vowels

(i) As V_1 /i/ and /u/ occur with everything else except the [-high, -low, +ATR] vowels /e/ and /o/.

(ii) As V_2 /i/ and /u/ occur with everything except for the [-high,-low, -ATR] vowels /ɛ/, / ɔ/ and the [+high,-ATR] vowel /ʊ/.

3.3 The vowel /ʊ/

In this section, I show that the [+high, -ATR] vowel /ʊ/ patterns with the [-ATR] mid vowels /ɛ/ and /ɔ/ in that /ʊ/ combines with both the [-ATR] mid vowels and with itself, but does not combine with the [+ATR] vowels /e/ and /o/. /ʊ/ also does not occur with /i/ and /u/ in the V_1 position. Recall that in the previous chapter there was an accidental gap in the occurrence of / u …ʊ / sequences in the underived inventory. This gap does not exist in the derived part of the lexicon. The examples in (115) and (116) below show that /ʊ/ co-occurs with vowels bearing [-ATR] specifications.

(115) Possible sequences of the vowel /ʊ/

V₁	V₂
[-ATR]	[-ATR]
[+high,-low]	[+high,-low]
ʊ	ʊ

bʊlʊ	say (1P)
k^hʊlʊ	open (1P)
tʊlʊ	lift (1P)
k^hʊsʊ	poke(1P)

(116) Possible sequences of medial vowels and /ʊ/

(a) V₁	V₂	(b) V₁	V₂
[-ATR]	[-ATR]	[-ATR]	[-ATR]
[+high]	[-high,-low]	[-high,-low]	[-high, -low]
ʊ	ɛ,ɔ	ɛ,ɔ	ʊ
pʊrɛ	fall (2Phon & 3P)	k^hɛlʊ	play(1P)
xʊwɛ	sleep(2P hon & 3P)	mɛlʊ	spread(1P)
k^hʊlɛ	open(2P hon & 3P)	sɛkʊ	strain(1P)
zʊrɛ	force(Erg)[23]	bɛsʊ	sell(1P)
pʊrɔ	burn (2P fam)	mɔrʊ	die(1P)
xʊwɔ	sleep (2P fam)	kɔrʊ	do(1P)
k^hʊlɔ	open (2P fam)	bɔhʊ	sit(1P)
sʊwɔ	touch (2P fam)	pɔrʊ	fall(1P)

The sequence in (117) shows that /i/ and /u/ can combine with /ʊ/ only when they precede /ʊ/ and the reverse of this sequence is not attested.

[23] Erg indicates ergativity.

(117) Possible sequence of high vowels and /ʊ/

V_1	V_2
[+ATR]	[-ATR]
[+high]	[-high, -low]
i,u	ʊ

	i-initial	Gloss	i-final
ʊ	pitʊ	beat(1P)	not attested
	kinʊ	buy(1P)	
	zikʊ	win(1P)	
	xikʊ	learn(1P)	

	u-initial	Gloss	u-final
ʊ	xuŋʊ	smell(1P)	not attested
	sulʊ	touch(1P)	
	xunʊ	listen(1P)	
	buzʊ	understand(1P)	

Now note that in (118) (i), the [+ATR] mid vowels do not occur in either side of the /ʊ/. (118) (ii) shows the high vowels /i/ and /u/ do not occur to the right of /ʊ/ in a stem suffix sequence.

(118) Impossible sequences with the vowel /ʊ/

(a)	V_1	V_2	(b)	V_1	V_2
	[-ATR]	[+ATR]		[+ATR]	[-ATR]
	[+high]	[-high,-low]		[-high,low]	[+high,low]
	ʊ	e,o		e,o	ʊ

(a)	V_1	V_2
	[-ATR]	[+ATR]
	[+high]	[+high,-low]
	ʊ	i,u

These patterns show that /ʊ/ never combines with [+ATR] mid vowels in either V_1 or V_2 positions and with high vowels when it is V_1. /ʊ/ behaves predictably when it comes to combining with other [-ATR] vowels, in that it occurs in both V_1 and V_2 positions in the presence of other [-ATR] vowels. The generalisations of /ʊ/ can be summarised as follows:

(119) Generalisations regarding the vowel /ʊ/
(i) /ʊ/ combines with /ɛ/ /ɔ/ and itself in both V_1 and V_2 positions
(ii) /ʊ/ does not combine with /e/ and /o/ in either V_1 or V_2 position.
(iii) /ʊ/ occurs with /i/ and /u/ only when it is in the V_2 position.

3.4 The mid vowels /ɛ/ /ɔ/ /e/ and /o/

This section only deals with the vowels /ɛ/ /ɔ/ /e/ and /o/ or, in other words, with the mid vowels which have contrasting specifications for the feature [ATR]. In the previous section, I already dealt with the occurrences of the high vowels with other vowels. In this section, I will discuss only the possibilities of mid vowels co-occurring with other mid vowels. The examples below illustrate that the mid vowels which are specified for [-ATR] can co-occur with each other.

(120) Possible sequences of medial vowels

V_1	V_2
[-ATR]	[-ATR]
[-low, -high]	[-low, -high]
ɛ,ɔ	ɛ,ɔ

ɛ-initial	Gloss
lɛk^{h}ɛ	'write' (2P&3P hon)
ɛrɛ	'leave' (2P&3P hon)
thɛlɛ	'push' (2P&3P hon)
mɛlɛ	'spread' (2P&3P hon)

ɛ-initial	Gloss	ɔ-/ɛ-	Gloss
ɛrɔ	'leave' (2P fam)	pɔrɛ	'fall' (2P&3P hon)
k^{h}ɛlɔ	'play' (2P fam)	mɔrɛ	'die' (2P&3P hon)
sɛpɔ	'squeeze' (2P fam)	d^{h}ɔrɛ	'hold' (2P&3P hon)
xɛkɔ	'heat' (2P fam)	xɔrɛ	'drop' (2P&3P hon)

ɔ-initial	Gloss
kɔrɔ	'do' (2P fam)
mɔrɔ	'die' (2P fam)
d^{h}ɔrɔ	'catch' (2P fam)
pɔrɔ	'fall' (2P fam)

Now note that combinations of mid vowels that do not agree in their [ATR] specifications cannot combine in a stem-suffix sequence:

(121) Impossible sequences of medial vowels

	(a) V_1	V_2	(b) V_1	V_2
	[-ATR]	[+ATR]	[+ATR]	[-ATR]
	[-high,-low]	[-high,-low]	[-high,-low]	[-high,-low]
	ɛ, ɔ	e,o	e,o	ɛ, ɔ

(122) Possible sequences of mid-vowels

V_1	V_2
[-ATR]	[-ATR]
[-high,-low]	[-high,-low]
ɛ, ɔ	ɛ, ɔ

(123) Possible sequences of mid vowels and high vowels

(a)		(b)	
V_1	V_2	V_1	V_2
[+ATR]	[+ATR]	[+ATR]	[+ATR]
[+high]	[-high,-low]	[-high,-low]	[+high]
i,u	e,o	ɛ,ɔ	i,u

The data convincingly shows that co-occurring mid-vowels always have to agree in their [ATR] specifications. The generalisations noticed in this section are summarised below:

(124) Generalisations

(i) As V_1 /ɛ/ and /ɔ/ occur with everything else except /e/, /o/

(ii) As V_1 /e/ and /o/ do not occur with /ɛ/ and /ɔ/

(iii) As V_2 /ɛ/ and /ɔ/ do not occur with /e/ and /o/

(iv) As V_2 /e/ and /o/ do not occur with /ɛ/ and /ɔ/

3.5 The low vowel /ɑ/

The low vowel /ɑ/ with the specification [-ATR] combines with the other [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/. /ɑ/ is never subject to harmony restrictions and therefore it co-occurs with /i/ and /u/ as well. There are no accidental occurrences of /ɑ/ with the vowels /e/ and /o/. From the examples of possible sequences in (125), it is evident that /ɑ/ combines with all the [-ATR] vowels in both V_1 and V_2 positions.

(125) Possible sequences of the vowel /ɑ/

V_1	V_2
[-ATR]	[-ATR]
[+low]	[+low]
ɑ	ɑ

ɑ-initial/ ɑ-final

k^hɑlɑ	‘eat’ (2P ord)
pɑlɑ	‘get’ (2P ord)
ɑsɑ	‘stay’ (2P ord)
sɑlɑ	‘see’ (2P ord)

(126) Possible sequences of the vowel /ɑ/ and medial vowels

(a)	V_1	V_2	(b)	V_1	V_2
	[-ATR]	[-ATR]		[-ATR]	[-ATR]
	[+low]	[-low +high]		[-low -high]	[+low]
	ɛ, ɔ	ɑ		ɑ	ɛ,ɔ

	ɛ-initial	Gloss		ɑ-initial	Gloss
ɑ	dɛkʰɑ	'see' (perf. conj.)	ɛ	pɑlɛ	'get' (2p hon & 3P)
	tɛpɑ	'squeeze' (perf. conj)		dʰɑlɛ	'pour' (2p hon & 3P)
	tʰɛlɑ	'push' (perf.conj)		gɑlɛ	'sing' (2p hon & 3P)
	ɛzɑk	'lot'		sɑlɛ	'see' (2p hon & 3P)

	ɔ-initial	Gloss		ɔ-final	Gloss
ɑ	pɔlɑ	'flee' (imp)	ɔ	ɑsɔ	'be' (2P fam)
	mɔrɑ	'dead' (vn[24])		pɑsɔt	'later' (loc)
	kɔrɑ	'do' (vn)		pɑrɔ	'can' (2P fam)
	pɔsɑ	'rot' (perf conj)		pɑrɔt	'side' (loc)

(127) /ɑ/ also freely occurs with /ʊ/

(a)	V_1	V_2	(b)	V_1	V_2
	[-ATR]	[-ATR]		[-ATR]	[-ATR]
	[+low]	[+high, -low]		[+high, -low]	[+low]
	ɑ	ʊ		ʊ	ɑ

ʊ-initial	Gloss	a-initial	Gloss
kʰʊlɑ	'open' (perf conj)	pɑlʊ	'got' (1P)
gʊlɑ	'mix' (perf conj)	kʰɑlʊ	'eat' (1P)
zʊnɑk	'moonlit'	ɑkʊ	'draw' (1P)
gʊzɑ	'plant' (perf conj)	sɑlʊ	'see' (1P)

Though /ɑ/ occurs with [+ATR +high] vowels (i.e. /i/ and /u/) in both V_1 and V_2 positions (already shown in (112), it does not occur with the [+ATR -high -low] vowels (i.e. /e/ and /o/).

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[24] VN indicates a verbal noun

(128) Impossible sequences of /ɑ/ and mid vowels

	(a) V_1	V_2		(b) V_1	V_2
	[-ATR]	[+ATR]		[-ATR]	[+ATR]
	[+low]	[-low, +high]		[-low, -high]	[+low]
	ɑ	e, o		e,o	ɑ

Finally, we can draw the following conclusions about /ɑ/.

(129) Generalisations regarding /ɑ/

(i) /ɑ/ occurs with /i/ /u/ /ʊ/ /ɛ/ and /ɔ/

(ii) /ɑ/ does not occur with /e/ and /o/.

This section shows that vowels always agree in the [ATR] specification within a word. The next section shows some other morphological concatenation processes.

4 Morphological concatenation processes in the non-verbal morphology

In this section we will see how morphological concatenation induces iterative vowel harmony in Assamese. In the previous section we had shown, that generally speaking, various co-occurrence restrictions in the derived part are similar to the ones discussed in the non-derived section in 2. But vowel harmony in Assamese is also iterative and therefore this section shows harmony in longer derived sequences. This section also shows that the morphological category of a prefix does not stop harmony from spreading to it. Furthermore, I also present data regarding some verbal monosyllables which instantiate a deviant harmony pattern. Though there are various ways of adjective and noun formation, the aim of this chapter is not to go into the details of the word formation processes, but rather to show how the addition of certain affixes trigger iterative changes in the preceding stem. In morphologically complex words, the [+high, +ATR] vowel at the right hand side of the word trigger vowel harmony. It will be shown that feminine, nominal and adjectival suffixes trigger iterative vowel harmony because of their [+ATR] specification. A small section discusses the participation of prefixes in vowel harmony. The next two sub-sections are on verbs and their inflections and the section ends with a conclusion. In the following sections I show the various suffixes which result in the alteration of the featural specification of the preceding stem vowels.

4.1 Affixes which result in vowel harmony

Vowels harmonise as a result of suffixation of /-i/, /-ikɑ/ which indicate gender. Feminine forms are mostly derived from masculine forms by adding a suffix.

(130) /i/ suffixation

	Root	Gloss	Suffix	Derivation	Gloss
(a)	p^hɛdɛlɑ	'ugly' (masc)	i	p^hedeli	'ugly' (fem)
(b)	gɛrɛlɑ	'fat' (masc)	i	gereli	'fat' (fem)
(c)	pɑgɔl	'mad' (masc)	i	pɑgoli	'mad' (fem)
(d)	k^hɛtɔr	'evil spirit'(masc)	i	k^hetori	'evil spirit' (fem)

(131) /ikɑ/ suffixation

(a)	premik	'lover' (masc)	ikɑ	premikɑ	'lover' (fem)
(b)	g^hʊxɔk	'announcer'(masc)	ikɑ	g^huxikɑ	'announcer' (fem)

(132) /-ti/, /-oti/ form adjectives and nouns in varied senses and they also result in vowel harmony.

	Root	Gloss	Suffix	Derivation	Gloss
(a)	bɔx	'settle'	oti	boxoti	'settlement'
(b)	mɔr	'die'	oti	moroti	'cursed to die'
(c)	p^hɔl	'result'	woti	p^holowoti	'bearing fruit'

(133) /-otiya/ is also an adjective forming affix and it is an extension of the previous /-oti/

	Root	Gloss	Suffix	Derivation	Gloss
(a)	xɛh	'last'	otiyɑ	xehotiyɑ	'recent'
(b)	tɔl	'below'	otiyɑ	tolotiyɑ	'subordinate'
(c)	kɔrɔt	'saw'	otiyɑ	korotiyɑ	'sawyer'
(d)	pɔk	'ripe'	otiyɑ	pokotiyɑ	'ripened'

(134) /-ori/ /-oriya/ affix forming nouns and adjectives

	Root	Gloss	Suffix	Derivation	Gloss
(a)	lɔg	'company'	ori	logori	'companion'(fem)
(b)	lɔg	'company'	oriyɑ	logoriyɑ	'companion'(neuter)

(c)	bɔn	‘jungle’	oriyɑ	bonoriyɑ	‘of the jungle’
(d)	pɔlɑ	‘flee’	oriyɑ	poloriyɑ	‘run-away’
(e)	k^hɑ	‘eat’	oriyɑ	k^hɑworiyɑ[25]	‘glutton’
(f)	nɔgɔr	‘town’	oriyɑ	nogoriyɑ	‘urban people’

(135) /- iyɑ/ used after nouns and verbal nouns

	Root	Gloss	Suffix	Derivation	Gloss
(a)	bɔyɔx	‘age’	iyɑ	boyoxiyɑ	‘aged’
(b)	kɛwɔl	‘only’	iyɑ	kewoliyɑ	‘unmarried’
(c)	kɛtɛrɑ	‘gruff’	iyɑ	keteriyɑ	‘irritable’
(d)	d^hʊl	‘drum’	iyɑ	d^huliyɑ	‘drummer’

(136) /-i/ affix forming nouns, adjectives and diminutives

	Root	Gloss	Suffix	Derivation	Gloss
(a)	pitɔl	‘brass’	i	pitoli	‘of brass’
(b)	b^hɛkʊlɑ	‘frog’	i	b^hekuli	‘frog’ (dim)
(c)	ʊpɔr	‘above’	i	upori	‘in addition’
(d)	k^hɔrɔs	‘spend’	i	k^horosi	‘prodigal’
(e)	nɔrɔk	‘hell’	i	noroki	‘sinful’
(f)	bɔsɔr	‘year’	i	bosori	‘yearly’

(137) /-uwɑ/ -adjectival, indicating ‘connected with’, ‘related to’ /uwɑ/ also behaves as a causative suffix when added to verbs.

	Root	Gloss	Suffix	Derivation	Gloss(Derivation)
(a)	pɔlɔx	‘silt’	uwɑ	poloxuwɑ	‘fertile land’
(b)	mɔr	‘die’	uwɑ	moruwɑ	‘kill’ (causative)
(c)	kɛsɑ	‘unripe’	uwɑ	keseluwɑ	‘not fully developed’
(d)	ɛr	‘leave’	uwɑ	eruwɑ	‘leave’ (causative)
(e)	dɛkɑ	‘young’	uwɑ	dekeruwɑ	‘young’ (adv)

[25] Examples like these show that if an affixal vowel occurs between an opaque vowel and a triggering affix vowel, it always agrees with the affixal triggering vowel and not with the opaque vowel. This property is diametrically opposed to the one in stem control (Bakovic 2000) where the affixal vowel always agrees with the opaque vowel. This happens in underived words as well (see example (105)).

(138) Others like /-obi/ and /-opi/ also result in adjectives as well as induce vowel harmony

	Root	Gloss	Suffix	Derivation	Gloss
(a)	pɔd	'position'	obi	podobi	'position-holder'
(b)	mɔd	'alcohol'	opi	modopi	'acoholic'

All the suffixes from (130) to (138) show that whenever there is an /i/ or /u/ in a suffix, they consistently impose changes to the [ATR] specifications of the vowels /ɛ/ /ɔ/ and /ʊ/, in the stem/root.

Therefore, it can be summarised that the vowels /ɛ/ /ɔ/ and /ʊ/ systematically change to /e/ /o/ and /u/ (respectively), in all stem-suffix environments, in the presence of a triggering high vowel in the suffix.

I would also like to draw attention to two observations. First, the unattested patterns in Section 1, shows that that the absence of certain sequences is directly related to the operation of [±ATR] harmony. For instance, the absence of */ɛ…i/, */ɛ…u/, */ɔ…i/ */ɔ…u/ */ʊ…i/ and */ʊ…u/ sequences clearly demonstrate that /ɛ/ /ɔ/ and /ʊ/ always change to /e/ /o/ and /u/ when followed by /i/ or /u/.

Second, notice that the examples in (134)(d) and (137)(c) and (137)(d) where /ɑ/ changes to /o/. This process is called /ɑ/ adaptation and it happens when the two morphemes /-iyɑ/ and /-uwɑ/ trigger harmony on a stem which has the vowel /ɑ/. This process is discussed in detail in chapter 7.

4.2 Prefixes and vowel harmony

The class of prefixes which signify negation are /ɔ-/, /ɔnɔ-/, /nir-/, /nis-/. There are other affixes like /prɔ-/ indicating excess and abundance. In the examples below in (139), I use /ɔ-/ and /prɔ/ to show how prefixes are affected by harmony triggered by either root vowels or suffixal vowels.

(139) Vowel harmony as a result of prefixation

	Prefix	Root	Gloss	Suffix	Derivation	Gloss
(a)	ɔ	g^hɔr	'home'	i	og^hori	'homeless'
(b)	ɔ	porisɔy	'introduce'	it	oporosit	'unintroduced
(c)	ɔ	tulɔnɑ	'compare'	iyɔ	otulɔniyɔ	'incomparble'
(d)	ɔ	porixim	'limit'		oporixim	'boundless'
(e)	prɔ	kriti	'shape'		prokriti	'nature'
(f)	prɔ	goti	'movement'		progoti	'progressive'
(g)	prɔ	sur			prosur	'abundance'

The examples above show how the prefixal vowels in /ɔ-/ and /prɔ-/ change their feature value to [+ATR], in an environment where there is an /i/ or /u/ in the right of the morphological word. Notice that in example (139) a, both the vowels in the root /g^hɔr/ 'house' and the prefix /ɔ-/ change to /o/ under the influence of the [+ATR] value imposed by the vowel /i/, in the suffix.

4.3 Vowel harmony in verbs

I have already shown that verbal roots undergo harmony in the sections 3.1 – 3.5. The aim of this section is to show verbal alternations in much more detail, so as to present the preliminary data related to problems to be analysed in detail in chapter 7. Verbal roots are always monosyllabic in Assamese and they inflect for person and tense and not for number. Apart from the first, second and third persons, verbs are also indicative of the degrees of familiarity. Below I show the conventions regarding degrees of familiarity that have been used in the verbal paradigms in (141).

(140) Conventions of degrees of familiarity
Familiar (Fam) - Most familiar
Ordinary (Ord) - Ordinary (Not so familiar)
Honorific (Hon) – Honoured

Root verbs consist of the following vowels /i/, /u/, /ɑ/, /ɛ/, /ɔ/, /ʊ/. There are no roots with /e/ and /o/. The table below, shows verbal roots containing each of the five vowels mentioned above. The verbal roots taken as examples are /k^{h}ɑ/ 'eat' /kɔr/ 'do' /xuŋ/ 'smell' /xʊ/ 'sleep' /k^{h}ɛl/ 'play' /kin/ 'buy'.

(141) Verbal conjugations

Root vowel	/ɑ/	/ɔ/	/u/	/ʊ/	/ɛ/	/i/
	'eat'	kɔr	xuŋ	xʊ	k^{h}ɛl	kin
	k^{h}a	'do'	'smell'	'sleep'	'play'	'buy'
Simple						
Present1P	k^{h}ɑʊ	kɔrʊ	xuŋʊ	xʊ	k^{h}ɛlʊ	kinʊ
2P(fam)	k^{h}ɑɔ	kɔrɔ	xuŋɔ	xʊɔ	k^{h}ɛlɔ	kinɔ
2P(ord)	k^{h}wɑ̃	kɔrɑ̃	xuŋɑ̃	xʊɑ̃	k^{h}ɛlɑ̃	kinɑ̃
2P(hon)&3P	k^{h}ɑi	kɔrɛ	xuŋɛ	xʊai	k^{h}ɛlɛ	kinɛ
Imperative						
2P(fam)	k^{h}ɑ	kɔr	xuŋ	xʊ	k^{h}ɛl	kin
2P(ord)	k^{h}wɑ̃	kɔrɑ	xuŋɑ̃	xʊɑ̃	k^{h}ɛlɑ	kinɑ̃
2P(hon)	k^{h}ɑwɔk	kɔrɔk	xuŋɔk	xʊwɔk	k^{h}ɛlɔk	kinɔk
Past Perfect						
1P	k^{h}ɑlʊ	korilʊ	xuŋilʊ	xulʊ	k^{h}elilʊ	kinilʊ
2P(fam)	k^{h}ɑli	korili	xuŋili	xuli	k^{h}elili	kinili
2P(ord)	k^{h}ɑlɑ	korilɑ	xuŋilɑ	xulɑ	k^{h}elilɑ	kinilɑ
2P(hon)&3P	k^{h}ɑlɛ	korilɛ	xuŋilɛ	xulɛ	k^{h}elilɛ	kinilɛ
Future						
1P	k^{h}ɑm	korim	xuŋim	xum	k^{h}elim	kinim
2P(fam)	k^{h}ɑbi	koribi	xuŋibi	xubi	k^{h}elibi	kinibi
2P(ord)	k^{h}ɑbɑ	koribɑ	xuŋibɑ	xubɑ	k^{h}elibɑ	kinibɑ
2P(hon)&3P	k^{h}ɑbɔ	koribɔ	xuŋibɔ	xubɔ	k^{h}elibɔ	kinibɔ
Present Progressive						
1P	k^{h}ɑisʊ	korisʊ	xuŋisʊ	xuisʊ	k^{h}elisʊ	kinisʊ
2P(fam)	k^{h}ɑisɔ	korisɔ	xuŋisɔ	xuisɔ	k^{h}elisɔ	kinisɔ
2P(ord)	k^{h}ɑisɑ	korisɑ	xuŋisɑ	xuisɑ	k^{h}elisɑ	kinisɑ
2P(hon) &3P	k^{h}ɑisɛ	korisɛ	xuŋisɛ	xuisɛ	k^{h}elisɛ	kinisɛ

Past Progressive						
1P	k^hɑisilʊ	korisilʊ	xuŋisilʊ	xuisilʊ	k^helisilʊ	kinisilʊ
2P(fam)	k^hɑisili	korisili	xuŋisili	xuisili	k^helisili	kinisili
2P(ord)	k^hɑisilɑ	korisilɑ	xuŋisilɑ	xuisilɑ	k^helisilɑ	kinisilɑ
2P(hon) &3P	k^hɑisilɛ	korisilɛ	xuŋisilɛ	xuisilɛ	k^helisilɛ	kinisilɛ
Perfect Conjuctive	k^hwɑ	kɔrɑ	xuŋɑ	xʊwɑ	k^hɛlɑ	kinɑ
Conditional Conjunctive	k^hɑlɛ	kɔrɛ	xuŋɛ	xʊwɛ	k^hɛlɛ	kinilɛ
Infinitive	k^hɑi	kori	xuŋi	xui	k^heli	kini

In the paradigms above, the [+high, +ATR] vowel /i/ always trigger a change in the preceding [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/. Verbs inflect in the order of Root+ Aspect (Perfective/Progressive) + Tense + Person. The pattern of inflection of the open monosyllables /xʊ/ 'sleep' and /k^hɑ/ 'eat' deserves attention. Note that the verb /xʊ/ 'sleep' inflects for its future and past perfect forms without the presence of the harmony triggering vowel, but with the alternation that the vowel triggers. Therefore, in the past perfect and future forms of /xulʊ/ /xuli/ /xulɑ/ /xulɛ/ /xubi/ /xum/ /xubɑ/ xubɔ/, vowel /i/ must be presumed to be deleted, such that the /i/'s in the /im/, /ib/ and /il/ are no longer visible after the inflection. Consequently, these altered forms exist in the verbal morphology as a result of vowel harmony triggered by the underlying presence of /i/. In (142) below, I have fleshed out all the verbal inflections, so that their presence becomes evident.

(142) Morphological markers in verbal conjugations of Assamese

Tense Markers

Present Tense	/-ϕ/
Past Tense	/-l/, /-il/
Future Tense	/-b/, /-ib/ /-m//-im/
Aspect Markers	
Perfective	/-ɑs/

Progressive	/-is/
Perfect Conjunctive	/-ɑ/
Conditional Conjunctive	/-lɛ/
Infinitive	/-loi/

(143) The following are the person markers which vary according to the tense.

	1Person	2Person	3Person
Present Tense	ʊ		ɛ/i
Familiar		ɑ	
Ordinary		ɔ	
Honorific		ɛ	
Past Tense	ʊ		ɛ
Familiar		ɑ	
Ordinary		i	
Honorific		ɛ	
Future Tense	m/im		ɔ
Familiar		ɑ	
Ordinary		i	
Honorific		ɔ	

From the tables above we can draw certain conclusions about the structural configuration of Assamese verbal morphology. As an example, the First Person Past Progressive form of /kɔr/ can be structurally broken up in the following way:

(144) Ex: /kɔr/+/is/+/il/+/ʊ/

Root+ Aspect (Perfective/Progressive)+ Tense+ Person

The detailed survey of verbs above shows that whenever there is an alternation in the root vowels, the suffix immediately following the root contains the [+ATR] value. Vowel harmony as a 'processual' event happens in all derived words without any exception.

4.3.1 Verbal monosyllables

Though monosyllabic verbal roots contain only the six vowels of /i/, /u/, /ɛ/, /ɔ/, /ʊ/, /ɑ/, the vowels /e/ and /o/ do emerge in verbs as a result of inflection. There are also certain verbal roots which have monosyllabic outputs containing /e/ and /o/ after inflection. The verbal paradigm of the roots /rɔ/ 'wait' /lɔ/ 'take' and /zɑ/ 'go' in (145) show that while /rɔ/ and /lɔ/ are regular, /zɑ/ is not. Looking at /rɔ/ first, we observe that its inflected forms consist of /rom/ /rolɑ/ and /rol/. These occurrences go against our observation that /e/ and /o/ do not occur in Assamese unless triggered by a following /i/ or /u/. On closer scrutiny, however, a closer scrutiny offers us the insight that that these monosyllables are the result of the underlying presence of the vowel /i/ in the inflected form.

(145) Occurrences of underlying /i/ in inflected forms

Root vowel	ɔ	ɔ	ɑ/ɔ
Root	rɔ 'wait'	lɔ 'take	zɑ 'go'
Simple Present			
1P	rɔʊ	lɔʊ	zɑʊ
2P(fam)	rɔwɔ	lɔwɔ	zɑwɔ
2P(ord)	rʊwɑ̃	lʊwɑ̃	zʊwɑ̃
2P(hon)&3P	rɔi	lɔi	zɑi
Imperative			
2P(fam)	rɔ	kɔr	zɑ
2P(ord)	rʊwɑ̃	lʊwɑ̃	zʊwɑ̃
2P(hon)	rɔwɔk	lɔwɔk	zɑwɔk
Past Perfect			
1P	rolʊ	lolʊ	golʊ
2P(fam)	roli	loli	goli
2P(ord)	rolɑ	lolɑ	golɑ
2P(hon)&3P	rol	lolɛ	gol

Future			
1P	rom	lom	zɑm
2P(fam)	robi	lobi	zɑbi
2P(ord)	robɑ	lobɑ	zɑbɑ
2P(hon)&3P	robɔ	lobɔ	zɑbɔ
Perfect			
1P	roisʊ	loisʊ	goisʊ
2P(fam)	roisɔ	loisɔ	goisɔ
2P(ord)	roisɑ	loisɑ	goisɑ
2P(hon)&3P	roisɛ	loisɛ	goisɛ
Past-Progressive			
1P	roisilʊ	loisilʊ	goisilʊ
2P(fam)	roisili	loisili	goisili
2P(ord)	roisilɑ	loisilɑ	goisilɑ
2P(hon)&3P	roisilɛ	loisilɛ	goisilɛ
Perfect Conjuctive	rʊwɑ	lʊwɑ	zʊwɑ
Conditional Conjunctive	rolɛ	lolɛ	golɛ
Infinitive	roi	loi	goi

We have already established that /-il/ and /-ib/ are the past and future tense markers respectively. In open monosyllables, like /lɔ/ and /gɔ/, the result of inflection is visible without the apparent presence of triggering vowels, similar to the behaviour of the open monosyllables discussed in section 4.2. Therefore what should have been /roil/ /roim/ and /roibɔ/ emerge as /rol/ /rom/ and /robɔ/ as a result of the underlying presence of the triggering /i/.

Sigificantly, this process does not occur when the inflectional morpheme /-is/ is closest to the root, it occurs only when the morphemes /-il/ /-ib/ and /-im/ are closest to the verbal root. (see paradigm in (141). The deletion of a segment and subsequent preservation of a feature in a verbal root in the presence of the inflectional suffixes /-il/ /-ib/ and /-im/ and the absence of deletion in the presence of the inflectional suffix /-is/ is theoretically accounted for in chapter 7.

The verbal paradigm shows exceptional occurrences which are not apparent on the surface, but nonetheless, it is the result of an alternation. The next section of this chapter deals with an exhaustive list of exceptions which are not the result of any alternations.

5 Exceptional occurences in vowel harmony

The data until this point strongly convey the impression that the outputs of vowel harmony [e] and [o] are allophonic and they do not occur independently. However, the purport of this section is to present instances of exceptional occurrences of these vowels without any accompanying alternation. This of course does not invalidate the facts of Assamese harmony that I have been arguing for till now. It simply shows that these words belong to a separate lexical substrata of their own and there are theoretical ways of capturing these lexically fossilised forms or other etymologically opaque processes. The theoretical treatment of these lexical aberrations will be discussed in chapter 7.

An near-exhaustive list of lexically distinct occurrences of [e] and [o] that I have found in my survey of the language are the following:

(146) Monosyllables [o]

dot	'a monster'	zot	'wherever'
tot	'there'	kot	'where'
sot	'month'	bol	'let's go'
dol	'temple'	rod	'sunshine'
dor	'run'		

(147) Monosyllables [e]

dex	'country'	zel	'jail'	(from English)[26]
bex	'role'	bel	'bell'	(from English)
bes	'good/well done'	bet	'bet'	(from English)
d^her	'lot'	kes	case'	(from English
xex	'end'	sek	'cheque'	(from English)
kex	'hair'	rel	'rail'	(from English)
d^het	interjective	get	'gate'	(from English)

[26] I am only considering those English loan words which have entered the Assamese lexicon as a result of widespread use.

The occurrences of [e] and [o] in monosyllables form a closed class; as far as my knowledge goes, these are the only words with [o] and [e]. While some of these instances are remnants of an earlier historical stage in the development of the language, others are recent borrowings.

(148) Bisyllables with [e]

ɑpel	'apple'	ɑk^{h}ez	'grudge'
ɑbeg	'emotion'	ɑdex	'order'
ɑmez	'delectable'	bɑze	'useless'

perɑ	'sweet'	nirdex	'command'
bidex	'foreign country'	ɔxex	'limitless'
utk^{h}ep	'launch'	udb^{h}ed	'exposure'

(149) Bisyllables with [o]

lorɑ	'boy'
kolɑ	'black'
kotɑ	'where'
sorɑ	'outhouse'

(150) Trisyllables etc.

ɑbestɔn	'enclosure'	ɑbedɔn	'appeal'
od^{h}ibexɔn	'conference'	niketɔn	'institute'
nibedɔn	'appeal'	bedɔnɑ	'pain'
ob^{h}ixek	'installation'	poribexɔn	

It is not unusual in vowel harmony languages to find disharmonic sequences in roots. This has been reported to be the frequently observed in languages like Turkish and Hungarian. However, the words in the exceptions above stand out not only for being disharmonic but also for the fact that [e] and [o] do not occur unless there is a [+ATR] vowel to its right. The occurrences in (146) - (150) therefore, do not belong to the regular phonology, and are instances of restricted or exceptional occurrences of lexically specified [e] and [o]. It may be safely concluded that these words belong to a limited set, consisting of borrowed words (the process which triggers exceptional realisations is discussed extensively in chapter 7).

In this regard, if we try to foray into the arena of historical linguistics, then mention must also be made of the pioneering work on Assamese linguistics, Kakati (1941), who first noted that Assamese exemplifies vowel harmony. Kakati also makes the important observation that there is a dichotomy in the preservation of mid vowels in *tatsama* words versus *tadbhama* words. /e/ is preserved only in *tatsama* words like /dex/ 'country' /cetɔna/ 'consciousness', etc. It is common practice among Indian grammarians to divide the lexicon of Modern Indian languages into two types: *tadbhama* and *tatsama*. *Tadbhama* words are of some native Indo-Aryan origin coming through a slow process of linguistic evolution to the Middle Indo-Aryan stage. These words are common to many Modern Indian languages but not traceable to that earlier source. On the other hand *tatsama* words are loan words from Sanskrit. Therefore many of these words with /e/ and /o/ are Sanskrit loans which have been preserved as close as possible to the source words. Kakati throws light on some of the monosyllabic exceptions in (146). Kakati gives a vivid description of the transformation of these words from early Assamese:

"In early Assamese[27], /ɔ/ followed by /i/ or /u/ (my transcription) were regularly diphthongized.

Old Indo Aryan	Middle Assamese	Modern Assamese	Gloss
kɔhitɔ	kɔitɔ	kot	'where'
sɔittɔ	sɔit	sot	(name of a month)
mayurɑ	mɔirɑ	morɑ	'peacock'
dɔittɔ		dot	'a tall ghost/spirit'
rɑuddɑ	raudrɑ	rod	'sunshine'
caurɑyɑ		sorɑ	'outhouse'

(my transcriptions)

But in modern Assamese /ɔ…i/ and /ɔ…u/ → /o/ /e/ e.g. /kot/ /sot/ /mora/ (written /ko't/ /so't/ /mo'ra/ (my transcriptions); the apostrophe indicating the elision of some vowel sound after having caused mutation of the preceding vowel. The diphthongal sound went out of favour and a new sound took its place.

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[27] Kakati divides these periods roughly into the following divisions - Early Assamese – 11th -16th century A.D., Middle Assamese – 17th – 19th century A.D. and Modern Assamese – beginning of 19th century A.D. to the present.

This change was fully recognised in middle Assamese of the prose chronicles." (Kakati 1941:128-129)

This shows that in these fossilised forms where /e/ and /o/ occur without the presence of a following triggering vowel are due to the loss of the trigger at some stage in the development of the language.

Therefore, some of these lexical aberrations can be linked to the etymology of the respective words. However, there are also loan words from English which have been adapted into the native vocabulary in a similar manner. See for instance in examples - /geit/ 'gate' → /get/ , /dʒeil/ →/zel/ 'jail', etc.

6 Summary

What stands out from the discussion on vowel harmony so far is that /i/ and /u/ can always trigger harmony on all the preceding [-ATR] vowels, and the value [+ATR] emanating from a high vowel can spread iteratively from one [-ATR] vowel to the next. The domain of the trigger is neither the root nor strictly the suffix and there is no way to adequately characterise the triggering position with the aid of a linguistically significant term. The presence of a triggering vowel in a syllable preceding the target has no triggering effect on the subsequent vowels.

(151) Schema of harmony in derived and underived words of Assamese: regressive [+ATR] harmony; no progressive [-ATR] harmony

[-ATR] + [+ATR]	[-ATR] + [+ATR]
/ɔ/ + /i/→ e-i	/ɛ/+ /u/ → e-u
/ɛ / + /i/→ e-i	/ɔ/+/u/ → o-u
/ʊ / + /i/→ u-i	/ʊ/ + /u/→ u-u

(152) [+ATR] + [-ATR]: no regressive [-ATR] harmony; no progressive [+ATR] harmony

[+ATR] + [-ATR]	[+ATR] + [-ATR]
/i/+/ɔ/ → i-ɔ	/u/+/ɔ/ → u-ɔ
/i/+/ɛ/ → i-ɛ	/u/+/ɛ/ → u-ɛ
/i/ + /ʊ/ → i-ʊ	/u/+/ʊ/ → u-ʊ

(153) underived forms

ɛɛ	e i	*e-o
ɔɔ	e u	*e-e
ɛ ɔ	o i	*o-o
ʊɔ	o u	
ʊɛ		
ɛʊ		
ʊʊ		
ɔʊ		
iʊ		

Thus, [e] and [o] occur only non-finally in the context of final [+ATR]. Irrespective of derived or non-derived environments, the vowel inventory of Assamese is has a number of constraints. The non-final mid vowel inventory and the final mid vowel inventory can be summarised below:

(154) Initial and medial vowel inventory

i	u	ʊ	
e	o	ɛ	ɔ
		ɑ	

(155) Final vowel inventory

i	u	ʊ	
*e	*o	ɛ	ɔ
		ɑ	

In a nutshell, this captures the generalisation about harmony and its allophonic outputs in Assamese. But there are certain exceptions to this all-encompassing generalisation, and in section 5, I present a near- exhaustive list of these exceptions.

Chapter 5

Regressive vowel harmony and Sequential Markedness constraints

1 Introduction

In the previous chapters, apart from providing a general introduction to the dissertation in general (chapter 1), I provided a background to vowel harmony (chapter 2) and a theoretical background (chapter 3). This was followed by a presentation of the relevant data (chapter 4). The present chapter provides a crucial connection between the empirical observations made in chapter 4 and the theoretical discussions in the remaining chapters of this dissertation. The chapter provides an analysis of regressive vowel harmony, mainly in Assamese, but it also shows how the same theoretical approach can be extended profitably to Pulaar, Bengali and Tripura Bengali, i.e. in those languages that were introduced in chapter 2 of this dissertation. The goal of this chapter is, therefore, to arrive at the universal factors governing directionally oriented vowel harmony.

