Directionality and Locality in Vowel Harmony

With special reference to Vowel Harmony in Assamese

Shakuntala Mahanta
Utrecht Institute of Linguistics (UiL-OTS)
Janskerkhoff 13, 3512 BL
Utrecht

Shakuntala.Mahanta@let.uu.nl

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Chapter 1

Introduction

1 Goals of this Dissertation

In phonological systems, it is sometimes observed that a segment requires greater similarity to neighbouring segments with respect to a certain feature. Examples of phonological patterns exhibiting such requirements for vowel processes abound in natural languages and these involve a wide cross-section of phonological features resulting in processes known as vowel harmony, metaphony, umlaut, etc[1]. This dissertation will concentrate on vowel harmony processes and try to enumerate certain fundamental constraints and characteristics of some vowel harmony languages. In unearthing those constraints, this dissertation will be guided by two goals. The goals are to contribute to an ongoing discussion within a theoretical framework (in this case Optimality Theory, henceforth OT, Prince and Smolensky 1993/2004) of how the notions of 'directionality' and 'locality' should be handled.

What unifies these two goals, among the many other facets of vowel harmony, is the fact that this dissertation leans to a large extent on vowel harmony in Assamese. The various theoretical problems, which were encountered while fleshing out vowel harmony in Assamese, guided this dissertation in the identification of these factors. Therefore the empirical domain receives a lot of attention in many chapters of this dissertation.

Assamese is spoken in Assam, which is a North-Eastern state of India. Assamese (also known as Asambe, Asamiya, etc.) and creoles of Assamese like Nagamese are spoken in the different north-eastern states. The variety described here is representative of

[1]Resulting also in processes that involve consonants – for instance, in nasal harmony, tonal spreading, consonant (coronal, retroflex etc.) harmony, voicing assimilation, etc. See Hansson (2001) for arguments against considering consonantal agreement on a par with vowel harmony and Pulleyblank (2002) in favour of it.

colloquial Assamese spoken in the eastern districts of the state of Assam in India. 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 in 2001).

Among the many empirical observations about Assamese vowel harmony, I will show that Assamese displays iterative regressive vowel harmony, a process a process which was not shown to exist in this language. I will show that the outputs of harmony [e] and [o] are allophonic in the language. The allophonic outputs [e] and [o] are present only in the surface inventory of the language, when harmony is triggered by a following /i/ or /u/. Further, I will explore the phonological status of the vowel /ʊ/ in Assamese, and show that the way /ʊ/ participates in vowel harmony is important to its phonological characterisation. I will also offer an acoustic experiment to establish that /ʊ/ is a [+high][+back][-ATR] vowel in the language, which is juxtaposed to the findings in Ladefoged (1996, 2001). The findings of my experiment endorse the phonological characterisation of all the vowels, including /ʊ/ in Assamese. This much is about the descriptive facts of Assamese vowel harmony.

Apart from these details of vowels and vowel-inventory related facts of Assamese vowel harmony, this dissertation demonstrates some of the far-reaching theoretical significance of different aspects of vowel harmony in Assamese (and to a lesser extent, Bengali and Tripura Bengali). It is to this aspect that I now turn, and take up the discussion of theoretical goals that were identified in the beginning of this chapter.

(a) Directionality: Recent work on vowel harmony claims that directionality is not an independent parameter along which vowel harmony languages are organised. For instance, 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 as well as 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 directional systems like Karajá and Assamese. Karajá, which is a 'Macro-Jê' language from Central Brazil presents strictly regressive [ATR] vowel harmony (Ribeiro 2001, Hansson 2002). It therefore shares two features with Assamese: leftward directionality and [ATR] harmony.

But primarily focussing on Assamese, I will show that harmony is exclusively unidirectional in Assamese. In Assamese harmony, the high [+ATR] vowels /i/ and /u/ regressively trigger harmony on the preceding [-ATR] vowels, /ɔ/ /ɛ/ and /ʊ/ (except /ɑ/). This regressive triggering is shown to be the result of a precedence relation, where a marked sequence of vowel features are prohibited. I argue that assimilatory agreement in Assamese (and in Pulaar, Karajá and Bengali) is the result of contextual neutralisation, which can be expressed in Optimality Theory terms as a contextual markedness constraint, where the occurrence of a feature value [-F] is marked, if followed by a [+F] value. Consequently, the sequence which needs to be avoided in Assamese (and Pulaar and Karajá) is the result of the constraint *[-ATR][+ATR], which in effect drives regressive [+ATR] harmony. This also brings us to the second important goal of this dissertation.