The chapter is organised as follows: Section 1 provides a summary of the facts germane to the description of Assamese vowel harmony. Assamese harmony facts were described in detail in chapter 4, and therefore the descriptive part of this chapter is restricted to a pre-theoretical introduction of the relevant rather than the full range of facts. Using the framework of Optimality Theory (Prince and Smolensky 1993/2004), section 2 discusses contextual markedness and faithfulness constraints in general and their relevance for the Assamese harmony facts in particular. These constraints were already introduced in chapter 3; therefore, this chapter provides their context of application in a broader approach to vowel harmony that has been assumed in this dissertation. It will be shown that sequential markedness can adequately account for both iterative and non-iterative regressive vowel harmony, both processes involve contextual neutralisation. Section 3 discusses Pulaar and Karajá and analyses these languages using sequential markedness constraints. Finally, section 4 takes up the formal analysis of Bengali and Tripura Bengali harmony

In previous analyses of vowel harmony systems by Baković (2000) and Krämer (2003), it has been shown that there is no ontological status of directionality in harmony. Stipulating directionality was totally rejected because it was shown that directionality is epiphenomenal, falling out of independently observed morphological or phonological factors like STEM-AFFIX FAITH (Baković 2000) or the need to assimilate to the unmarked value [-ATR] in dominant-recessive systems.

As discussed and exemplified in great detail in chapter 4, vowel harmony in Assamese is regressive and always proceeds leftwards when [+high, +ATR] vowels trigger harmony on all the [-ATR] vowels to the left. This system does not fit into the strict confines of the so-called stem-controlled and dominant-recessive vowel harmony systems. Regressive assimilation in Assamese spreads from any /i/ or /u/ which follows a [-ATR] vowel. Regressive harmony is not dependent on any derived environment either, that is, assimilation can spread root-internally as well as from a suffix. However, unlike typical dominant-recessive systems, the dominant valued high vowels can spread harmony only regressively, and not progressively. The thrust of this chapter is to show that while there are languages in the world where directionality is not solely the result of faithfulness to the stem (cyclically) or root-initial syllable, or even emergence of the unmarked (as claimed by Baković for dominant-recessive systems), these directional systems need not be dictated by an alignment constraint favouring alignment of morphologically or prosodically defined edges. Adopting featural agreement, the result of this discussion will show that regressive harmony in most known systems is the product of the avoidance of sequences of vowels which differ in their feature specification. The constraints responsible for such markedness relations are expressed in terms of precedence, where a sequence of two vowels is marked, such that if the preceding vowel is [-F], the following vowel cannot be [+F]. Succinctly, this precedence relation is expressed by a constraint *[-F][+F], and it will be satisfied by any [αF][αF] sequence, but violated by a [-F][+F] sequence. In effect, this produces the results of neutralisation in the context of a certain environment, and it effectively captures all types of neutralisation facts, regardless of whether these involve total regressive spreading or partial spreading, or prosodically governed neutralisation.

It should be taken care to mention here that the advantage of using sequential markedness constraints in order to successfully explain directionality has been shown by

Hansson (2002) for Karajá vowel harmony and consonant harmony in Chumash. The present work extends the applicability of sequential markedness constraints to another directional system, i.e. Assamese, and also to a supposedly morphologically controlled system i.e. Pulaar, and also shows the advantage of using sequential markedness constraints for partial spreading in Assamese, Bengali and Tripura Bengali.

In this chapter, I will show that regressiveness can appear in various guises: strictly directional and allophonic (Assamese and Pulaar), strictly directional with a dominant value (Karajá) noniteratively directional with a dominant value (Bengali) and, finally, non-iteratively directional but allophonic (Tripura Bengali). I show that all these languages show instances of contextual neutralisation (also claimed in Hansson 2002), and that sequential markedness constraints can handle all these diverse instances of regressive spreading, both iterative and non-iterative.

Thus I show that leftward directionality in Assamese is, on the one hand, the result of the interleaving of contextual markedness constraints, which militate against a sequence of certain feature combinations, and articulatorily grounded substantive constraints, on the other, which filter out candidates passed down by the contextual markedness constraints. Together with faithfulness constraints, they capture the full facts of phonological harmony in Assamese.

1.1 Descriptive facts

In Assamese, all vowels in a word must agree in the feature value [ATR]. Examples of vowel harmony are presented below.

(156) /uwɑ/ harmony triggers

	Root	Gloss	Suffix	Derivation	Gloss(Derivation)
(a)	pɔlɔx[28]	'silt'	uwɑ	poloxuwɑ	'fertile land'
(b)	mɛr	'curl'	uwɑ	meruwɑ	'curled'
(c)	gʊbɔr	'dung'	uwɑ	guboruwɑ	'fly living in dung'

[28] Closed syllables attract main stress in Assamese. Closed syllables also *block* spreading of harmony. This will be discussed extensively in chapter 6.

(157) /i/ suffix

	Root	Gloss	Suffix	Derivation	Gloss
(a)	bʰɛkʊla	‘frog’	i	bʰekuli	‘frog’(di
(b)	ʊpɔr	‘above’	i	upori	‘in
(c)	kʰɔrɔs	‘spend’	i	kʰorosi	‘prodigal’

Although harmony in Assamese derived words is triggered by suffixes[29], it is not strictly a suffix-driven process. [ATR] harmony processes are observed throughout the lexicon - there is stem-internal assimilation as well as assimilation within the affixal material. Therefore the source of harmony is not solely confined to suffix vowels. The underived words presented below end in a high vowel and the preceding vowels all agree in their [+ATR] specifications:

(158) Agreement in underived words

	Word	Gloss
(a)	beli	‘sun’
(b)	pelu	‘worm’
(c)	teteli	‘tamarind’
(d)	leteku	‘berry’

What is important, however, is that harmony is always regressive, affecting only the [-ATR] vowels on the left hand side of a word, primarily targeting the the preceding [-ATR] vowels.

[29] It probably has not escaped the reader’s notice that there are fewer /u/ suffixes than /i/ suffixes (also noted in chapter 4). It is a fact of the language that /i/ suffixes far outnumber suffixes with /u/. However, /u/ triggers harmony whenever it occurs, as shown in the data in (156). Wim Zonneveld (p.c.) points out that /i/ is more unmarked than /u/, and that this kind of situation is probably similar to languages with regressive voicing assimilation, where there are voiced obstruent suffixes fewer than voiceless suffixes, again possibly because of markedness. cf. Lombardi (1995) on Yiddish.

(159) Occurrences of /ɛ/ and /ɔ/

(a)	tɛrɔ	‘thirteen’
(b)	bɛtɔn	‘salary’
(c)	pɔxɛk	‘week’

When there are no [+ATR] triggers on the right hand side, vowels appear with their [-ATR] values. The mid vowels /ɛ/ and /ɔ/ and the high vowel /ʊ/ are the targets of leftward spreading only. There is no harmony when the potential triggers do not occur on the right as shown in (160).

(160) Disharmony if the triggers are not on the right side

	Roo	Gloss	Suffix	Derivation	Gloss	
(a)	kin	‘buy’	ɛ	kinɛ	‘buy’	(3Person Present)
(b)	p^hur	‘travel’	ʊ	p^hurʊ	‘travel’	(1Person Present)
(c)	buz	‘understand’	ɔ	buzɔ	‘understand’ (2 Person)	

(161) Ill-formed Assamese words

(a) *tero

(b) *beton

(c) *poxek

(d) *olek^h

The words in (161) above are unattested patterns in Assamese as /e/ and /o/ occur only as a result of phonological derivation, and independent occurrences of /e/ and /o/ are restricted to a small handful of exceptions[30].

(162) To summarise the basic harmony facts:

(i) Harmony is regressive (neither stem controlled nor dominant-recessive), always extending until the initial syllable.

(ii) Regressive harmony is triggered by the vowels /i/ and /u/ on the right side.

(iii) The harmony process always targets the vowels /ɛ/, /ɔ/ and /ʊ/ resulting in the surface realisation of [e], [o] and [u], respectively, depending on the presence of a

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[30] A near-exhaustive list of exceptions was provided in chapter 4.

following [+high, +ATR] vowel.

2 Towards a formal analysis of Assamese: ATR vowel harmony governed by markedness and faithfulness constraints

As pointed out in chapter 3, there is an inherent conflict between markedness and faithfulness constraints in OT. Markedness constraints try to exact simplification in surface structures, whereas Faithfulness requires maximum conservation of input structures. Markedness requirements form an important part in regulating assimilation processes, and as such, Markedness ≫ Faithfulness forms the core OT generalisation in its approach to neutralisation. I showed that although this ranking in effect captures agreement in general, the direction of the process may not be captured by the markedness constraint in question (like AGREE). The relevant markedness constraint which successfully captures the direction of harmony in a strictly directional vowel harmony system is given below.

(163) Sequential markedness constraint (repeated from chapter 3)
*[-F][+F]
Assign a violation mark to a [+F] segment preceded by a [-F] segment.

Constraints like AGREE (also discussed in chapter 3, sections 4.1 and 4.5) fail to capture the direction of spreading a spreading feature [+F] because AGREE does not identify the locus of violation. If we were to obtain regressive harmony in an input candidate with the featural make-up [-F][+F][-F] then AGREE fails to deliver, as shown in (164) below:

(164) AGREE in assimilation

I: [-F][+F][-F]	AGREE	IDENT[+F]	IDENT[-F]
a. [-F][+F][-F]	*!		
b. ☹ [+F][+F][-F]	*!		*
c. 💣 [+F][+F][+F]			**
d. [-F][-F][-F]		*!	

The actually occurring output in regressive harmony of the Assamese type is (164)-b., but AGREE miscalculates because it fails to identify the locus of violation. However, a sequential markedness constraint can identify the position of a violation, as shown below:

(165) *[-F][+F] identifies the marked sequence

I: [-F][+F][-F]	*[-F][+F]	IDENT[+F]	IDENT[-F]
a. [-F][+F][-F]	*!		
b. ☞ [+F][+F][-F]			*
c. [+F][+F][+F]			**!
d. [-F][-F][-F]		*!	

Similarly, the constraint which compels harmony in Assamese is given below:

(166) *[-ATR][+ATR]
Assign a violation mark to a [-ATR] vowel followed by a [+ATR] vowel.

This constraint prohibits the linear precedence of [-ATR] vowels when followed by a [+ATR] vowel. To give a concrete example, in Assamese when the verbal root undergoes inflection /kɔr/+/i/ (‘do’+inf), the output */kɔri/ will violate *[-ATR][+ATR], whereas the attested /kori/ will satisfy the constraint. Note that this constraint evaluates candidates only locally (see chapter 3 for a possible distal formulation).

However, typical of OT’s requirement of conflicting constraints, there will be other candidates which will be discarded because of violations of other constraints, for instance, faithfulness constraints. It is to these faithfulness constraints that I now turn. Faithfulness constraints evaluate the identity of correspondent elements. The IDENT family of constraints, initially proposed as below in McCarthy and Prince (1995), relate corresponding input and output features of a segment:

(167) IDENT(F)
Let α be a segment in S_1 and β be any correspondent of α in S_2. If α is [γF], then β is [γF].
(“Correspondent segments are identical in feature F”.)

Taking this formulation of IDENT to account for [-ATR] harmony domains, we can show that [-ATR] vowels do not change their underlying values. Therefore, IDENT [ATR] can be held responsible for the fact that vowels retain their underlying values in the absence of any harmony-inducing high vowel.

(168) IDENT [ATR]:
A segment in the output and its correspondent in the input must have identical specifications for [ATR].

Segments never change their height features under any circumstances. Only [ATR] features are subject to alternations. One of the relevant constraints is IDENT [high] which preserves the height features of the input.

(169) IDENT [high]:
A segment in the output and its correspondent in the input must have identical specifications for [high].

For vowels with [-ATR] values, satisfaction of the constraint inducing harmony is more important than maintaining underlying distinctions. Therefore, *[-ATR][+ATR] is ranked above IDENT [ATR]. In Assamese, there are no advanced high vowels which are front. This is related to the articulatory constraint that retracted tongue root and the feature [-back] together is marked. This translates into an incorporation of the following two articulatory constraints in (170) and (171):

(170) If [+high] then [+ATR]; if [+high] then not [-ATR]
If [-back] then [+ATR]; if [-back] then not [-ATR]
Archangeli and Pulleyblank 1994: 178

The non-emergence of the vowel /ɪ/ is an effect of the undominated constraint which bans the co-occurrence of [+high, -ATR, -back][31]. Therefore, an important requirement

[31] See Archangeli and Pulleyblank (2000) for the inclusion of the grounding condition ATR/FR (Archangeli & Pulleyblank 1994, Davis 1995), preferring that advanced vowels be [-back], not [+back]. Grounded condition: ATR/FR If [+ATR] then [αback]. The articulatory grounding for this constraint lies in the tendency for advanced vowels to be front, not back.

of this analysis is to allow for a grammar in which the markedness constraint given below is ranked above the harmony constraint.

(171) *[+high -ATR -back]
The feature value [-ATR] is marked in [+high] and [-back] vowels

Bringing all these assumptions together, we arrive at the following hierarchy:
(172) ID [high], *[+high -ATR -back][32] ≫ *[-ATR][+ATR] ≫ ID[ATR][33]

An important feature of this analysis is that it does not crucially assume that inputs are underspecified. The grammar has to produce the right outputs regardless of underspecification (Archangeli 1984; Inkelas, Orgun and Zoll 1997; Kiparsky 1985, Ringen & Vago 1998). [+ATR] harmony requires a high ranked IDENT [high] constraint and the co-occurrence constraint *[-ATR +high -back], and these constraints remain high-ranked even if the input is underspecified.

(173) [+ATR] harmony domains require a high ranked IDENT [high] constraint and the co-occurrence constraint *[-ATR +high -back]

Input : /kɔr/+/-i/ 'do'+inf	ID [high]	*[+high -ATR +back]	*[-ATR][+ATR]	ID[ATR]
a. kɔri			*!	
d. kɔrɪ		*!		*
c. kɔrɛ	*!			*
b. ☞ kori				*

In the tableau above in (173), the input vowel /ɔ/ is not an underspecified vowel, rather it is the vowel of the underlying form. The optimal surface form /kori/ is selected by the ranking in (173).

[32]The constraints in this strata remain unviolated in Assamese. Conseuently, they are included only where relevant.

[33] This ranking logic is not justified from the violations incurred in the hierarchy here. But this ranking is necessary because whenever an opaque segment intervenes, it never violates the undominated constraints, but does violate *[-ATR][+ATR].

(174) Harmony even if underspecified vowels are assumed[34]

Input: /kOr/+/-i/ 'do'+inf	ID [high]	*[-ATR +high -back]	*[-ATR][+ATR]	ID[ATR]
a. kɔri			*!	
d. kɔrɪ		*!		*
c. kɔrɛ	*!			*
b. ☞ kori				*

In the tableau above in (174) the alternating vowel is assumed to be underspecified, and the tableau generates the actually occurring output. The constraint *[-ATR][+ATR] keeps out /kɔri/. The lowest constraint ID[ATR] do not play a decisive role in determining the output candidate here.

(175) Harmony in the presence of hypothetical input vowel /ɪ/

Input: /kɔr/+/-ɪ/ 'do'+inf	ID [high]	*[-ATR +high -back]	*[-ATR][+ATR]	ID[ATR]
a. kɔri			*!	*
b. kɔrɪ		*!		
c. kɔrɛ	*!			
d. ☞ kori				**

In the tabeaux above, the low ranking constraint ID[ATR] also do not determine the output /kori/.

The three tableaux from (173)-(175) show that underspecification would not affect any crucial aspect of vowel harmony. The highly ranked feature co-occurrence constraint against [high] and [-back] [ATR] vowels prevents any change in the height and [ATR] specification of high front vowels. Similarly, IDENT [high] prevents height alternation in vowels capturing the fact that Assamese harmony does not involve any change in the height of vowels in order to satisfy agreement.

[34] Following McCarthy and Prince 1993, I assume that IO IDENTITY is violated by all such output representations which are different from their underlying representations. As a result, IO IDENTITY is violated by outout candidates when evaluated against their underlying representations as well.

2.1 ATR harmony in the presence of mid vowels

The focal interest of this section is ATR harmony in forms where there are only mid vowels. In the absence of a harmony trigger to the right, only [-ATR] mid vowels can occur and this can be accounted for by the articulatorily grounded constraint *[-high +ATR]. The grounding conditions in Archangeli and Pulleyblank's work (1994) pertain to the fact that tongue root advancement ([ATR]) and tongue body raising (height) are articulatorily synchronised, while the combination of tongue root advancement ([ATR]) and tongue body lowering (low) are articulatorily incompatible. Their constraints are of the type ATR/low which prohibit the [-ATR] feature specification from co-occurring with a [-low] specification (that is, vowels that are [-ATR] must be [+low]). As a consequence, at this stage, another feature co-occurrence constraint becomes relevant.

(176) *[-high +ATR]: The feature value [+ATR] is marked in [-high] vowels. (Archangeli and Pulleyblank 1994)

This constraint will play a role in the evaluation of words where there are only mid vowels. In order to ensure that this constraint restricts the inventory in the face of hypothetical inputs, let us consider inputs where all vowels are [-high +ATR]. A highly ranked constraint *[-ATR][+ATR] would try to enforce agreement, but *[-high +ATR] would prevent multiple occurrences of /e/ and /o/[35].

(177) Hypothetical input: /tero/

I:/tero/	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR]
a. tero		**!	
b. tɛro	*!	*	*
c. ☞ tɛrɔ			**

The tableau above in (177) shows that the constraint *[-high +ATR] prohibits output occurrences of /e/ and /o/ and *[-ATR][+ATR] penalises disharmonc sequences. At this stage, we can see that it is important to agree in terms of [ATR] rather than assuming [-high +ATR] values.

[35] In chapter 7 I will show one of the ways of capturing exceptional occurrences of underlying /e/ and /o/ within OT.

2.2 ATR harmony in the presence of high and mid vowels

We have already discussed inputs with a mid vowel /ɔ/ and a triggering vowel /i/ in (173) to (175). But we have not yet considered candidates lacking either a /ɛ/ → [e] or a /ɔ/→ [o] alternation, precisely because of the regressive nature of harmony in Assamese. The occurrence of forms like /kinɛ/ which we will discuss shortly, involves feature co-occurrence restrictions along with sequential markedness restrictions, because [-high +ATR] vowels do not occur in positions which are not followed by [+high +ATR] vowels. Therefore, the surfacing of /kinɛ/ vs. */kine/ can be attributed to a feature co-occurrence constraint in the context of a prominence restriction which prevents occurrences of [-high +ATR] in marked positions.

(178) *[-high +ATR] restricts [e] and [o] together with *[-ATR][+ATR]

I:/kin/+/ɛ/	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR]
a. ☞kinɛ			
b. kine		*!	*
c. kɪne	*!	*	**

The tableau in (178) shows that the constraint *[-high +ATR] clearly restricts the inventory for all unattested cases like */kine/ but cannot exclude real occurrences like /kori/, because of the nature of constraint ranking in OT. The ranking of the constraint *[-ATR][+ATR] above the *[-high +ATR] constraint triggers vowel harmony in all other cases where harmony is attested.

At this point we also need to consider the output-oriented aspect of OT's optimal candidate evaluation. This is related to the notion of Richness of the Base (henceforth RoB), which requires that all possible inputs must result in actually occurring surface forms of a language as an end-product of the same constraint hierarchy. In Optimality Theory, the principle of Lexicon Optimisation (Prince and Smolensky 1993/2004, Itô *et al* 1995), is a means of arriving at the correct underlying representation:

(179) *Lexicon Optimisation* (adopted from Itô *et al* 1995)
Of several potential inputs whose outputs all converge on the same phonetic form, choose as the real input the one whose output is the most harmonic.

If a learner has to choose from inputs which all converge on the same output, then she will choose as the underlying representation the input which is closest to the output form. Keeping this in mind, let us consider inputs with /e/ and /o/, which RoB might present in the generation of the optimal output candidate. The tableau below shows that *[-high +ATR] effectively constrains all invalid surface occurrences of marked feature combinations even if RoB presents hypothetical inputs like */kine/.

(180) *[-ATR][+ATR] and *[-high +ATR] restrict the output occurrence of /e/ and /o/ that RoB may present in the input

I:/kin/+/e/	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR]
a. kine		*!	
b. kɪne	*!	*	*
c. ☞kinɛ			*

The tableau above in (180) shows that the markedness constraint *[-high +ATR] restricts output patterns like *[kine] where the [-high +ATR] vowel occur in positions following the triggering vowel, preventing the hypothetical input candidate from being the perfect output correspondent of this evaluation. This also shows the operation of the sequential markedness constraint *[-ATR][+ATR], which does not choose between the candidates /kinɛ/ and */kine/, and leaves the evaluation to be decided by the markedness constraint *[-high +ATR]. Recall chapter 3 where it was shown how an all-inclusive constraint like AGREE fails in situations like these. AGREE would have chosen */kine/ over /kinɛ/ leaving the evaluation to be decided by some positional constraint, which is not a suitable alternative in Assamese.

Finally, the ranking logic of *[-ATR][+ATR] » *[-high +ATR] » ID[ATR] is justified because under harmonic conditions it is far worse to violate *[-ATR][+ATR] than violating *[-high +ATR], as shown below:

(181) *[-ATR][+ATR] » *[-high +ATR] » ID[ATR]

I:/kɔr/+/i/	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR]
a. kɔri	*!		
b. ☞kori		*	*

2.1 ATR harmony and the high vowel /ʊ/

We have not yet discussed inputs where one of the vowels is the [+high -ATR] vowel /ʊ/. The current constraint hierarchy does not make any reference to the input–output correspondence of [+high -ATR, +back] vowel /ʊ/. Under regressive harmony, /ʊ/ always changes to /u/, a relatively unmarked vowel which is not subject to any special feature co-occurrence constraint. The unmarked status of /u/ is also borne out by the fact that /u/ is not subject to any positional restrictions in its occurrences. It is only /ʊ/ which undergoes harmony, but there are no positional restrictions in the occurrences of /ʊ/ either. The upshot is that /u/ does not undergo any alternation to produce /ʊ/, but /ʊ/ alternates to /u/ as a result of regressive assimilation. For the sake of clarity, I repeat the occurrences of /ʊ/ and /u/ in Assamese in a schematic form:

(182) Distribution of /ʊ/ and /u/

σ1	σ#	σ1 + [+ ATR]$_{suffix}$	σ + [-ATR] $_{suffix}$
ʊ	ʊ	*ʊ	ʊ
u	u	u	u

2.3 A new IDENT IO constraint : IDENT [+high ATR]

In order to prevent the emergence of a non-underlying vowel /ʊ/ which may show up as a result of harmony (resulting in unattested [-ATR] harmony), as well as protect /ʊ/ (resulting in unattested progressive harmony), one more modified IDENT[ATR] constraint is required. The proposed way of dealing with the problem just mentioned is to modify the constraint IDENT[ATR] in such a way that there are faithfulness conditions on both [ATR] and [high] quality of vowels.

(183) IDENT [high +ATR]
A high vowel is identical in its input and output specification for [+ATR]

Thus, the constraint constrains [ATR] alternation in [+high] vowels. The combined forces of *[-ATR][+ATR] and IDENT [high +ATR] facilitate limited assimilation in [+high -ATR] vowels.

(184) ID [high +ATR] to protect the [ATR] values of high vowels

I: /pʰur/-ʊ/	ID [high +ATR]	*[-ATR][+ATR]	IDENT[ATR]
a. ☞pʰurʊ			
b. pʰʊru	*!	*	**
c. pʰuru			*!
d. pʰʊrʊ	*!		*

In the evaluation above in (184), the candidate [pʰʊrʊ] with regressive assimilation incurs a violation of IDENT [high +ATR] and [pʰuru] with progressive assimilation does not. The winning candidate satisfies all the candidates and therefore this ranking hierarchy needs to be justified in the rest of the section. Before that, I will briefly try to elaborate on the nature of this newly introduced constraint.

This constraint is required in Assamese in order to account for the asymmetry where /ʊ/ → /u/, but /u/ does not change to /ʊ/. The new IDENT constraint makes reference to both the features [high] and [ATR]. Thus, a context free constraint requiring the protection of [+ATR] values of [high] vowels is needed to capture the remaining facts of regressive vowel harmony in Assamese. While we posited a markedness constraint *[-high +ATR], to prevent instances of non-underlying /e/ and /o/ we posit a faithfulness constraint to protect the [+ATR] values of high vowels[36]. Unlike /e/ and /o/, all the high vowels in the Assamese inventory are non-allophonic and therefore a markedness constraint prohiting their occurences would not suffice our purposes.

2.4 Assamese longer sequences: trisyllables

Recall from chapter 4 that Assamese harmony is attested in longer domains. In this section longer sequences will provide the testing ground for the evaluation of the constraints postulated until now.

[36] This is not to mean that this is a language particular constraint invoked for the analysis of Assamese. Only. Preliminary investigation shows that the constraint is going to give results in Kinande (Archangeli and Pulleyblank 2002, and all languages where [ATR] alternation in [high] vowels is minimal. Otherwise, the full potential of this constraint is yet to be verified.

(185) *[-ATR][+ATR] ≫*[-high +ATR] ≫ ID[ATR]

I:/k^hɔrɔs+i/	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR
a. k^hɔrɔsi	*!		
b. k^hɔrosi	*!	*	*
c.☞ k^horosi		**	**

In the tableau in (185) the constraint *[-ATR][+ATR] crucially constrains non-optimal outputs in a trisyllabic harmony domain as well. The optimal output in (185)-c shows that a combination of mid and high vowel in the input results in total agreement (of the high vowel with the preceding vowels). All the losing candidates with partial or no agreement are unanimously rejected by the constraint *[-ATR][+ATR]. I now turn to look at mid vowels, which fail to undergo harmony in a /i…ɛ…ɛ/ sequence.

(186) *[-high +ATR] restricts mid vowels

I:/kihɛ/ + /rɛ/	*[-ATR][+ATR]	*[-high +ATR]	IDENT[ATR]
a. ☞ kihɛrɛ			
b. kihɛre	*!	*	*
c. kiherɛ		*!	*
d. kihere		*!*	**

The evaluation in (186) brings to light the importance of avoiding [-high +ATR] specifications. While *[-high +ATR] is a violable constraint, it plays a vital role when the constraint *[-ATR][+ATR] is vacuously satisfied by the candidates (186)-c and (186)-d. The ranking decides in favour of the optimal candidate in (186)-a because this constraint favours /kihɛrɛ/ instead of */kiherɛ/ as the latter violates *[-high +ATR].

(187) *[-ATR][+ATR] correctly generates partial regressive harmony

I:/kɔr/ + /i/ + /bɔ	*[-ATR][+ATR]	*[-high +ATR]	IDENT[ATR]
a. kɔribɔ	*!		
b. ☞ koribɔ		*	*
c. koribo		**!	**

The tableau in (187) presents a crucial input candidate /kɔr+i+bɔ/ and *[-ATR][+ATR] effectively winnows down the candidate set to /koribɔ/ and */koribo/. The burden of the evaluation between /koribɔ/ and */koribo/ is passed down to the next constraint, *[-high +ATR]. The candidate */koribo/ incurs more violations of *[-high +ATR] and therefore the most optimal candidate is /koribɔ/. This candidate is important because it is vital in showing the difference between *[-ATR][+ATR] and AGREE. It is in the face of an input candidate like /kɔr/+/i/+/bɔ/ that AGREE fails. Both /koribɔ/ and */kɔribɔ/ incur single violations of AGREE, and therefore neither of them successfully complete the evaluation.

I will now turn to trisyllabic words which occur with both the high vowels /ʊ/ and /u/. As we have already discussed in the section on disyllables, ID[high +ATR] is required to handle alternation in the presence of an /u…ʊ/ or /u…ʊ/ input.

(188) mid-high trisyllables in the presence of the constraint IDENT [high +ATR]

I:/sʊsɔr+u/	ID[high +ATR]	*[-ATR][+ATR]	ID[ATR]
a. sʊsɔru		*!	
b. susɔrʊ	*!		*
c. sʊrɔsʊ	*!		*
d. ☞susoru			**

In tableau (188), the evaluation of a high-mid-high combination of input vowels shows the importance of the constraints *[-ATR][+ATR] and IDENT [high +ATR]. The most faithful candidate (188)-a violates *[-ATR][+ATR] and the next candidate (188)-b violates IDENT [high +ATR]. The winning candidate violates IDENT [ATR], which is ranked lowest in the hierarchy.

(189) high-high vowels in trisyllables

I:/sʊru+sʊ/	*[-ATR][+ATR]	ID[high +ATR]	IDENT [ATR]
a. sʊrusʊ	*!		
b. ☞ surusʊ			*
c. sʊrʊsʊ		*!	*
d. surusu			**

In the tableau above, we see a similar candidate to the mid-high combination in (188). The only difference is that the input vowels here are all high. Regressive harmony takes place and affects only the immediately preceding vowel. While *[-ATR][+ATR] rejects the fully faithful candidate, */sʊrusʊ/, and IDENT [high +ATR] rejects (189)-c [sʊrʊsʊ], the decision between the two candidates /surusʊ/ with partial regressive harmony and */sʊrʊsʊ/ with total harmony is made by the constraint IDENT [high +ATR].

I show here how an alternative to the solution proposed here and also show how it will fail[37]. According to the proposed solution, if we do not bring into consideration the constraint ID [high +ATR] and instead invoke * [+high -ATR] and rank it below IDENT [ATR], then it would account for most cases, like the input considered in (188), as shown below:

(190) alternative analysis using *[-ATR][+ATR] » IDENT[ATR] »*[+high -ATR]

I:/sʊru+sʊ/	*[-ATR][+ATR]	IDENT [ATR]	*[+high -ATR]
a. sʊrusʊ	*!		**
b. ☞ surusʊ		*	*
c. sʊrʊsʊ		*	**!*
d. surusu		**!	

However, the proposed analysis will fail to produce the correct output when the input is /sʊsɔr+u/

(191) the failure of the constraintranking *[-ATR][+ATR] » IDENT[ATR] » *[+high - ATR]

I:/sʊsɔr+u/	*[-ATR][+ATR]	ID[ATR]	*[+high -ATR]
a. sʊsɔru	*!	*	*
b. susɔrʊ		** !	*
c. 💣sʊsɔrʊ		*	**
d. ☹susoru		**!	

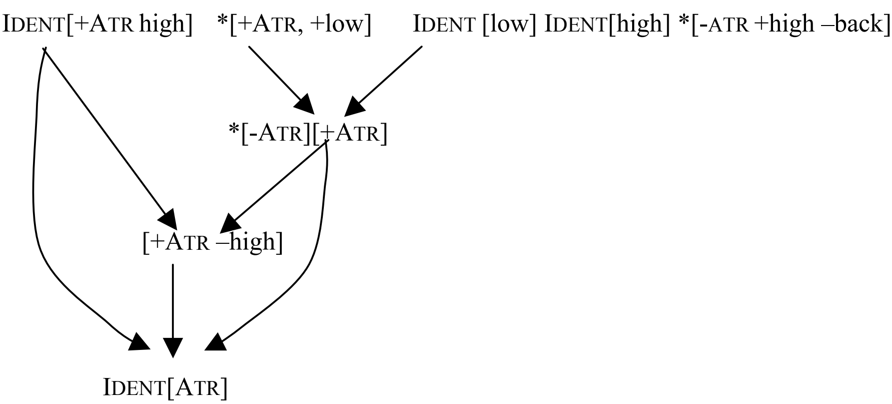
The constraint ranking fails because the contraint ID[ATR] penalises all faithfulness violations and the combined result of the constraints *[-ATR][+ATR] and ID[ATR] is not

[37] This alternative analysis and its failure was originally suggested by René Kager (p.c.).

effective in getting the results of iterative regressive harmony, demonstrated in the failed candidate [susoru].

All the constraints proposed for the Assamese analysis along with their respective inputs and competing candidates were checked in the software package “OT soft” (Hayes, Tesar and Zuraw 2003). The software ranked all the constraints correctly and the following hasse diagram was generated as a result of further use of the “Graphviz” software:

(192) Ranking of all the constraints proposed for Assamese in this chapter:



The constraints relation to each other are shown on the basis of how constraints fare in pairwise evaluation. The hierarchy shows that *[-ATR +high –back] and IDENT[high] may not be necessary. However, IDENT[high] is present in the hierarchy to show faithfulness violations of losing candidates, while *[-ATR +high –back] prevents the emergence of non-underlying /ɪ / in the language. Apart from these undominated constraints, the ranking IDENT[+ATR high] » *[-ATR][+ATR] » *[+ATR –high] » IDENT[ATR] captures the most basic harmony pattern of Assamese, where regressive [ATR] harmony affects the mid vowels /ɛ/ and /ɔ/ and the high vowel /ʊ/. The ranking *[-ATR][+ATR] » [+ATR -high] » IDENT[ATR] alters [ATR] specification of mid vowels, at the ame time preventing non-allophonic occurrences of /e/ and /o/. The ranking IDENT [+ATR high] » *[-ATR][+ATR] » IDENT[ATR] allows regressive alternation of the high vowel /ʊ/. This is only a partial ranking, however, and there will be further modifications to this hierarchy in the subsequent chapters.

3 Sequential markedness constraints in regressive harmony across languages

So far in this chapter we have seen that regressive harmony can be satisfactorily captured with the aid of sequential markedness constraints. The aim of this section is to show that the sequential markedness constraint that I have argued to be operative in Assamese, can be extended to other languages as well, and more specifically, to Pulaar. Pulaar was already considered in chapter 3 while discussing regressive harmony in [ATR] systems. Pulaar harmony has been analysed in various frameworks within and outside OT, and the only consensus that emerges out of all of them is regarding its leftward orientation in harmony. I show that Pulaar is also a variant of neutralisation in the presence of marked structures.

3.1 Pulaar

In Futankoore Pulaar (Breedveld, Paradis), as already introduced in chapter 1, there are seven vowels where four are ATR [i, u, e, o] and three are non-ATR vowels [ɛ, ɔ, a] represented in the following chart.

(193) Pulaar vowel inventory

i	u
e	o
ɛ	ɔ
a	

/i/ and /u/ trigger [ATR] harmony in the preceding [-ATR] vowels /ɛ, ɔ/ resulting in the surface forms [e,o].

3.2 Pulaar vowel harmony

For a considerable proportion of the Pulaar lexicon /e/ and /o/ are allophonic, as all instances of /ɛ/ and /ɔ/ are realised as [e]and [o] on the surface, provided there is a following /i/ or /u/.

(194) Stems followed by class markers (Paradis 1992)

ATR	Gloss	non-ATR
sof ru	‘chick’	cɔfɔn
serdu	‘rifle butt’	cɛrkɔn

peeci	'slits'	pɛɛcɔn
dogooru	'runner'	dɔgɔwɔɔn

(195) Stems followed by verbal suffixes (Paradis 1992)

ATR	Gloss	Non-ATR	Gloss
ɓet-ir-dɛ	'to weigh with'	bɛtdɛ	'to weigh'
hel-ir-dɛ	'to break with'	hɛldɛ	'to break'
feyy-u-dɛ	'to fell	feyya	'to fell' (imperfective)

While the examples in (194) and (195) show that harmony is regressive and affects the entire word, the examples below in (196) show that harmony is not progressive under any circumstance.

(196) No progressive harmony in Pulaar (Paradis 1992)

(a)	dillɛrɛ	'riot'	*dillere
(b)	fuy-ɛrɛ	'pimple'	*fuyere
(c)	bin^{n}dɔɔwɔ	'writer'	*bin^{n}doowo

It is clear from the limited data on Pulaar that there is no way of determining whether Pulaar is strictily a suffix-driven harmony process. All examples presented in Paradis (1992) are the result of affixation to monosyllabic stems. Hence, whenever a trigger is on the right hand side (which is always the suffix in the examples available to us) harmony appears to be suffix-driven. The real test for Pulaar's suffix driven vowel harmony status versus a regressive harmony system will come from roots/stems where /i/ and /u/ following the [-ATR] vowel do not trigger harmony. Therefore, a lack of the relevant data means that we cannot make any convincing argument in favour of suffix driven harmony in Pulaar.

3.3 Analysis of Pulaar

There are a multitude of approaches proposed to analyse Pulaar over the years. While some proposed alignment analyses (Cole and Kisseberth 1994, 1995, Archangeli 2000), Krämer (2003) proposes an analysis which promotes the values of the affix or 'affix control'. Alignment in a regressive system does not provide us with an adequate explanation as there is no linguistically significant morphological or prosodic edge which can be used to designate edge alignment. It can also potentially result in candidates which are aligned to the wrong edge (Hansson 2002). With respect to the affix controlled analysis, I will briefly recapitulate the basic analysis of Pulaar provided in Krämer (2003). In his work, Krämer explains right-hand control with a highly ranked IDENTITY constraint on the last vowel, i.e. IO IDENT (right) [ATR]. This constraint is dominated by the two markedness constraints, prohibiting a phonemic difference in the [ATR] specification of high vowels and low vowels to surface. This constraint is postulated to prevent retracted high vowels and advanced high vowels at the right edge of the word. The constraint which demands vocalic agreement among neighbouring vowels is S-IDENT, which like AGREE requires featural agreement betweenneighbouring vowels.

(197) Pulaar mid vowel plus high vowel (Krämer's analysis)

I:/lEf-ɔn/	*[+high, -ATR]	*[+low +ATR]	IO-ID right(ATR)	S-IDENT
a. lefɔn				*!
b. lefon			*!	
☞c.lɛfɔn				

In the tableau in (197), the markedness constraints *[+high -ATR], *[+low +ATR] are ranked above S-IDENT, the constraint demanding agreement. The incorrigible faithfulness of the final segment is accounted for by a positional faithfulness constraint IO IDENT $_R$ (ATR).

3.4 A sequential markedness analysis of Pulaar

As I have mentioned before, paucity of data prohibits us from forming a convincing argument in favour of affix-driven vowel harmony in Pulaar. The employment of sequential markedness constraints, however, provides the insight that the restriction, which could be at work may be the avoidance of offending sequences of *[-ATR][+ATR]. In addition, the articulatorily grounded constraint *[+high -ATR] also plays a significant role in Pulaar, as shown by the tableaux below:

(198) * [-ATR][+ATR] plays its role in Pulaar [38]

I: /sɔf-ru/	*[+high -ATR]	[*+low +ATR]	*[-ATR][+ATR]	*[-high +ATR]
a. sɔf-rʊ	*!			
b. sɔf-ru			*!	
c.☞sof-ru				*

The tableau in (198) shows that *[-ATR][+ATR] drives regressive harmony in Pulaar. The candidate */sɔf-ru/ without harmony is rejected by this constraint.

(199) *[-high +ATR] plays a role in Pulaar

I: /lɛf-ɔn/	*[+high -ATR]	[*+low +ATR]	*[-ATR][+ATR]	*[-high +ATR]
a. lefɔn				*!
b. lɛfon			*!	*
c. ☞lɛfɔn				
d. lefon				*!*

In the analysis that I present here, the allophonic status of [e] and [o] in Pulaar requires a markedness constraint which prevents [e] and [o] in non-harmony contexts. While the seqential markedness constraint *[-ATR][+ATR] prevents instances of disharmony like the one in (199)-a, the constraint *[-high +ATR] rules out the candidates [lefɔn] and [lefon] in the evaluation above.

3.5 Exceptional /e/ and /o/ suffixes in Pulaar

The extremely general statement that was put forward in the beginning of the section about the allophonic outputs of harmony [e] and [o], is countered by a few examples of class suffixes provided by Paradis. These classs suffixes with /e/ and /o/ occur in Pulaar without any following /i/ and /u/, which means /e/ and /o/ occurring in these suffixes are not allophonic. In addition to what we have seen so far, there is an intriguing aspect which every analysis of Pulaar has to contend with, and that is the existence of two class-suffixes with /e/ and /o/, which trigger harmony in the preceding [-ATR] vowels.

[38] Just like Assamese, the justification of this ranking logic, i.e. the lower ranking *[-ATR][+ATR] lies in the fact that in the presence of the opaque segment /a/, this constraint is violated by the optimal candidate.

(200) Class suffixes with e and o in Pulaar

gel	class suffix	
gol	class suffix	
fof	‘all’	
gorgol	‘aunt’	
ATR: gel, gol	non ATR:kɔn	Gloss
lef-ol		‘ribbon’
lef-el	lɛf-ɔn	dim. (sg and pl.)
keer-ol		
keer-el	kɛɛr-ɔn	dim.(sg. and pl.)
ceelt-ol		‘cut’
ceelt-el	cɛɛlt-ɔn	dim. (sg. and pl.)
cef-ol		‘incantation’
cef-el	cɛf-ɔn	dim. (sg. and pl.)
cooy$^{\text{ŋ}}$-gel	cɔɔy-kɔn	‘spinster’ (dim.sg.and pl.)

The examples show that the vowels in these suffixes can also trigger harmony. Paradis advocates an account postulaing floating features in the underlying representation of these vowels, so that the floating vowel determines the [+ATR] quality of the word. Krämer proposes a fully specified account and argues that any account with floating features will have to grapple with the fact that this feature plays a role only in harmony and occurs only on the right-hand side of a word, and secondly there are no [-ATR] floating features. I will not have anything original to add to the debate about whether the [+ATR] feature in these class suffixes are floating or not.

However, it might be profitable to consider the possibility that /e/ and /o/ suffixes in Pulaar are exceptional. There are various ways of handling exceptionality in the phonological literature and such an approach may preclude any appeal to the existence of floating features[39].

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[39] See chapter 7 on various ways of dealing with exceptionality. Even though assuming exceptional suffixes subverts ROOT FAITH » SUFFIX FAITH, the universal metaconstraint assumed in McCarthy and Prince (1995), it

In the entire lexicon of Pulaar, the presence of only a few class suffixes which trigger leftward harmony emanating from /e/ and /o/, can justifiably be considered exceptional. I show here that these suffixes can be analysed by the indexation of a faithfulness constraint[40] (Fukuzawa 1999, Itô and Mester 1999, 2001, Kraska-Szelenk 1997, 1999) IDENT[ATR]$_L$. The indexed constraint is cloned from one of the constraints, which is already present in the Pulaar hierarchy:

(201) IDENT[ATR]$_L$

Output correspondents contain a phonological [+ATR] component of the input of a morpheme lexically indexed as L.

This constraint will be indexed to the set of morphemes which are stored in the lexicon as L. The appropriately ranked indexed constraint chooses the right output whenever these indexed morphemes are responsible for harmony.

(202) Lexicon : /gel/ /gol/ /fof/ /gorgol/

(203) Ranking: ID[ATR]$_L$ ≫ *[-ATR][+ATR] ≫ *[-high +ATR] ≫ ID[ATR]

I: /lɛf-el/$_L$	ID[ATR]$_L$	*[-ATR][+ATR]	*[- high +ATR]
a. lɛfɛl	*!		
b. lɛfel		*!	*
c. ☞lefel			**

In the tableau above in (203), the lexically indexed faithfulness chooses the candidate /lefel/. The competing candidates [lɛfɛl] and [lɛfel] violate ID[ATR]$_L$ and *[-ATR][+ATR] respectively. Alternatively, simply assuming a right edge faithfulness constraint as proposed by Krämer, alongwith the constraints that have been proposed for the sequential markedness analysis, will also give us the right results in Pulaar:

captures the generalisation that unfaithfulness to the value of the root is the exception and not the rule for harmony in Pulaar.

[40] This is only a cursory examination of exceptions in vowel harmony within a theory of lexical indexation. Constraint indexation and its ability to deal with morpheme specific exceptionalities is dealt with extensively in chapter 7.

(204) Pulaar, using a positional constraint

I: /lɛf-el/	*[-ATR][+ATR]	IO-ID Right	*[- high +ATR]
a. lɛfɛl		*!	
b. lɛfel	*!		*
c. ☞lefel			**

The tableau above shows that IO-ID Right along with a sequential markedness constraint can also handle leftward vowel harmony in Pulaar. The analysis of these suffixes as exceptional is superior, as it explains an important fact of Pulaar harmony, namely that this kind of triggering by [+ATR] mid vowels is restricted to a few suffixes only and not characteristic of the entire phonology of Pulaar. Following a similar argument, IO-ID Right needs to be invoked only for the analysis of harmony triggered by a few suffixes and it is therefore superfluous.

3.6 Affix control in Pulaar

Krämer (2002) demonstrates that when a low root vowel combines with a mid affix vowel followed by another affix vowel, the almost universal ranking of INTEGRITY AFFIX over INTEGRITY ROOT is reversed in Pulaar. This inverse ranking of the meta-constraint in McCarthy and Prince FAITH ROOT » FAITH AFFIX has been discussed in chapter 3. I will briefly recapitulate the relevant aspects of that discussion. While McCarthy and Prince's FAITH ROOT » FAITH AFFIX postulates a universal metaconstraint whereby roots are always more faithful than affixes, Krämer postulates constraints against multiple correspondences, (INTEGRITY constraints) where features of a given underlying segment are realised only to one segment in the surface representation.

(205) Positional Integrity:

a. INTEGRITY (F) Affix

No feature of an affix in an input has multiple correspondents in the output.

b. INTEGRITY (F) Root

No feature of the root in an input has multiple correspondents in the output.

These constraints block harmony or spreading between adjacent feature bearing units 'within the same representation'. INTEGRITY (F) Root prevents augmentation of the features of the root, whereas INTEGRITY (F) Affix prevents the augmentation of the affix.

As a result, in Krämer's analysis, in order to account for affix control, INTEGRITY Root has to rank above INTEGRITY Affix, while in root controlled systems INTEGRITY (F) Affix outranks INTEGRITY Root.

(206) Affix control with Integrity constraints (Krämer 2000)
a. Root control: INTEGRITY (F) Affix ≫ INTEGRITY (F) Root
b. Affix control: INTEGRITY (F) Root ≫ INTEGRITY (F) Affix

For the exemplification of affix control, Krämer (2002) employs the form /bin^{n}d-ɔɔ-wɔ/ 'writer'. For Krämer, it was impossible to disentangle the behaviour of the mid-vowel from the influence of the neighbouring suffix vowel, leading to the need for a reversal of the universal ranking as proposed in McCarthy and Prince (1995). I replicate the tableau in (207) below from Krämer (2003: 144) for the sake of clarity.

(207) Affix-control in Pulaar, Krämer (2003: 144)

I: /bin^{n}doowɔ/	*[+high, -ATR]	[*+lo, +ATR]	IO-ID$_{R}$	S-ID [ATR]	IN Root	IN Affix
a. bɪn^{n}d-ɔɔ-wo	*!			**		
b. bin^{n}d-oo-wo			*!			
c. bin^{n}d-oo-wɔ				*	*!	
d. ☞bin^{n}d-ɔɔ-wɔ				*		*

In the example above, candidate (207)-d is selected because the rival candidate (207)-c */bin^{n}d-oo-wɔ/ violates higher-ranked INTEGRITY ROOT. The other candidates violate even higher ranking constraints.

Note that Krämer formulates constraints against prominence augmentation which are dubbed INTEGRITY constraints, where it is worse to augment the ROOT than the AFFIX, and therefore INTEGRITY ROOT is ranked above INTEGRITY AFFIX. It will not be judicious to consider INTEGRITY ROOT ≫ INTEGRITY AFFIX to be a variant of FAITH SUFFIX ≫ FAITH ROOT as employing the latter (supposed) variant gives us the wrong results in the same environment. The input candidate /bin^{n}d-oo-wɔ/ is chosen for the evaluation in Krämer, so that the output /bin^{n}dɔɔwɔ/ reflects the operation of the ranking INTEGRITY ROOT ≫ INTEGRITY AFFIX. The evaluation of 'affix control', as postulated in Krämer is only a non-proliferation of the values present in the root (which can also be interpreted directionally, but I am using Krämer's term here) and is not equivalent to 'affix control' as claimed by Krämer. He stresses that "the analysis of vowel harmony derived here is that the 'pathological ranking' in the view of McCarthy and Prince (1995), that of affix faithfulness (i.e., Integrity Affix) above root faithfulness (i.e., Integrity Root), is rather the rule than the exception."In this analysis, I propose to show that neither Krämer's Integrity Root ≫ Integrity Affix, nor McCarthy and Prince's Faith Root ≫ Faith Affix are required for the analysis of Pulaar. In fact, Pulaar harmony is not dependent on any morphological faithfulness constraint whatsoever, though they may be present somewhere in the Pulaar constraint hierarchy as a means for evaluating other morphological relations.

Tentatively, I present the supposed equivalent to Integrity Root ≫ Integrity Suffix, which is Faith Suffix ≫ Faith Root, and show that invoking a faithfulness ranking of this kind would also not be sufficient to capture regressive harmony in Pulaar.

(208) Non-proliferation of the [Atr] value of the root in Pulaar

I: /bin^{n}d-oo-wɔ/	*[+high, -Atr]	*[+lo, +Atr]	IO-Id$_{R}$	S-Id [Atr]	Faith Suff	Faith Root
a. bin^{n}d-ɔɔ-wo			*!	**	**	
b. bin^{n}d-oo-wo			*!		*	
c. 💣 bin^{n}d-oo-wɔ				*		
d. ☹ bin^{n}d-ɔɔ-wɔ				*	*!*	

In the tableau in (208), candidate (208)-d fails to win because it incurs multiple violations of Faith Suffix. This shows that faithfulness to affixal values cannot predict the right results, although an additional or separate constraint allowing the spread of affixal values would lead to the correct output[41]. What this means is that spreading the values of the suffix need not be restricted to the morphological domain of the root. Importantly however, even if we were to assume that Faith Suufix is ranked below Faith Root – even then, it would lead to exactly the same results because Faith Root

[41] Constraints cyclically evaluating the faithfulness of suffixal quality of vowels can also derive these results, in effect giving rise to anti-stem identity. This wouldn't settle the case in favour of Faith Suffix ≫ Faith Root because of absence of data where only suffixal vowels trigger harmony. Examples of the type where the input is [-F].[+F]/[-F] are not available for Pulaar.

does not incur any violation marks[42]. This goes to show that in Pulaar, the faithfulness of morphological categories in spreading vowel harmony can at best only be considered with skepticism.

As I show in the tableau below, morphological faithfulness constraints are not at work in Pulaar – Pulaar harmony can be eefectively shown to be the result of a sequential markedness constraint with the aid of constraints which have already been postulated for Pulaar, and this does not need to burden the grammar with additional machinery associated with INTEGRITY constraints.

(209) leftward harmony in Pulaar with sequential constraints

I: /binⁿd-oo-wɔ/	*[+high -ATR]	[*+low, +ATR]	*[-ATR] [+ATR]	*[-high+ATR]	IDENT [ATR]
a. binⁿd-ɔɔ-wo			*!	*	**
b. binⁿd-oo-wo				*!**	*
c.binⁿd-oo-wɔ				*!*	
d. ☞ binⁿd-ɔɔ-wɔ					**

The tableau above in (209) shows that the relevant constraints which prevents the non-occurring candidates from being successful in the evaluation are *[-ATR][+ATR] and *[-high +ATR]. The winning candidate /binⁿd-ɔɔ-wɔ/ does not incur faithfulness or markedness violations of the higher-ranking constraints and therefore emerges victorious. The closest rival candidate is (209)-c which incurs two violations of *[-high +ATR].

3.6.1 Summary of the discussion on Pulaar

I conclude that just like Assamese, vowel harmony in Pulaar is also the result of sequential markedness constraints. All cases of harmony in Pulaar can be satisfactorily accounted for with these constraints. The need for a lexically indexed faithfulness constraint emerges because of a few exceptional suffixes, which appear at the right edge of a word, and which also trigger harmony in Pulaar. Finally, I have shown that the general principle of harmony behind Pulaar does not involve reversal of ROOT FAITH ≫

[42] I am grateful to René Kager for pointing this out.

SUFFIX FAITH; rather harmony in Pulaar is a result of the markedness constraint *[-ATR][+ATR].

3.7 Karajá

Karajá has already been mentioned in the introductory chapters in 1 and 3. Karajá presents strictly regressive [ATR] vowel harmony. Some examples of Karajá vowel harmony are presented from Ribeiro (2001).

(210) Vowel harmony in Karajá

(a) rʊbɛhɛre	rubeˈhere
3-CTFG-INTR-hit=CTFG-IMPERF	'He/she hit.'
(b) rarɪre	rariˈre
3-CTFG-INTR-go.down=CTFG-IMPERF	'He/she went down.'
(c) brɔrɛdĩ	broreˈni
3- CTFG-INTR -leave= CTFG-IMPERF	'He/she was left.'
(d) bɛbɔdĩ	beboˈni
deer-similar.to	'cow'
(e) rəkʊdĩ	rəkuˈni
filhote (fish sp.)-similar.to	'a type of *filhote*'

Hansson (2002) was the first to analyse Karajá with sequential markedness constraints, which have also been shown to be effective in analysing other directional systems in this dissertation. However, Karajá shows an important difference when compared to Assamese and Pulaar; in Karajá the outputs of [ATR] harmony are not allophonic. Hansson therefore proposes a notion of 'value control' – a ranking where IDENT[+ATR] ≫ IDENT[−ATR]. This ranking results in directional harmony, with harmony propagating from the segment with the [+ATR] value is superior to that with the value [ATR]. Hansson presents the following tableau to show regressive vowel harmony in Karajá[43].

[43] Hansson discusses another type of directionality, viz. one where both the values can trigger harmony.

(211) Regressive vowel harmony in Karajá I

I:/rɪɗɔre/	*[ATR][+ATR]	IDENT [+ATR]	IDENT [-ATR]
a. rɪɗɔre	*!		
b. ☞riɗore			**
c. rɪɗɔrɛ		*!	

In the tableau above, high ranked *[- ATR][+ATR] and ID[+ATR] result in harmony in the word. The resulting optimal output is [riɗore] and not *[rɪɗɔre] and *[rɪɗɔrɛ] as they violate *[-ATR][+ATR] and IDENT[+ATR] respectively.

(212) Regressive vowel harmony in Karajá II

I:/rɪkɔrɛ/	*[-ATR][+ATR]	IDENT[+ATR]	IDENT[-ATR]
a. rɪkɔre	*!		
b. rikore			*!**
c.☞ rɪkɔrɛ			

The tableau in (212) shows that it is [+ATR] which asymmetrically triggers harmony in Karajá. When the input contains only [-ATR] vowels, then there is no violation of either *[-ATR][+ATR] or IDENT [+ATR], resulting in the output [rɪkɔrɛ] where all the vowels are [-ATR].

Karajá represents a language where directional harmony does not perpetuate to obliterate [±ATR] contrasts, as the outputs of harmony are contrastive. Contextual neutralisation in Karajá rather perpetuates the dominant value [+ATR] in a manner similar to dominant recessive systems (discussed in chapter 2). The same does not hold for languages like Assamese where the outputs of harmony can also be allophonic, and as a result requires markedness constraints in order to prevent the rich base from presenting them as inputs. Thus the co-occurrence restriction *[-high +ATR], which plays a substantial part in Assamese allophonic harmony, does not play a decisive role in Karajá.

Analysing consonant harmony in Chumash, he shows that directional systems where both values can trigger harmony requires targeted constraints (Wilson 2002, 2006). However, no known vowel harmony system behaves in this way.

4 Non-iterative harmony in Bengali and Tripura Bengali

In chapters 1 and 3, it was stated that insofar as contextual neutralisation is concerned, one of the goals of this dissertation is to show that non-iterative harmony processes should also be considered to be on a par with iterative harmony systems insofar as contextual neutralisation is concerned. The challenge for any formal system is to show how this could be executed. This section follows up on this particular claim about non-iterative systems in the preceding chapters by proposing a simple modification of sequential markedness constraints, which can lead to the satisfactory explanation of vowel harmony characteristics in non-iterative harmony in two related languages, Bengali[44] and Tripura Bengali. These two languages were already introduced in chapter 2 alongside Assamese.

4.1 Bengali vowels

Standard Bengali has seven vowels. The vowels can be identified as /i, e, ɛ, a, ɔ, o, u/ in monosyllables. Whereas /i, e, a, o, u/ occur in all positions, /ɛ/ and /ɔ/ can occur in stressed positions only.

(213) Distribution of /ɔ/ and /o/

Word	Gloss
gɔlpo	‘story’
kɔtok	‘Cuttack’
kɔntok	‘thorn’
nɔʤor	‘keep an eye’
bɛton	‘salary’
tɛro	‘thirteen’

Note that, unlike Assamese, /e/ and /o/ are not allophonic in Bengali. The two vowels are phonemic and they contrast with the [-ATR] mid vowels /ɛ/ and /ɔ/. Whereas in Assamese /ɛ/ and /ɔ/ can occur in all positions of a word, in Bengali they are subject to prosodic and morphological restrictions (they occur only in stressed syllables and do not occur in suffixes).

[44] The dialect of Bengali considered here is Standard Colloquial Bengali as already identified in chapter 1.

4.2 Vowel harmony in Bengali

In Bengali nouns, regressive harmony is triggered by the high vowels /i/ and /u/, inducing the [-ATR] mid vowels /ɛ/ and /ɔ/ to raise to /e/ and /o/.

(214) Harmony in Bengali

Root	Gloss	Suffix	Derivation	Gloss
pɔtro	'letter, document'	ika	potrika	'horoscope'
kɔnt^{h}o	'voice'	i	kont^{h}i	'one with a good voice'
pɔton	'downfall(n.)'	ito	potito	'downfallen(adj)'
k^{h}ɛtro	'place, land'	i	k^{h}etri	'landowning caste'
k^{h}ɛla	'game'	i	k^{h}eli	'to play'
ʤɔy	'gladness'	i	ʤoyi	'glad'
pɔt^h	'way'	ik	pot^{h}ik	'traveller'

In nouns, the vowels /ɛ/ and /ɔ/ vowels are regressively raised as a result of the influence of neighbouring high vowels[45]. In Standard Colloquial Bengali there is no iterativity in vowel harmony. Consider the following forms:

(215) Non-iterative harmony in Bengali

Word	Gloss	Word	Gloss	Word	Gloss
kɔt^{h}a	'spoken words'	kot^{h}ito	'uttered'	kɔthoniyo	'speakable'
kɔlpo	'resembling'	kolpito	'invented'	kɔlponiyo	'imaginable'
pɔd	'position'			pɔdobi	'position holder'
ɔʃɔt	'dishonest'			ɔʃoti	'dishonest'(f)
ʤɔnoni	'mother'				
ʤɔyotri	'mace'				

[45] Ghosh (1996) also presents a few examples of non-iterative progressive raising in a few colloquial nouns. For eg. /puʤa/ → /puʤo/ 'religious festival', /ʃuta/→/ʃuto/ 'thread' etc. Since these are only sporadic instances of progressive raising, I will not consider them here.

4.3 Analysis of the basic harmony pattern

As shown in the examples in (214) and (215) above, /i/ and /u/ in Bengali trigger harmony in the preceding [-ATR] vowels /ɛ/ and /ɔ/. In Bengali, like Karajá, the outputs of harmony are not allophonic, leading to the neutralisation of the phonemic [-ATR] values of /ɛ/ and /ɔ/. [+ATR] is the dominant value and therefore higher ranking IDENT [+ATR] is instrumental in driving harmony in lower ranked IDENT [-ATR].

As demonstrated thus far, the three directional harmony systems of Assamese, Pulaar and Karajá can be suitably analysed with the harmony driving sequential markedness constraint *[-ATR][+ATR]. Similarly, in Bengali if we assume that *[-ATR][+ATR] is ranked above IDENT [±ATR], then as a result of this ranking, vowels will try to satisfy the constraint inducing harmony. These constraints function in the following way in the constraint hierarchy:

(216) *[-ATR][+ATR] ≫ ID[±ATR]

This hierarchy shows us the results in the following way:

(217) Partial and incorrect Bengali harmony

I: kɛʃ+i	*[-ATR][+ATR]	IDENT[±ATR]
a. kɛʃi	*!	
b. ☞ keʃi		*

The candidate exhibiting vowel harmony in (217)-b is chosen over the fully faithful candidate in (217)-a because the constraint *[-ATR][+ATR] rejects the former in favour of the latter. This much strongly resembles the constraint ranking that we have witnessed in the previous section for Karajá.

In Bengali, in words of two or more than two syllables, high vowels on the right-hand side trigger harmony in the preceding syllable. It is precisely in trisyllabic contexts like the ones cited in example (215) that we need to reconsider the constraint *[-ATR][+ATR] that has been used in the tableau above. As the examples in (215) show, agreement is limited to the strictly adjacent vowels only. Adjacency of this sort can be elegantly handled in a theory with contextual markedness, by showing that non-iterativity in this case is the result of non-triggering status of the non-high vowels /e/ and /o/. This can be captured in sequential markedness as a constraint prohibiting sequences of *[-ATR][+high +ATR]. In other words, in Bengali, the context of neutralisation needs further refinement as [+ATR] is not the most appropriate context for harmonic neutralisation, whereas [+high +ATR] is. This constraint can be defined as below:

(218) *[-ATR][+high +ATR]
Assign a violation mark to a [-ATR] vowel followed by a [+high +ATR] vowel.

In this dissertation it is assumed following Archangeli and Pulleyblank (1994), that there are articulatory constraints which govern the combination of the two vowel features [ATR] and [high]. Further, [+high] and [+ATR] interact more closely in some languages than in some others. For instance in Kimatuumbi (a Bantu language spoken in Tanzania, Odden 1991, 1996), in a word, [+ATR] vowels have to agree in their [+high] specifications, otherwise all vowels are [-ATR]. I will not go into the details of these languages, but I assume that it is not far-fetched to think of [ATR] and [high] to have close interactions in languages displaying vowel harmony. I will now proceed to analyse Bengali with the aid of the constraint just presented above:

(219) Non-iterative harmony in Bengali

/pɔd/ + /ɔbi/	*[-ATR][+high +ATR]	ID[±ATR]
a. ☞pɔdobi		*
b. podobi		**!
c. pɔdɔbi	*!	
d. podɔbi	*!	

The constraint *[-ATR][+high +ATR] rejects candidates (219)-c and (219)-d, but the lower ranked faithfulness constraint IDENT[±ATR] also returns a stomping verdict against the candidate which surfaces with agreement in all the vowels. For the sake of comparison, the constraint *[-ATR][+ATR] would have been violated by the winning candidate of this tableau, leading to the selection of *[podobi] (which is actually the output of the related language Assamese).

4.3.1 Vowel harmony in Bengali verbs

Thus far, I have accounted for the basic grammar of Bengali, leading to the crucial observation that noniterative harmony is the result of a more stringent requirement on the features which require agreement. In this section, I will concentrate primarily on the verbal paradigm, as there are additional requirements for vowel harmony in verbs. The additional requirements relate to the fact that alternations in verbs demonstrate a chain shift. This will be seen to require a constraint conjunction. Furthermore, verbal roots also seem to be indeterminate regarding the height quality of their underlying vowel. Verbal roots frequently surface in CVC shapes and root vowels are the product of alternation triggered by the following vowel. Regressive harmony in verbs produces a harmony process which affects all the four mid vowels /ɛ/, /ɔ/, /e/ and /o/, but fails to apply to the low vowel /ɑ/ (except when the perfective /e/ triggers harmony, which will be discussed in chapter 7). For the time being, the following examples show the problem where the root vowel can be assumed to be indeterminate:

(220) Examples from the verbal paradigm

	Nominal	/-i/ 1st person Present	/-un/ 2^{nd} person Honorific	Gloss
(a)	$\int ek^h a$	$\int ik^h i$	$\int ik^h un$	'to learn'
(b)	$k^h ola$	$k^h uli$	$k^h ulun$	'to open'
(c)	$d\varepsilon k^h a$	$dek^h i$	$dek^h un$	'to see'
(d)	kɔra	kori	korun	'to do'

As the examples show, Bengali verbs appear in agreement with the inflectional augments following the root. Whenever the inflectional extension is /ɑ/, the root appears with a lowered vowel, but when the inflectional augments are the high vowels /i/ and /u/, the raised counterpart surfaces. This poses a problem for postulating underlying forms for verbal roots in Bengali because verbs appear in agreement with their morphological extensions[46]. Following Ghosh (1996), I assume that the underlying verb roots contain

[46] One can postulate multiple hypotheses to account for the underlying representation of Bengali verbal roots. Ghosh presents a possible alternative: Assume that the verb roots have the underlying forms /i/ (/kin/ instead of /ken/), /e/ (/dek^h/ instead of /$d\varepsilon k^h$/), /u/, and /o/. However, under the influence of a following /a/, they undergo lowering resulting in /i/ → /e/, /e/ → /ɛ/, /u/ → /o/ and /o/ → /ɔ/. Under this assumption, verbs will be assumed to undergo lowering when they appear with /a/, but will be assumed to be underlyingly higher than the result of the alternation. It is possible to add a third possible hypothesis (suggested by Paroma Sanya,l p.c.), which is to assume that Bengali verb 'roots' do not occur independently without their inflectional markers and each surface always forms appears with their tense, aspect or nominalising extensions. Perhaps an elaboration of

/e/ /ɛ/ /o/ and /ɔ/, and that these vowels undergo raising which results in the following alternations: /e/ → /i/, /ɛ/ → /e/, /o/ → /u/, /ɔ/ → /o/ and /a/→ /e/. As a result of this assumption, the underlying form of the surface verbal form of 'buy' will be assumed to be /ken/ (and not /kin/), and its appearance as /kin/ will be the result of raising under the influence of a following high vowel. As Ghosh argues, raising is consistently encountered in nouns and this can be attributed to the general phonological behaviour of the language. Ghosh also argues that unmarked imperatives (2P) do occur in their underlying shapes as /dɛk^h/ 'see'/ken/ 'buy'/bɔl/ 'say' and /ʃon/ 'listen'. On the other hand, / dek^h/, /kin/, /bol/, /ʃun/ and /kin/ never appear independently. The unmarked imperatives are shown to be basic and uninflected and the raised vowels their counterparts under alternation. I will follow Ghosh in assuming that the underlying verbal inventory of Bengali comprises only the vowels /ɛ/, /e/, /ɔ/, /o/ and /a/, and that these vowels undergo raising under the influence of following high vowels. The systematic raising in Bengali verbs does not mean that agreement involves the feature [ATR] only. This can be more gainfully interpreted as a process where both the features [high] and [ATR] play a role. The examples below again show that verbs undergo raising as a result of harmony.

(221) Vowel harmony in Bengali verbs

Present Continuous	Root	1P	2P Ordinary
	ʃon	ʃunc^h-i	ʃunc^h-iʃ
	ken	kinc^h-i	kinc^h-iʃ
Present Continuous	Root	1P	2P Ordinary
	bɔl	bolc^h-i	bolc^h-iʃ
	dɛk^h	dek^h-c^h-i	dek^h-c^h-iʃ
Past Continuous	Root	1P	2P Ordinary
	bɔl	bol-c^{h}i-lam	dek^h-c^{h}i-li
	dɛk^h	dek^{h}c^h-i-l-am	dek^h-c^h-i-l-i

this idea will be akin to an allomorphy analysis proposed in OT by Kager (1999) amongst others.

Past Continuous	Root	1P	2P Ordinary
	ʃon	ʃun-c^{h}i-lam	ʃun-c^{h}i-li
	ken	kinc^h-i-l-am	kinc^h-i-l-i

In order to offer a complete OT analysis of the Bengali verbal paradigm, the /ɔ/ → /o/, /o/ → /u/ and /ɛ/ → /e/, /e/ → /i/ height based alternations need additional constraints apart from the constraints already present in the hierarchy of constraints proposed until now. To recapitulate, the hierarchy of constraints proposed for nouns in Bengali is as follows:

(222) *[-ATR][+high +ATR] ≫ ID [±ATR]

Like nouns, the verbal paradigm also demonstrates cases where a morpheme /i/ triggers regular harmony in the mid [+ATR] vowels, so that /ɛ/ → /e/ and /ɔ/ → /o/. As the tableau below shows, we need an additional IDENT constraint on high vowels in order to cover all aspects of non-iterativity in Bengali:

(223) Sequential markedness constraint in Bengali

I:/kɔr/+/i/	*[-ATR][+high +ATR]	ID[±high]	ID[±ATR]
a. kɔri	*!		
b. ☞ kori			*
c. kɔre		*!	
d. kore		*!	**

In the tableau, /kori/ is selected as it fulfils the requirement that preceding vowels may be [+ATR], when followed by [+ATR][+high] values in a following vowel. The other candidates incur violations of IDENT [+high] and hence they lose in the evaluation.

However, this partial hierarchy does not account for candidates where there are height-based alternations i.e. /e/ → /i/ and /o/ → /u/, and this process calls for the introduction of another constraint. I propose the following constraint to this effect:

(224) *[-high][+high]
Assign a violation mark to a [-high] vowel followed by a [+high] vowel.

Apart from this constraint, which demands height alternations, there needs to be another constraint which prevents /ɛ/ → /i/ and /ɔ/ → /u/ alternations in Bengali. Following Kirchner (1996), I will assume that the local conjunction of two IDENT constraints regulates chain shifts in Bengali.

(225) IDENT [high] & IDENT [ATR]
Output values of [ATR] and [high] vowels are faithful to their input correspondents

Constraint conjunction prevents the changes of /ɔ/ → /u/ and /ɛ/ → /i/, as it would result in violation of both ID[ATR] and ID[high]. This will ensure that when there is an input like /kɔr/ as in (223) above, any change from /kɔr/ to */kur/ will be ruled out.

(226) Sequential markedness constraint in Bengali

I:/d^ho/+/cc^hi/	ID[high]&ID[ATR]	*[-high][+high]	ID[±high]	ID[±ATR]
a. d^hocc^hi		*!		
b. ☞ d^hucc^hi			*	

All the competing candidates vacuously satisfy the highest ranking *[-ATR][+high, +ATR]; the active constraints here are *[-high][+high], IDENT[±high][47]. The winning candidate, /d^hucc^hi/, violates IDENT [±high] but this is not a fatal violation. The candidate (226)- a violates *[-high][+high].

4.4 Tripura Bengali

The final language taken up for discussion here is Tripura Bengali. Tripura Bengali (henceforth TB), which is a variety of Bengali, spoken in the Indian state of Tripura. TB has the following inventory:

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[47] For all intents and puposes, I assume that ID[+hi] is ranked higher than ID[-hi], which keeps out the candidate */d^hocc^he/.

(227) TB vowel inventory

i	u
e	o
ɛ	ɔ
a	

Here again (like Pulaar and Standard Colloquial Bengali), the four vowels /i, u, e, o/ are [+ATR] and the vowels [ɛ ɔ a] are [-ATR]. TB shows regressive vowel harmony and triggers harmony only in the preceding syllable. Das (2002) notes that harmony in TB operates as a "result of the phonetic space which lies vacant because of restructuring of the vowel inventory". As a result, the marked vowels /e/ and /o/, which are in the core inventory of Standard Colloquial Bengali, are being systematically replaced by /i/ and /u/. The following are some examples of these replacements which have taken place in TB:

(228) Restructuring in TB

SCB	TB	Gloss	SCB	TB	Gloss
ʃ ek	sik	'learn'	gel	gil	'swallow'
ken	kin	'buy'	ʈep	ʈip	'press'
peʈ	ɸiʈ	'beat'	tʃen	sin	'know'
p^heɽ	$ɸ^h$ir	'return'	g^her	g'ir	'surround'

(229) Restructuring in TB

SCB	TB	Gloss
bodʒ^h	buz	'understand'
g^hor	g'ur	'turn around'
oʈ^h	uʈ	'get up'
k^hõʈ	k^huʈ	'erase with nail'

The process of replacing /e/ with /i/ and /o/ with /u/ is seen by Das as a progression towards a vowel inventory which falls in line with universally unmarked tendencies[48].

[48] Das points out that there are a few word-initial syllables where /e/ and /o/ occur independently. He argues that the word-initial syllable is itself the 'legitimate licensor' in order to allow the occurrence of this marked

Das argues that the underlying presence of /e/ and /o/ signals the presence of more marked peripheral vowels in the inventory. Leaving aside marked or unmarked tendencies, it is clear that just like Assamese, /e/ and /o/ have an allophonic status in TB. As the examples below show, /e/ and /o/ occur as a result of harmony in verbal and nominal paradigms, resulting in the shifts /ɛ/ → /e/ and /ɔ/ → /o/ alternation:

(230) Harmony in TB verbal roots

Verb Roots	Suffix		
lɛk	i	lehi[49]	'write, 1P, Pres.'
dɛk	i	dehi	'see, 1P, Pres.'
bɛs	i	besi	'sell, 1P, Pres.'

(231) Nominal paradigms

Nouns	Suffix		Denominal adjectives	
dɛʃ	i	'country'	deʃi	'native'
tɛz	i	'anger'	tezi	'angry'
kɛʃ	i	'hair'	keʃi	'hairy'
bɛʃ	i	'dress'	beʃi	'person wearing that dress'

(232) Harmony resulting in /ɔ/ → /o/ alternation:

Verb root	Suffix	Gloss
sɔl	i	soli 'walk, 1P Pres'
ʃɔr	i	ʃori 'move aside, 1P Pres'
gɔn	i	goni 'count, 1P Pres'

---

vowel (as medial non-peripheral vowels are known to be universally marked). 'Faithfulness to prosodic heads' drives this kind of licensing and the independent occurrence of /o/ is exclusively restricted to the word-initial position: and in all other positions /o/ is followed by a high vowel in the next syllable. Thus the two mid vowels /e/ & /o/ can exist independently – i.e. when not followed by a succeeding high vowel - iff they occur in the most prominent syllable of the word.

[49] The /k/ ~ /h/ alternations seen here is the result of a process of lenition where underlying aspiration is preserved despite the deletion of the obstruent in the derived form. I will not discuss this in any more detail here. See Das (1996) for details.

lɔr	i	lori 'waver, 1P Pres'

The discussion thus far has focussed on disyllables only. However, data pertaining to longer syllables show that when harmony is triggered by a final vowel, it can affect only the preceding vowel. In other words, just like the Standard variety of Bengali, there is no iterativity of assimilation in TB. The examples are given below:

(233) Non-iterative harmony in Tripura Bengali

bɔʃɔt	i	bɔʃoti	*boʃoti	'residence/locality'
ɔʃɔt	i	ɔʃoti	*oʃoti	'fem. of immoral'
pɔd	obi	pɔdobi	*podobi	'title'
kɔtɔk	i	kɔtoki	*kotoki	'talkative person'

Das confines himself to the analysis of the stress facts of Tripura Bengali and therefore does not provide any analysis of its harmony facts, which I will attempt to do in this section. Most of the data provided here were taken from Das (2002) but some others have been gathered from Das through personal communication.

4.5 Non-iterative agreement in Tripura Bengali

As I have already argued before, iterative and non-iterative operations in vowel harmony are the result of the interaction of featural markedness constraints, rather than being different processes *per se*. While taking into consideration the difference in iterativity exemplified by the members of the Eastern Indic group, i.e. Assamese, Tripura Bengali and Standard Colloquial Bengali, it has become clear that at least for this group of languages differences in the iterativity of assimilation are a matter of cross-linguistic variation. The ability of sequential markedness to handle cases of non-iterativity will shortly be exemplified for TB as well. However, unlike Bengali, but similarly to Assamese, the outputs of harmony in TB are allophonic.

The basic harmony pattern, which is non-iterative, can be analysed just like Bengali with the high ranking constraint *[-ATR][+high, +ATR]. I define this constraint as below:

(234) *[-ATR][+high +ATR]
Assign a violation mark to a [-ATR] vowel followed by a [+high +ATR] vowel.

Like Assamese, allophonic agreement in TB involves the co-occurrence constraint *[-high +ATR].

(235) *[-ATR][+high +ATR] ≫ *[-high +ATR] ≫ ID[ATR]

/dɛʃ / + /i/	*[-ATR][+high +ATR]	*[-high +ATR]	ID[± ATR]
a. dɛʃi	*!		
b. ☞ deʃi		*	*

Non-iterativity is analysed as the non-availability of the context for neutralisation, and there is therefore no violation of the constraint which drives neutralisation, whenever harmony does not occur in the whole word.

(236) *[-ATR][+high +ATR] ≫ *[-high +ATR] ≫ ID[± ATR]

/pɔd + ɔbi/	*[-ATR][+high +ATR]	*[-high +ATR]	ID[± ATR]
a.☞ pɔdobi		*	*
b. podobi		**!	**
c. pɔdɔbi	*!		
d. podɔbi	*!	*	*

As we have already discussed, an all-inclusive constraint like AGREE would have caused all the vowels to harmonise, leading to the selection of [podobi] as the output. However, a sequential constraint is not violated even if there is only partial assimilation. In (236) above, context sensitive neutralisation requiring alteration of [-ATR] only in the presence of high [+ATR] vowels produces the right output candidate /pɔdobi/. This output candidate does not require complete harmony, so that /ɔ/ and /o/, the first and second vowel can remain as a disharmonic sequence. /ɔ/ and /o/ do not agree because /o/ does not provide /ɔ/ with the context for agreement, thereby producing partial assimilation. The constraint *[-ATR][+high +ATR] allows agreement in the example in (235) as well.

Another important question which vies for attention here is the relation of this requirement of adjacency to the prosodic domain of foot, etc. Under binary parsing, there is no way that the triggering vowel and the harmonised vowel can be within the same foot in the examples given above[50] – it is only the requirement of strict adjacency which drives this kind of harmony.

4.5.1 Conclusion

This chapter has been central in this thesis with respect to the analysis of regressive harmony across a number of languages, including Assamese, which plays an important role in this dissertation. I have shown in this chapter that regressive harmony in a range of languages as diverse as Assamese, Pulaar, Karajá, Bengali and Tripura Bengali can be suitably analysed as neutralisation in context. Plenty of phonological processes have been shown in the generative literature to be the effects of contextual neutralisation, including umlaut (Kiparsky 1981). While earlier approaches involved rule-based mechanisms, OT approaches benefit from expressing a markedness requirement in a linear sequence of features. True to the predictions of OT, such markedness requirements can be shown to have a universal basis, as shown by the application of the constraint *[-ATR][+ATR] to regressive [+ATR] harmony languages as diverse as Assamese (section 2), Pulaar (section 3) and Karajá (section 3.7). It has also been shown in this chapter that non-iterative neutralisation in Bengali and Tripura Bengali are also the effects of sequential markedness. Abstracting away from further complications like non-allophonic /ʊ/ in Assamese (section 2.2) and the chain shift in Bengali verbs (section 4.3.1), the following ranking of constraints captures the interaction of these constraints in regressive harmony languages:

(237) Types of regressive harmony systems

(i) Iterative and allophonic harmony in Assamese and Pulaar
*[-ATR][+ATR] ≫ *[-high +ATR] ≫ ID[ATR]

(ii) Iterative and contrastive harmony in Karajá
*[-ATR][+ATR] ≫ ID[+ATR] ≫ ID[-ATR]

(iii) Non-iterative and contrastive harmony in Bengali
*[-ATR][+high +ATR] ≫ ID[+ATR] ≫ ID[-ATR]

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[50] TB exemplifies ternary rhythm and Das (2002) analyses it as binary parsed. Even with a different parsing, the foot would not be a relevant harmony domain here.

(iv) Non-iterative and allophonic harmony in Tripura Bengali
*[-ATR][+high +ATR] ≫ *[-high +ATR] ≫ ID[ATR]

Thus, while epiphenomenal directionality can be shown to be the result of morphological dominance of the root/stem (as in Turkish or Finnish) or the dominance of a feature in dominant–recessive systems (as in the examples in section 2 of chapter 2), regressive vowel harmony systems, both iterative and non-iterative are the result of neutralisation in the context of marked feature combinations. Furthermore, sequential markedness constraints imply that agreement proceeds locally and iterativity affects one possible target after another. This iterative agreement can however be terminated by multiple featural requirements (in our case in Bengali and Tripura Bengali, in section 4) which results in local agreement only. Next, a word about the typological relevance of *[-ATR][+ATR]. Instantiated in so many languages accounted for in this chapter, the universal significance of this constraint is beyond reasonable doubt. However, I expect that rather than assuming similar markedness sequences for all other features, for instance *[-back][+back] or *[-round][+round], exists in Universal Grammar is far-fetched, future research can effectively restrain such constraints because only [±ATR] is involved in regressive processes.