(b) Locality: The second important goal of this dissertation is to show that harmony involves local agreement (see also McCarthy 2004, Wilson 2006). Harmony processes of the world are long distance processes embracing entire words and phrases, but one of the assumptions of this dissertation is that these occurrences of harmony proceed iteratively, and the locality of such apparently non-local processes is evident from how blocking of these phonological processes is obtained. 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 traditionally 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. However, in this work I claim that consonants are physiologically 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. If nasals are present only in the absolutely adjacent position to the triggering vowel, they are able to block the spread of vowel harmony. Nasals in all other positions do not block the spread of harmony. I propose that this behaviour is related to the sonority of the nasal, which makes it a compatible segment to bear the local vocalic agreement relation. If all consonants in all positions were able to bear vocalic features emanating from a triggering vocalic segment, then, languages like Turkish, Nawuri and Assamese, where vowel harmony is blocked by intervening consonants, would not arise.

Locality is also clearly noticeable from exceptional triggering by morphemes, where the exceptional occurrence is confined only to the immediately adjacent segment (Chapter 7).

A somewhat different kind of locality is shown to be existent in Bengali where harmony is not unbounded at all. I argue that this follows from the requirement in Bengali that agreement is possible only with [+high] and [+ATR] vowels, and simply a [+ATR] specification is not sufficient to spread harmony. In the linear order of things, the harmonised mid vowel does not meet this criteria any more; therefore, harmony does not spread beyond this vowel. This is in effect the manifestation of contextual neutralisation, which is indeed the case in all instances of harmony discussed in Chapter 5.

In this chapter, in section 2, I briefly touch upon the languages that will be discussed extensively in this dissertation. 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 is devoted to all the vowel harmony data in Assamese). 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 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 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 an eight-vowel inventory, which is asymmetrically paired with regards to the [+hi -ATR] vowel /ʊ/ and the low vowel /ɑ/. This inventory of eight vowels is a highly uncommon pattern 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 - they will be discussed in greater detail in Chapter 2, section 2.2). Assamese is also a unidirectional harmony pattern which is distinct from the 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 few more regressive systems in Chapter 3, namely Pulaar and Karajá, 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 harmony. But there are a few non-high suffixal morphemes which trigger harmony in Pulaar. I assume that apart from sequential markedness constraints, there is an indexed faithfulness constraint operative in Pulaar. Karajá also operates in a way very similar to that of Assamese as it only requires sequential markedness without any additional device, like positional faithfulness, for instance.

To an extent lesser than that of Assamese, I will discuss Bengali, a language closely related to Assamese, which displays non-iterative harmony. 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 the dialect supposed to be representative of 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). Bengali is 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 non-availability of complete featural correspondence with neighbouring segments, beyond the one in the immediately following syllable.

3 Overview of the Dissertation

In chapter 2, I present a broad overview of features, triggers and targets that are involved in vowel harmony. In section 1 of this chapter I show that the 'definitions' of harmony offered in the previous literature are not sufficient as it is impossible to constrain harmony as involving only those processes which 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 to be the result of agreement among neighbouring vocalic elements so that the process can be iterative as well as non-iterative. It is potentially an unattainable task to predict domains and directionality in vowel harmony. This observation is linked to one of the goals of this dissertation - that this unpredictability results in regressive directional systems like Assamese and regressive non-iterative systems like Bengali (section 4). Systems like these also reinforce the theoretical claim of this dissertation that these regressive systems are actually neutralisation of a marked order of vowels. Before discussing this theoretical aspect in the next chapter, in this section, I describe some other facets of vowel harmony languages, their organisation into inventories and features which may be responsible for the domain and directionality of spreading (section 2). In section 3, I surmise some of the substantive linguistic factors which underscore vowel harmony, namely preference for the vowel quality of the root, featural restrictions and preference for the unmarked feature value in the output of vowel harmony. Finally, in section 4, I highlight some of the distinguishing characteristics of umlaut and vowel harmony, and also reiterate that they do not form any separate category of vocalic agreement.