As pointed out by René Kager (p.c.), another possibility which was not explored in detail in this dissertation is the factorial typology of the non-iterative systems that the proposed analysis predicts. Accordingly, the prediction of non-iterativity in Bengali will be borne out only if the mid [-ATR] target vowel directly precedes the trigger. However, as I have shown in Bengali, there is a process in the verbal morphology where there is a 'chain-shift', with mid vowels raising to higher vowels. In such a case, the output of harmony will result in a new violation of the constraint demanding non-iterative agreement. In that case, a second change will be required to undo this violation. This hypothetical condition will result in a series of repairs, unless the representation meets a [-ATR] mid vowel which will stop this semi-iterative process. I have to assume that this process is hypothetical, given that in the languages examined until now, no such semi-iterative effect has been noticed. In Bengali itself, this kind of semi-iterativity does not occur because in the verbal patterns where the chain shift occurs, the verbal roots are always monosyllabic. There is also no prefixation which can occur to the verbal base. Therefore, the chain shift can affect the verbal base only once, and thereby limiting the effects of the constraint demanding non-iterativity. Given the current constraint set, such a language is definitely predicted by the factorial typology at large.

Further, *[-ATR][+ATR] can be satisfied by undoing the markedness violation in one of the two ways – by output candidates which are [+ATR][+ATR] as well as by [-ATR][-ATR]. The former implies regressive harmony of the Assamese, Pulaar and Karajá type, the latter implies the presence of regressive [-ATR] harmonies. Such types of harmony are not typologically unattested (Kimatuumbi, Odden 1991 for example). *[-ATR][+ATR +high] also predicts that candidates can satify the constraint by height alterations. This again brings us back to the question of semi-iterativity discussed in the previous paragraph. The fact that in Bengali itself, IDENT[high] is not undominated shows that there is no universal ranking of IDENT[high] » *[-ATR][+ATR +high] . But the question of the gap in the factorial typology with an unattested semi-iterative system still lingers and typologically, it will be definitely be a milestone if such a type of semi-iterativity is noticed in any of the many dialects of Bengali and elsewhere.

Chapter 6

Harmony blocking by vowels and consonants

1 Introduction

In chapter 5, I characterised phonological harmony in a language such as Assamese as the result of a sequential markedness constraint *[-ATR][+ATR] which, together with other faithfulness and markedness constraints, selects on the optimal output. I will propose a modification of this constraint in this chapter. The reason for this modification lies in a range of blocking facts, which interrupt the spread of vowel harmony in Assamese. Most importantly, I will also show in this chapter how sonority plays a role in blocking harmony, more specifically, it is typically more sonorous elements which are involved in blocking harmony. Canonical vowel harmony is expected to spread from vowel to vowel without affecting[51] or being affected by intervening consonants. This is only an ideal state of affairs, and it is often violated in a significant number of vowel harmony languages. The core of this chapter deals with three kinds of blocking encountered in Assamese: blocking by the [-ATR, +low] vowel /ɑ/, blocking by the nasal consonants /n/, /m/ and /ŋ/, and blocking by consonants in a moraic position. The goal of this chapter is to show that in Assamese, local intervention by consonants and vowels is driven by the principle of sonority. In contrast, non-local blocking, i.e. intervention by consonants which are not segmentally adjacent is the result of prosodic requirements. This chapter therefore addresses the question of adjacency and its consequences for languages where only some segments intervene in spreading processes and others do not. The arguments in this chapter will motivate a theory of segments that may stand between the trigger and target and that impede spreading of the relevant [αF] vocalic feature. Importantly however, I do not deal with so-called 'transparent' vowels where an intervening vowel is left unscathed by the spreading process. The non-delineation of

[51]Under the strict locality condition (Ní Chiosaín and Padgett 1997, 2001, Walker 1998), it is expected that vowel harmony will influence all the intervening segments, without resulting in distinctive featural changes.

transparency should not be considered as a drawback of the analysis, as the driving force behind the chapter is opacity and not transparency[52]. By laying more importance on opacity driven by consonantal segments, I hope to fill a void with respect to analyses of consonantal intervention within OT in vowel harmony, save a few (Ní Chiosaín and Padgett 1997, and others). In this chapter, along with consonantal blocking in Assamese, I also discuss vowel harmony blocking by consonants in Turkish, where harmonisation of vowels in terms of the feature [+back] is blocked by palatal consonants. It will be shown that thisa phenomenon is also compatible with the definition of consonantal blockers that will be developed here.

Section 1.1 is a brief introduction to phonologically opaque segments in Assamese. Section 2 presents an in-depth account of nasals blocking harmony. This section is divided into three subsections in order to present more evidence for the universal tendency of more sonorous elements to participate in vocalic processes. Section 3 presents a broad overview of consonantal participation in harmony processes and discusses various feature-based theories before presenting the proposal that potential undergoers tend to block harmony. The section cocludes with a synopsis of the unified analysis of consonants and vowels blocking harmony in vowel harmony languages. Section 4 presents an account of harmony blocking by coda consonants and shows that it is related to the prosody of the language. Section 5 is on the opacity of the low vowel /ɑ/. This section is further subdivided into four subsections which first show how an analysis based on sonority is more plausible for the opaque intervention manifested by /ɑ/. Section 5.3 takes up the problem of 'sour grapes' (McCarthy 2004), a problem which is predicted to happen when harmony is only partial (also discussed in chapter 3). Section 5.4 presents a conclusion within the so-called OT theory of Harmonic Serialism which shows that the problem of 'sour grapes' needs to be tackled with a locality convention. The chapter concludes with an overall conclusion in 5.5.

1.1 The opacity of vowels and consonants

It is commonly assumed that phonological opacity arises as a result of vowels not bearing the features that harmony spreads. If a non-alternating vowel occurs between the target vowel and the trigger, the harmony span of the triggering vowel is blocked.

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[52] Furthermore, there are no transparent vowels in Assamese.

Hence these non-alternating vowels are called opaque vowels. There are a staggering number of languages where /ɑ/ blocks harmony[53].

In this chapter, I propose that the opacity of /ɑ/ arises because of its sonority. The standard treatment of phonological opacity is by using multiple feature markedness constraints (Baković 2000, see also Archangeli and Pulleyblank 1989, Kiparsky 1981 amongst others). However, in many languages, for example in Turkish vowels also alternate to other vowels, which are not their exact counterparts in the inventory (In Turkish, prospective [æ ɤ] are prohibited by re-pairing the mid [-low, -back] with the [+low, +back] vowel [ɑ]). In Assamese too, /ɑ/ alternates to /e/ and /o/ when /-iyɑ/ and /-uwɑ/ exceptionally trigger harmony as in /mɑr/ 'beat' + /iyɑ/ → /moriyɑ/ 'beat' (causative), /d^{h}ɑr/ 'debt' + /uwɑ/ → /d^{h}oruwɑ/ 'debtor' (see the next chapter for a detailed analysis). The undominated constraint *[+ATR +low], would only prohibit the non-occurring vowels [æ, ɐ] but not the potential ones, [e] and [o][54]. Therefore, the motivation for blocking is not solely provided by *[+ATR +low], as it is not able to prevent other ways of resolution of phonological opacity. The constraint *[+ATR +low] is not activated to prevent potential instances of [e] and [o] when /ɑ/ exceptionally undergoes harmony. To resolve the ambiguity that *[+ATR, +low] gives rise to, we need another constraint IDENT[low] which is violated when /ɑ/ changes to other [+ATR] vowels in the inventory.

In an OT analysis, the opacity of /ɑ/ can be shown to be the result of a high ranking faithfulness constraint on low vowels, i.e. IDENT[low]. The intrinsic sonority of vowels has been widely accepted to vary according to the following hierarchy:

(238) sonority hierarchy of vowels:
LOW ≫MID≫HIGH
a ≫ e, o, ≫ i, u

---

[53] This has been reported for [±ATR] harmony in Hall et al (1980), mostly in West African languages e.g. Wolof, Fula, Diola Fogni. In all these systems, the organising principle is such that [+ATR] vowels are dominant and [-ATR] vowels are recessive, so that opaque vowels can block the harmony propagated by the triggering [+ATR] vowel and start their own harmony domain.

[54] This implies that there are two sets of languages, one where *[+ATR +low] is violated in the inventory and as a means of avoiding opacity, and onother where *[+ATR +low] is never violated. This is discussed again in chapter 7.

I propose that the need for this highly ranked faithfulness constraint arises in order to protect more sonorous elements[55]: I follow approaches which express the sonority scale in terms of faithfulness constraints (see Howe and Pulleyblank 2004):

(239) Harmony-as-faithfulness:

FAITHLOW	≫	FAITHMID	≫	FAITHHIGH
a	≫	e,o	≫	i,u

The operation of the constraint FAITH[low] and the way it is ranked vis-à-vis the rest of the constraint hierarchy proposed in the previous chapter will be demonstrated in section 5.

As far as blocking by /ɑ/ is concerned, Assamese vowel harmony is not very special; the special feature of Assamese is that there are also other non-vocalic segments that block the spread of the feature [ATR], namely nasal consonants and all consonants in coda positions.

This chapter argues that vowel harmony blocking by consonants is not an anomaly and consequently, one of the goals of this chapter is to explore the phonological explanation for these occurrences. I do not address the issue of feature spreading to all elements (in a certain domain) *per se*. Rather I show that in Assamese non-vocalic elements may *block* harmony. In other words, even though consonantal elements may allow harmony to permeate from one element to the other, there may be consonantal segments which stop harmony from spreading. Vowel harmony blocking in consonants is driven by the principle of 'similarity' in the appropriate local domain. The problem lies in defining what exactly similarity is. I propose that a consonant's similarity to a vowel in vowel harmony can be evaluated in two ways: (i) it can be measured by a consonant's proximity to vowels on the sonority scale; (ii) similarity can also be apparent from features that both vowels and consonants could possibly share.

[55] While discussing the inapplicability of non-contrastive visibility (cf. section 3.1) to various case of opacity, Nevins (2004) proposes that instead of non-contrastiveness, sonority should be considered the guiding principle in assessing opaque interactions in languages. This argument is fuelled by data from Wolof, Hungarian, written Manchu, etc., where despite the presence of contrastive vowels, only the non-contrastive ones are opaque. However, opacity is proposed to be non-existent in this target-centric theory.

Importantly, I do not adopt the autosegmental approach to blocking by vowel harmony. I intend to show that vowels and consonants are not always bound by the conventions of locality proposed in previous work, which adopts the autosegmental requirement of segregated levels. It will be shown that in the case of blocking, the important defining characteristic is the higher sonority of the blocking segment, which in Assamese simply precedes the triggering vowel.

With this brief background on the main ideas that will be explored in the following sections, I proceed to present the data and analysis of nasals blocking harmony in Assamese.

2 Nasals blocking harmony in Assamese

Vowel harmony is sometimes blocked by intervening nasal consonants. As shown in the examples in (240)(a-d) vowel harmony is blocked by an intervening nasal consonant.

(240) Nasals blocking harmony in Assamese

	Word	Gloss	
(a)	sɛkɔni	'strainer'	(*sekoni)
(b)	xɔmɔniɑ	'colleague'	(*xomoniɑ)
(c)	pʊtɔni	'dumping ground'	(*putoni)
(d)	k^hɔmir	'leavening agent'	(*k^homir)

All the nasals /n/, /m/ and /ŋ/ in non-derived words block harmony in the examples above. Harmony is blocked if the nasal occurs in similar positions in derived environments as well:

(241) blocking by nasals in derivations

	Root	Gloss	Suffix	Derivation	Gloss (Derivation)
(a)	d^hɔr	'hold'	ɔni	d^hɔrɔni	'support'
(b)	mɔt^h	'churn'	ɔni	mɔt^hɔni	'churning stick'
(c)	pʊr	'burn'	ɔni	pʊrɔni	'burn'
(d)	pɛlɑ	'throw'	ɔni	pɛlɔni	'throw'
(e)	zɔmɑ	'humour'	ɔni	zɔmɔni	'humorous'

The special feature of Assamese is that there is also a positional restriction on the nasals which block harmony: if the nasal is in the onset position of a syllable containing /i/ or /u/, vowel harmony will not take place, see (242) (a-c); whereas a nasal somewhere else in the word does not function as a blocker, i.e. if the nasal is not in the onset position of a syllable undergoing vowel harmony it will not block harmony. In (242) (a-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:

(242) No blocking in the presence of a nasal distally

	Word	Gloss
(a)	porinoti	'consequence'
(b)	ponoru	'onion'
(c)	somokit	'frightened suddenly'

Note also that only when a sequence of the high-mid back vowel /ɔ/ and a nasal occurs, is [ATR] harmony blocked.

2.1 Analysis of nasals blocking harmony in Assamese

Nasals blocking harmony is a local process, i.e. the spreading process can be arrested by an intervening nasal only when it *immediately precedes* the triggering element. Local assimilation is dependent on phonotactic conditions and coarticulation, which requires adjacency of the participating segments[56]. For example, post-nasal voicing is often attributed to a coarticulation difficulty in devoicing following a nasal (Hayes & Stijvers 1995, Pater 1999). I assume that in the case of consonantal blocking in vowel harmony, the following (ad-hoc) principle plays a role:

(243) Let $a > b > c$ be a string of segments in the input, for any agreement relation Ɽ in terms of feature (f), such that the potential output is a(+f) >b(+f) > c(+f), but the actual output is a(+f) >b(-f) > c(-f), if b prevents agreement, then b is vocalically compatible/ has agreeable features and b is segmentally adjacent.

[56]For an articultorily motivated explanation of nasals blocking harmony in Assamese, see Grijzenhout and Mahanta (2004). Though I assume such constraints are at work in both assimilation and blocking, in this dissertation I do not offer an analysis based on articulatory constraints for blocking.

I assume that this principle plays a role in the GEN component of UG. For an OT account of nasals blocking harmony, I propose a sequential markedness constraint, *[oNi] which observes the principle of locality principle espoused in (243). The constraint is expressed as below:

(244) *[oNi]: There are no [+ATR -high +back] vowels in the presence of an immediately following Nasal consonant and a high vowel.

The feature [+ATR] percolates leftward from one non-low vowel to the next until it reaches the beginning of the word or a low vowel, and this process of regressive harmony can be arrested by an intervening nasal existing in an immediately preceding position to the triggering vowel. The tableau below shows an OT analysis of nasal blocking.

(245) *[oNi] blocks the spread of the feature [+ATR]

I:/mɔni/ 'pearl'	*[oNi]	*[-ATR][+ATR]	*[-high +ATR]	ID[ATR]
a.☞mɔni		*		
b. moni	*!		*	*

From the ranking above, it is evident that satisfying the constraint *[oNi] is more important than obeying the *[-ATR][+ATR] constraint. Note that the former is a sequential markedness constraint and not a featural markedness constraint like, *[+ATR, Nasal]. This is because there is only a co-occurrence restriction prohibiting local nasal and ATR sequences and no such restriction distally (see examples in (242)). This constraint bars candidates with vowel harmony only if the blocking nasal is in the immediately preceding position of the triggering vowel.

(246) *[oNi] does not prevent harmony in the presence of a nasal distally

I:/pɔnɔru/ 'onion'	*[oNi]	*[-ATR][+ATR]	*[-high+ATR]	ID[ATR]
a. pɔnɔru		*!		
b. ☞ponoru			**	**

*[oNi] does not choose between the candidates (246)-a and (246)-b because neither of them violate the markedness constraint. This constraint does not prohibit either

candidate from winning because the nasal is not in the immediately preceding position of the triggering syllable, showing that absolute adjacency is required to obtain the kind of blocking exemplified above. Eventually, it is left to the harmony driving constraint *[-ATR][+ATR] to decide between the two candidates, and *[-ATR][+ATR] chooses (246)-b, the harmonised candidate.

2.2 Nasalisation and harmony in other languages

Trigo (1991) shows that in Madurese, a [+ATR] specification spreads from a voiced obstruent but not from a voiceless obstruent and nasal; some of the data are given below:

(247) [-ATR] specification of nasals
(a) kʱ ɤman 'weapon'
(b) ŋaŋkʱiʔ-i

While this shows that nasals are [-ATR], the relevance of this feature for nasals may not be so straightforward in a vowel harmony context. Some more interactions between nasals and oral vowel sequences have been identified in a variety of cases exemplified below:

In Ijesa and Ekiti, (Przezdziecki, 2005) pronouns with [+ATR] oral vowels alternate, while those with [-ATR] or nasal vowels do not.

(248)	[+ATR]	[-ATR]
	(a) órígi 's/he saw a tree.'	ɔ́rɪ́lá 's/he saw okra.'
	(b) arígi 'we saw a tree.'	arɪ́lá 'we saw okra.'
	(c) ɛ̃rígi 'you (pl) saw a tree.'	ɛ̃rɪ́lá 'you (pl) saw okra.'

In Karajá (Ribeiro 2002), the vowels /ã/, /õ/, and /ẽ/ are opaque, systematically blocking the spread of regressive [ATR] harmony:

(249) Blocking by nasal vowels in Karajá

(a)	rɛhãɖere	'I hit (it).'
(b)	rakɔhɔdɛkõre	'He/she didn't hit.'
(c)	rɛmẽre	'I caught (it).'

Uffman (2006) shows that in epenthetic vowel assimilation in Shona loan words, sonority of the intervening consonants play a distinctive role in this language - vowel harmony only occurs across labial and coronal obstruents, not across sonorants. . In Shona, vowel harmony only occurs across labial and coronal obstruents, not across sonorants.

(250) Epenthetic vowels after a sonorants

(a)	aitemu	'item'	(d)	kirabhu	'club'
(b)	kiripi	'clip'	(e)	chifi	'chief'
(c)	timu	'team'	(f)	kirimu	'cream'

While Madurese shows a direct connection between [-ATR] and nasals, the other examples show a correlation between nasals and [ATR], i.e. there are constraints in the co-occurrence of the two. While this may or may not translate into a featural configuration of a nasal as [-ATR], it is quite plausible that there are articulatory constraints on nasals and non-low vowels occurring together. Although postulating a [-ATR] feature for nasals does not help us in Assamese, because nasals only in the onset position of a triggering syllable block harmony. However, I wills till assume that there is one and therefore, I now move on to show the implications of nasals blocking vowel harmony in a broader cross-linguistic perspective.

2.3.1 The acoustic and articulatory dimension of blocking by nasals

Continuing the discussion from the previous section, I consider some phonetic and phonological factors in search of a feature [ATR] or [high] that may be present or absent in consonants. Though there is no constriction in the production of nasals, the articulatory mechanisms required for the production of nasals involve the lowering of the velum, and a subsequent constriction of the pharyngeal cavity. In this section I discuss the function of these pharynx-larynx interactions and consider whether these factors lead to the specification of nasals phonologically as [-ATR].

Trigo (1991) and Vaux (1996) observe that many languages show interactions between consonant voicing and vocalic [ATR] values, mainly inducing vowels to change to [+ATR]. Vowels surface as [+ATR] after voiced obstruents, and as [-ATR] after voiceless obstruents. These phenomena have been effectively interpreted by these authors as resulting from a rule spreading [+ATR] from a consonant to a succeeding vowel. Phonetically, tongue root advancement has been shown to be of crucial importance in the articulation of voiced stop consonants (Vaux 1996). According to Vaux, voiced stop production increases pressure in the subglottal area ensuring continuous vibration of the vocal folds, and resulting in an expansion of the pharyngeal cavity and concomitant advancement of the tongue root. Trigo (in the case of Madurese, as shown in (247) notes some articulatory subtleties in the occurrences of [-ATR] vowels with nasals: (a) nasals and low vowels together enhance the perception of nasality as their resonances are close together; (b) nasality and low vowels are articulatorily related - one of the muscles that constricts the pharynx also lowers the soft palate.

Whalen and Beddor (1988) show that in Eastern Algonquian nasalisation developed historically without any consonantal conditioning. They furthermore show that a correlation between low vowels and distinctive nasalisation is not uncommon cross-linguistically. This is probably connected to the lower position of the velum found for low vowels. Beddor (1983:168) comments on the fact that many of the languages in her study "involve tongue position differences between oral and nasal vowels".

2.3 Implications of nasal intervention in vowel harmony

Though cross-linguistically not common, nasals blocking/participating in harmony cannot be considered an aberration. Existing linguistic theories had already shown that vowels and nasals interact more easily than other segment types. As a case in point, Walker (1998) proposes a typology of nasal harmony which predicts which segments are most likely to undergo harmony and which segments are most likely to block nasal spreading. According to this hierarchy, vowels are the most widely attested nasal segments and are the most susceptible to acquiring nasalisation in nasal spreading. Walker shows that all variation in the set of target segments in nasal harmony is based on the phonetically grounded universal harmony scale of nasalised segments, which corresponds to the implicational hierarchy in (251). It is evident that the ranking in (251) also duplicates the effects of the sonority hierarchy:

(251) *Nasalised segment harmony scale*
nasal sonorant stop > nasal vowel > nasal glide > nasal liquid > nasal fricative > nasal obstruent stop

Similarly, consonantal intervention in vowel harmony involves blocking by segments which are more likely to acquire vocalic features. Nasals, laterals and palatalised segments are the only segments which block harmony because they are more sonorous (i.e. by virtue of being ranked higher in the sonority scale, i.e., the nasals- and higher) and therefore they can potentially block to vocalic spreading. Cross-linguistically, nasals are regarded to be high sonority elements as they are capable of bearing the syllable nucleus. Nasalisation and nasal harmony are processes which lead to the articulation of the feature nasal on vowels as well as consonants. This means that consonants do take part in the process of harmony, and those features with a high degree of sonority, either primary or secondary, are eligible to be harmony blockers[57]. Therefore the phonological sonority hierarchy can be assumed to operate for consonantal blocking in vowel harmony as well:

(252) glides > liquid > nasal > fricative > obstruent stop

The hierarchy above only replicates the sonority scale which is supposed to be operative in Universal Grammar, but the property of being more sonorous is not the only criteria which is important in the blocking of harmony; featural compatibility is also required to be a consonantal blocker. This means that the motivation of a sonority scale does not imply that all the higher sonority elements in the scale will necessarily block harmony in the concerned language. The sonorous element blocking harmony will also have to be complemented by an additional featural requirement. The question which also needs to be answered here is regarding the necessity of having the dual requirements of sonority as well as featural compatibility in blocking vowel harmony. The answer to this lies in the fact that though voiced consonantal segments also show the requirement of a [-ATR] feature, their demonstrated ability to block vowel harmony has not been recorded so far.

3 A Broad outlook on consonant-vowel relationships

Having shown in the preceding sections how nasal consonants can create disharmony in Assamese and how nasals behave in harmony processes, I will now give a bird's eye view of how previous theories have proposed to deal with consonant-vowel interactions. Subsequently, I will explicitly state my own view regarding this phenomenon.

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[57] I assume that consonants do not trigger harmony and impose their consonantal features on vowels, as it is generally accepted as uncontroversial that imposing a consonantal place on a vocalic segment would lead to the undesirable consequence of prohibiting syllabification by converting a vowel into a consonant. (Ní Chiosaín and Padgett 1997 and others).

While linear phonology made it possible for rules to apply to non-adjacent segments, the advance of non-linear phonology made room for a hierarchical set of features within a segment and made it possible to view long-distance rules as rules operating between segments at some level of representation. This theory was then subjected to various locality conditions, which required local elements to be subject to 'internal requirements' (Howard 1972) and a class of segments to be 'relevant' to the spreading rule (Jensen 1974). In autosegmental theory (Goldsmith 1976, 1979), potential Feature Bearing Units (FBU) bear the spreading feature, so that the rule of spreading targets only the feature bearers excluding the non feature bearers (consonants in vowel harmony for instance). The No Crossing Constraint (NCC) forms the crucial constraint on the autosegmental analysis of intervening elements. The well-known NCC operating within autosegmental theory can be stated as below:

(253) Association lines may not cross a plane
(Clements 1990)

The NCC prohibits crossing of association lines, i.e. segments specified for the harmonising property cannot be excluded from the rule of spreading. In this theory, consonantal and vocalic place features are represented on different planes. Spreading of vocalic place features across consonants does not result in violation of the NCC, since consonants and vowels are on different planes. The NCC was used to explain facts like opacity and neutrality of some vowels in the harmony process. The No Crossing Constraint represents blocking of spreading through a [-αF] specification on the blocking segment. Significant developments ensued in understanding adjacency requirements in spreading processes, which includes as central studies, among many others, Steriade (1995) and Archangeli and Pulleyblank (1987, 1994). According to Steriade (1995:121):

(254) The elements related by a phonological rule or constraint must be adjacent on some tier.

The Prosodic Licensing Hypothesis (Itô 1986) proposed that features can be surface-true only when they are incorporated into the prosodic structure. The prosodic model by Hyman (1985) McCarthy and Prince (1986 1990), Hayes (1989) and Itô (1988, 1989) proposes that features are aligned to prosodic structure, either into moras or into syllables. The length of long vowels, and coda consonants, can be counted as extra moras. In line with this tradition, Archangeli and Pulleyblank (1994) also propose that features could have prosodically defined anchors, which are (i) a non-head mora, (ii) syllable head mora, (iii) any mora, head or non-head. Odden (1994) proposed two adjacency parameters: syllable adjacency and root adjacency. van der Hulst and van de Weijer (1995) and Piggott (1996) proposed that harmony is a relation which holds either between segments or between suprasegmental units.

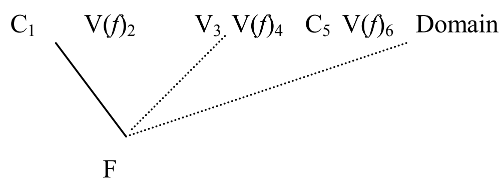
With this background on the paradigmatic relationships which have been proposed to exist between segments in a harmony domain, I move on to discuss some feature theories which have contributed to the understanding of consonant-vowel relationships.

3.1 Feature Theories

Different representational mechanisms have been assumed in linear as well as non-linear theories to explain segment skipping in vowel harmony domains (see also discussion in the preceding section on approaches to opacity and neutrality of vowels). Vowel Place Theories (Clements 1985, 1987, 1989) segregate vocalic and consonantal Place features.

Clements (1980) and Goldsmith (1976, 1979), propose that segments which undergo a change under harmony are possible targets because they can bear the harmonising 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 (255) below where the harmonising feature F propagates only to those segments which are the 'legitimate feature bearers' or *(f)* in a vowel harmony domain (prosodic word, morphological word, foot, etc).

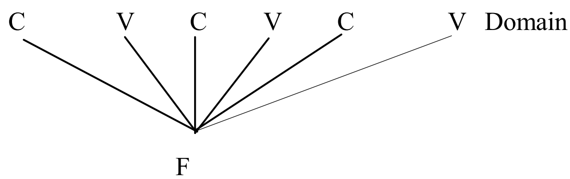
(255) Vowel harmony as spreading of a harmonising feature F



Intervening segments are regarded as non-participants in the vowel harmony process (see above).

In the Unified Feature Theory (Clements 1989), a single set of Place features for both consonants and vowels has been proposed. Others, such as the advocates of strict locality, propose ‘No segment skipping’ (Ní Chiosaín & Padgett 1997, Gafos 1998). These approaches (also Walker (1998) regard 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. This is schematically shown below:

(256) Vowel harmony as spreading of a harmonising feature F affecting all elements within a certain domain



In this context, Casali (1995) treats blocking by consonantal segments in Nawuri labial harmony as the result of a place theory where labials occupy the same tier as vowels. In Nawuri, round vowels and glides trigger high vowels in an immediately preceding syllable to become round. In careful speech, assimilation is blocked by intervening plain labial consonants. The examples below show singular noun class prefix /gI-/, where /I/ represents a high vowel whose roundness and [ATR] qualities are determined by the following vowel.

(257) Nawuri Labial harmony

(i)	gɪ-sɪbɪta	‘sandal’	(ii)	gɨ-mu	‘heat’
	gɨ-keːliː	‘kapok tree’		gɨ-fufuli	‘white’
	gʊ-sʊ	‘ear’		gɨ-pula	‘burial’
	gu-ɟo	‘yam’		gɨ-boːtoː	‘leprosy’

Casali analyses this assimilation as spreading of [labial] from a [-consonantal] segment. Since the place node and its dependent features (e.g. [labial], [coronal]) occupy the same tier in consonants and vowels, labial consonants can lead to the blocking of labial harmony.

Finally, Articulator Theories see spreading as implementation on terminal nodes in the feature tree (Halle 1995, Halle et al. 2000). Halle (1995) shows that the reason why vowel features spread across intervening consonants is that vowel features are executed by dorsal and coronal articulators and Labial and Dorsal are non-contrastive among consonants. In this regard, Halle (1995) discusses the vowel copy rule in Ainu. In Ainu, suffix vowels are copied from the stem vowel. However, vowel copying does not take place once the glides [y w] intervene between the stem and the suffix.

(258) vowel-copying in Ainu

mak-a	'open'	tas-a	'cross'	ray-e	'kill'
pop-o	'boil'	tom-o	'concentrate'	poy-e	'mix'
pis-i	'ask'	nik-i	'fold'	eiw-e	'sting'

The Ainu glides [y w] are considered to be positional variants of the high vowels [i u]. Dorsal will spread freely across intervening consonants, but vowel features will not spread across a [y w] glide, since in Ainu these glides are segmentally equivalent to high vowels and therefore possess a full set of dorsal features that will prevent the spreading of the vowel features.

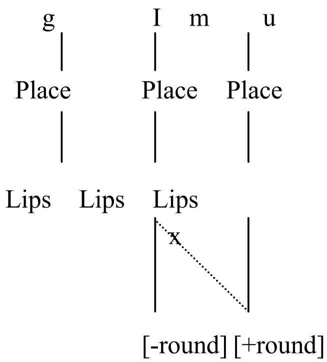
In the Revised Articulator Theory (Halle et al 2000), henceforth RAT, which is very much like the AT, feature spreading is seen as an operation affecting only the terminal nodes of the feature tree. Spreading of terminal nodes is dominated by the place node, thereby allowing feature spreading. According to the principles of terminal spreading, terminal features can spread individually or simultaneously. Halle et al (2000) furnish various arguments concerning how RAT is superior to other theories: it replicates the actual functioning of the articulatory mechanism by assuming a representational hierarchy of features/designated articulators which correspond to their actual place in the vocal tract.

Contrastiveness, in the sense of Calabrese (1995), plays a significant role here. Contrastiveness in this theory is related to the notion of markedness. Some feature combinations are marked and in languages where the marked combination exists, the two values of the feature are contrastive. According to RAT, only contrastive features are *visible* to the harmony rule. In the authors' (Halle et al. 2000:412) words:

"In the AT account the interaction or non-interaction of consonant and vowel places is determined solely by the contrastiveness or markedness of features…"

In RAT, blocking by labial vowels in Nawuri is handled in the following way:- Nawuri contrasts plain and rounded labial consonants in its phonemic inventory: /p/ contrasts with /p^{w}/ and /b/ with /b^{w}/, /f/ with /f^{w}/ and /m/ with /m^{w}/. In RAT, rounded labials are contrastively specified as [+round] and plain labials are contrastively specified as [-round]. The rule of spreading adopted here is: Spread contrastive [round] right to left from a [-consonantal, +sonorant] segment. This rule is applicable only to contrastive [round] specifications, it is blocked by the contrastive [-round] plain labials, as exemplified below:

(259) Spreading in Nawuri according to RAT



The rule of spreading is blocked in this case, but the rule applies successfully in other cases where segments without the relevant contrast intervene. Thus the singular noun-class prefix /gI/ becomes round before a round vowel in a following syllable.

In Turkish, on the other hand, the palatal lateral blocks harmony if it is in the word-final position, where it can also occur contrastively:

(260) Palatal laterals block harmony in Turkish

/petroʎ/		'gasoline'
petroʎ	*petrol	nom-sg
petroʎ-y	*petroʎ-u	acc-sg
petroʎ-de	*petroʎ-da	loc-sg
/meʃguʎ/		'busy'
meʃguʎ	*meʃgul	'he is…'

meʃguʎ-dym	*meʃguʎ-dum	'I was…'
meʃguʎ-ym	*meʃguʎ-um	'I am…'

The palatal laterals interaction with harmony shows that harmony is not a syllable head to syllable head interaction. Levi (2004) deals with the question of which segments have the relevant features. Levi concludes that harmony interacts with all segments which have the appropriate features, independent of the nuclear or syllabic status of the segments.

3.2 Syllable head theory

Discussing consonantal interference in vowel harmony van der Hulst and van de Weijer (1995:530) state that: "cases where such interaction takes place have been used to argue that features for representing place in consonants and vowels are partly the same, but precisely under what circumstances vowels harmonise with consonants is not clear…". These authors argue that allowing consonants to freely influence vowel harmony would be a drawback to a theory of harmony where only syllable heads are expected to participate in harmony, although vocalic content even in non-head positions may participate directly in harmony. The impetus for vowel interactions has thus been shown to be subject to some intervening secondary articulatory phenomenon. In vowel harmony languages, the interaction between vowels and consonants was noticed primarily in Turkish, where secondary place features trigger harmony, imitating rounding vowel harmony in Turkish. Clements and Sezer (1982) report Turkish words where palatalised velars spread their palatalised quality to following suffix vowels.

(261) /k^j/ determines vowel harmony in Turkish

infil^{j}ak	infil^{j}ak^{j}i	explosion
idrak	idrak^{j}i	perception
ittifak	ittifak^{j}i	alliance
istirak	istirak^{j}i	participation
helak	hel^{j}ak^{j}i	exhaustion

These authors also mention other palatal harmony languages like Bashkir (based on Poppe 1962), where front velars are found in words with [-back] vowels and back velars are found in words with [+back] vowels.

3.3 Towards a unified analysis of harmony blocking by consonants and vowels

Most of the theories discussed in the preceding sections fail to capture Assamese consonant-vowel interactions. In Assamese, there is no way to show that nasals are contrastive for the feature [ATR], as predicted by the Articulator Theories. On the other hand, as predicted by the syllable head theory, nasals are never syllabic in the language. Putting the proposals from the previous sections aside for a moment, I propose that vowel harmony blocking by consonants is driven by the principle of 'similarity' in the appropriate local domain. I consider two factors to determine similarity[58]:

(i) similarity can be measured by a consonant's proximity to vowels in a sonority scale;
(ii) it can also be apparent from features that both vowels and consonants could possibly share. This is also evident from other phenomena where consonant-vowel interactions involve agreement, as features like dorsal, coronal and labial can be seen as properties of both vowels and consonants. Though unbounded feature spreading between vowels and consonants has not been established unequivocally, spreading between vowels and consonants does exist.

In the literature on harmony processes, it has been commonly shown that harmony is a process of establishing a relation of identity between adjacent syllables, moras, and the like (Archangeli and Pulleyblank 1994, van der Hulst and van de Weijer 1995, Krämer 2003 Piggott 1999). The high sonority of nasals and their degree of closure may also make them suitable as being a part of prosodic domains which other consonantal features may be deprived of. In this prosodic view, locality would require segments to be adjacent in one of the tiers of the prosodic hierarchy. Locality construed in these prosodic terms is paradigmatic and therefore segments can be adjacent to each other at a specific prosodic level even though at the level of segmental structure, they are not strictly speaking adjacent.

I argue that consonantal segments can block vowel harmony to the extent that they can bear the spreading feature in some way. The notion of 'similarity' as used here should be understood in the sense of elements, which have a higher sonority (at least

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[58] Walker and Rose (2004) examine Long Distance Consonant Agreement (LDCA), and formally analyse it as a relationship of similarity between the participating segments. For their computation, they use similarity scales as proposed by Frisch et al (in press) and these function as the basis for relative similarity along with a survey of attested LDCA patterns. It remains to be seen if such similarity scales play a role in blocking patterns attested in harmony.

nasal and higher), and at the same time can share some feature specification of the triggering vowel. Nasals in Assamese can block harmony because while the nasal is sonorous it also interacts with [-ATR] feature in the language. The following is a partial list of consonants which have been known to have non-prosodically ‘blocked’ the spread of vowel features:

(262) Non-prosodic blockers in languages

Glides,	Nasals	liquids
Turkish	Assamese, Karajá	Turkish, Warlpiri

An implicational hierarchy assuming the following sonority scale can be constructed for all these cases of consonantal blocking. The result of this hierarchy would produce the following relevant constraints regarding consonantal blocking across languages:

(263) Turkish
***glides+round** ≫ *liquid+round ≫*nasal+ round ≫ fricative, round ≫ *obstruent stop

(264) Turkish
*glides+round ≫ ***liquid+round** ≫*nasal+ round ≫ fricative+round ≫ *obstruent stop.

(265) Assamese, Karajá
*glides+ATR ≫ *liquid+ATR ≫ ***nasal+ATR** ≫ *fricative+ATR ≫ *obstruentstop +ATR

The constraint hierarchies show how the notion of the sonority hierarchy in blocking vowel harmony across languages can be incorporated. The typological prediction that this hierarchy makes is that in [ATR] harmonies, nasal segments would more easily block harmony than any other segment. In front/round harmonies, glides and liquids would be the most preferred opaque cosonantal segments in harmony than other consonants. In this context, it is easy to see that feature sharing also plays a role in blocking vowel harmony. Typologically, there are no attested systems in which voiceless obstruents block harmony. This only goes to show that more sonorous segments (in the sonority hierarchy, the sonority threshold being the nasal segments) would block harmony more easily than less sonorous segments. I also assume, as far as the data presented from various languages in this chapter is concerned, that blocking by sonorous elements follow a sonority threshold which does not exceed that of the nasals. In other words, consonantal blocking is predicted to occur only when there are elements as sonorous as nasals or more sonorous than nasals.

Furthermore, in vowel harmony, it is not important whether primary or secondary features interact with harmony. The relevant attribute of intervening consonantal segment is whether the segment which is involved in the harmony domain is vocalically compatible, or, if the consonantal segment shares some vocalic feature. With this discussion on non-prosodic intervention by consonants in vowel harmony, I move on to show how coda consonants block harmony in Assamese.

4 Harmony blocking by coda consonants in Assamese

Let us now turn to instances of blocking when more than one consonant intervenes between the triggering vowel and the target vowel. The existence of two (or more) consonants creates an impediment in spreading of the harmonising feature values in Assamese. There is no morphemic or syllabic specification in this kind of blocking. The observed facts are completely phonological. It shows that Assamese [±ATR] agreement does not take place whenever more than one consonant appears between the vowel which is responsible for spreading harmony and the preceding vowels.[59] This is shown below in (266):

(266) Disharmony in the presence of two intervening consonants

	Word	Gloss
(a)	bɔnti	'lamp'
(b)	xɔkti	'strength'
(c)	kɔlki	'last incarnation of Vishnu'
(d)	xɔrɔswoti	'Hindu goddess of learning'
(e)	xɔnd^{h}i	'junction'
(f)	gʊst^{h}i	'clan'
(g)	kɛtli	'kettle'
(h)	kɛrketuwa	'squirrel'
(i)	sɔnduk	'box'

[59] There are also some exceptions: /bostu/ 'object', /osru/ 'tears' /bonduk/ 'gun' /xotru/ 'enemy' /zontu/ 'animal' /bond^{h}u/ 'friend', /xendur/ 'vermilion' /endur/ 'rat'.

(j) k^hɔnzori ‘small tambourine’

Similarly, in derivations too, whenever there are two intervening consonants, vowel harmony is blocked. This is shown below in (267):

(267) Derived words where harmony is absent due to two intervening consonants

	Root	Gloss	Suffix	Derivation	Gloss(Derivation)
(a)	sɔkrɔ	‘circle’	ika	sɔkrikɑ	‘platelet’
(b)	kɔrmɔ	‘work’	i	kɔrmi	‘active person’
(c)	kɔlpɔ	‘wish’	i	kɔlpi	‘one who imagines'(fem)
(d)	k^hɔndɔ	‘fragment’	it	k^hɔndit	‘severed’
(e)	xɔbdɔ	‘sound’	it	xɔbdit	‘resounded’
(f)	gɔrb^hɔ	‘uterus’	woti	gɔrb^howoti	‘pregnant’
(g)	tɛz	‘strength’	swi	tɛzɔswi	‘powerful’

The derived examples above again show that [+ATR] agreement does not take place whenever there are more than two consonants between the two vowels concerned (Krämer 2001 discusses similar facts of Yucatec Maya).

Consonants in a coda or a final position sometimes lend weight to the syllable so that stress may be drawn to that syllable by virtue of its weight. These weight bearing elements are called mora (represented as μ, see also (269)). In Assamese, in the presence of two consonants word medially, the preceding consonant is the coda of the first syllable. Assamese has been shown to be a language which projects a mora when there is a syllable-final consonant. The following section discusses this fact of Assamese and in section 4.2, this prosodic factor is used to explain blocking in Assamese.

4.1 Stress and weight to position in Assamese

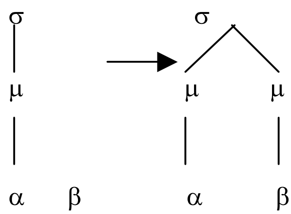
Within the Assamese word stress system, main stress is always assigned to the initial syllable (Mahanta 2001), see also chapter 8). Morphologically, stress shifts to the initial syllable under prefixation. Stress is not sensitive to affixation and the initial syllable is always the main stress bearing syllable regardless of its morphological status. In a sequence of open syllables, stress assignment is in the following manner:

(268) Stress in Assamese

[bɔ́ga] ‘white’ [bósori] ‘yearly’

Weight by position (Hyman, 1985) a factor which renders closed syllables heavy, is interpreted in terms of coda consonants which are assigned a mora, as in the following schema:

(269) Weight by position



where σ dominates only μ (Hayes, 1989)

Mahanta (2002) shows that in Assamese weight to stress is a relevant factor as it counts the number of moras in order to assign stress. The examples below in (270) show that stress is on the initial syllable. However, owing to quantity – sensitivity, if a heavy syllable immediately follows a light syllable, the heavier counterpart emerges as the prominence bearing unit. The second syllable is prominent if it is heavy and the first syllable is light. Otherwise the first syllable is prominent. Assamese follows a trochaic rhythm and therefore stresses the initial syllable.

Heavy syllables never occur as primary stress bearing units beyond the second syllable. Coda consonants are moraic in the language, and therefore attract prominence by virtue of Weight-by-Position (CVV's are excluded from discussion as length distinctions are not phonemic in Assamese). This measure also keeps the prohibited *(**L**H)[60] foot at bay. Moreover, in trisyllables, heavy syllables have secondary prominence, and whenever a stress clash is imminent, it is averted by leaving a syllable unfooted.

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[60] The *(**L**H) foot is the marked foot structure for trochaic systems.

(270) Stress in Assamese

	(**L**L)	Gloss		L(**H)**	Gloss
(a)	[só.ku]	'eye'	(c)	[zi.bɔ́n]	'life'
(b)	[rɑ́ti]	'night'	(d)	[bɑ.gɑ́n]	'garden'
	(**L**L)L			(**L**L)(**H**)	
(e)	[gɔ́.hɔ.nɑ]	'jewellery'	(g)	[m.rɔ́.mɔ̀r]	'loved'
(f)	[zɔ́.hɔ.ni]	'cholera'	(h)	[zɑ́.zɑ.bɔ̀r]	'vagabond'
	L(**H**)L			L(**H**)H	
(i)	[ɑ.nɔ́n.dɔ]	'happiness'	(k)	[ɑ.rɔ́m.bɔr]	'luxury'
(j)	[gu.rút.tɔ]	'importance'	(l)	[ɔ.hɔ́ŋ.kɑr]	'pride'

If we assume foot structures, then it becomes clear from the examples above that the words have been parsed under strict binarity. Thus Assamese follows a strong – weak rhythmic profile, in which a foot is always bimoraic, as prominence always requires a bimoraic minimum, limiting the domain to the mora only. This factor limits foot shapes to either [σ(μμ)] or [σ(μ)σ(μ)], i.e. minimally and maximally two elements of identical status or two moras. The language also displays considerable sensitivity to quantity in all positions, unless there is a possibility of evading it by the occurrence of stress clash.

As already stated, Assamese follows a Trochaic (strong-weak) rhythm at the left edge of the word, and therefore invariably stresses the initial syllable. Furthermore, coda consonants are moraic in the language and all VC / CVC / CVCC syllables are therefore labelled heavy (H). This factor (Weight by position) renders codas stress bearing units. Mahanta (2002) also shows that in an (**LL**) sequence, there is a distinct low fall on the first syllable. In an L(**H**), instead of a low fall on either of the syllables, the F_0 trace is like a plateau, where there is no sharp rise or fall. In this contour, the low pitch of the first syllable spreads over to the second syllable to indicate prominence on the second syllable.

This property of the language requires the postulation of a constraint whereby agreement is among the vocalic moras. That this moraic agreement was not motivated in the chapter discussing the regular harmony pattern (as the one analysed in chapter 5) does not falsify the results that we have obtained in the previous chapter. Vocalic agreement between a heavy syllable and a light syllable violates the requirement of agreement among the vocalic moras. As a result of this requirement, vowels must be absolutely adjacent to each other without the intervention of a consonantal mora. The following constraint is postulated to account for vowels which agree only when the moraic requirement among flanking vowels is met.

(271) *[-ATR] $_{\mu}$ [+ATR]

Assign a violation mark to a [-ATR] vowel followed by a [+ATR] vowel in an adjoining vocalic mora.

As a result of this constraint, only moraic vowels which are adjacent to each other without the interception of a consonantal moraic unit can agree with each other. The constraint and its actual operation is shown in the next section. Furthermore. It must be asserted that this constraint is not just a language particular

(272) Schematic representation of agreement between vocalic moras

#CV ◄—— CV#		#CV C ◄~~X~~— C V#	
μ μ	μ μ	μ μ μ	μ μ
σ	σ	σ	σ

4.2 An OT account of blocking by consonantal moras in Assamese

In the tableau below, agreement between moras is demanded by the constraint *[-ATR]$_{\mu}$[+ATR][61]. As a result of this constraint only adjoining vocalic units will agree with each other, but agreement will be blocked elsewhere when there are intervening consonantal units.

(273) Harmony blocking by consonantal moras

I:/xɔk/+/ti/ 'do'+1P	*[-ATR]$_{\mu}$ [+ATR]	*[-high +ATR]	ID[ATR]
a. ☞xɔkti			
b. xokti		*!	*

The candidate selected in the evaluation i.e. /xɔkti/, is unassimilated and therefore the fully faithful candidate. Significantly, the candidate */xokti/ fails because it agrees with

[61] Just to keep things simple, I will refrain from using the moraic version of this constraint in all further instantiations of Assamese vowel harmony. This is not to mean this is a language-specific modification of the constraint *[-ATR][+ATR]. As discussed in section 4.3, Lango which also has [ATR] harmony shows similar restrictions.

the feature value of the triggering vowel, despite the presence of an intervening consonantal mora. The constraint *[-ATR]$_{\mu}$ [+ATR] does not assign any violation mark to either of the candidates. [xɔkti] does not violate *[-ATR]$_{\mu}$ [+ATR] because the constraint penalises [-ATR] and [+ATR] sequences in vocalic moras only, to the exclusion of consonantal moras. [xokti] does not violate this constraint either because both the vowels are [+ATR].

4.3 Prosodically determined blocking in Lango

The kind of prosodically determined harmony just derived for Assamese has been argued to exist in other languages, too. In Lango (Woock and Noonan 1979, Archangeli and Pulleyblank 1994), there are two progressive harmony rules. The [+ATR] vowels are [i, e, ə, o, u] and the [-ATR] vowels are [ɪ ɛ a, ɔ, ʊ]. If the stem vowel is [+ATR], then the suffix is also realised as [+ATR]. If the stem is [-ATR], then the suffix also surfaces as [-ATR]:

(274) Lango harmony

(a)	cìŋ	'hand'	cíŋə́	'my hand'
(b)	wòt	'son'	wòdə̀	'my son'
(c)	ŋèt	'side'	ŋètə́	'my side'

However, rightward [+ATR] spreading is blocked when two consonants intervene, as seen in the examples below:

(275) Lango harmony in closed syllables

(a)	dòk	'cattle'	(d)	dòkka	'my cattle'
(b)	ñə̀ŋ	'crocodile'	(e)	ñə̀ŋŋá	'my crocodile'
(c)	gwèn	'chickens'	(f)	gwènná	'my chickens'

In Lango the restriction is that in the presence of two consonants, the source of harmony must be [+high] vowels /i/ and /u/. So the process of harmony is not affected in the following words with intervening geminates:

(276) Lango blocking

(a)	pîg	'juice'	pîggə́	'my juice'
(b)	òpúḱ	'cat'	òpúkkə	'my cat'

Archangeli and Pulleyblank deal with this blocking by appealing to prosodic structure, where harmony progresses from mora to mora, and the moraicity of coda consonants blocks spreading.

Finally therefore, the claim that a weight-bearing unit impedes the process of harmony by blocking agreement between the two vowels has also been shown to work for Lango. A similar analysis is also presented for Yucatec Maya (Krämer 2003). Assamese, like Yucatec Maya and Lango, counts moras as a significant unit not only by assigning weight to the coda consonant, but also by considering a vocalic mora as an actual category of agreement.

4.4 Closed syllables blocking harmony as syllable structure

I have shown that the blocking of harmony in closed syllables is a result of the moraic nature of syllable final consonants in Assamese. An alternative analysis would be to assume that there is a structural constraint which prohibits [+ATR] vowels from surfacing in closed syllables. Either way, it is evident from the data presented in (266) and (267) that there is a prosodic restriction in the occurrence of [+ATR] vowels in closed syllables. I present an analysis in section 4.3 which shows that the markedness constraint which drives this blocking phenomena in Assamese is *[-ATR]$_{\mu}$[+ATR]. The constraint *[-ATR]$_{\mu}$[+ATR] requires agreement between moraic vowels because it relates the prosodic factor of stress, weight and harmony blocking in closed syllables in a straightforward way[62].

There may be further complications in an analysis with a constraint prohibiting [+ATR] vowels in closed syllables. For instance, Assamese has a [±ATR] contrast between high back vowels, (for instance, /xut/ 'interest', versus /xʊt/ 'flow'). The contrast between [+ATR] and [-ATR] high back vowels is maintained in closed syllables. However, to analyse harmony blocking in closed syllables like /xʊt+ti/ 'little flow', one would require a constraint which prohibits [+ATR] vowels in closed syllables, i.e. *[+ATR]C. However, then the presence of [+ATR] in examples like /kus.t^{h}i/ 'horoscope' etc., may give rise to concerns about McCarthy's (2003) 'grandfather effect', where a new markedness constraint blocks a general phonological process, but does not change marked structures that are already present.[63] In Assamese, by positing a

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[62] See van Oostendorp (1995) for discussion of the relations between laxness and syllable closure.

[63] However, assuming that only mid [+ATR] vowels are disallowed in closed syllables may be a way out of the problem. The typological motivation for such a constraint would be less than convincing, however.

constraint on syllable structure, like *[+ATR]C, one will also have to account for the presence of such marked structures which already exist[64]. However, this is not a problem for the present analysis.

With this presentation on the various ways in which consonants can block harmony, I move on to an analysis of blocking by the vowel /ɑ/.

5 Revisiting blocking by /ɑ/

In this section I discuss blocking by the vowel /ɑ/ in Assamese. I will argue that corresponding to the theory of consonantal blockers developed in the previous sections, blocking by /ɑ/ is also the result of its high sonority. /ɑ/ in Assamese can shift to in special morphemic environments. Its non-alteration in all other environments can therefore not be attributed to the lack of an appropriate counterpart, as assumed in most approaches to blocking (see section 1.1). In addition, I will also present an analysis involving a 'locality convention' in order to account for partial harmony in some cases where blocking by /ɑ/ does not allow complete spreading in the whole word.

One of the main goals of this dissertation is to explore the locality relations that a harmony phenomenon establishes as it spreads from one vowel to another. This chapter shows that this locality relation is relevant in the presence of intervening vowels as well. Furthermore, vowels which block the spread of vowel harmony can be problematic in a non-derivational theory like OT, because constraints do not evaluate local agreements, but restrict themselves to the evaluation of whether there is agreement or not.

In this respect, recall that Assamese has an eight-vowel surface inventory of [i, u, ʊ, ɛ, ɔ, e, o, ɑ]. Whereas /ɛ/ alternates with [e], /ɔ/ alternates with [o] and /ʊ/ alternates with /u/, /ɑ/ is a vowel which does not undergo alternation under normal circumstances. /ɑ/ therefore, behaves as an opaque vowel. Examples are presented below:

(277) Assamese trisyllables / quadrisyllables with medial /ɑ/

	Word	Gloss
(a)	kʊlɑhɔl	'commotion'
(b)	xɔdɑgɔr	'merchant'

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64 In /xut/ 'interest' versus /xʊt/ 'flow', [±ATR] is contrastive. This contrast is lost in /xʊt/+/i/ → /xuti/ 'stream'. In a comparative markedness (McCarthy 2003) analysis, a new markedness constraint will block the assimilation process in closed syllables. Ex. /xʊtti/ 'little flow' etc.

(c) xɔnatɔn 'eternal'
(d) sɔlasɔl 'act of moving'

In the examples in (277) notice that there are no words with [+ATR] vowels. All the vowels in the word have the feature value [-ATR] and simultaneously /ɑ/ occurs between the potentially alternating vowels /ɔ/, /ɛ/ and /ʊ/. This shows that /ɑ/ in Assamese which is a [-ATR] vowel, agrees with [-ATR] vowels in its neighbouring environment.

(278) Assamese trisyllables with final /ɑ/

	Word	Gloss
(a)	thɔpɔrɑ	'roundish'
(b)	dɔgɔd^{h}ɑ	'heavy'
(c)	ɛsɛrɛŋɑ	' beam of sunlight'
(d)	mɛk^{h}ɛlɑ	'Assamese skirt'

The examples in (278) show words in which /ɑ/ occurs word-finally. Here again, all the vowels in a word are [-ATR]. The vowels /ɛ/, /ɔ/ and /ʊ/, which are capable of alternating to /e/, /o/ and /u/, respectively, retain their [-ATR] specification in the presence of the vowel /ɑ/.

(279) Assamese trisyllables with medial /ɑ/ and final /i/

	Word	Gloss
(a)	mɔdɑhi	'drunkard'
(b)	kɔpɑhi	'of cotton'
(c)	pɛtɑri	'covered cane basket'
(d)	zʊkari	'shake'

The examples in (279) are words in which /ɑ/ occurs word-medially and there is no agreement with the [+ATR] value of the triggering vowel /i/ on the right-hand side. Instead, the leftmost vowel is [-ATR] and it has not been influenced by the [+ATR] vowel in the right periphery. This shows that the vowel /ɑ/ is phonologically opaque in the language.

5.1 /ɑ/ suffixes opaque to harmony

There are various suffixes with /ɑ/ which result in opacity by blocking the spread of [+ATR] harmony. The ones that are discussed below are /-ɑri/ /-ɑru/ /-ɑli/ and /-ɑl/.

(280) /ɑru/ - A nominalising suffix which normally implies a profession related to the root word.

	Root/Stem	Gloss	Suffix	Derivation	Gloss(Derivation)
(a)	lɛk^h	‘write	ɑru	lɛk^{h}ɑru	‘writer’
(b)	xʊd^h	‘ask’	ɑru	xʊd^{h}ɑru	‘enquirer’
(c)	xʊn	‘gold’	ɑru	xʊnɑru	‘tree with golden flowers’
(d)	zuz	‘fight	ɑru	zuzɑru	‘fighter’

(281) /ɑri/ is also a nominalising suffix

	Root/Stem	Gloss	Suffix	Derivation	Gloss(Derivatio
(a)	zuwɑ	‘gambling	ɑri	zuwɑri	‘gambler’
(b)	xʊn	‘gold’	ɑri	xʊnɑri	‘gold jeweller’
(c)	pɛt	‘belly’	ɑri	pɛtɑri	‘covered cane
(d)	puzɑ	‘prayer’	ɑri	puzɑri	‘priest’

(282) /ɑli/ is an adjectival or nominal suffix which means ‘having the quality of’

	Root	Gloss	Suffix	Derivation	Gloss
(a)	b^{h}ʊg	‘enjoyment’	ɑli	b^{h}ʊgɑli	‘enjoyable’
(b)	xʊn	‘gold’	ɑli	xʊnɑli	‘golden’
(c)	k^{h}ɔr	‘dryness’	ɑli	k^{h}ɔrɑli	‘dry season’
(d)	bɛz	‘doctor’	ɑli	bɛzɑli	‘doctorship’

(283) /ɑl/ - Suffixes with this ending means ‘possessing/ pertaining to’

	Root	Gloss	Suffix	Derivation	Gloss
(a)	tɛz	‘blood’	ɑl	‘energetic’	tɛzɑl
(b)	nɛz	‘tail’	ɑl	‘tailed’	nɛzɑl
(c)	gɔp	‘proud	ɑl	‘proud’ (adj)	gɔpɑl
(d)	b^{h}ɔr	‘to fill up’	ɑl	‘store-house’	b^{h}ɔrɑl

In the examples in (280), (281) and (282) above, harmony spreading from the potential trigger vowels, i.e. the word-final /i/ and /u/ vowels in the suffix, is blocked by the suffixal vowel /ɑ/. However in (283), where the suffix /-ɑl/ attaches to the base, there are

[-ATR] vowels only, as there is no final /i/ or /u/. An intervening [+low] segment is not affected by harmony and the [-ATR] domain prevails, or to put it differently, it blocks harmony. This shows that there is no morphemic prespecification in the blocking pattern shown by the vowel /ɑ/, and it is the phonological attributes of /ɑ/ which results in blocking.

5.2 ATR harmony and the low vowel – OT account

As already stated in section 1.1, the presence of the vowel /ɑ/ does not result in vowel harmony. The constraints which prevents [-ATR] values of low vowels from changing are, first, a faithfulness constraint preserving the low value of /ɑ/ due to considerations of sonority:

(284) [IDENT low]: Correspondent segments are identical in feature [low] (McCarthy and Prince 1995)

The constraint which restricts the inventory to [-ATR] low vowels is:

(285) *[+ATR +low]
low vowels must not be [+ATR]

(286) /ɑ/ remains unaltered in the presence of a following trigger

I:/kɔpɑh/+/i/ 'car'	*[+ATR +lo]	ID[low]	*[-ATR] [+ATR]	*[-high +ATR]	ID [ATR]
a. ☞ kɔpɑhi			*		
b. kopohi		*!		*	*
c. kopæhi	*!			*	*

The inertness of /ɑ/ to the harmony process is accounted for by high ranked IDENT [low] and *[+ATR +low]. These constraints are ranked higher than the harmony driving constraint *[-ATR][+ATR], therefore the candidate (286)-a which does not undergo any /ɑ/ alteration is the winning candidate.

In OT, the standard approach to blocking is with multiple feature markedness constraints such as the one in (285). However, this motivation for blocking needs to be approached with some caution. In so far as blocking by the low vowel /ɑ/ in [+ATR] harmony systems is concerned, a system where *[+ATR +low] is violated in order to avoid opacity[65] is non-existent, as far as I am aware. In this sense, standard OT overgenerates the possibilities of actually attested factorial typologies of [ATR] harmony and blocking. However, my proposal using sonority and corresponding faithfulness also suffers from a similar problem, that is, it cannot account for all the complexities of blocking in vowel harmony. The problem of opacity and repairs requires proper examination and providing a thorough analysis is beyond the scope of this chapter. Future research in this interesting area will shed more light on this phenomenon.

5.3 'The sour grapes' problem

In this dissertation, I try to analyse Assamese as displaying local iterative vowel harmony. However, data such as those below prevented a complete analysis of the facts with the constraint hierarchy and the tools offered by standard non-derivational OT.

(287) Partial harmony in Assamese

	Word	Gloss	Infinitival	Derivation	Gloss
(a)	sɑpɔr	'bend'	i	sɑpori	'to bend'
(b)	pɑhɔr	'forget'	i	pɑhori	'to forget'
			Perfective		
(c)	pɑlɛ	'get'	high	pɑlehi	'reach' (3P present perfect)
(d)	k^hɑlɛ	'eat'	high	k^hɑlehi	'eat' (3P present perfect)

These are examples of the 'sour-grapes' problem discussed in chapter 3. The problem of 'sour-grapes'arises because harmony is only partial when an opaque segment intervenes. These instantiations of the 'sour-grapes' problem clearly show that harmony progresses until it meets the blocking segment /ɑ/. In other words, the relationship of harmony is formed from one vowel to the next upto the point it meets an opaque segment.

Opaque segments intervene in the harmony process wherever they occur. In the global non-gradient evaluation of candidates by constraints like *[-ATR][+ATR], the data above cannot be accounted for. There is no way of capturing the harmonic improvement of /sɑpori/ ≫ /sɑpɔri/, as *[-ATR][+ATR] assigns a violation mark to both candidates. This is shown below:

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[65] Leaving aside systems where the complete ten-vowel inventory (see chapter 2 section 2.2) is already present, or if there are [+ATR +low] counterparts present in the inventory.

(288) Assamese ‘sour grapes’ problem

Input : /sɑpɔr/+/i/	*[+ATR +low]	ID[low]	*[-ATR] [+ATR]	*[-high +ATR]	ID [ATR]
a. 💣 sɑpɔri			*		
b. ☹sɑpori			*	*!	*
c. sopori		*!		*	*
d. sæpori	*!			*	*

The optimal candidate is (288)-b but because it is harmonically bounded by (288)-a, it cannot surface under any ranking. The hierarchy predicts the wrong output because *[-ATR][+ATR] does not capture the harmonic improvement of /sɑpori/ ≫ /sɑpɔri/.
There is no way of attending to this problem in the standard non-derivational OT adopted thus far[66] (apart from Span Theory or ALIGN, but not the model adopted here).

Here, I will show a possible solution to this problem, namely that of Harmonic Serialism, that this dissertation can adopt in analysing the data with the constraint hierarchy that I have proposed for Assamese. I will show that Harmonic Serialism allows us to overcome this problem because it recognises that harmonic improvement can only be achieved in a stepwise manner and a single global evaluation often leads to wrong results and unattested typologies. The goal of this exercise is of course not to undermine the approach taken in the dissertation as a whole, but to show that what is at stake here is locality in iterative assimilation. Any account of this phenomenon has to take this factor into consideration. It is clear that candidate (288)-b is more harmonic than candidate (288)-a as the former partially satisfies the harmony constraint. Vowel harmony in Assamese is iterative: there is no long distance blocking to be observed here. Harmony spreads until it reaches the edge of a word or a blocking segment. The locality and non-iterativity displayed by these examples can be handled with a derivational approach to

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[66] A way out of this problem may have been to use the constraint *[-ATR +high][+high], which, if it had been successful, would have elegantly captured partial harmony, as it also accounts for non-iterative harmony in Bengali. However, this constraint fails in the face of inputs where the opaque vowel /ɑ/ is distant from the trigger, for instance /CɑCɛCɛCi/. The constraint *[-ATR +hi][+hi] will then, wrongly predict the candidate with partial harmony, i.e. /CɑCɛCeCi/ instead of the occurring /CɑCeCeCi/.

OT that has been proffered by McCarthy (2006a, b), but only with a locality convention which will be discussed shortly.

5.4 Persistent OT or Harmonic Serialism

In Harmonic Serialism or Persistent OT (McCarthy, 2006, 2007), harmony is achieved gradually in a stepwise manner in ‘single harmony improving operations’. In this version of OT, the standard assumption of the Richness of the Base is maintained, but it vouches for a more restrained GEN which allows only one operation at a time, instead of the (by now) familiar parallel evaluation of the entire constraint hierarchy in standard OT. In standard OT, unbounded harmony is achieved by applying the entire constraint hierarchy in one go. Thus, in standard OT, the gradualness or iterative character of unbounded harmony is not an issue. However, as McCarthy (2006) shows, the differences between local and global harmonic improvement is apparent from phenomena involving metathesis. Among the many examples that McCarthy cites, I choose the example of epenthesis in Lardil, because it clearly shows how Harmonic Serialism works.

(289) Lardil augmentation (Klokeid 1976, Wilkinson 1988)

Root	Nominative	Locative	
/ɽil/	ɽil.ta	ɽil.e	‘neck’
_tal	_tal.ta	_ta.le	‘vulva’
maɽ	maɽʈa	ma.ɽe	‘hand’
/kaŋ/	kaŋka	kaŋe	‘speech’

Underived roots receive a homorganic augmentation (/lt/, /ɽʈ/, /ŋk/ in the examples above).

In Standard OT, /ɽil/ → [ɽil.ta] is obtained by a constraint hierarchy where ALIGN-R (Mword, σ) is left unranked with regard to FT BIN, since the output [ɽil.ta] does not violate any of these constraints. ALIGN-R (Mword, σ) requires underlying final segments in the morphological word to align to the right edge of a syllable, and FTBIN requires binary feet.

(290) Lardil augmentation in Classic OT

/ɽil/	FTBIN	ALIGN-R(Mword, σ)	DEP
→ɽil.ta			**
a. ɽil.a		*!	*
b. ɽil	*!		

The actual output is easily predicted by the hierarchy above. If we assume that GEN epenthesises only once each time the candidate passes through EVAL then the /ɽil/ → /ɽil.ta/ mapping is an overgeneration of epenthetic material.

Harmonic Serialism applies a stricter ranking where FTBIN ≫ ALIGN-R (MWord, σ) to show that epenthesis in Lardil proceeds serially, i.e. /ɽil/ → /ɽil.a/ → /ɽil.ta/. Each step in this derivation is a harmonic progression over the most faithful /ɽil/[67]. However, /ɽil.ta/ → /ɽil.t/ violates FT-BIN.

(291) Higher ranking FTBIN selects /ɽil.a/

/ɽil/	FTBIN	ALIGN-R (MWord, σ)	DEP
→ ɽil.a			*
ɽil	*!		

The intermediate output candidate, /ɽila/, passes through another operation, in order to arrive at the most harmonic of all the candidates. Harmonic Serialism captures a core insight of OT that conflicting constraints ranked hierarchically will lead to the selection of the optimal output. In this case, the conflict between FTBIN and ALIGN-R(Mword, σ) selects / ɽil.ta/ over /ɽil.a/.

(292) Selection of the most harmonic candidate / ɽil.ta/

ɽil.a	FTBIN	ALIGN-R(Mword, σ)	DEP
ɽil.a		*!	*
→ɽil.ta			

In the final evaluation, ALIGN-R (Mword, σ) selects /ɽil.ta/ and no more improvements are possible.

[67] However, /ɽil.ta/ → /ɽil.t/ violates FT-BIN

McCarthy points out that for exactly the reason that gradualness cannot be captured by constraints with global evaluation. Any spreading constraint will have to account for the fact that [-F][-F][+F] ≫ [-F][+F][+F] ≫ [+F][+F][+F], where spreading continues until the end or until it meets a blocking segment. A gradient constraint will successfully distinguish between the candidates [-F][-F][+F] and [-F][+F][+F], whereas a constraint like AGREE will assign a violation mark to both the candidates.

McCarthy notes that in Harmonic Serialism, long distance harmonic ordering cannot be compelled by markedness constraints which do not allow the comparison of harmonic pairs. In other words, AGREE with global evaluation cannot work in Harmonic Serialism. AGREE fails because it does not identify the loci of violation (AS also noted in chapters 3 and 5). This dissertation has already adopted sequential markedness constraints which identify the sequence which constitutes a markedness violation. In this sense, some progress towards achieving the locality criteria in iterative harmony has already been made. However, the constraint *[-F][+F] alone will not salvage the optimal output when harmony is only partial. The emergence of this problem also non-trivially shows that *[-F][+F] can only superficially evaluate iterativity in assimilation processes. The presence of a blocking segment at the edge of a potentially assimilating string gives rise to partial assimilation as well as blocking. *[-F][+F] fails to correctly evaluate such a sequence because, in its quest for total assimilation, *[-F][+F] will not tolerate *any* instance of *[-F][+F]..

In order to account for the 'sour grapes' problem in (288), what is thus required here is an additional locality convention which can account for the fact that (288)-b is more harmonic than (288)a. because the locality convention applies successfully in the former[68]. Following Pater and Mahanta (2006), I will assume the following definition of locus of violation of a constraint:

(293) *Locus of minimal violation*
A locus of minimal violation of constraint C in representation R is the smallest substring of R that incurs a violation of C.

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[68] This analysis was a joint presentation with Joe Pater in the LOT Sound Circle. See also Pater (2006 b) for an implementation of the same idea within Harmonic Grammar using weighted constraints. Locality of unbounded spreading is also explored by Wilson (2006) within the TCOT framework. In that sense, Wilson (2006) is the precursor of the locality notion espoused here.

The solution to the problem in (288) is based on the observation that the medial segment participates in a distinct locus of violation of *[-ATR][+ATR] in (288)-a and (288)-b:

(294) *A locality convention for harmonic serialism*

Let X be an input representation to which Gen applies an operation, and Y be its output correspondent. Let C be a constraint that is violated in X and Y. If a segment is contained in some locus of violation of C in X, and a distinct locus containing a minimal violation of C in Y, then only the locus of violation in X produces a violation mark.

By adopting a version of Harmonic Serialism that is subject to the restriction in (294), we avoid the 'sour grapes' problem for Agree-type constraints discussed by McCarthy (2004) and Wilson (2000, 2006).

The locality convention in (294) allows (288)-b to escape harmonic bounding, as shown in (295), where the final derivation is indicated by a pointing finger, and a following wrong step by a bomb. In the tableaux that follow, the 'cancelled' violation marks are placed in parentheses.

(295) No sour grapes in local harmonic serialism

sɑpɔr+i	*[LOW, +ATR]	*[-ATR][+ATR]	IDENT-ATR
a. sɑpɔri		*	
b. ☞sɑpori		(*)	*
c. 💣sæpori	*		

The evaluation shows that single modest steps of harmony are indeed desirable but must also be regulated by a locality convention. Without the locality restriction, even persistent OT would result in predicting the wrong output for the data in (287).

However, this is only an exploration of the stringency introduced by the locality requirements that the candidate set in Harmonic Serialism may be subject to. Given the fact that locality is already a requirement in the application of Harmonic Serialism, its broader typological implications remain to be investigated.

5.5 Conclusion

One of the important claims of this chapter is that consonants are unable to block harmony at the level of segmental adjacency. A consonant may be eligible to block harmony at the segmental level, provided it is vocalically compatible or shares some feature with the triggering segment. More importantly, the shared feature need not be a secondary place feature. On the other hand, all attested cases of harmony blocking by consonants in a non-local position (in Assamese, Lango, Yucatec Maya, etc.) are prosodically governed in the coda position. The presence of closed syllables results in the non-propagation of harmony because coda consonants are assigned a mora. In Assamese, the harmony process at this level is blocked because harmonising vowels are not flanked by each other because of the intervening mora.

The consequence, then, is that there are some conditions on the systematic intervention of consonants in a vowel harmony domain:

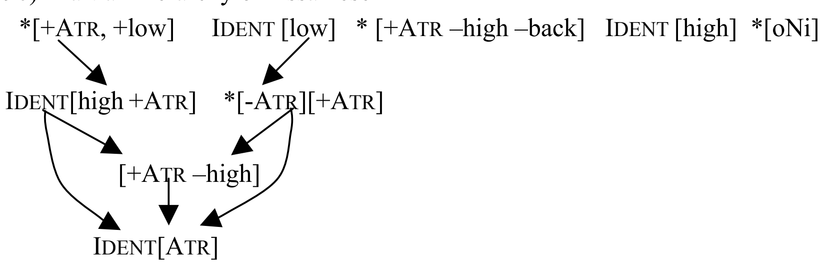
(i) Only a consonant that is sonorous can block harmony non-prosodically.

(ii) All other consonants can intervene due to structural or prosodic factors. Non-compatible interveners may not be segmentally adjacent, but they will be constrained by prosodic factors.

I also dealt with blocking by the vowel /ɑ/. I showed that blocking by /ɑ/ is also the I also dealt with blocking by the vowel /ɑ/. I showed that blocking by /ɑ/ is also the reflex of a sonority condition on vowels – the more sonorous vowels in the inventory, the more opaque they will be, because they tend to be more faithful. This will be addressed in the next chapter (chapter 7) and there, it will be shown how IDENT [low] is subject to violations under the influence of two affixes /-iyɑ/ and /-uwɑ/.

This chapter furthermore added more constraints to the hierarchy that was developed in chapter 5. The hierarchy argued for thus far is as represented in the Hasse diagram below:

(296) Partial Hierarchy of Assamese



Apart from new additions to the hierarchy, I have also shown that to tackle the ‘sour grapes’ problem we need a locality convention within Harmonic Serialism. However, for this analysis to be complete, I need to show how Harmonic Serialism would be beneficial for the analysis of the entire harmony facts discussed in this dissertation. For present purposes, however, the adoption of Harmonic Serialism adequately justifies the contention that harmony involves local iterative agreement. Clearly, to complete the account in this chapter I had to summon the technology offered by a non-standard version of OT. The adoption of Harmonic Serialism still shows that what is important here is to capture the local iterative nature of assimilation. Whether we import tools available in other versions of OT or not is mainly a matter of execution. Future research area in this area will show the results this theoretical orientation will deliver.

Chapter 7

Exceptions in vowel harmony

1 Introduction

In this chapter I will discuss certain exceptional occurrences in non-derived as well as derived environments in Assamese vowel harmony. On the theoretical side, this chapter underscores the role of indexation of both markedness and faithfulness constraints in accounting for various kinds of exceptionality. I will give special emphasis to certain morpheme specific harmony phenomena in derived words, both in Assamese, and more peripherally, in Bengali. The constraint hierarchy proposed in the previous chapters did not predict these phenomena, as it was established in chapter 5 that the unmarked case for derived words in Assamese and Bengali is to behave like underived words, including most derivational affixes.

In the analysis of harmony in chapter 5, it was shown that Assamese harmony is regressive, and always triggered by an immediately following /i/ or /u/. It is also characterised by a disjunction, as the harmony constraint produces the alternations /ɛ/ → [e], /ɔ/ → [o], and /ʊ/ → /u/, where the outputs [e] and [o] are allophonic, but /u/ is not. In the constraint hierarchy in chapter 5, I motivated the sequential markedness constraint *[-ATR][+ATR] (also see a modification in the previous chapter), to account for regressive harmony in Assamese, along with the newly proposed faithfulness constraint IDENT [high +ATR], and the substantively grounded markedness constraints *[+high -ATR] and *[-high +ATR]. In this situation, the occurrences of [e] and [o] without a following triggering vowel are exceptional, as they violate the tenets of the rich base in OT. As shown in chapter 5, the candidates which may be presented by the rich base with [e] and [o] and without any accompanying alternation are filtered out by the appropriately ranked markedness constraint *[-high +ATR]. In this chapter, I will show how candidates which exceptionally show [e] and [o] can be suitably analysed in Optimality Theory as cases of constraint indexation. It was shown in chapters 4 and 6 that /ɑ/ is opaque to vowel harmony. However, /ɑ/ exceptionally undergoes harmony under the influence of the morphemes /-iyɑ/ and /-uwɑ/. These instances of exceptionality will be handled by the indexation of a markedness constraint. A dominant strain in this dissertation has been to approach vowel harmony as a phenomenon which involves the establishment of local relationships. This is also borne out by morphemic influences on vowel harmony, as the two kinds of triggering involved in the exceptional processes can be shown to be predominantly local.

Section 1 presents a general background to exceptional morphological occurrences in vowel harmony; Section 2 deals with data and problems relating to the exceptional triggering of harmony by the affixes /-iyɑ/ and /-uwɑ/ in Assamese, and the perfective suffix /-e/ in Bengali. A lexically indexed markedness constraint is shown to be the preferred solution in these derived environments. In both languages, exceptional triggers lead to harmonisation of the otherwise non-participating /a/ or /ɑ/. Section 3 extends the theory of constraint indexation to account for cases of morpheme deletion in Assamese. Section 4 presents the data pertaining to exceptional occurrences in underived environments and an analysis based on constraint indexation.

Leaving aside the underived cases, this chapter deals with two cases of morphologically idiosyncratic behaviour in Assamese: in the first case, a morpheme is expressed on the otherwise non-participating vowel /ɑ/. In traditional terms, this function of the morpheme can be seen as an overapplication of harmony, which otherwise applies only to [+high -ATR] - /ʊ/ or [-high -ATR] - /ɛ/ and /ɔ/ vowels but never to a [+low -ATR] vowel - /ɑ/. The application of harmony in this context violates the constraint IDENT [low], which turned out to be highly ranked in the previous chapter.

Secondly, a case will be presented in which a suffixal morpheme is deleted but in which the [+high] vowel of the deleted morpheme still alters the vowel of the root morpheme from [-ATR] to [+ATR]. This behaviour of inflectional suffixes is a case of opacity, where the conditioning environment of the process is lost and the resultant output form is not surface apparent. By using constraint indexation for these cases I show that indexing of the marked constraint NOHIATUS can also lead to a satisfactory analysis of non-surface true underlying instances of morphemes, which exhibit local behaviour in Assamese. Overall then, the analyses in this chapter show that constraint indexation can adequately handle various aspects of morpheme specific phonology.

1.1 Background

Typically in OT analyses, idiosyncratic morphological influences on vowel harmony have been difficult to capture. While some approaches within this framework relied on underspecification (Noske 2001), others accounted for morpheme specific faithfulness with the presence of some undominated positional faithfulness constraint that requires morphemes to surface with their underlying feature values. Baković (2000), for example, treats such morphemes in Kalenjin and Turkana[69] with positional faithfulness constraints like DOMINANT -IDENT [ATR] and RECESSIVE-IDENT [ATR].

Before moving to the core of this chapter, I will discuss some of the relevant literature. Harmony systems exist where certain morphemes determine the direction and as well as nature of vowel harmony. A familiar example discussed in the literature is that of Nez Perce (Aoki 1966, Hall and Hall 1980, Kiparsky 1982). In this language, the vowels are divided into a dominant class of vowels, which consist of the [-ATR] vowels /ɔ ɑ/ and a recessive class with the [+ATR] vowels /i/ /æ/ /u/. Nez Perce examples:

(297) Recessive vowels

(a) næʔmæq	næʔmæχ
(b) paternal uncle-1 poss	'my paternal uncle'
(c) mæqæʔ	mæqæʔ
(d) paternal uncle	'paternal uncle!'- voc

(298) Dominant root/suffix

(a) næʔtɔ:t	nɑʔtɔ:t
(b) father-1 poss	'my father'
(c) cæqæ:tʔɑjn	cɑqɑ:t'ʔɑjn
(d) raspberry-for	'for a raspberry'
(e) sɔ: jæ:pu	sɔ:jɑ:pɔ:
(f) people	'the white people'

Nez Perce shows that if a morpheme anywhere in the word has a dominant vowel, all other vowels become dominant valued.

[69] In Turkana some exceptional [-ATR] dominant suffixes trigger regressive [-ATR] harmony in a word. But in this situation an adjacent /ɑ/ which normally undergoes progressive harmony remains opaque.

Another language of the type is Nandi-Kipsigis Kalenjin, but with an additional requirement that a class of affixes must be opaque to [+ATR] dominant-recessive harmony (Vergnaud and Halle 1981, Lodge 1995). In Kalenjin, opaque morphemes are specified [-ATR] and do not alter their [+ATR] value even when there are neighbouring dominant morphemes, and they stop the spread of [+ATR] to other 'adaptive' or recessive morphemes.

(299) Kalenjin dominant-recessive harmony

(a) kiɑkɛr	dist. past	'shut'	kiɑgɛr	'I shut it' 1 sg
(b) kiɑke: rɪn	dist. past 1sg	'see'	kiɐge: rin	'I saw you (sg.)' sg
(c) kɪɑkɛre	dist. past 1sg	'shut' (non compl)	kiɐgere	'I was shutting it'

In these dominant-recessive types of harmony systems, some morphemes influence the neighbouring vowels to agree to the dominant value borne by them, so that the recessive values succumb to their influence. In these systems, it is a characteristic feature that only the presence of the morpheme results in a change. In certain other types of vowel harmony systems, morphemes exhibit different kinds of exceptionality[70].