In Chapter 3, I present some of the mainstream theoretical approaches to vowel harmony. These include rule-based approaches, metrical and autosegmental approaches (section 1). The rest of the chapter deals extensively with OT approaches to harmony, as the OT approach has been chosen to be the tool for theoretical explanation in this dissertation. After showing how any OT approach will have to deal with vowel harmony in the state-of-the-art in section 3.1, I move on to deal with some influential treatises of vowel harmony within this theoretical mode. All the subsections in section 4 deals with the mainstream approaches to vowel harmony and directionality within OT, namely Syntagmatic Correspondence, Stem Affix Faithfulness, Alignment, Spread, Featural Agreement, Optimal Domains Theory and Span Theory. I conclude this chapter with a detailed schemata of the Sequential Markedness Constraints and 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 inventory —/i, u, ʊ, e, o, ɛ, ɔ, ɑ/ 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 emergence of [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 (which is completely unrelated) can be shown to be the result of contextual markedness constraints. Regressive directionality in all these languages emerge from the markedness principle *[-F][+F] (Pulleyblank 2002, Hansson 2002). In this analysis it is proposed that both iterative and non-iterative harmony can be shown to be the effect of contextually motivated markedness constraints. In non-iterative harmony, the context for neutralisation needs additional featural requirements, which does not exist beyond the immediately neutralised segment. So while iterative processes like Assamese 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 with simply sequential markedness constraints without relying on the so-called INTEGRITY constraints (Krämer 2003).

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 this chapter deals with three kinds of blocking encountered in Assamese: blocking by the [+low -ATR] vowel /ɑ/ (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 (6)a) by both vowels and consonants is driven by the same principle – high sonority. Non-local blocking (6)b), 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. V C V C V b . V C C V

X X

F F

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 occurrences of deletion of the morpheme /i/ and subsequent surfacing of [e] and [o] without the presence of a following high vowel, are triggered by the need to faithfully preserve a morpheme by means of vowel harmony. The motivation for the preservation of the feature value of the deleted segment emanates from the constraint IDENT [+ATR]$_L$. It is also crucial that that the triggering morpheme is deleted to satisfy the constraint NO-HIATUS. The constraint IDENT [+ATR]$_L$ demands satisfaction only locally and it does not demand any long distance morpheme realisation.

In chapter 7, I also show some exceptional occurrences 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 normally opaque vowel /ɑ/ undergoes harmony when harmony is triggered by the adjectival suffixes /-iyɑ/ and /-uwɑ/. This is dubbed /ɑ/ adaptation and this morphemically conditioned adaptation is possible only when /ɑ/ is immediately adjacent to the triggering /-i/ and /-u/ of the morphemes /-iyɑ/ and /-uwɑ/. /ɑ/ never alternates when it is not adjacent to the triggering morpheme. The only possible way to realise the value of the suffixal morpheme's [+ATR] value, in the presence of an /ɑ/, is by adapting it to other [+ATR] vowels in the inventory, i.e. /e/ and /o/. The constraint indexation approach proposed by Pater (2006) is chosen to be the most suitable because it involves locality restrictions in the application of indexed constraints, and as a result makes the correct predictions in the exceptional triggering of vowel harmony.

In chapter 8, I try to probe into the functional motivation for regressive harmony and show that though Assamese looks like the metaphonic systems of Romance, where the high vowel in the weak position determines harmony, the reason for regressiveness cannot be accounted for by resorting to 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 such behaviour of the high vowel is indeed related more to articulatory factors than any perceptual threat to high primary vowels like /i/ and /u/.

4 Symbols and Data Collection

Finally, as a matter of detail it must also be pointed out that in the transcription of Assamese and Bengali, I will consistently rely on International Phonetic Association symbols and diacritics in this dissertation, unless otherwise noted. The following is the IPA chart revised to 1993.

		[−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]	

The gaps in the chart above indicates vowels which are not attested.