The purpose of this brief excursus into dominant-recessive systems and exceptionality in morphemic influences on vowel harmony is to demonstrate that the exceptionality of the kind reported in this section has (as far as I am aware) not been recorded prior to this work. In Assamese, there are no instances of exceptional root or suffixal morphemes which *undergo* harmony under special circumstances or cases where morphemes do not undergo harmony because they are opaque to the spreading process. The Assamese data are unique cases of exceptional triggers. However, they are only unique as far as exceptionality in vowel harmony is concerned. Such cases of local exceptionality are found in other morpheme specific phonology as well – in Finnish for instance, which will also be discussed in this chapter.

1.2 Towards a characterisation of exceptional triggering in Assamese

Assamese has regular phonological harmony where /ɛ/ /ɔ/ and /ʊ/ in the preceding syllables shift to /e/, /o/ and /u/, respectively, under the influence of a following /i/ or an /u/. In this harmonising environment, /ɑ/ functions as opaque to [+ATR] harmony, as it is

[70] See Finley (2006) for discussion on exceptional undergoers and non-undergoers in harmony systems, which are also shown to be local.

protected by a faithfulness constraint IDENT [low]. /ɑ/'s involvement in harmony would also result in the violation of *[+ATR +low], an undominated constraint, because low [+ATR] vowels are absent from the surface inventory[71]. The participation of only two morphemes /-iyɑ/ and /-uwɑ/ in triggering exceptional realisation of harmony can be characterised as morphologically induced harmony, which is obtained at the cost of flouting the highly ranked phonological constraint IDENT [low] (which prevents any alteration of the low vowel /ɑ/). This violation leads to the harmony of the normally opaque vowel /ɑ/ in such a way that it alters to a vowel which is already present in the surface phonetic inventory. Exceptional triggering of the type discussed in this chapter cannot be deemed to be the same as dominance in vowel harmony or other kinds of exceptionalities recorded in the literature.

2 Regular harmony triggered by /-iyɑ/ and /-uwɑ/

In this section, I will first show in detail the environments in which the exceptional morpho-phonological patterns alluded to above occur. Before going into the details of exceptionality, I will draw examples from the regular morphology to show the operations of vowel harmony in a regular derived environment domain. In the examples in (300) and (301) below, the high vowels in the suffixes trigger [+ATR] harmony in the preceding root/stem.

(300) Monosyllabic roots and regular vowel harmony

Root	Gloss	Suffix	Derived	Gloss
(a) mɛr	'wind'	-uwɑ	meruwɑ	'wind'(causative)
(b) d^hʊl	'drum'	-iyɑ	d^huliyɑ	'drummer'
(c) tɛl	'oil'	-iyɑ	teliyɑ	'oily'

[71] This does not imply that I am arguing for a structure preserving (Kiparsky 1973) approach to Assamese harmony. The very fact that the outputs of harmony, i.e. [e] and [o] have an allophonic status shows that such an approach will not reflect the actual harmonic process of Assamese.

(301) Regular vowel harmony in bisyllabic stems

Root/Stem	Gloss	Suffix	Derived	Gloss
(a) bɔyɔx	'age'	-iyɑ	boyoxiyɑ	'aged'
(b) tɔlɔt	'below'	-iyɑ	tolotiyɑ	'subordinate'
(c) gʊbɔr	'dung'	-uwɑ	guboruwɑ	'fly(with dung-like smell)

The examples above show that there is ample evidence that the adjectival suffixes /-iyɑ/ and /-uwɑ/ trigger regular [ATR] harmony in the preceding [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/.

2.1 Blocking by /ɑ/ and /ɑ/- adaptation

Whereas /ɛ/ alternates with [e], /ɔ/ alternates with [o] and /ʊ/ alternates with /u/, /ɑ/ is a non-alternating vowel in the inventory. Therefore, /ɑ/ behaves as a phonologically opaque vowel. When a stem has /ɑ/ in its final syllable, ATR-harmony is blocked[72]. Blocking in Assamese has already been extensively discussed in chapter 6. For the sake of clarity, I will briefly repeat some examples:

(302) Assamese trisyllables with medial /ɑ/ and final /i/

Root/Stem	Gloss	Suffix	Derivation	Gloss
(a) kɔpɑh	'cotton'	-i	kɔpɑhi	'made of cotton'
(b) zʊkɑr	'shake'	-i	zʊkɑri	'shake' (inf)

The examples in (302) represent words in which /ɑ/ occurs word-medially and there is no agreement with the [+ATR] value of the triggering suffixal vowel. Instead, the leftmost vowel is [-ATR] and has not been influenced by the [+ATR] vowel in the right periphery. There are also various suffixes with /ɑ/, which result in opacity, and the ones that are discussed below are /-ɑru/ and /-ɑli/. In the examples in (303), we see the regular examples where /ɑ/ blocking occurs. See examples below:

(303) /-ɑru/ and /-ɑli/ block harmony

Root	Gloss	Suffix	Derivation	Gloss
(a) lɛk^h	'write'	-ɑru	lɛk^{h}ɑru	'writer'
(b) gɔz	'grow'	-ɑli	gɔzɑli	'sprout'

[72] However, not all stem-final vowels undergo adaptation. See the discussion below the examples in (307).

Opaque vowels of this kind are supposed to reflect gaps in the language's vowel inventory, that have been analysed in the past as a result of multiple-feature markedness constraints. However, as I have argued in chapter 6, the opacity of /ɑ/ probably is not related to the lack of a [+ATR] counterpart to /ɑ/ in Assamese. Phonological opacity in many languages is not the result of the lack of equivalent and complementing paired vowel sets. As a result vowels can also be opaque despite the presence of complementing vowels and, I argue that it is the sonority of the vowel /ɑ/ that makes it resistant to harmony and therefore opaque to spreading.

The reason of lack of a counterpart is also less compelling for another reason: /ɑ/ does change to other vowels under *exceptional* circumstances, and even when it does, the vowels that it changes to are [e] and [o], but not [ɐ] or [æ], the vowels that the constraint *[+ATR +low] prevents from occurring. This shows that this constraint is not active at all, and its high ranked status is due to the fact that it makes an inventory related prediction about the absence of [ɐ] and [æ]. /ɑ/ exceptionally harmonises to /e/ and /o/, the [-high +ATR] vowels that are already present in the surface vocalic inventory. I take this evidence to demonstrate that a faithfulness constraint is active in guarding the values of /ɑ/, and it is this faithfulness constraint which is violated when /ɑ/ is raised to [e] or [o]. As a result of /ɑ/'s alternation with [e] and [o], we can observe that the choice of 're-pairing' (term due to Baković) is probably available to the core phonology as well. In the core phonology, however, 're-pairing' is available as a strategy to avoid opacity: /ɑ/ does not alter in response to that choice. To explain this phenomenon in Assamese, I adopt the term 'adaptation' to indicate raising only in exceptional circumstances, and not in the regular phonology. Although nothing extraordinary hinges on this choice of nomenclature, it simply makes the point that if /ɑ/ re-pairing would have been the strategy, it might be expected to show up in the regular phonology as well[73].

In /ɑ/ adaptation, the preceding stem vowel ([-low, -back] or [-low, +back]) determines the [±back] feature that /ɑ/ might assume, so that it becomes a [+ATR] vowel [e] or [o], respectively. The result of the process is that it is not only /ɑ/ which

[73] See Baković (2000) for an analysis of 're-pairing' in Maasai, Turkana and Turkish. In the specific case of Turkish, prospective [æ ɤ] are prohibited by re-pairing the mid [-low, -back] with the [+low, +back] vowel [ɑ]. Though this is characteristic of the entire phonology of Turkish, in Assamese 'adaptation' is the result of harmony triggering only by the exceptional morphemes.

changes its [-ATR] specification, the preceding vowel also receives the harmonious [+ATR] value of the span. Thus, the reason this process is dubbed /ɑ/ adaptation in this dissertation is in the fact that /ɑ/ adapts itself to some other [+ATR] vowel under exceptional circumstances, but remains inalterable in all other cases because of its intrinsic sonority.

2.2 /ɑ/ adaptation: data and problem

/ɑ/ adaptation occurs when the two affixes /-iyɑ/ and /-uwɑ/ trigger harmony in morphemes containing /ɑ/. In monosyllabic stems, /ɑ/ always adapts itself to /o/, when followed by /-iyɑ/ or /-uwɑ/. In disyllabic stems, the [±back] feature that /ɑ/ assumes for adaptation is determined by the preceding vowel. In contrast, /ɑ/ in a root/stem position never alters the [±back] quality of the prefixal vowel. An /ɑ/ following a prefixal position always shifts to /o/.

(304) /ɑ/-adaptation triggered by /–uwɑ/

Word	Gloss	Suffix	Derivation	Gloss
(a) ɛlɑh	‘laziness’	-uwɑ	elehuwɑ	‘laziness’
(b) bɔzɑr	‘marketplace’	-uwɑ	bozoruwɑ	‘cheap’
(c) kɛsɑ	‘raw’	-uwɑ	keseluwɑ[74]	‘raw(ness)’
(d) b^hʊl	‘daze’	-uwɑ	b^huluwɑ	‘mislead’
(e) dɛkɑ	‘young’	-uwɑ	dekeruwɑ	‘young-ish’

[74] Nothing much can be said about the epenthetic /l/ here and the epenthetic /r/ in 304 (e) There are instances of epenthetic /l/ and /r/ in Assamese, probably because coronals are unmarked epenthetic segments. With regard to the choice between /l/ and /r/ it must be considered to be a pretty much idisncratic choice.

(305) /ɑ/-adaptation triggered by /–iyɑ/

Word	Gloss	Suffix	Derivation	Gloss
(a) kɔpɑl	'destiny'	-iyɑ	kopoliyɑ	'destined'
(b) d^hɛmɑli	'play'	-iyɑ	d^hemeliyɑ	'playful'
(c) gʊlɑp	'rose'	-iyɑ	gulopiyɑ	'pink'
(d) misɑ	'lie'	-iyɑ	misoliyɑ	'liar'

The pattern observed above shows that when /-iyɑ/ and /-uwɑ/ trigger harmony, /ɑ/ alters to either [e] or [o], depending on the [±back] value of the stem-initial vowel. When /ɑ/ is the only stem vowel, it is realised as [o] when followed by /-iyɑ/ in the suffix. See examples below:

(306) /ɑ/-adaptation in monosyllabic roots

Root/Stem	Gloss	Suffix	Derivation	Gloss
(a) sɑl	'roof'	-iyɑ	soliyɑ	'roof-ed'
(b) dɑl	'branch'	-iyɑ	doliyɑ	'branch-ed'
(c) d^hɑr	'debt'	-uwɑ	d^horuwɑ	'debtor'
(d) mɑr	'beat'(v)	-uwɑ	moruwɑ	'beat'(causative)

In the examples above, /ɑ/ invariably assumes [+back] quality. The examples below show that /ɑ/ adaptation does not occur when the stem is longer than two syllables (the final /ɑ/ in trisyllables deletes itself).

(307) No /ɑ/-adaptation in trisyllables with final /ɑ/

Word	Gloss	Suffix	Derivation	Gloss
(a) kɛtɛrɑ	'spoken harshly'	-iyɑ	keteriyɑ	'peevish or irritable'
(b) sɔkɔlɑ	'a round flat piece'	-iyɑ	sokoliyɑ	'slice'

These examples have been presented to show that there is a minimal domain in which /ɑ/-adaptation can occur and it is limited to the first two syllables of a word. In all likelihood, there is a constraint which limits /ɑ/-adaptation to the foot which bears primary prominence in Assamese (Assamese follows a strong-weak or trochaic rhythm, see also chapter 6, section 4.1 and chapter 8, section 4). However, this does not bear on the analysis of exceptionality to be provided later. Hence I will leave this section with the knowledge that /ɑ/ adaptation is bound by a foot structure constraint which is inviolable in the language.

2.2.1 /ɑ/- adaptation and prefixes

The examples below show how the prefixal vowels /ɔ-/ and /ɛ-/ change their feature value for [±ATR] in an environment where there is an /i/ or /u/ on the right side of the morphological word:

(308) Prefixal participation in [+ATR] harmony

Prefix	Root/Stem	Gloss	Suffix	Derivation	Gloss
(a) ɔ	g^hɔr	‘home	-i	og^hori	‘homeless’
(b) ɛ	k^hʊz	‘steps’	-iyɑ	ek^huziyɑ	‘going slowly’

Similarly, a process of /ɑ/-adaptation similar to the one observed in examples (304) and (306), applies when /ɑ/ belongs to the root and /ɛ-/ or /ɔ-/ are prefix vowels.

(309) /ɑ/-adaptation and prefixes

Prefix	Gloss	Root	Gloss	Suff	Derivation	Gloss
(a) ɛ	one	sɑl	‘roof’	iyɑ	esoliyɑ	‘one roof-ed’
(b) ɛ	one	dɑl	‘branch’	iyɑ	edoliyɑ	‘one branch-ed’
(c) ɛ	one	pɑt	‘leaf’	iyɑ	epotiyɑ	‘one branch-ed’
(d) ɛ	one	d^hɑl	‘slope’	iyɑ	ed^holiyɑ	‘sloping to a side’
(e) sɔ	six	mɑh	‘month’	iyɑ	somohiyɑ	‘six months old’

In the examples in (309), the root /ɑ/ does not change its value for the feature [±back] to that of the preceding prefixal vowel. The reason for this behaviour is dependent on the affiliation of /ɛ-/ and /ɔ-/ as prefixal vowels. Under such circumstances, the [±back] value that the vowel /ɑ/ must assume depends on the [+back] value of /ɑ/, so that it invariably changes to [o] instead of [e] (by assuming the [+back] quality of /ɑ/). Given this description of the pattern of alternation, I will now discuss the locality requirements in these exceptional environments.

2.3 Local exceptional triggering

The behaviour of the vowels above may imply that the exceptional triggering encountered here is not local. Specifically, observe, that in (308) and (309) the [+ATR] value spreads to the entire word. However, the data below show that /ɑ/-adaptation is restricted to the vowel adjacent to the triggering morpheme[75]. All other instances of harmony in the examples in (309) are the result of regular harmony; to wit, /ɑ/ adaptation does not occur when /ɑ/ is not adjacent to the triggering vowel:

(310) /ɑ/ does not change when it is not adjacent to the triggering vowel

Root/Stem	Gloss	Suffix	Derivation	Gloss
(a) pɑtɔl	'light'	-iyɑ	pɑtoliyɑ	'lightly'
(b) ɑpɔd	'danger'	-iyɑ	ɑpodiyɑ	'in danger'
(c) ɑbɔtɔr	'bad time'	-iyɑ	ɑbotoriyɑ	'bad timed'
(d) ɑlɑx	'luxury'	-uwɑ	ɑloxuwɑ	'pampered'
(e) ɑd^{h}ɑ	'half'	-uwɑ	ɑd^{h}oruwɑ	'halved'

[75] Since this analysis was written and completed, two instances of non-local triggering have come to light. /t^{h}ɑpɔr/ 'slap'+/iyɑ/ - /t^{h}oporiyɑ/ slap(causative). /mɑtɑl/ 'mad' + /iyɑ/ - 'drunk/not in control of one's senses'. How to analyse these aberrant forms is the question here. One approach may be to go in the direction of the etymological status of these words. These words seem like more recent forms (probably borrowed from Hindi) and thereore they have different constraints governing them. However, I assume a wug test or similar devices would throw more light on what constraints Assamese speakers use while harmonising novel forms.

In the examples in (310) (a) – (c), in examples with the composition /ɑCɔ../, harmony triggered by /-iyɑ/ only affects the immediately preceding [-ATR] vowel /ɔ/, but non-adjacent /ɑ/ does not undergo harmony. However, this is not different from the behaviour of similar sequences when harmony is triggered by suffixes other than /-iyɑ/ and /-uwɑ/ (see examples in (304) and (306)). They would all produce the same result. The local triggering behaviour of /-iyɑ/ and /-uwɑ/ is exemplified very clearly in the examples in (310) (d) – (e). In these cases, there are two instances of /ɑ/, but only the vowel adjacent to the triggering vowel undergoes harmony. See the illustrations below for a more explicit instantiation:

(311) Environments for /ɑ/-adaptation

[CɑC_{root}]] iyɑ_{sfx}]]] ⟶ /ɑ/-adaptation locally
[mɑr_{root}]] iyɑ_{sfx}]]] ⟶ /moriya/

[ɑCɑC_{root}]] uwɑ_{sfx}]]] ⟶ No /ɑ/-adaptation non-locally
[ɑlɑx_{root}]] uwɑ_{sfx}]]] ⟶ /ɑloxuwa/(cf.*/oloxuwɑ/ */olɑxuwɑ/)

/ɑ/-adaptation triggered by /-iyɑ/ and /-uwɑ/ violates IDENT [low], which was ranked highly in chapter 6. However, IDENT [low] violations are as minimal as possible, because /ɑ/-adaptation is restricted to the smallest possible domain.

With respect to exceptionality, there is another aspect of locality which needs further elaboration here. If we recall the examples in section 2.2 ((304), and (306)), where it was shown that the [±back] value of /ɑ/ depends on the preceding /ɛ/ and /ɔ/ (if they are not prefixal), it is clear what emerges from this behaviour is that the stem-initial vowel is responsible for initiating a type of progressive front harmony which is not dependent on the triggers /-iyɑ/ and /-uwɑ/, although the morphological environment for this exceptional front/back harmony is provided by those two morphemes. The highlight of this process is, again, also that this morpheme-specific front/back harmony focuses on a local domain, like that of /ɑ/ adaptation; in this case this local domain includes the vowel in the immediately following syllable.

I will now present a general background to various OT approaches towards exceptional occurrences and especially morphologically determined ones.

2.4 Background

Generative phonologists (Kisseberth 1970, Zonneveld 1978) working within rule-based frameworks devoted considerable interest to the study of exceptions. In recent theoretical discussions in the OT framework, there has been renewed interest in the way exceptional morphological interferences in phonology can be modelled (Pater 2000, Anttila 2002, Inkelas and Zoll 2003, Pater 2006a, to appear). It is of special interest in an OT framework, where all constraints are universal and individual grammars are a result of permutation of these constraints. Falling out of this ranking biased schema is the fact that constraints organised hierarchically cannot be reversed in order to provide room for morphological idiosyncrasies. At the same time it would be difficult to maintain that morpheme specific constraints are regarded universal[76]. The interest then, lies in how morphologically conditioned 'aberrations' can be handled in an OT approach.

In the co-phonology approach of Antilla (2002), morphemes select their own ranking from a set of partially ordered constraints. Accordingly, only constraints that are unranked in the grammar can have lexically specified rankings. I will not go into the details of the co-phonology approach (cf. Antilla 2002, and Inkelas and Zoll 2003, for an elaboration of the framework, and Pater 2003, 2006a, to appear) for arguments against the constraint ranking approach and in favour of constraint indexation). Again among the diacritic approaches[77], the ones favouring faithfulness constraint indexation are many and varied (e.g. Fukuzawa 1999, Itô and Mester 1999, 2001, Kraska-Szlenk 1997, 1999; see also Benua 2000, Alderete 2001).

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[76] Cf., however, McCarthy and Prince (1995) , which relies on morpheme-specific constraints, (for instance, for the analysis of Tagalog /um/ affixation).

[77] In the rule based approach of Kiparsky (1981), the proposed analysis for exceptions in Hungarian vowel harmony also advocates the use of a lexically designated morphological diacritic feature [-vowel harmony].

Pater (2006a, to appear) shows that most of the problems tackled in morpheme-specific constraint ranking, as well as faithfulness-only constraint indexation theories, can be analysed in terms of constraint indexation of both markedness and faithfulness constraints. At the same time, however, the fact that exceptional triggering or blocking by morphemes is never an unbounded phenomenon, is only predicted by lexically indexed constraints. Constraint indexation is of special relevance in this chapter because the predicted 'local' behaviour of morphemically indexed constraints is borne out in the exceptional data of Assamese. In the constraint indexation approach, morphemes that trigger a process are indexed for a lexically specific faithfulness or markedness constraint. It is assumed that these indexed constraints are cloned from already existing constraints, which are ranked lower in the hierarchy. A case in point is the situation in Finnish, a language in which the stem-final low vowel /-a/ either deletes or is raised to /o/, under the influence of a following /-i-/. The examples below show that the alternations are idiosyncratic as well as local, given the environment in which it occurs:

(312) Exceptional morpho-phonological occurrences in Finnish

(a) /tavara+i+ssa/	[tavaroissa]	'thing (plural inessive)'
(b) /jumala+i+ssa/	[jumalissa]	'God (plural inessive)'
(c) /itara+i+ssa/	[itaroissa] ~ [itarissa]	'stingy (plural inessive)'

The following locality convention captures the locality encountered here:

(313) $*[ai]_L$

Assign a violation mark to any instance of *[ai] that contains a phonological exponent of a morpheme specified as L.

The definition of the constraint above shows that the constraint is violated only when the specified string *[ai] occurs in the output. The application of this constraint is, however, ony relevant to that part of the morpheme which contains a part of the suffix. Therefore, this constraint is violated *iff* this string occurs in exactly the part which contains the specified morpheme. Other occurrences of this sequence in the word do not incur a violation of this constraint. Without any further elaboration, I will simply repeat the constraint hierarchy and the (partial) tableau from Pater in order to provide an illustration. The constraint *[ai] works in the following way:

(314) Grammar: *[ai]-$_{L1}$ ≫ MAX-$_{L2}$, IDENT-$_{L3}$ ≫ MAX, IDENT ≫ *[ai]

(315) Lexicon: /-i-/L_1 /-i-/L_1 /-isi-/ /tavara/L2 /jumala/L3

Input	Output	*[ai]-$_{L1}$	MAX-$_{L2}$	IDENT-$_{L3}$	MAX	IDENT
/tavara$_{L2}$- i$_{L1}$-ssa/	tavaraissa	* !				
	tavarissa		* !		*	
	☞tavaroissa					*
/jumala$_{L3}$-i$_{L1}$-ssa/	jumalaissa					
	☞jumalissa				*	
	jumaloissa			* !		*

The constraint *[ai] does not apply in an unbounded manner. It only applies to that part of the word where the suffixal /i/ also occurs. All other [ai] sequences are not shielded by this constraint. As shown in the tableau, there are other lexically specified faithfulness constraints, which apply to different suffixes. Depending on the relative ranking of the indexation, the output structures will surface with either deletion or mutation. Since /jumala/ is indexed to IDENT L3, it surfaces with deletion rather than mutation[78]. On the other hand, /tavaroissa/ is selected because of the high ranking *[ai] constraint as well as a lexically indexed faithfulness constraint defending /tavara/.

The lexically indexed markedness constraint is able to predict the right results because in this context, only a markedness constraint relativised to the proper morpheme can account for a process, which triggers a phonological change. The fact that indexation of a markedness constraint predicts the right results in Finnish, shows that it accommodates phonological processes which may occur as a result of the derived environment, where morphology provides the context of such occurrences, but the process remains truly phonological. Unbounded application of this indexed markedness constraint is also prohibited and therefore any non-local instantiations of the parts of this string will be counted as violations. In this way, the constraint indexation approach

[78] There is also some variation between the outputs: /itaroissa/ ~ /itarissa/ (example in (312)), which is accounted for by unranked MAX and IDENT constraints, so as to generate variation between lexical items. It is outside the scope of this chapter to go into these details of Finnish. See Anttila (2001) and Pater (2006, 2007) on how such variations can be accounted in cophonology and constraint indexation approaches, respectively.

offers a maximally simple way of accounting for morphophonological effects in derived environments. This is in contrast to the tenets of the ‘cophonology’ programme, which categorically argues against morphological contexts for phonological constraints. In this sense, constraint indexation strikes a balance by postulating a phonological constraint applicable only to a part of the morpheme.

2.5 An analysis of exceptionality in Assamese

‘Locality’ or the application of a phonological process to a certain smallest possible domain is of special relevance in this chapter. In Assamese, the two morphemes /-iyɑ/ and /-uwɑ/ exceptionally trigger harmony in the otherwise opaque vowel /ɑ/. This kind of triggering behaviour is exceptional, as it is confined only to these two morphemes, but it is also systematic: /ɑ/ systematically changes only when it is adjacent to the harmony triggering morpheme, i.e. if /ɑ/ does not occur in immediate proximity to the triggering vowel, it does not harmonise (see diagram (311)). The local effect schematically represented in (311) can be captured by adapting the locally applicable markedness constraint (in (313)) to Assamese. The constraint which I propose as active here is the indexed version of the contextual markedness constraint $*[\text{-ATR}][\text{+ATR}]_{L1}$.

(316) $*[\text{-ATR}][\text{+ATR}]_{L1}$
No instance of [-ATR] followed by [+ATR] includes a phonological component of the morpheme lexically specified as L.

The locality convention manifests itself in this constraint in the form of a condition on the position of violation of this constraint. This constraint is violated only in the absolutely adjacent syllabic position of the triggering morpheme specified as L1. Any further instantiations of [-ATR][+ATR] are not under the jurisdiction of this constraint. This constraint is formulated in another way in Pater (to appear):

(317) $*[\text{-ATR}][\text{+ATR}]_{L}$
Assign a violation mark to the minimal string containing a [-ATR] vowel followed by a [+ATR] vowel, if that string contains a phonological exponent of a morpheme indexed as L

Both these formulations of the same constraint maintain that exceptional triggering in Assamese observes a locality premise which is not violated in the 'minimal domain' as expressed by Pater in (317). The full ranking of Assamese exceptional triggering is given below in (318) and the corresponding tableau exemplifying the analysis is in (319):

(318) Ranking:
*[-ATR][+ATR]$_{L1}$ ≫ ID[low] ≫ *[-ATR][+ATR] ≫ *[+ATR-high] ≫ ID[ATR]

(319) Indexed morphemes in the lexicon: /-iyɑ/$_{L1}$ /-uwɑ/$_{L1}$

(320) /ɑ/ harmonises in the presence of /-iyɑ/

Input: /mɑr/+/iyɑ/$_{L1}$	*[-ATR] [+ATR]$_{L1}$	IDENT [low]	*[-ATR] [+ATR]	*[+ATR - high]	IDENT [ATR]
a. mɑriyɑ	*!		*		
b. ☞moriyɑ		*		*	*
c. moriyo		**!		**	**

The lexically indexed constraint *[-ATR][+ATR]$_{L1}$ penalises a sequence where [ɑ] is followed by the triggering [i]. Note that the constraint *[-ATR][+ATR]$_{L1}$ does not refer to the entire morphemic sequence of /-iyɑ/ and /-uwɑ/, but only to a portion of it. (320)-a. is ousted because it violates the highly ranked lexically indexed constraint. The choice between the two remaining candidates (320)-b. and c. is determined by the faithfulness constraint IDENT[low] which is violated twice by the failed candidate in (320)-c.

In the tableau below, I show how this constraint hierarchy works when there are two instances of /ɑ/ in the input. The tableau below shows that *[-ATR][+ATR]$_{L1}$ inhibits occurrences of [-ATR][+ATR] only in the minimal domain.

(321) Local alternation of /ɑ/ when followed by /iyɑ/ or /uwɑ/

Input: /ɑlɑx/+/uwɑ/$_{L1}$	*[-ATR] [+ATR]$_{L1}$	IDENT [low]	*[-ATR] [+ATR]	*[-high +ATR]	IDENT [ATR]
a. ɑlɑxuwɑ	*!		*		
b. ☞ɑloxuwɑ		*	*	*	*
c. oloxuwɑ		**!		**	**

This tableau shows the markedness requirement of the exceptional trigger /-uwɑ/, i.e. its local application. The indexed constraint *[-ATR][+ATR]$_{L1}$ does not apply to the initial /ɑ/ of the stem /ɑlɑx/. (321)-a violates the top ranked *[-ATR][+ATR]$_{L1.}$ Multiple violations of the faithfulness constraint IDENT [low] leads to the disqualification of the candidates (321)-c.

With this discussion on exceptional /ɑ/ adaptation, I move on to discuss exceptional front harmony in Assamese.

2.6 Exceptional front harmony in Assamese: exceptional and local

As discussed in section 2.3, exceptional triggering in Assamese also involves simultaneous changes in other featural dimensions, i.e. it is not only the [±ATR] quality of the low vowel which changes; but also the [±back] quality of the vowel /ɑ/. When there are no preceding vowels in the presence of /-iyɑ/ and /-uwɑ/ triggers, /ɑ/ assumes its own inherent back quality while adapting itself to a raised [+ATR] value. Therefore, IDENT[±back] remains unviolated in such circumstances, as shown by the tableau below:

(322) /ɑ/ is faithful to IDENT[+back]

Input: /mɑr/+/iyɑ/$_{L1}$	*[-ATR] [+ATR]$_{L1}$	IDENT [±back]	IDENT [low]	*[-ATR] [+ATR]	*[-igh +ATR]	IDENT [ATR]
a. mɑriyɑ	*!			*		
b. ☞moriyɑ			*		*	*
c. meriyɑ		*!	*		*	*

The example above also shows that the [±back] specification of the low vowel is not influenced by the [±back] quality of the triggering morpheme. The vowel /ɑ/ retains its

[+back] value despite the fact that the triggering morpheme is [-back]. IDENT[+back] is higher ranked than IDENT[low] as faithfulness to the [back] value of /ɑ/ is substantially more important than faithfulness to the [low] value[79]. This accounts for the failure of candidate (322)-c because of its [back] value alteration.
However, to analyse cases where the [±back] specification of the low vowel does change as a result of a stem-initial vowel, I will propose a sequential markedness constraint which requires the simultaneous agreement of [±back] values in the smallest possible domain.

(323) [-back -high][+back -high]$_{L1}$
No instance of [-back, -high] followed by [+back, -high] includes *any* phonological component of a morpheme lexically specified as L1.

Further the constraint defned above requires the additional requirement of [-high] from the participating vowels. This is so because [+high] vowels do not participate in this front /back harmony. This kind of exceptionality is also restricted to the mid vowels /ɛ/ and /ɔ/.

This constraint also requires a modification of our understanding of the locus of violation. While the context of application of the constraint *[-ATR][+ATR]$_{L1}$ was a portion of the morphemes /-iyɑ/ and /uwɑ/, in this case /-iyɑ/ and /-uwɑ/ provide the environment for the application of this constraint by spreading [ATR] harmony to the preceding vowels. This constraint is locally applicable only to the [±back] values of the vowels in the root. The domain-oriented nature of exceptional front/back harmony in Assamese can be described as below:

[79] The ranking is not reflected here, but it will be shown in all other instances where /ɑ/ alters to /e/ when the mid vowel precedes it.

(324) *[-back -high][+back -high]

$$\left(*[\text{-back -high}][\text{+back -high}]_{L1}\right)_{\text{derived}}$$

No instance of [-back] followed by [+back] *in the derived domain of the bisyllabic root* includes any phonological component of a morpheme lexically specified as L1.

Recall from section 2.5, that the Finnish *[ai] constraint eludes the root because *[ai] does not include any part of the root. Vowel harmony is a process whch is normally iterative and therefore includes all the vowels in its harmony domain. This of course excludes the /ɑ/-adaptation case because /ɑ/ is normally a non-undergoer in the language. However, when exceptional occurrences involve other [-ATR] mid vowels, harmony is unbounded. As a result, when /-uwɑ/ triggers unbounded harmony and the preceding vowels are /CɛCɑ-/, then another exceptionality shows up. The fact that the resultant output is /CeCe-/ with both [+ATR] and [front] harmony, shows that the output bears a phonological exponent i.e. [+ATR] of the triggering vowel in /-uwɑ/ in order to surface with simultaneous [-back] harmony.

Despite these dual exceptionalities, the process does not infringe on any other point beyond that of the succeeding vowel. This shows that [ATR] and front harmony are co-dependent and a phonological component of the [+ATR] vowel in /-uwɑ/ is required for the exceptional front harmony to surface. But does this mean /-iyɑ/ and /uwɑ/ trigger long-distance front/round harmony in the root? The answer is no. This emergent front/round harmony is restricted to the [±back] values in the root, which is always disyllabic as far as /ɑ/ adaptation is concerned (see section 2.2 on the foot as a domain for these exceptional processes). This front/back harmony is restricted to the smallest domain of the root only.

Pater (2006a, to appear) gives examples of possible long distance effects that an unconstrained theory of morpheme-specific phonology could give rise to. One instance is where a reversal of ONSET ≫ DEP, would result in the exceptional blocking of stem-initial epenthesis. If a suffix is lexically indexed to DEP, and this constraint applies to the whole word, it could potentially prevent epenthesis in the initial vowel of a stem. He gives the following example where /ba/ is the hypothetical exceptional morpheme.

(325) /amana/ [ʔamana] /amana+da/ [ʔamanada]
/amana+ba$_L$/ [amanaba]

However, the Assamese case cannot be considered to be the same type of a distal phenomenon, because emergent front/back harmony is only restricted to the smallest domain of the root. Under all other circumstances, however, the sequential constraint *[-back][+back] is normally lower ranked in the phonology of Assamese, reflecting the fact that front/back harmony does not form an integral part of the vowel harmony landscape of Assamese. The constraints *[-ATR][+ATR]$_{L1}$ and *[-back -high][+back -high]$_{L1}$ are ranked together and any optimal candidate has to respect both of these constraints.

(326) Co-dependent *[-ATR][+ATR]$_{L1}$ and *[-back -high][+back -high]$_{L1}$ I

I: /ɛlɑh/+/uwɑ/$_L$	*[-ATR] [+ATR]$_{L1}$	*[-back -high] [+back -high]$_{L1}$	IDENT [-back]	IDENT [+back]	IDENT [low]	*[-ATR] [+ATR]
a. ɛlɑhuwɑ	*!					*
b. elɑhuwɑ	*	*!				*
c. ☞elehuwɑ				*	*	
d. olohuwɑ			*!		*	
e. elohuwɑ		*!			*	
f. olehuwɑ			*!	*	*	

The tableau in (326) shows how constraint indexation can satisfactorily capture two processes which are indexed to the same morpheme. The selected candidate [elehuwa] satisfies the highly ranked lexically indexed markedness constraint *[-back -high][+back -high] $_{L1}$. It also simultaneously satisfies *[-ATR][+ATR]$_{L1}$. Strikingly, both these processes require the same environment, i.e. exceptional triggering by the vowels in /-iyɑ/ and /-uwɑ/, but they do not contravene the principle of locality that constraint indexation espouses. Both the processes of exceptional /ɑ/-adaptation and front/back harmony are concentrated on the absolutely adjacent syllable or ‘minimal string’. The evaluation shows how this constraint ranking prohibits candidates (326)-b and (326)-e because they violate *[-b -high][+b -high] $_{L1}$. Candidates (326)-d and (326)-f are barred from being selected in this evaluation because of their multiple violations of IDENT[-back].

The tableau below shows an input which contains a /CɔCɑ-/ sequence.

(327) Co-dependent *[-ATR][+ATR]$_{L1}$ and *[-back -high][+back -high]$_{L1}$ II

Input: /bɔzɑr/+/uwɑ/$_{L1}$	*[-ATR] [+ATR]$_{L1}$	*[-back-high] [+back-high]$_{L1}$	IDENT [-back]	IDENT [+back]	IDENT [low]	*[-ATR] [+ATR]
a. bɔzɑruwɑ	*!					*
b. bozɑruwɑ	*!					*
c. ☞bozoruwɑ					*	
d. bezeruwɑ				*!*	*	
e. bozeruwɑ			*!	*	*	
f. bezoruwɑ		*!		*	*	

The constraint hierarchy is able to generate the right output [bozoruwa] because the selected output violates neither *[-back -high][+back -high]$_{L1}$ nor *[-ATR][+ATR]. All the other candidates incur fatal violations of either the two high ranking constraints or the constraint demanding faithfulness to the [back] values.

2.7 Exceptional triggering in indexed constraint ranking and faithfulness only indexation approaches

In this section, I show how other theories of indexation (which might be considered as alternatives to analyse the Assamese cases) would produce unattested results in the face of the Assamese data discussed in this chapter until now. According to the lexically indexed constraint ranking approach (Anttila 2002), only unranked constraints can be lexically specified. In Assamese, we can rank *[+ATR, +low] above the unranked constraints IDENT[low] and *[-ATR][+ATR]. The specific lexical items in the lexicon then choose their ranking from the unranked pair. Accordingly, indexation of constraint ranking will produce /kɔpɑhi/ and /moriyɑ/ respectively in each of the two lexical items listed in (329)(a) and (b)

(328) Constraint ranking in the Grammar:
*[+ATR +low] ≫ IDENT[low], *[-ATR][+ATR]

(329) Constraint ranking in the Lexicon:
(a) kɔpɑh-i $_{\text{IDENT[low]} \gg \text{[-ATR][+ATR]}}$
(b) mar-iyɑ $_{\text{*[-ATR][+ATR]} \gg \text{IDENT[low]}}$

It is quite easy to show that the indexed constraint ranking approach would then generate *[oloxuwɑ] for the input /ɑlɑx-uwɑ/ as a result of the following indexed ranking in the lexicon. The tableau below shows how ranking indexation would predict the wrong results for local /ɑ/-adaptation.

(330) ɑlɑx-uwɑ $_{\text{*[-ATR][+ATR]} \gg \text{IDENT[low]}}$

Input: /ɑlɑx/+/uwɑ/	*[+ATR +low]	*[-ATR] [+ATR]	IDENT [low]	*[+ATR -high]	IDENT [ATR]
a. ɑlɑxuwɑ		*!			
b. ☹ɑloxuwɑ		*!	*	*	*
c. 💣oloxuwɑ			**	**	**

The candidate in (330)-c would be the predicted outcome in ranking indexation. The actual output in (330)-b incurs a violation of the constraint *[-ATR][+ATR].

Another possibility would be to adopt a morpheme-specific faithfulness analysis. Such an analysis would require faithfulness constraints indexed to morphemes. In a situation like exceptional triggering, where faithfulness does not provide any solution, a solution involving faithfulness of both the triggering morphemes as well as the undergoing morpheme is bound to fail. The required locality in the output [ɑloxuwɑ] will not follow from a faithfulness approach because it will only prefer faithfulness of all the triggering morphemes:

(331) Grammar: MAX$_L$, IDENT$_L$ ≫*[-ATR][+ATR] ≫ MAX, IDENT
Lexicon: /-iyɑ/ /-uwɑ/ $_L$

Input: /ɑlɑx/+/uwɑ/	MAX$_L$	ID$_L$	*[-ATR] [+ATR]	*[-high +ATR]	IDENT [ATR]	MAX	IDENT
a. ɑlɑxuwɑ			*!				
b. ☹ɑloxuwɑ			*	*	*		*
c. 💣oloxuwɑ				**!	**		**

The faithfulness-only constraint indexation approach compels non-local unfaithfulness and therefore predicts the wrong candidate with long-distance /ɑ/-adaptation (candidate (331)-c). The desired output candidate in (331)-b is faithful to the indexed morphemes, but incurs a violation of the high ranked *[-ATR][+ATR].

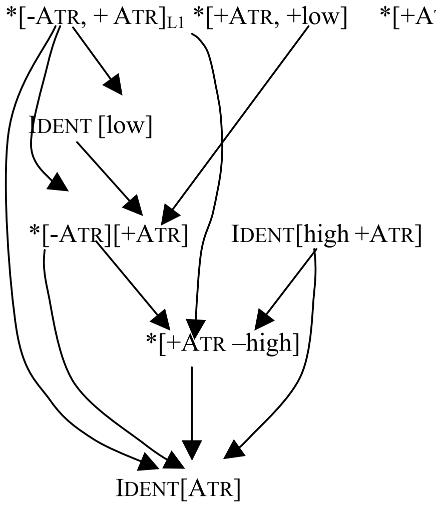
The discussion above only shows how the alternative approaches will fail to account for local /ɑ/-adaptation. However, accounting for emergent front/back harmony will also come with some attendant difficulties. Constraint ranking indexation would also be confounded with the additional requirement for /ɑ/-adaptation – that it requires the agreement of front/back values of the stem initial vowel to match with /ɑ/. The ranking indexation would then make the wrong prediction, viz. that the output of this process is variable between one which chooses [ATR] harmony and another which opts for front/back harmony. The unranked constraints *[-ATR][+ATR]$_{L1}$ and *[-back -high][+back -high]$_{L1}$ will result in ranking indexation that there is variation between [elehuwa] and [ɛlɛhuwa].

When morphological structure is indicated by an alternation and an accompanying morphological addition, the resulting alternation needs to be as restricted and local as possible. The locality issues brought to the forefront by morpheme-specific phonology have also been noticed for phenomena other than Assamese vowel harmony. We have already shown the Finnish examples where morphemically determined mutation in /tavara/ ~ /tavaroissa/, etc. applies only locally. Other examples include, German plural formation where [Palast] singular – [Paläste] Plural cf. *Pälaste, *Päläste (Wiese 1996b: 183-184). This notion of locality plays a major role in a theory of constraint indexation by specifying a morpheme which will trigger or undergo a process in a manner as restricted as possible. While doing so, a morpheme is specified for a phonological constraint, but the constraint does not apply directly to the entire string. In the Assamese case, the morphemes /-uwɑ/ and /-iyɑ/ are the specified morphemes so that when the constraint *[-ATR][+ATR] applies, the context for the application of the constraint, i.e. the [+ATR] vowel /i/, is provided by the triggering part of the morpheme. Similarly the same morphemes are also involved in further exceptional behaviour. Their presence triggers progressive front/back harmony in an otherwise regressive [+ATR] harmony process. This exceptional behaviour is also elegantly captured by a theory of constraint indexation which requires morpheme-specific processes to be bounded to the smallest possible domain. As a result, the progressive front/back 'emergent' harmony is also limited to the immediately following vowel.

Consistency of Exponence (McCarthy and Prince 1993, 1994) is a principle which states that lexical specifications of morphemes can never be altered by the GEN component of OT. This particular attribute of OT requires a morpheme's underlying phonological material to be unaltered in its surface output form. Emergent front harmony requires a derived environment domain and the process does not involve any change in a morpheme's affiliation in GEN[80]. Therefore the process does not exhibit any challenge to the principle of Consistency of Exponence. Furthemore, front hamony only affects the root morpheme to the exclusion of the suffix as well as the prefix. For example in the example to be discussed below in (326) /ɛlɑh/+/uwɑ/, where the output is /elehuwɑ/, front harmony affects the root morphemes only.

[80] As pointed out by Kie Zuraw, the other option would be to appeal to a constraint conjunction in a Derived Environment Domain (Following Lubowicz 2002). For example *[-bk –hi] & IDENT(low) » IDENT (bk)

(332) Demotion of IDENT[low] and ranking of lexically indexed *[-ATR, + ATR]$_{L1}$



The ranking shows that there are four strata of constraints in Assamese and these have been arrived at by pairwise evaluation of candidates. This ranking shows exactly which highly ranked constraint directly dominate a lower ranked constraint. In the ranking shown above, it is also evident that IDENT [low] now needs to be demoted because in a pairwise evaluation, a wining candidate violates IDENT [low] and satisfies *[-ATR, + ATR]$_{L1.}$

3 Verbal morphology and exceptional NOHIATUS

I will now move on to a type of morphological effect in the vowel harmony pattern of Assamese which is different from the cases of exceptional triggering discussed in the preceding sections. Firstly, it exhibits no incongruity in the phonological environment in which harmony is triggered. The vowel /i/ triggers regular harmony in the verbal paradigm, but it is the phonological requirement of NOHIATUS which results in the surface appearance of [e] and [o]. Secondly, in these instances of morpho-phonemic alteration, there is no violation of IDENT [low]. The /ɑ/ in the verbal root /k^{h}ɑ/ 'eat' for instance, does not change because of the underlying presence of the /i/ morpheme. Thus these instances of faithfulness to the [+ATR] value of the deleted morpheme will be shown to be the result of lexically indexed faithfulness constraints. The locality conventions followed by indexed faithfulness constraints will also be discussed in the following sections. The upshot of the discussion will be that indexed faithfulness constraints will be shown to be able to account for a non-surface true phenomenon with the advantage of explaining some demonstrably local effects. Before delving into the intricate details of the phenomenon of vowel deletion in verbs, I will briefly discuss the status of NOHIATUS as a constraint operative in the phonology of Assamese.

3. 1 NOHIATUS in Assamese

In this section, examples from the nominal paradigm show that in the presence of vowel-initial suffixes, vowels undergo deletion. Although there are no [+ATR] harmony triggering affixes in the examples in (333), these forms show that in Assamese phonology some suffixes are realised as vowel-initial when the stem syllables they attach to are closed, but as consonant-initial when the stem syllable is open.

(333) [-ATR] initial suffixes

Root	Ergative	Accusative	Dative	Genitive	Locative	Instrumental
	/ɛ/	/k/ /ɔk/	/loi/	/r/	/t/ /ɔt/	/rɛ/
			/ɔloi/	/ɔr/		/ɛrɛ/
b^hɑt	b^hɑt-ɛ	b^hɑt-ɔk	b^hɑt-oloi	b^hɑt-ɔr	b^hɑt-ɔt	b^hɑt-ɛrɛ
mɑ	mɑ-yɛ	mɑ-k	mɑ-loi	mɑ-r	mɑ-t	mɑ-rɛ

The insight we gain from the case marking system is the following:

(i) In a suffix of the shape VC, the vowel may undergo deletion if the stem also ends in a vowel, to avoid hiatus (mɑ +ɔk→mɑk)

(ii) In a suffix of the shape V, there is epenthesis if the stem also ends in a vowel (mɑ + ɛ → mɑyɛ).

These observations show that the NOHIATUS is operative as a constraint in the phonology of Assamese.

It is a well-observed phenomenon that segments may be either deleted or inserted in order to resolve hiatus, and result in the linking of two adjacent segments, which may be present at the edges of a morphological domain. For instance, /r/ insertion in Boston English (McCarthy 1994, among others). [81]

It should also be noted that though NOHIATUS is operative in the nominal examples in (333), there is no concomitant realisation of the deleted vowel of the morpheme. I attribute this to the fact that there is no corresponding faithfulness constraint which militates to preserve the contents of the deleted morpheme. This brief detour also suggests that NOHIATUS is present in the phonology of Assamese, independent of vowel harmony. NOHIATUS sometimes kicks in to preserve the ideal phonological shape of a morpho-phonological word, when morphology provides the context of a juncture. However, as will be discussed in the following section, NOHIATUS is not an undominated constraint and may be relevant only in specific morphophonological interactions. For our purposes in this chapter, I define the constraint as below:

(334) NOHIATUS

"Avoid heterosyllabic vocalic sequences"

The constraint NOHIATUS is a prohibition against heterosyllabic vowel-vowel sequences. On the one hand NOHIATUS (in the nominal examples in (333) above is responsible for the insertion of /y/ and /w/ when V suffixes are appended to the base, and on the other hand, it motivates deletion when VC affixes are adjoined to the base.

With this as the backdrop, let us turn to the phenomena where harmony induced by [+ATR] vowel-initial suffixes interacts with NOHIATUS.

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[81] The status of NOHIIATUS in OT is controversial. In McCarthy (1993), NOHIATUS is only mentioned as a probable constraint and it is shown that /r/ insertion in Boston English is the result of the interaction of the constraints *Final C and NO CODA, because what seems like hiatus resolution is actually the banning of final consonants word finally in lexical words (not function words) and in all contexts except phrase-medially. It is possible that in Assamese the relevant constraint is ONSET which requires deletion and epenthesis so as to provide for syllable-initial nsets. However, the result in rɔ + im → /rom/ would not satisfy any constraint requiring Onsets, and */royim/ would be more optimal under the influence of ONSET. I will therefore use NOHIATUS as a cover constraint for the processes of hiatus resolution in Assamese for the time being, until further research is able to establish convincing proof in favour of or against any alternative motivation.

3.2 /i/ deletion and vowel harmony in verbs

The relevant process that will discussed in these sections will be /i/ deletion in the verbal morphology, which will be shown to be the result of a lexically indexed NOHIATUS constraint in a derived domain. Again recall from the previous chapters that Assamese does not allow the presence of /e/ and /o/ without a following /i/ or /u/. In such a scenario, the result of harmony when the verbal root /rɔ/ 'wait' is suffixed with /il/ is expected to be /roil/. The existence of the apparently impossible sequences /rol/, /gol/ (after the deletion of /i/)[82], etc., is therefore unpredictable, given the morphology of the verbal paradigm. This situation emerges because the eventually occurring surface output forms /rol/ and /gol/ surface with the harmonised segment even though the triggering segment has been deleted. This shows that the deleted segments influence the surface structure of morphosyntactic words. I argue that a lexically indexed NOHIATUS constraint is operative in driving these kinds of non-surface-true alternations This an anlysis shows that NOHIATUS is operative as a constraint in the core phonology of Assamese. This markedness requirement can also show up in a paradigm (in this case the verbal paradigm) by demanding it to be lexically indexed to a particular morpheme. The analysis is spelled out in the next section.

3.3 Vowel harmony in verbs

Assamese verbal inflection was already examined in detail in chapter 4 (section 4.3), while discussing harmony in derived words. Below, I present a small sample of the vowel harmony pattern displayed in verbs (repeated from chapter 4, section 4.3):

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[82]In his typological study, Casali (1997) notes that in a root and suffix boundary, if the suffix is VC, a ranking of MAX MS (a constraint preserving all input segments) over MAX LEX (a faithfulness constraint protecting lexical words) would produce a deletion pattern, such as the one instantiated in Assamese. A discussion of various typological issues, as the ones raised by Casali is outside the scope of this chapter.

(335) Vowel harmony in the verbal paradigm

Root vowel	ɔ	ɔ	ʊ	ɑ
Verbal root	rɔ'wait'	lɔ 'take'	d^hʊ 'wash'	k^hɑ 'eat'
Past perfect	il + ʊ/i/ɑ/ɛ	il+ ʊ/i/ɑ/ɛ	il+ ʊ/i/ɑ/ɛ	il + ʊ/i/ɑ/ɛ
1P	rolʊ	lolʊ	d^hulʊ	k^hɑlʊ
2P(fam)	roli	loli	d^huli	k^hɑli
2P(ord)	rolɑ	lolɑ	d^hulɑ	k^hɑlɑ
2P(hon)&3P	rolɛ	lolɛ	d^hulɛ	k^hɑlɛ
future	im/ib+i/ɑ+ɔ	im/ib+i/ɑ+ɔ	im/ib+i/ɑ+ɔ	im/ib+i/ɑ+ɔ
1P	rom	lom	d^hum	k^hɑm
2P(fam)	robi	lobi	d^hubi	k^hɑbi
2P(ord)	robɑ	lobɑ	d^hubɑ	k^hɑbɑ
2P(hon)&3P	robɔ	lobɔ	d^hubɔ	k^hɑbɔ

In the paradigms above, the [+high +ATR] vowel /i/ always trigger a change in the preceding [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/. Verbs inflect in the following order:

(336) Root + Aspect (Perfective/Progressive) + Tense+ Person

The pattern of inflection of the open monosyllables /d^hʊ/ 'wash' and /k^hɑ/ 'eat', deserves attention because only open monosyllables provide the context for vowel deletion. Therefore, only such forms of monosyllables have been taken into consideration. Note that the verb /rɔ/ 'wait' inflects for its future and past perfect forms without the presence of the harmony-triggering vowel, but with the alternation that the deleted vowel triggers. Therefore, in the past perfect and future forms of all the verbal forms above, the vowel /i/ is deleted, such that the initial vowels in /im/, /ib/ and /il/ are left invisible after inflection. Consequently, these altered forms exist in the verbal morphology as a result of vowel harmony triggered by the underlying presence of /i/. (361). However, the paradigm in (335) is not representative of the entire verbal morphology of Assamese. In other words, /i/ deletion under hiatal conditions is not attested across the board in the verbal morphology of the language. Take for instance the following paradigm as a result of affixation of /-is/, the perfective suffix (repeated from chapter 4, section 4.3, with different examples):

(337) affixation of /-is/

Root	k^hɑ + is + ʊ/ɔ/ɑ/ɛ	rɔ + is + ʊ/ɔ/ɑ/ɛ	d^hʊ + is + ʊ/ɔ/ɑ/ɛ
Present Progressive			
1P	k^hɑisʊ	roisʊ	d^huisʊ
2P(fam)	k^hɑisɔ	roisɔ	d^huisɔ
2P(ord)	k^hɑisɑ	roisɑ	d^huisɑ
2P(hon)&3P	k^hɑisɛ	roisɛ	d^huisɛ
	k^hɑ + is + il + ʊ/ɔ/ɑ/ɛ	rɔ + is + il + ʊ/ɔ/ɑ/ɛ	d^hʊ + is + il + ʊ/ɔ/ɑ/ɛ
Past-Progressive			
1P	k^hɑisilʊ	roisilʊ	d^huisilʊ
2P(fam)	k^hɑisili	roisili	d^huisili
2P(ord)	k^hɑisilɑ	roisilɑ	d^huisilɑ
2P(hon)&3P	k^hɑisilɛ	roisilɛ	d^huisilɛ

The set of examples above show that the morphological extension /-is/ does not involve any step towards hiatus resolution. The constraint on hiatus resolution is blatantly violated by the verbal derivations produced as a result of the addition of /-is/, as the most initial extension. I will show that this behaviour of the morpheme is the result of an indexed NOHIATUS constraint demanding the preservation of the entire morpheme which is ranked higher than the NOHIATUS constraint.

3.4 /i/-deletion in the verbal paradigm and indexed NOHIATUS

The type of deletion and subsequent fusion of a featural quality is also known as coalescence. Before providing the complete analysis of the patterns discussed in Assamese I will present the constraints are which required for an anlysis of this pattern of deletion in Assmaese verbs. The constraint which prohibits coalescence in OT is the following :

(338) UNIFORMITY — "No Coalescence"
No element of S_1 has multiple correspondents in S_2 .
(McCarthy and Prince 1995)

This faithfulness constraint that requires an output segment to correspond to only one input segment The constraint UNIFORMITY is violated by those segments which exhibit output correspondents where multiple elements in the input representation are fused in the output. In the evaluation in Assamese it will be shown that this constraint will be violated by sequences where the alternation is the one as following:

(339) $/r_1ɔ_2/+/i_3l_4/ \rightarrow / r_1o_{2,3}\ l_4/$

In this type of an alternation multiple elements i.e. /ɔ/ and /i/ are fused in the output to be realised as /o/.

Another faithfulness constraint which is relevant in the analysis of the type of deletion encountered here is the IDENT I→O [F] constraint, proposed in Pater (1999). This constraint was proposed to deal with the asymmetry (as opposed to MAX constraints, where MAX[F] penalises deletion and DEP penalises insertion) in the IDENT family of constraints proposed in the correspondence model of faithfulness (McCarthy and Prince 1995). In the IDENT family of constraints (McCarthy and Prince 1995) an IDENT[F] constraint can be violated only in the presence of a segment's feature value in the output, and not in its absence. The faithfulness constraint required to prohibit featural deletion in Assamese is IDENT I→O [ATR], which is stated below:

(340) IDENT I→O [+ATR]

Output correspondents of a feature specified as [+ATR] must be [+ATR]

This faithfulness constraint will evaluate the faithfulness of [+ATR] values in the output. In other words, an output representation with the deletion of a corresponding input [+ATR] value would incur a violation mark.

Turning to the faithfulness of a deleted morpheme in verbs, we will see that an indexed NOHIATUS constraint determines the emergence of vowel patterns hitherto unattested until this chapter. I formulate this lexically specified faithfulness constraint as below:

	Constraint	Lexicon
(341)	NOHIATUS $_{L2}$	/il/ /ib/ /im/

"Avoid heterosyllabic vocalic sequences"

The analysis to be presented holds that NOHIATUS $_{L2}$ is crucial in determining the output candidate when the triggering segment is deleted in morpheme-specific surface well-formedness constraints.

As a result of independent principles of grammar (where NOHIATUS is present even when there is no harmony, as shown by the instances of hiatus resolution in case of nominal affixation in the previous section), NOHIATUS is indeed operative as a crucial constraint in Assamese. This constraint has the potential to either delete or insert a segment in order for the output to comply with it. This constraint also needs to be indexed to account for that part of the verbal morphology which overrides all other constraints in order to satisfy NOHIATUS. The result of this indexation is shown below:

(342) NOHIATUS $_{L2}$ and faithfulness of the deleted feature

/rɔ/+/im/$_{L2}$	NOHIATUS $_{L2}$	IDENT I→O [+ATR]	UNIFORM	*[-ATR] [+ATR]	NO-HIATUS
a. rɔim	*!			*	*
b. roim	*!				*
c. rɔm		*!			
d.☞ rom			*		

In the tableau above, NOHIATUS $_{L2}$ effectively bars the candidates (342)-a and (342)-b from being the winners in the evaluation. In the absence of an indexed constraint, the candidate in (342)-b, [roim] would offer the most competition as it satisfies UNIFORM which the candidate now selected as a result of satisfying the highest ranking NOHIATUS L_2 does not. IDENT I→O [+ATR] prohibits (342)-c from emerging as the winner as it does not preserve the [+ATR] quality of an input segment.

By evaluating another candidate which has a suffix of the shape /VCV/, we can see that the same process applies throughout the verbal morphology wherever the morphemes indexed as L_2 appear. While hiatus resolution drives deletion, requirements of featural faithfulness result in the expression of the morpheme's [+ATR] feature on the preceding vowel. In the tableau below, while the high-ranking NOHIATUS $_{L2}$ requires vowel deletion, the constraint IDENT I→O [ATR] preserves the [ATR] feature in the output form, resulting in the optimal candidate which satisfies both constraints.

(343) NoHiatus L_2 drives hiatus resolution in some parts of the verbal morphology

/rɔ/+ /-ilɑ/$_{L2}$	NoHiatus $_{L2}$	Ident I→O [Atr]	Uniform	*[-Atr][Atr]	NoHiatus
a. roilɑ	*!				*
b. rɔilɑ	*!			*	*
c. rɔlɑ		*!			
d.☞ rolɑ			*		

In the evaluation in the tableau above, the resultant output form /rolɑ/ is a product of the combined forces of Ident I→O [Atr] and NoHiatus $_{L2}$. Candidates (343)-a and (343)-b violate NoHiatus L_2. Candidate (343)-c violates Ident I→O [Atr], which demands faithfulness to the feature value of the deleted segment, resulting in a failed candidate.

3.5 Unbounded harmony due to *[-Atr][+Atr]

Ident I→O [Atr] is necessitated in order to faithfully realise the deleted segment in the immediately preceding context, but all other realisations of the feature [+Atr] are the effect of the constraint *[-Atr][+Atr]. For instance, it is common to have sequences like /norolɑ/ 'did not wait (2P)', emerging out of the triggering of vowel harmony in the vowel preceding the vowels in /rolɑ/.

The tableau below in (344) shows that morpheme deletion and its simultaneous preservation can appear to be an iterative process, but iterativity is the result of the lower ranking constraint *[-Atr][+Atr].

(344) Unbounded harmony due to *[-Atr][+Atr]

nɔ+rɔ+ilɑ$_{L2}$	NoHiatus $_{L2}$	Ident I→O [Atr]	Uniform	*[-Atr] [+Atr]	NoHiatus
a. noroilɑ	*!				*
b. nɔrɔilɑ	*!				*
c. nɔrɔlɑ		*!			
d. nɔrolɑ			*	*!	
e.☞ norolɑ			*		

The candidate (344)-d is not the correct output because it violates *[-Atr][+Atr], even though it satisfies IDENT I⸺O [ATR]. This candidate can be compared to (344)-e which does not violate *[-ATR][+ATR] and emerges as the winner.

The negative particle in Assamese can be regarded as a clitic with the representation / NEG /+/V/, as it copies the vowel of the verbal base and although initial it is never the stress bearing element. Hence, it can also be argued that the NEG element copies the vowel of the harmonised base, instead of undergoing iterative harmony. In either case, the contention here is that it is *[-ATR][+ATR] which plays a decisive role in preferring /norolɑ/ to */nɔrolɑ/. Examples of harmony spreading to the negative element preceding the stem abound in the verbal morphology, and the following examples of Neg+ Verb Root+ Inflection are presented as some of the instances:

(345) Examples of NEG + Verb Root+ Inflection

nɔ+lɔ + il + ɑ →	/nololɑ/	
NEG+take+past+2P fam		you did not take
nʊ+xʊ+il+ɑ →	/nuxulɑ/	
NEG+sleep+past+2P fam		you did not sleep
nɛ+dɛk^h+il+ɑ →	/nedek^{h}ilɑ/	
NEG+see + past+2P fam		you did not see

Regressive spreading of the vowel quality of the triggering morpheme across the immediately adjacent segment, to the most initial segment is ‘normal’ when considered from the viewpoint of iterative harmony in Assamese and this does not bear on the hiatus resolution process observed in some parts of the verbal morphology.

3.6 Non-application of indexed NOHIATUS

As discussed in section 2.5 on the verbal morphology, a part of the verbal morphology does not show any tendency to exceptionally satisfy the constraint NOHIATUS and this section presents a brief exposition of these facts of the verbal morphology. The hierarchy proposed till now is ranked as below:

(346) NOHIATUS $_{L2}$, IDENT I⸺O [ATR] ≫ UNIFORM ≫ *[-ATR][+ATR] ≫ NOHIATUS

However, the examples like /roisʊ/, etc. which do not incur violation of NOHIATUS also need to be accounted for in this analysis. These instances of non-applicabilty of exceptional hiatus resolution are a result of non-indexation of these verbal morphemic extensions to any constraint demanding exceptional hiatus resolution. Hence this shows that the proposed analysis correctly predicts prevention of hiatus resolution as a result of non-indexation of the morpheme /-is/ to any constraint demanding hiatus resolution, even though hiatus resolution is present as a strategy in the core phonology of the language.

(347) No violation of indexed NOHIATUS by non-indexed morphemes

rɔ+is + il_2 + ɑ	NOHIATUS $_{L2}$	IDENT I→O [ATR]	UNIFORM	*[-ATR] [+ATR]	NOHIATUS
a. rɔisilɑ				*!	*
b. ☞ roisilɑ					*
c. rɔsilɑ		*!		*	
d. rosilɑ			*!		

In the tableau above, the lexically indexed faithfulness constraint does not demand hiatus resolution even under conditions where hiatus should have been resolved, because the morpheme /-is/ is not indexed to it. In the tableau in (347) candidate (347)-a which is the most faithful candidate violates *[-ATR][+ATR], the harmony driving constraint. Candidate (347)-b is the most optimal candidate, and although it violates NOHIATUS, it does not affect the evaluation because NOHIATUS is ranked lowest in this hierarchy and therefore does not need to be satisfied under all circumstances. (347)-c violates IDENT I→O [ATR] and therefore rejected from the evaluation. (347)-d violates UNIFORM and therefore loses out to (347)-b which is the winner in this evaluation.

Finally, recall that in Assamese deletion of the inflectional suffix is encountered in the verbal morphology as a result of addition of /-il/ and /-im/. There are instances of hiatal epenthesis in other parts of the lexicon. For instance, recall the examples /keseluwa/ (cf (304) c) /dekeruwɑ/ (cf. (304) e) and misoliyɑ (cf. 0 above d).

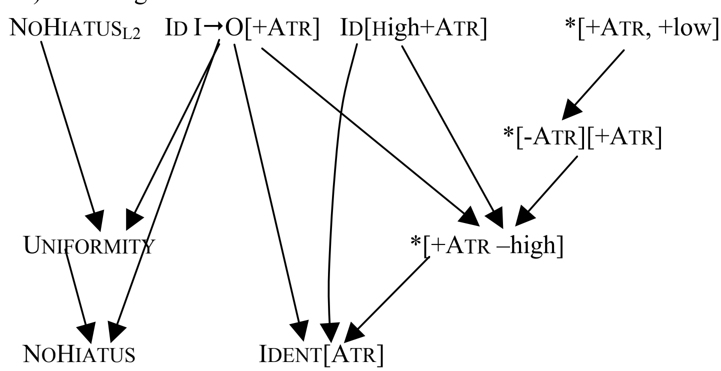
In these examples, a hiatus is resolved by epenthesising /l/ and /r/ respectively. The tableau below shows that such epenthetic behaviour is fully accounted by the constraint hierarchy posited till now:

(348) NOHIATUS and epenthesis

misɑ+iyɑ	NOHIATUS $_{L2}$	IDENT I→O [ATR]	UNIFORM	*[-ATR][+ATR]	NOHIATUS
a. misɑliyɑ				*!	
b. ☞ misoliyɑ					
c. misoyɑ			*!		
d. misoiyɑ					*!

The tableau above shows that even though NOHIATUS is low-ranked, its presence in the hierarchy is responsible for ensuring that hiatus can still be resolved by epenthesis.

(349) Ranking of NOHIATUS related constraints



The Hasse diagram shows the results obtained thus far. NOHIATUS$_{L2}$ and ID I→O[+ATR] are undominated, and they are ranked higher than UNIFORMITY which is ranked above NOHIATUS.

4 Exceptional occurrences in the underived lexicon

Upto this point of the chapter, I have concentrated exclusively on the derived domain, and as promised in the introduction, in this section I try to integrate the theory of constraint indexation to include exceptional occurrences in the underived domain too. Itô and Mester (1995, 1999) allow for etymologically motivated variation in Japanese with stratally indexed faithfulness constraints which are ranked at different points in the grammar. On the other hand, Pater (2000) allows for exceptional secondary stress in English to be governed by indexed constraints which are also exemplified in other places in the hierarchy.

In Assamese the generalisation about [e] and [o] being completely allophonic is disturbed by some lexical exceptions. The examples are presented in chapter 4, section 5, and these examples also include those in (352). In this section, I motivate the treatment of these special cases in terms of a lexically-specific constraint. I assume that the lexical form of a word like /ɑbedɔn/ which straightforwardly violates the constraint *[-ATR][+ATR] as well as the markedness constraint against *[+high -ATR] vowels, is governed by a lexically indexed markedness constraint. In order for the faithful occurrence of this monomorphemic word, which violates both these constraints, there must be a faithfulness constraint to shield these [e] and [o] occurrences. In order to distinguish this set of lexicalised forms from the instances of /e/ and /o/ in the derived inventory, this set of lexical items receive the diacritic L3, and the constraint ID[+ATR]$_{L3.}$

(350) ID[+ATR]$_{L3}$
Input specifications of [+ATR] are preserved in the output.

(351) Grammar: ID[+ATR]$_{L3}$ ≫ *[-ATR][+ATR] ≫
*[+high –ATR] ≫ ID[+ATR]

(352) Lexicon

abestɔn	'enclosure'	abedɔn	'appeal'
od^{h}ibexɔn	'conference'	niketɔn	'institute'
nibedɔn	'appeal'	bedɔna	'pain'
ob^{h}ixek	'installation'	setɔna	'consciuosness'…

The tableau below shows how this grammar works relative to the constraint hierarchy proposed so far:

(353) IDENT[+ATR]$_{L3}$ governs lexical items which bear [e] and [o] without any alternation

I: abestɔn$_{L3}$	ID[+ATR]$_{L3}$	*[-ATR][+ATR]	*[-high +ATR]	ID[+ATR]
a. ☞ abestɔn		*	*	
b. abeston		*	**!	
c. abɛstɔn	*!			*

The constraint hierarchy shows that the most faithful candidate wins because it bears the lexically specified [+ATR] feature. The rival candidate in (353)b) violates the markedness constraint *[-high +ATR] twice and therefore it is not chosen as the optimal output. Candidate (353)c) incurs a fatal violation of the lexically indexed constraint.

The ranking above also shows that constraint indexation leads to only a minimal violation of *[-high +ATR]. The lexical item bearing the indexation L3 violates this constraint only minimally. The same goes for all the items in the list provided in (352) above and in section 5 in chapter 4. All other instances of violation of *[-high +ATR] are the result of vowel harmony (see /ob^{h}ixek/ in the list in (352) for instance).

(354) Multiple instances of *[-high +ATR] violation is as a result of harmony

I: ɔb^{h}ixek$_{L3}$	ID[+ATR]$_{L3}$	*[-ATR][+ATR]	*[-high +ATR]	ID[+ATR]
a. ɔb^{h}ixek		*!	*	
b. ☞ob^{h}ixek			**	*
c. ɔb^{h}ixɛk	*!	*		*

The tableau above shows all exceptional occurrences violate *[-high +ATR] only minimally. *[-high +ATR] prevents multiple occurrences of the allophonic vowels [e] and [o].

5 Exceptional triggering in Bengali

Recall from chapter 5 that in Bengali verbal phonology the underlying quality of vowels in roots formed a difficult issue. As discussed before, it may be possible to postulate that the causative suffix and the nominaliser, both of which share the overt morphological marker /-a/, are responsible for lowering harmony. Whenever these two morphemes occur, the root vowel appears with a vowel height which is lower. The following examples are repeated from chapter 5:

(355) Root alternations in Bengali

Nominal	/-i/ 1st person Present	/ un/ 2nd person Honorific	
ʃekʰa	ʃikʰi	ʃikʰun	‘to learn’
kʰola	kʰuli	kʰulun	‘to open’
dɛkʰa	dekʰi	dekʰun	‘to see’
kɔra	kori	korun	‘to do’

As the examples show, Bengali verbal roots appear in agreement with the inflectional augments following the root. Whenever the inflectional extension is /a/, the root appears with a lowered vowel, but when the inflectional augments are the high vowels /i/ and /u/, the raised counterpart surfaces. However, the causative morpheme itself appears without any alternation in the presence of the otherwise triggering morphemes, /-i-/, /-iʃ/, etc. See examples below:

(356) Bengali verbal roots appear with low vowels in the presence of a following /a/

Roots : /ʃon/ ‘hear’ /ken/ ‘buy’

	First Person	Second Person (Ordinary)	Second Person (Familiar)
Present	ʃon-a-c-cʰ-i	ʃon-a-c-cʰ-iʃ	ʃon a-c-cʰ-o
Continuou	ken-a-c-cʰ-i	ken-a-c-cʰ-iʃ	ken a-c-cʰ-o
Past	ʃon-a-c-cʰ-i-l-am	ʃon-a-c-cʰ-i-l-i	ʃon-a-c-cʰ-i-l-e
	ken-a-c-cʰ-i-l-am	ken a-c-cʰ-i-l-i	ken-a-c-cʰ-i-l-e
Future	ʃon-a-b-o	ʃon-a-b-i	ʃon-a-b-e
	ken-a-b-o	ken-a-b-i	ken-a-b-e

The causative /-a-/ in the table above does not undergo any visible alteration. This might lead one to conjecture that /a/ is consistently opaque in Bengali. In the examples below, however, alternation in the verbal root is induced by the perfective /-e/. The perfective only affects the vowel /a/ by raising it to /-e/.

(357) Perfective /-e/ exceptionally triggers raising
Root:/nam/ 'take'

	First Person	Second Person (Ordinary)	Second Person (Familiar)
Perfect	nem-e-c^h-i	nem-e-c^h-iʃ	nem-e-c^h-o
Causative	nam-a-c-c^h-i	nam-c-c^h-iʃ	nam-a-c-c^h-o
Perft causative	nam-i-e-c^h-i	nam-i-e-c^h-iʃ	nam-i-e-c^h-o
Simple	nam-l-am	nam-l-i	nam-l-e
Continuous	nam-c^h-i-l-am	nam-c^h-i-l-i	nam-c^h-i-l-e
Perfect	neme-c^h-i-l-am	nem-e-c^h-i-l-i	nem-e-c^h-i-l-e

Exceptional triggering in Bengali verbs is introduced by the perfective morpheme /e/, where the root vowel /a/ changes to /e/[83]. By postulating the same sequential markedness constraint as Assamese, but this time indexed to the perfective morpheme in Bengali, I try to capture this morphemic alternation. The constraint *[-ATR][+ATR]$_L$ is exactly the same as we had witnessed for Assamese in the preceding sections.

(358) *[-ATR][+ATR]$_{\text{PERF}}$
No instance of [-ATR] followed by [+ATR] includes a phonological component of the morpheme lexically specified as $_{\text{PERF}}$

This constraint is placed at the top of the constraint hierarchy of Bengali that was postulated in chapter 5:

(359) Ranking:
*[-ATR][+ATR]$_L$ ≫ ID[ATR]&ID[high] ≫ *[-ATR][+ATR,+high] ≫ ID[+ATR] ≫ ID[-ATR]

(360) Indexed Morpheme in the Lexicon: perf /e/$_L$

[83]Lahiri (2000) attributes the behaviour of the Bengali progressive in triggering /a/ raising (as opposed to other suffixes, like the person marker /e/) to its place on a different morphological level.

(361) high ranking *[-ATR][+ATR]$_{perf}$ leads to exceptionality

Input: /nam/+/le/ $_{perf}$	*[-ATR] [+ATR]$_{perf}$	ID[high] & ID[ATR	*[-ATR] [+ATR,+high]	ID [+ATR]	ID [-ATR]	*[-ATR] [+ATR]
a. namle	*!					*
b. nɛmle	*!					*
c. nimle		*!				
d. ☞nemle					*	

The lexically indexed constraint *[-ATR][+ATR]$_{perf}$ prohibits */namle/ and */nɛmle/, i.e. the candidates (361)-a and (361)-b respectively. The perfective morpheme exceptionally triggers harmony only in the verbal paradigm in the presence of /a/ in the root. As a result of the highly ranked *[-ATR][+ATR]$_{perf}$ candidate (361)-c is optimal because it also respects the local conjunction ID[high] & ID[ATR]. This ranking prohibits */nimle/ in (361)-d. because Bengali demonstrates a chain shift in terms of height and [ATR].

Although I captured exceptionality in Bengali with an indexed markedness constraint, there is no obvious locality restriction that needs to be taken into account. However, in the same breath, it should be noted that the perfective morpheme does not trigger long distance alternation in examples like [nam-i-e-c^h-i] and prohibits any occurrence of *[nemiec^{h}i].

With this extended discussion on markedness requirements in exceptional morpheme-specific environments in Assamese and Bengali, I will now turn to a faithfulness requirement that is observed in the exceptional verbal morphology of Assamese.

6 Conclusion

In this chapter, I have addressed various exceptional environments in non-derived as well as derived environments, which challenge the purely phonological grammar developed for Assamese and Bengali harmony developed in the previous chapters. I have shown that although regressive vowel harmony in Assamese may seem to ignore morpheme boundaries, there are morpheme related factors which cast doubt upon this observation.

Exceptional triggering in vowel harmony is analysed to be the result of constraint indexation, where /ɑ/-adaptation is triggered by the two morphemes /-iyɑ/ and /-uwɑ/. /ɑ/-adaptation occurs only locally and in all instances of harmony where /-iyɑ/ and /-uwɑ/ trigger harmony non-locally, no adaptation is involved. Analysed to be the consequence of indexation of the markedness constraint *[-ATR][+ATR]$_{L}$, the analysis arrives at the welcome result that exceptional morphological triggering can be considered to be systematically local and therefore probably a more learner-friendly approach.

The constraint indexation approach is also extended to the exceptional triggering of harmony by the perfective morpheme /e/ on verbal roots containing the otherwise opaque vowel /a/ in Bengali.

Section 2 shows that NOHIATUS$_{L2}$ is an indexed version of the constraint NOHIATUS which mandates that in a part of the verbal morphology NOHIATUS is absolutely essential. IDENT I6O[+ATR] preserves the value of the triggering morpheme, despite the fact that the regular phonology would have factored out such occurrences in other domains. Deletion of the /-i/ morpheme results in the satisfaction of the NOHIATUS constraint at the expense of violating markedness requirements which prohibit independent occurrences of [e] and [o]. This also shows how OT responds to phonotactic restrictions in a grammar. Though [e] and [o] do not occur in closed syllables in Assamese (as showed in chapter 6), OT shows that it is simply a manifestation of restriction on output structures. Though there is no harmony in closed syllables, in OT this is a violable constraint which can be overruled by NOHIATUS$_{L2}$. Finally therefore, violation of the constraint *[-ATR][+ATR] and enforcement of higher ranked NOHIATUS$_{L2}$ can also lead to the emergence of [e] and [o] in closed syllables.

However, I have not discussed many other contending theories which have been proposed to analyse phenomena similar to deletion in the verbal morphology. Theoretical approaches involving morpheme realisation, structural approaches and the like, have not been explored as suitable alternatives. As will have become clear the problem presented here may also be amenable to the MAX SUBSEGMENT constraint of Zoll (1998), where ‘ghost’ vowels have a floating feature status. I do not adopt approaches favouring floating features in this dissertation; hence I do not adopt it as a suitable alternative in these cases either. One straightforward reason is of course the tool of locality in constraint indexation which elegantly captures most of the morpheme-specific phenomena in Assamese and Bengali. Many of the phenomena discussed in theories proposing floating features involve long distance effects, but many others within morpheme realisation theory have been argued to be primarily local and they therefore deserve reanalysis along similar lines[84]. I have also not explored the full range of effects that the application of indexed constraints for cases like that of Assamese /i/-deletion can generate.

Apart from this, there are many other questions that a researcher in the field of exceptionality in morpheme specific phonology may need to find answers to. Further questions in this regard may involve how much restriction in terms of minimal domains does a theory need to need to bind itself to. As far as rankings are concerned, Pater (2006a, to appear) observes there are numerous rankings allowed by all the constraint indexation theories, and how much refinement each theory should or not should not allow will eventually depend on the restrictions that a constraint based theory itself is able to come up with. Furthermore, the debate over the relative merits of 'Item and Process' (Anderson 1992) where morphological matter such as the affix is the result of the application of phonological rules versus the conventional 'Item and Arrangement' (which assumes that all morphemes are independent lexical items) continues unabated. In this context, the real anxiety about morpheme-specific constraints seems to be regarding the possibility of generating markedness hierarchies for each individual morpheme. Pater (to appear) looks at the direction of learnability, and shows how learners can successfully execute constraint indexation. He shows that when a learner detects inconsistency it seeks a constraint that 'favours only winners for all instances of some morpheme'. The constraint can then be ranked when it is indexed to the morphemes for favouring only winners. (See McCarthy 2004a, Prince 2002, Tesar and Prince 2004, Tesar *et al* 2003, Tesar and Smolensky 1998, Tesar 1998, for inconsistency detection).

This chapter emphasises the role of locality and minimality in the evaluation of harmony domains. As envisaged in the introduction, harmony is presumed to be a local iterative assimilation process. It was shown how these local relations manifest themselves in the face of morpheme specific phonology. Morphemes exceptionally and locally trigger harmony in the presence of /ɑ/, the domain of the process is limited to the absolute minimal string. The same minimality requirement holds for exceptional

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[84] See Wolf (2004) for an analysis of local effects in mutation using structural constraints. And Horwood (1999) for locality in anti-faithfulness.

front/back harmony. Further, minimality is also sustained in preservation of a deleted morpheme. Lastly, this chapter showed that when lexical items exceptionally bear [e] and [o] they only minimally violate the constraint which prohibits such occurrences.