Further, 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 (Apendix II). Though I did not carry out any statistical analysis of the recorded data, it will definitely be useful to conduct further experiments in vowel harmony.

Chapter 2

Background to Vowel Harmony

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. Section 2 discusses harmony properties of 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 be independent factors which constrain occurrences of vowel harmony. Section 4 attempts to arrive at a consistent and coherent classification of metaphony (and to a lesser extent Germanic umlaut), but shows that both, especially so-called metaphony, are equivalent to harmony, and the only difference lies in the factors which constrain them.

1.1 Definitions of harmony

The scope of this dissertation is vowel harmony and a characterisation of the process is therefore indispensable for our purposes. But it is no easy task to define and contain 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 languages which abide by a few select principles as against some others which do not meet these envisaged criteria. To reduce these often divergent behaviours 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 sees 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' 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 the properties identified by Clements, arguing that none of the characteristics are sufficient to capture the diversity seen among vowel harmony languages as also to distinguish them from other phenomena like umlaut and metaphony. According to Anderson, phonetic motivation does not always determine harmony. In Uralic and Altaic systems, historical change alters the basis of phonetic motivatedness. For instance, in Buriat Mongolian, the original diphthongs /oy/ and /ay/ are realised as /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 spread to the initial syllable as a result of both umlaut and reduction:

(9) /banan+um/ → /banönum/ → /bönunum/

Contradictions were found to exist for each and every principle of vowel harmony. Anderson concluded that a proper definition of vowel harmony is elusive, though it may be obvious, and there are no principles as such to establish these distinctions convincingly. However, reservations among phonologists in order to accept metaphony and umlaut-like systems within the domain of harmony is widely persistent, 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 circumscribe the range of vocalic agreement phenomena noticed in the world's languages: as long as vocalic agreement exists, a language may be said to possess vowel harmony, and there is no difference between harmony and assimilation by itself. The only criteria that may play a role is the presence of two alternating sets of vowels in the inventory. When one induces the other to change, vowel harmony exists in that language. It is therefore not a worthwhile theoretical persuasion to analyse 'vowel harmony' and 'assimilation' as two separate processes, and they are the 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 the two closely related languages, Assamese and Bengali: whereas harmony is iterative and regressive in Assamese, it is non-iterative in Bengali. Going back to the definitions offered by Clements and Ultan, neither of these languages would have qualified to be harmonic, as Assamese demonstrates regressive harmony where /i/ and /u/ trigger harmony only in the preceding vowels, and therefore not bi-directional, root-controlled, or word-based at all, and in Bengali /i/ and /u/ would affect only one preceding vowel and, therefore defiantly contravene all laws of harmony. Time and again in this dissertation, I come back to the point that both Assamese and Bengali are vowel harmony languages, because theoretically speaking, it will not serve any principle of economy 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. 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 direction and domains. The factors which set the limits of the scope of harmony in a language may be 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 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. Though there are many feature groups involved in assimilatory alternation 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 which 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 the language that will be discussed extensively, i.e. Assamese will be shown to demonstrate [ATR] harmony. Section 2.1 is a prelude to [ATR] harmony in general with a follow-up section in 2.2 which 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 be realised as expansion of the pharyngeal cavity along with laryngeal lowering (Lindau 1975). [ATR] was traditionally thought to be synonymous with tense/close or lax/open. But Stewart (1967, 1971) argued that the category of tongue root position gave a simple explanation to phenomena like vowel harmony systems 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 contrast phonologically along the lines of [$\pm$ATR], and not height. Work by Ladefoged (1964), and Ladefoged *et al* (1972), have shown 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 reports [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 so far as 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. Further, 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 observe these inventory related predictions of Stewart, but they still do not empower us to predict assimiltory relationships. Triggers, targets and directionality do not necessarily fall out from the inventory, and even identical full-blown ten vowel inventories displaying [ATR] harmony can lead to different behaviours. As already explained, ten vowel systems consist of all the vowels that are, in principle, said to be the complete [ATR] inventory. I will consider a ten-vowel [ATR] harmony system in a language called 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

[biri]	'black'
[bɪrɪ]	'red'
[firi]	'to lend'
[fɪrɪ]	'to fail'