Chapter 8

Conclusions, remaining problems and perspectives

1 Introduction

In this dissertation I have presented a detailed analysis of Assamese vowel harmony, and discussed some of the implications that it may have for a broader typological characterisation of vowel harmony systems. Language-specific contributions included the fact that this regressive vowel harmony process had not earlier been shown to be a feature of this language; that the harmony outputs [e] and [o] are allophonic in the language; and an experimentally sustained exploration into the phonological status of the vowel /ʊ/, showing that the way this vowel participates in vowel harmony is important to its phonological characterisation In this final chapter, however, I will focus on the theoretically orientated goals of this dissertation, trying to assess the success it has been able to achieve in the targets set out at the beginning of the dissertation. In section 2, I will discuss my findings on the directionality component of the harmony process. In section 3 I will discuss the various facets of locality that vowel harmony brings into the limelight. In this section I also discuss the problems that non-derivational Optimality Theory faces when accounting for locality, and that a solution to the problem can be found in introducing the concept of a ‘minimal distinct locus of violation’ in Harmonic Serialism. In Harmonic Serialism or Persistent OT (McCarthy, 2006, 2007), harmony is achieved gradually. This facet of Harmonic Serialism along with the locality convention is used to analyse partial harmony when an opaque segment intervenes (McCarthy 2004, Wilson 2006). This situation arises in examples like /sɑpɔr/ ‘bend’ +/i/ → /sɑpori/ ‘to bend’ instead of */sɑpɔri/ and */sopori/ where all the vowels are either [-ATR] or [+ATR]. The adoption of this variant of OT leads to the optimal output with partial harmony in /sɑpori/, instead of favouring */sɑpɔri/ or*/sopori/. Section 4 contains a discussion of the approach of positional licensing, which might have been thought to be applicable to regressive harmony systems emanating from a perceptually weak trigger. I show that perceptual weakness of the trigger will definitely not account for regressive vowel harmony across the board, and regressive harmony is more related to articulatory rather than perceptual factors. The chapter ends with a conclusion, in which I speculate briefly on 'functional' factors possibly involved in phonologially conditioned regressive harmony of the Assamese type.

2 "The allure of directionality" (Baković, 2000: 194)

As identified in the beginning and argued pervasively in the rest of this dissertation, directionality in assimilation is a phenomenon to be seriously reckoned with. Directionality often has, but is not required to have anything to do with morphological categories like root and affix prevailing on each other. Directionality may appear in various guises, but there may be no epiphenomenal force behind it. Rather, such blind and pervasive directionalilty is shown here to be the case for Karajá and Pulaar (languages known from earlier literature) and Assamese, a newly added language. Stepping aside from earlier analyses of directional systems, this dissertation shows that an OT framework need not rely on ALIGN constraints (Smolensky, Pulleyblank and others) with built-in directionality. Whenever a process is randomly directional, it is the result of contextual neutralisation, but it can be captured only with a constraint that specifies the markedness context in terms of a sequential markedness constraint. In this context, [ATR] vowel harmony systems show wide heterogeneity in directional behaviour. The way [ATR] systems behave in this respect has received detailed treatment in chapter 2, where it was shown that there is hardly anything definitive in the inventory of an [ATR] harmony system which would allow any prediction in terms of the direction that the harmony process will take. This dissertation also shows that directional systems may be either iterative or non-iterative, which further strengthens the claim of sequential markedness. Non-iterativeness is shown to be the result of a more stringent locality condition in the agreement of consecutive vowels. The lack of context for further assimilations is the result of a requirement which cannot be satisfied by the harmonised vowel, that is, if the trigger is [αF βG] and the following segment harmonises only with the [αF] feature, then the harmonised segment can no longer provide the context for any further neutralisation. This process is also regressive showing that regressive directional harmony is all about context-sensitive neutralisation. Further, I classify four different types of regressive directionality and the following is a full list of the languages according to their type of regressive harmony:

(a) Iterative and allophonic - Assamese and Pulaar belong to the type where harmony is iterative and it also produces allophonic outputs among the mid vowels.
(b) Iterative and contrastive – Karajá, where harmony is iterative but it also enhances contrast, as the outputs of harmony are phonemic.
(c) Non-iterative and contrastive – Bengali, where harmony spreads only to the preceding vowel, but all the vowels are contrastive.
(d) Non-iterative and allophonic – Tripura Bengali is like Bengali harmony as it only affects the preceding vowel, but the vowels are allophonic like Assamese and Pulaar.

Thus I show, and one would hope convincingly, that directionality as a phonological process exists in various forms, and it is not an extraordinary fact which is limited to Assamese vowel harmony alone. It is indeed well-attested and needs to be cast in the broader light of contextual neutralisation. This dissertation is exclusively about regressive vowel harmonies: the question which needs to be asked is whether there are comparable non-epiphenomenal progressive vowel harmony systems, both iterative and non-iterative.

At this point, the predictions made in Hyman (2001) are thought-provoking and potentially present interesting challenges for further research. Hyman argues that root triggered vowel harmony on suffixes is a fallout of post-tonic reduction. He also discusses how prefixes are bad triggers, which he concludes can be attributed to the resistance of roots to 'vowel reduction'. In the absence of reduction, the process would not be anticipatory, which would be the only option if the process is not related to reduction. This is so because all vowel harmony which is not due to reduction is anticipatory. Hyman shows that 'Vowel harmony is preferentially regressive, other things being equal'. Therefore roots are good triggers because suffixes are potentially subject to reduction. On the other hand, suffixes are able to trigger harmony because the process would then be anticipatory and also lead to unmarkedness. Assuming that these predictions are correct, one would not expect non-epiphenomenal progressive vowel harmonies, either iterative or non-iterative to be abundantly available. However, this has to be said cautiously because there is not a shred of doubt that not all vowel harmony systems have been described or much less, discovered.

3 Harmony as local agreement

The other linguistic phenomenon which has received compelling support in this dissertation is locality. I have argued that harmony involves iterative local agreement. This can be shown with *[-ATR][+ATR] which evaluates sequences of [ATR] sequences. The constraint is modified to *[-ATR][+ATR +high] in order to account for absolutely local and minimal application of harmony in Bengali and Tripura Bengali. This is the gist of chapter 5 of this dissertation. In chapter 6 I show that the issue of locality of harmony domains emerges again in the context of harmony blocking by nasals – where only a nasal in the onset position of the triggering segment can block vowel harmony and nasals in any other position do not result in harmony blocking. This can be accounted for by a constraint which disallows sequences of *[oNi]. This constraint also accounts for the fact that nasals do not disturb spreading of vowel features in /porinoti/ cf. */porinɔti/ because the nasal is not in the onset position of the triggering segment.

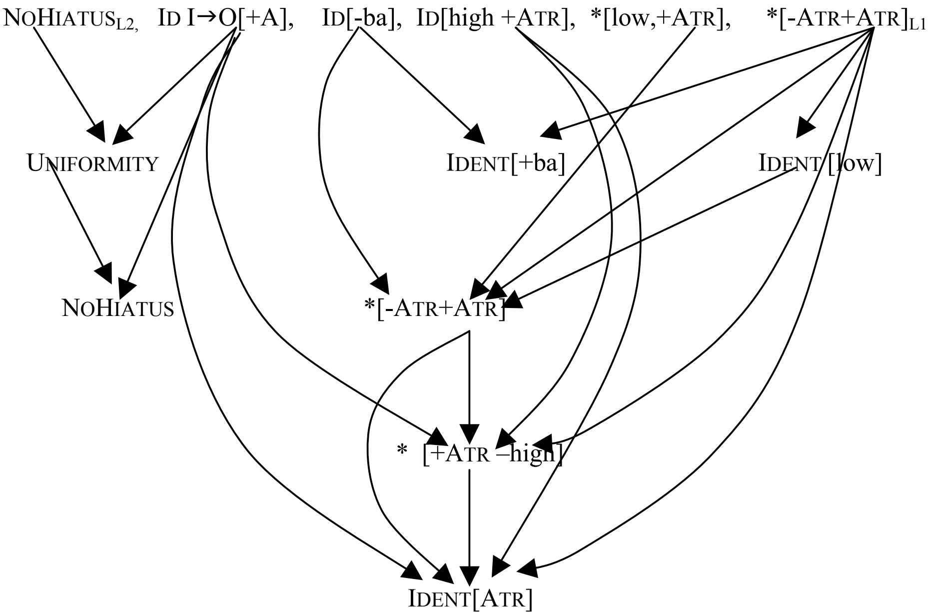
Another important contribution of this chapter is a prediction regarding which vowels are most likely to intervene in harmony processes. I show with examples from languages as diverse as Assamese and Karajá, that in [ATR] harmony systems, nasals are most likely to intervene because they are 'potential undergoers' of harmony. Similarly, in front/round harmony systems, liquids are most likely to intervene and block the spreading of vowel harmony. Therefore blocking due to non-prosodic factors, requires an additional factor, i.e. sonority, apart from the factors of feature sharing in the case of Nawuri labial harmony.

I also present an account of harmony blocking in the presence of two consonants. It is not very intuitively obvious whether the markedness requirement here is the avoidance of marked [-high +ATR] vowels in closed syllables which is a structural constraint, or if it is a prosodic requirement mandating agreement between vocalic moras; because Assamese counts moras and a consonant in a final syllabic position is counted as the one which bears a mora and which is therefore heavy. I adopt the prosodic approach because it gives a more substantive reason to the blocking of harmony in closed syllables, but I recognise that the data may lend themselves to a structural analysis.

The stumbling block to a complete analysis of local iterative assimilation in terms of classic OT is blocking by the vowel /ɑ/. The nature of blocking by /ɑ/ is not like the absolute precedence required by the nasal segment. /ɑ/ blocks harmony wherever it occurs. Therefore, it leads to the emergence of partial harmony where harmony proceeds up to the point it meets a blocking segment, and in this case /ɑ/. This cannot be dealt with satisfactorily in the standard version of OT because it professes 'all or nothing', i.e. when a candidate is non-gradiently evaluated by a constraint like *[-ATR][+ATR], then either a candidate incurs a violation mark or it does not. This problem was attacked by invoking Harmonic Serialism with the aid of a locality convention. One of the main goals of this dissertation is to show the locality effects that show up at various points in the execution of long distance iterative harmony. Summoning the tools of Harmonic Serialism was essentially considered to be a matter of execution.

Finally, chapter 7 shows that exceptional triggering by the morphemes /-iyɑ/ and /-uwɑ/ induces a change only in the preceding /ɑ/, though /ɑ/ in all other circumstances remains opaque. The significance of this process is that it is not only exceptional, it is restricted only to the immediately preceding vowel. This is interesting because vowel harmony is supposed to spread iteratively from one vowel to the other, but it shows that exceptional environments can stall such unboundedness. I also discuss other exceptional processes, for instance /i/ deletion and its subsequent preservation. I also deal with exceptional occurrences of [e] and [o] in a closed set of lexical items. I show that all these instances of exceptionalities can be suitably analysed within a theory of constraint indexation (Pater 2006a, to appear) which espouses a locality condition on exceptional occurrences triggered by morpheme-specific phonology. However, though this locality is observed only in deference to morphemes, it clearly shows that morphology can impose limits on a potentially unbounded phenomenon.

(362) Final Assamese ranking



The Hasse diagram illustrated above summarises the facts of harmony in Assamese. The constraints IDENT [high] *[-ATR, -back +high] *[-back +back]$_{L1}$, *ONi and IDENT[+ATR]$_{L3}$ which are also undominated are not shown in the hierarchy. The ranking arguments clearly show that in order to result in exclusively regressive harmony *[-ATR][+ATR] needs to ranked lower than constraints demanding faithfulness to certain features like IDENT[ATR +high] or featural markedness constraints as in *[-ATR, -back +high]. *[-ATR +ATR] dominates *[+ATR –high] which suppreseses unwanted instances of [e] and [o], which in turn dominates IDENT[ATR], resluting in a language where [e] and [o] emerges as outputs of harmony. Further, /ʊ/ ⇢/u/ occurences only as a result of regressive harmony is regulated by the same ranking of *[-ATR +ATR] » IDENT[ATR]. However, IDENT [ATR +high] restricts /u/ ⇢/ʊ/ correspondences. In effect these rankings show that regressive harmony can be obtained by a small set of constraints without any constraint with a built-in directionality statute. The exceptional occurrences also bring in their own set of complexities and show how they can interact with the other constraints in the hierarchy. Exceptional /ɑ/ adaptation required the demotion of highly ranked IDENT[low]. IDENT[-back] required to be ranked higher than IDENT[+back] as /ɑ/ alters with /e/ and never vice-versa.

With this summary of how this dissertation has tried to meet its goals, I move on to discuss one final issue concerning a superficially plausible different approach than the one taken here, namely a licensing approach to regressive vowel harmony, and show that such an approach would have been less than satisfactory.

4 Is regressive harmony the result of perceptual weakness of the trigger?

One alternative approach to the analysis of Assamese vowel harmony put forward in this dissertation, one which in fact might have been thought to be a serious proposition too, is that of Positional Licensing, as proposed in work by Walker (2006). The way weak positions in metaphonic systems (weak positions are unstressed and these unstressed vowels trigger harmony in metaphonic languages, recall chapter 2, section 4 for some more discussion) participate in vowel harmony processes gives rise to important questions regarding the function of a trigger in a non-prominent position. One important question is why the right edge vowel in a regressive system is a trigger if it is high and [+ATR], and why is it resistant to harmony if it is [-ATR]; in other words, are there any functional reasons for the existence of absolute, non-epiphenomenal directionality? This is where the expositional statement of this section on Positional Licensing is of significance: in a very basic and oblique way, Assamese harmony resembles metaphony where a high final vowel or a high unstressed vowel triggers propagation in the entire word or up until the stressed syllable (Zubizarretta 1979, Hualde 1989, 1998 Calabrese 1985, 1989, Walker 2006, and others). Therefore, it may look like as if it can be analysed using a Positional Licensing constraint.

A case in point is Central Veneto, a variant of Italian (spoken in the Veneto provinces of Padova, Rovigo, and Vicenza) discussed by Walker (2006). In this kind of harmony the vowels /i/ and /e/ are eligible to appear in both tonic and post-tonic positions. Pretonic vowels are generally affected only when raising is triggered by a post-tonic unstressed vowel.

(363) Stressed vowel raising

(a)	b[é]v-o	b[í]v-i	‘drink’ (1sg/2sg)
(b)	g-[é]-va	g-[í]-vi-mo	‘had’ (3sg/1pl impf. ind)
(c)	fas-[é]-a	fas-[í]-vi-mo	‘did’ (1sg/1pl impf. ind)
(d)	kant-[é]-se	kant-[í]-si-mo	‘sing’ (1sg/1pl impf. subj.)

(364) Inertness of the stressed high vowel

(a)	m[o]v-í	‘move’ (2pl)	cf. m[ú]v-i (2sg)
(b)	kr[e]d-í	‘believe’ (1pl)	
(c)	d[e]slíg-o	‘untie’ (1sg)	
(d)	v[o]-í	‘will’ (1pl)	

Veneto exemplifies height harmony of the type known in the Romance literature as ‘metaphony’. In the specific case of Veneto, a high vowel in an unstressed position triggers raising of a preceding stressed mid vowel. It is clear from these examples that only unstressed /i/ always trigger harmony in the presence of preceding stressed vowel /e/, and the vowels can occur in all positions.

Veneto also presents variation in its harmony patterns. Not only are unstressed high vowels sources of raising in stressed mid vowels, they also cause raising of mid vowels preceding the stressed vowel. The latter is called the ‘maximal extension pattern’ (Walker 2006) where a [+high] unstressed vowel spreads the feature [+high] to all preceding syllables, while in the stress-targeted case [+high] spreading does not proceed beyond the stressed syllable.

(365) Maximal extension

(a) s[e]nt-é-se	s[i]nt-í-si-mo	‘feel, hear’ (1sg/1pl impf. subj.)
(b) m[o]v-é-se	m[u]v-í-si	‘move’ (1sg/2sg impf. subj.)
(c) d[e]fénd-e	d[i]fínd-i	‘defend’ (3sg/2sg)
(d) p[e]ns-é-a	p[i]ns-í-v-i	‘thought/was thinking’ (3sg/2sg. impf. ind.)’

In the positional licensing analysis advocated by Walker, the grammatical imperative to induce stressed vowel raising versus unstressed vowel lowering arises from the need to avoid the alternation of more sonorous vowels in unstressed positions (i.e. prevents the alteration of low sonorous vowels like /ɑ/ in unstressed positions). In Walker's analysis of Veneto, the primacy of the weak trigger is accounted for by a positional licensing constraint which associates the feature [+high] of the post-tonic vowel to that of the stressed vowel. The specific constraint is as below:

(366) LICENSE([+high] post-tonic, stressed syllable): [+high] in a post-tonic syllable must be associated to the stressed syllable

The author calls upon the intrinsic and positional disadvantage of stressed high vowels in order to argue for a positional licensing analysis in post-tonic vowels. But a post-tonic analysis does not give us the desired results for the examples in (365), hence she proposes a faithfulness constraint on the final triggering position, IDENT[FINAL]. The faithfulness constraint IDENT[FINAL] alongwith a constraint SPREAD [ATR] LEFTMOST takes care of the instances of variable maximal extension pattern displayed in Veneto. She advocates this approach because in Veneto, "the phonological strength of the final syllable stands despite its lack of metrical prominence… I speculate that faithfulness to the word-final syllable might instead be what prevents spreading from the penult to the final vowel" (Walker 2006:955).

The pattern observed for Veneto in (365) is of special relevance to the analysis of Assamese presented in this dissertation. Assamese also displays a combination of the stress-targeted and maximal extension pattern. 'Stress-targeted' does not rule out 'maximal extension' in Assamese, as the vowel harmony process always spreads till the word-initial syllable, which is also the stress-bearing syllable. For Veneto, Walker appeals to a solution using the constraint SPREAD [ATR] LEFTMOST in order to account for the maximal extension pattern. This means that positional licensing is not at work in the grammar for all the patterns of harmony attested in the language. This strikes one as a less desirable solution as both patterns have exactly the same pattern of alternation except for the fact that one stops at the stressed syllable and the other does not.

4.1 Stress, accent and the harmony trigger in Assamese

I will now proceed to present some basic facts about stress and prominence in Assamese, so as also to explore its place in the 'weak trigger' harmony systems (terminology from Walker 2006). In Mahanta (2007) it was argued that instead of perceptual weakness of the triggering high vowels, the faithfulness of final and unstressed vowels are responsible for triggering harmony in languages like Assamese. However, in this dissertation it is shown that a sequential markedness constraint provides a more complete analysis of regressive harmony in Assamese. Despite the difference in analysis however, the facts of stress and prominence remain the same. Given that, it is only proper that we proceed to take a look at the same.

Within the Assamese word stress system, main stress is always assigned to the initial syllable (see also chapter 6). Morphologically, stress shifts to the initial syllable under prefixation. Stress is not sensitive to affixation and the initial syllable is always the main stress bearing syllable regardless of its morphological status. In a sequence of open syllables, stress assignment is in the following manner:

(367) Stress in Assamese

[bɔ́ga]	'white'	[bósori]	'yearly'

Accent is on the first syllable if the second one is light but if the second syllable is heavy, accent is attracted to it. An L*H melody is associated with word level stress, where L* is borne by the accented syllable while H is associated to the following part of the word, triggering a rising movement from L*. The accented syllable is prominent as it is significantly longer than the other syllables and the final syllable is always devoid of any pitch movements (Mahanta 2001). There are no other phonetic correlates of prominence like duration or intensity. With this information in mind, I will now proceed to elaborate on the analysis based on perceptual weakness of the trigger and how it falls short of properly capturing the full picture of regressive harmony, which may bear resemblance to metaphonic systems.

4.2 Perceptual weakness of the trigger?

In a Walker type of analysis only the vowels which can occur in both the triggering and non-triggering positions are delegated to trigger metaphonic occurrences, while vowels which do not occur in all positions do not trigger height harmony. Furthermore, it is suggested that metaphonic occurrences are possible only under circumstances of a high/mid contrast in the position where the triggering vowel occurs. The harmony trigger in Assamese is always unstressed, but it does not combine with corresponding presence of the feature [-high +ATR] in the triggering position. /e/ → /i/ or /ɛ/ → /e/ alternations in the final vocalic position (which is also the position where the trigger can occur) are not attested, suggesting that the adoption of perceptual improvement strategies in the vowel harmony process of Assamese would not be appropriate. The function of 'contrastive occurrence' of [+ATR –high] as against [-ATR –high] and its role in the triggering position of harmony is at its best quite unclear. If it is not the perceptually perilous position of the triggering vowel, what objective could be behind this kind of harmony?

As regards the perceptual vulnerability of the spreading feature [+high], Walker adopts the approach of Kaun (1995: vii) who points out that 'harmony serves to extend the duration of phonetic information which is phonologically important (i.e. distinctive), but which is transmitted by means of relatively subtle acoustic cues'. Kaun (1995) argues convincingly that vocalic contrasts that are expressed in terms of F1 rather than F2 are perceptually more salient, allowing height contrasts to be more substantive than roundness or backness. Trubetzkoy (1958, trans. by Baltaxe, 1969) shows that all inventories consistently show height contrasts even if other contrasts are absent. According to Lindblom (1975), the distance between the high vowels /i/ and /u/ substantially higher than that between /i/ and /a/ and also between /u/ and /a/. Crothers (1978) also shows that the typologically preferred vowels between /i/ and /u/ is zero. By contrast, inventories most often have one more additional vowel to occupy the space between between /i/ and /a/ and between /u/ and /a/. F1 has a greater inherent intensity than F2 (as well as the higher formants). Lindblom (1986) invokes this acoustic asymmetry to explain the primacy of the height dimension over the backness and rounding dimensions in vowel inventory patterns.

Here, I do not adopt the licensing approach developed by Walker, as the primary vowels /i/ and /u/ do not qualify to be vowels with diminished perceptual prominence. The acoustic evidence shows that high vowels have low amplitude and therefore they are not perceptually threatened. I suggest that the final vowel's incorrigible faithfulness to its underlying value is facilitated by its primary nature. The feature high is phonologically 'primary' (Stevens & Keyser 1989) and a phonological account assuming perceptual markedness of /i/ does not provide us with an adequate explanation. The results obtained in Walker can be alternatively derived from independent principles assuming that features in weak positions may be unyielding to alternation because of their primary nature rather than perceptual markedness. As Walker states:

"Patterns rooted in perceptual weakness of the trigger will be identifiable by an asymmetry: perceptually difficult vowels will initiate harmony but not perceptually strong ones. On the other hand, harmonies that are asymmetrically triggered by vowels in a position of prosodic strength – i.e. where the relevant feature(s) are contrastive in both prosodically strong and prosodically weak positions, but only the prosodically strong vowels initiate harmony – cannot be attributed to a perceptual threat.” (Walker 2006: 939)

But there are no phonologically marked (e.g. non-peripheral vowels) which asymmetrically control harmony from an unstressed position. If peripheral high vowels are proven to be perceptually more marked, then how do we understand the non-triggering status of phonologically marked vowels? In short, is there any correlation at all between perceptually marked and phonologically marked? I propose that before these questions are properly answered, any analysis presupposing the perceptual markedness of /i/ is better abandoned. However, I do not challenge the idea that there are harmony processes which extend the duration of hard to perceive contrasts and thereby favour marked feature combinations (Kaun 1995).

In the short paragraph below, I briefly discuss a slightly different problem with LICENSE constraints which has been pointed out in the recent OT literature.

4.3 Too many solutions problem

Constraints of the LICENSE type has been shown to present a “too many solutions” problem (Blumenfeld, to appear). The constraint “LICENSE [+high]/ post-tonic, if licensed by a stressed syllable” is going to be satisfied both by vowel change as well as by a shifting the stress away from the licensor. For Veneto, in order to satisfy the constraint LICENSE, an input like / bévi/ can surface with stress on the second syllable as well as by licensing the initial vowel. Blumenfeld, in work dealing with licensing constraints, discusses the typology of segmental processes, which are determined by prosodic structure. He points out that such interaction always proceeds unidirectionally and changes segmental structure instead of conditioning the construction of prosodic structure. He also shows that implicational OT constraints of the current type (a if b) allow for too many ways to resolve the marked structure in environments where prosody conditions segmental repairs, as in the example given below:

(368) *MidV/NONHEAD
'No mid vowels in the weak position of a foot'

Constraints as the one above have a prosodic as well a segmental part. Hence, there are two potential ways of satisfying them: (1) the segment mid vowel can be repaired and (2) the weak position can be altered. Blumenfeld discusses many other constraints of this type and shows that the range of segmental repairs that these constraints predict far outnumber the attested repairs.

In sum, I suggest that the licensing approach to the triggering status of the high vowels in a weak position would not provide a satisfactory alternative to the Assamese regressive harmony data. Licensing as a potential approach to weak trigger harmony in general is also beset with theoretical problems.

4.4 Concluding remarks

Finally, if in this dissertation it is assumed that regressive directionality is due to articulatory factors rather than perceptual factors, then of course the ultimate questions is why it should be so. Research in consonant harmony has also probed answers to similar questions. Hansson (2001) connects widespread instances of regressive consonant harmony to the domain of speech planning, and provides experimental substantiation from the works of Dell et. al. (1989) showing that consonant harmony is akin to phonological speech errors. The similarity of the triggers and targets and a bias towards anticipatory interactions are the attributes which consonant harmony has in common with speech errors.

A functional explanation of regressive vowel harmony may also be in the domain of articulation rather than in that of perceptual factors. Though there is no direct connection between regressive vowel harmony and speech errors, most occurrences of assimilation in child phonology are also primarily regressive. It may be more fruitful to seek a functional explanation of regressive harmony and regressive metaphony in articulatory factors rather than perceptual ones. Hence, the sequential markedness constraints defended in this dissertation can be concluded to be most likely on the right track, though more research on perception and articulation will be required to make a convincing argument for or against one or the other approach.

Samenvatting

Het is een bekend en frequent geobserveerd verschijnsel in natuurlijke talen dat klanken zich aanpassen aan andere klanken in hun omgeving, klinkers niet anders dan medeklinkers. Een van die aanpassingsprocessen staat bekend als vocaalharmonie (vowel harmony). In vocaalharmonie zorgt een 'trigger'-klinker (of klinker-s) ervoor dat een bepaald vocalisch kenmerk zich verspreidt over een domein van een bepaalde grootte. Vocaalharmonie is een klassiek onderwerp met erkende theoretische implicaties in de theoretische fonologie. Elke variant van de theoretische fonologie zal zich op vocaalharmonie moeten richten voor zijn eigen ontwikkeling, en als bewijs van zijn empirische adekwaatheid. Dit proefschrift heeft als doel in deze zin een bijdrage te leveren aan de discussie over vocaalharmonie in Optimality Theory (OT, Prince and Smolensky 1993/2004).

Het empirische materiaal voor dit proefschrift is afkomstig van nieuw en origineel onderzoek van de auteur naar het Assamees, een van de talen van het Indiase subcontinent, en – als ondersteuning daarvan, maar in mindere mate – naar de gerelateerde talen Bengali en Tripura Bengali. Het Assamees wordt gesproken in het noordoosten van India, voornamelijk in de staat Assam, door een meerderheid van de inwoners van de staat. Volgens het meest recente onderzoek (telling van 2001) telt deze taal 20 miljoen eerste of tweede taal sprekers. Bengali heeft 150 miljoen sprekers in India en Bangladesh, in dit proefschrift worden twee varianten besproken: 'standard colloquial' Bengali zoals gesproken in en rond Kolkata, en Tripura Bengali.

Het Assamees is nog maar weinig onderzocht, en daardoor levert dit proefschrift ook een aantal taalspecifieke bijdragen. Daaronder valt zeker het empirisch onderzoek naar, en de analyse van, de vocaalharmonie in de taal, dat hier voor het eerst wordt gepresenteerd, als een (iteratief) regressief verschijnsel met [+ATR] als spreidend kenmerk, en als triggers de hoge klinkers /i/ en /u/. Een uitkomst van deze analyse is ook dat de klinkers [e] en [o] moeten worden beschouwd als allofonen (van de middenklinkers [E] en [O]). Rekening houdend met het vocaalharmoniegedrag van de

klinker [˛], en ondersteund door een speciaal daarvoor uitgevoerd experiment op het Assamese klinkersysteem, wordt aangetoond dat de [˛] een [-ATR] hoge achterklinker is – een nieuwe bevinding ten opzichte van eerder werk van Ladefoged (1996, 2001).
De theoretische implicaties van dit proefschrift liggen op twee gebieden: die van de theorievorming over de *spreidingsrichting* ('directionality') van het harmoniekenmerk, en die van de *localiteit* ('locality') van het harmonieproces zelf.

In dit proefschrift wordt beargumenteerd dat een van de meest intrigerende eigenschappen van vocaalharmonie in het Assamees is, dat wat betreft de spreidingsrichting van het kenmerk [+ATR] de taal consistent regressieve harmonie vertoont, met hoge [+ATR] vocalen (/i/ en /u/) als triggers. In vergelijking met de veel bekendere systemen van 'root-controlled' en 'dominant-recessive' harmonie (een overzicht daarvan in hoofdstuk 2 van deze dissertatie), is dit een nog weinig geanalyseerd type, maar in deze dissertatie worden eerder geanalyseerde talen als het Pulaar (West Afrika) en het Karaja (Brazilie) in dezelfde groep getrokken, net als - nieuw - het Bengali. Deze talen hebben in deze analyse een links-directionele vocaalharmonie, zonder enige vorm van morfologische conditionering waaruit de specifieke directionele eigencxhappen zouden kunnen volgen. De harmonie wordt veroorzaakt door de aanwezigheid in de grammatica van deze talen van, in OT termen, een 'contextual markedness constraint', die verboden vocaalopeenvolgingen aanwijst: *[-ATR][+ATR] leidt tot de selectie van outputkandidaten zonder de ongewenste opeenvolging, dus tot harmonie.

In de tweede plaats wordt in dit proefschrift vocaalharmonie in het Assamees geanalyseerd als een voorbeeld van 'local agreement' in (OT-) termen van McCarthy (2004) en Wilson (2006). Gewoonlijk wordt vocaalharmonie in natuurlijke talen gezien als een langeafstandsproces ('long distance') binnen relatief grote domeinen zoals woorden en frases. In dit proefschrift wordt het echter beschreven als een locaal verschijnsel dat zich 'door het woord verplaatst' via 'iteratieve' evaluatie met de geformuleerde contextuele constraint. De noodzaak tot iterativiteit wordt analyserend afgeleid uit het blokkerend ('blocking') gedrag binnen het vocaalharmonieverschijnsel van nasale medeklinkers: alleen onmiddellijk-adjacente ('strictly local') nasalen blokkeren vocaalharmonie, en niet nasalen in andere posities. Deze eigenschap van nasalen wordt gerelateerd aan hun relatief hoge sonoriteit, die het mogelijk maakt dat zij optreden als 'licensors' van de locale 'agreement'-relatie tussen twee klinkers. Localiteit speelt daarnaast een rol in de blokkering van het proces door morfemen met een uitzonderingskenmerk, waarbij de blokkering ook beperkt is tot onmiddellijk-adjacente morfemen.

Ter ondersteuning van de iteratieve (in plaats van ‘long distance’) analyse van het Assamees, wordt het gerelateerde Bengali geanalyseerd als een taal waarin onder subtiel andere omstandigheden vocaalharmonie niet-iteratief is. Ook in het Bengali is vocaalharmonie het gevolg van contextuele neutralisatie, maar dan op [+hoog, +ATR] klinkers, waardoor iterativiteit geen kans krijgt. Iterativiteit en niet-iterativiteit zijn dus geen principieel verschillende situaties, maar het gevolg van marginaal (maar wel cruciaal) verschillende constraints.

In hoofdstuk 2 wordt een overzicht gegeven van een groot deel van de relevante literatuur op het gebied van de vocaalharmonie. Daarbij wordt er de nadruk op gelegd dat de voorspelbaarheid van het domein van het proces en van de richting ervan veel minder groot zijn dan vaak gedacht wordt. Daardoor wordt de weg voorbereid voor een analyse van het verschijnsel als contextuele neutralisatie van gemarkeerde’ klinkerkenmerken. Dit wordt begeleid door een bespreking van begrippen zoals de geprefereerde klinkereigenschappen van een stam, kenmerkrestricties, en ongemarkeerde kenmerkwaarden in de output. Vocaalharmonie wordt vergeleken met de verschijnselen ‘umlaut’ en metafonie (‘metaphony’) met als conclusie dat er geen principiële verschillen zijn tussen deze drie processen.

Hoofdstuk 3 presenteert Optimality Theory als het theoretisch-analytische kader van dit proefschrift. Na een bespreking van de minimale vereisten die moeten worden gesteld aan een ‘OT-theorie van vocaalharmonie’, volgt een overzicht van een aantal bestaande verschijnsel-specifieke benaderingen: Syntagmic Correspondence, Stem-Affix faithfulness, Alignment, Spread, Featural Agreement, Optimal Domains Theory, en Span Theory. Deze bespreking wordt afgesloten met een schema voor zogenaamde Sequential Markedness Constraints (‘contextuele gemarkeerdheid’), met een indicatie van hun mogelijkheden om ingezet te worden in gevallen van iteratieve en niet-iteratieve regressieve harmonie.

Hoofdstuk 4 geeft een beschrijving van de vocaalharmoniepatronen van het Assamees, op grond van een grote hoeveelheid uniek en nieuw empirisch materiaal. De [+ATR] klinkers /i/ en /u/ veroorzaken [+ATR] harmonie op voorafgaande [-ATR] klinkers (/ɛ, ɔ, ¸/), met als resultaat [e, o, u] waarvan de eerste twee allofonisch zijn in de taal. De klinker /ɑ/ is consequent een blokkeerder van het proces.

In hoofdstuk 5 wordt deze analyse uitgewerkt als een OT-analyse met behulp van 'sequential markedness constraints', en in verband gebracht met vergelijkbare, eerder gerapporteerde, verschijnselen in het Karaja en het Pulaar. In tegenstelling tot de analyse van Kräemer (2003) behoeft de nieuwe analyse geen zgn. Integrity-constraints (vergezeld van een taalspecifieke omkering van de gewoonlijk universeel geldige Rooth-Faith » Suffix-Faith hierarchie).

Hoofdstuk 6 behandelt blokkeringsverschijnselen ('interruptie van het anderszins iteratieve verschijnsel') die zich in Assamese vocaalharmonie in een aantal hoedanigheden voordoen. Het gaat om blokkering door de lage klinker /ɑ/, blokkering door nasale medeklinkers, en door medeklinkers een in mora-positie (dus in het rijm van de lettergreep). Het doel van dit hoofdstuk is tweeledig. Ten eerste wordt aangetoond dat de verschillende soorten locale blokkering een gemeenschappelijke factor hebben, namelijk hoge sonoriteit ('high sonority') van het element in kwestie. En ten tweede dat deze vorm van blokkering in OT kan worden geformaliseerd via Harmonic Serialism (McCarthy 2006ab). Niet-locale blokkering is typisch het gevolg van prosodische condities op het harmonieproces.

In hoofdstuk 7 worden uitzonderlijke omstandigheden besproken waaronder harmonie al of niet kan plaatsvinden. De deletie van een /i/-morfeem ter beantwoording aan de constraint *Hiatus, waardoor [e, o] aan de oppervlakte verschijnen zonder waaneembare trigger, wordt geanalyseerd als een geval van het handhaven van (eigenschappen van) een morfeem via vocaalharmonie. Onverwachte gevallen van harmonie in het Assamees en het Bengali buiten de normale condities om, worden geanalyseerd via 'lexically indexed constraints' in de zin van Pater (2006), een werk dat als voordeel heeft dat het (de empirisch gewenste) localiteitscondities meebrengt voor zijn centrale mechanisme van indexed constraints.

In hoofdstuk 8 tenslotte richt de discussie zich speculerend op de functionele aspecten van het onderzochte verschijnsel, met name die aspecten die betrekking hebben op het regressieve en fonologische (niet-morfologisch geconditoneerde) karakter ervan. Een verklaring wordt gezocht in articulatorische eerder dan perceptieve eigenschappen van de klinkers die er in het Assamees bij betrokken zijn, met name de hoge triggers /i/ en /u/.

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Curriculum vitae

Shakuntala Mahanta was born on 4th of July, 1975, in Jorhat, Assam, India. She completed high school from Carmel School, Jorhat, Assam. She received a B.A.in 1995 with a distinction and major in English literature from Cotton College, Guwahati, Assam, and then an M.A. in English literature in 1999 from Gauhati University, Assam. She was awarded a fellowship to complete Post Graduate Diploma in the Teaching of English (PGDTE) by the Central Institute of English and Foreign Languages (CIEFL) in Hyderabad, India. She received an M.Phil degree in Language and Linguistics from CIEFL in 2002. She was awarded a fellowship to join the Utrecht Institute of Linguistics-OTS (of Utrecht University) as an International PhD student from September 2003. The present dissertation is the result of her research carried out at UiL-OTS from 2003 to 2007.

Appendices

Appendix I
Data Collection and Experiments

I confirmed my judgements with native speakers and recorded multiple instances of harmonic and disharmonic sets of words. The list of words were then transcribed. The method of data collection mostly involved presentation of the data in the native script (Assamese for Assamese speakers and Bengali for Bengali speakers). The experiment was conducted in Assam using a DAT recorder and unidirectional microphones.

Due to the lack of a sound-proof room, care was taken that the surroundings were suitable for making good recordings. There were 4 informants- 2 male and 2 female. All speakers were educated (minimally the high school graduate level) and in the age group 20-30. They were all brought up in the eastern district of Jorhat in Assam and they spoke the representative standard Colloquial dialect of Eastern Assam. Two speakers had to be left out of consideration because of frequent hesitation in their speech. Four iterations of the following words were recorded for the vowels.

(1) Vowel Inventory
/bil/ /bul/ /bʊl/ /bel/ /bɛl/ /bo/ /bɔl/ /bɑl/

However, an analysis both spectrographic and statistical was conducted only for the vowel inventory above.

For recordings of harmonic and disharmonic sequences, the target tokens were embedded within a carrier sentence in order to avoid word boundary effects. The informants were then requested to read and repeat the sentences thrice. However, no instrumental measurements were carried out and the recordings were also made in a normal setting (taking care to avoid perturbation as much as possible), but not in a sound-proof room. I leave it to future work to carry out acoustic measurements of the recorded data.

(2) Harmony

/zelepi/ /leteku/ /bogoli/ /tekeli/ kotoki/ /bogori/ /porohi/ /xoru/ /potu/ /dʰenu/ /potu/ /zetʰi/ /kʰeti/ /mezi/ /bohi/ /soki/ /gʰori/ /renu/ /beni/ /porinoti/ /ponoru/ /somokit/

(3) Blocking by /ɑ/

/pɛtɑri/ /pʊhɑri/ /mɔdɑhi/ /kɔpɑhi/ /gɔzɑli//pʰɑguni/

(4) Blocking by consonant clusters

/kɔlki/ /xɔkti/ /bɔnti/ /kɔlki/ /gʊstʰi/ /kɛtli/ /kɛrketuwa/ /kɔrmi/ /gɔrbʰɔwoti/

(5) Blocking by a nasal

/sɛkɔni/ /xɔmɔniɑ/ /pʊtɔni/

(6) high-Mid sequence

/igɔl/ /sitɔl/ /utɔl/ /surɔt/ /pitɔl/ /ʊkʰɔ//xɔpʊn/

(7) high-high sequence

/tumi/ /uki/ /mʊkʊt//zʊrʊn/

(8) Mid-mid sequence

/gɔnɔk/ /gɔrɔm/ sɛtɛp/ /bɛlɛg/

(9) Mid-Low sequence

/bɔgɑ/ /dɛkɑ/ /bɔtɑh/ /bɑpɛk//ɑnarɔs/

Appendix II


INDIA
JAMMU & KASHMIR
HIMACHAL PRADESH
PUNJAB
C
UTTARANCHAL
HARYANA
DELHI
UTTAR PRADESH
RAJASTHAN
SIKKIM
ARUNACHAL PRADESH
ASSAMESE
ASSAM
NAGALAND
MEGHALAYA
MANIPUR
BIHAR
TRIPURA
MIZORAM
JHARKHAND
W.BENGAL
GUJARAT
MADHYA PRADESH
CHHATISGARH
DAMAN & DIU
D & N HAVELI
MAHARASHTRA
ORISSA
BENGALI
TRIPURA BENGALI
ANDHRA PRADESH
P
GOA
KARNATAKA
C CHANDIGARH
P - PONDICHERRY
LAKSHADWEEP
P
TAMIL NADU
PONDICHERRY
P
A & N ISLANDS
KERALA