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

(12) [ATR] alternation in Twi affixes

mɪ.bɛ.firɪ.ɪ	mibefirii	I will borrow it
1P .FUT. borrow. it		
mɪ.bɛ.fɪrɪ.ɪ	mɪ.bɛ.fɪrɪɪ	I will miss it

1P. FUT. miss. It		
ɔ.biri	o.biri	It is black
3P. black		
ɔ.bɪrɪ	ɔbɪrɪ	It is red
3P. red		

In Twi, harmony appears to be bidirectional and it 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)

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) Harmony in Kalenjin

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

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:

(15) kiagere ‘I was shutting it’

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

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

ɔ̀ nɪ saká pì ‘he did not cook the rice’

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

ɔ̀kázapɪ ‘he will cook food’

ɔ̀kázʌpɪ

ɔ̀kʌ́zʌpɪ

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 operating between their triggers and targets, each language has the option to spread either [-ATR] or [+ATR] in a word, but the domains and processes they choose are 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, there is hardly any idealisation that a harmony language could strive for. 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 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

ebuo	'nest'
ɛbʊɔ	'stone'

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

(21) /ɑ/ occurs with both the [ATR] values

bisɑ	'to ask'
pʊrɑ	'to sweep'

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

(22) Affixal harmony in Akan

o-bisa -ɪ 'he asked'

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 tells us that a perfect ten-vowel inventory has no restrictions on triggers and targets in [ATR] vowel harmony. All words 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] mismatch in vowels.

Further, it has been 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 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 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

à- á-bɛ̀mɔ́	è-é-ré-mú
He incl. beats me	It inc. hurt me
He is beating me	It is hurting me
*à-á-bɛ́-mu	*à-á-ré-mɔ
He is beating me	It is hurting me

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

Keeping in mind all the sorts of variations possible, it is now interesting to see that Pulaar brings with it another dimension of control – here harmony is regressive.

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

lef-ol		'ribbon'CLASS
lef-el	lɛf-ɔn	'ribbon'DIM SG/DIM PL
keer-ol		'boundary'CLASS
keer-el	kɛɛr-ɔn	'boundary'DIM SG/DIM PL
paɗ-el	paɗ-ɔn	'shoe'DIM SG/DIM PL

(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. ATR spread applies between stems and prefixes but not between stems and suffixes.

(25) Yoruba Vowel Harmony

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

Here again, though the three languages have the same inventory, their interactions show a load of complexities. In Pulaar, suffixes trigger harmony, whereas in Yoruba it 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[2]. There are boundless 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 with it a multitude of possibilities with regard to variation in the assimilatory nature. That being said, languages with exactly similar inventories may also display wide dissimilarities in harmony.

3 Possible Determining Factors in Vowel Harmony

However, it will be an unfair assessment of harmony to indicate 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 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):

(26) Finnish Illative Suffix:

maa+han	'land'
tuo+hon	'that'
jo+hon	'relative pronoun'
tähän	'this'

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

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.

(27) 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.

(28) The Turkish vowel inventory

	round		non-round	
	front	back	front	back
High	Ü	u	I	ɨ
non-high	Ö	o	e	a

(29) Standard Turkish vowel harmony (From Clements and Sezer 1982)

Nom Sg.	Gen.Sg	
ip	ip-in	‘rope’
kɨz	kɨz-ɨn	‘girl’
yüz	yüz-ün	‘face’
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.

(30) Superclose harmony in Phuthi

kú-bịt-ịs-a	to help/make call	ku-bịt-a	to call
kú-bị́t-ị́sịs-a	to call intensively		
kú-thụ́s-ị́s-a	to cause to help	ku-thụs-a	to help
kú-thụ́s-ị́sịs-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 the answers to these intriguing questions can only be found in the general linguistic principles (like stem/root faithfulness or unmarked vowel spreading or even positional faithfulness). Morphological and positional factors, etc. can be restrictive 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 move to 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 of 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 depends 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 the 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 untouched. In Tudanca, all the vowels in the stressed foot until the stressed vowel are affected:

(31) Harmony within the stressed foot in Tudanca

θéra	'wax'	(θirî)ya'match'	
séka	'dryness'	(sikú)ra	'thirst'
merendár	'to have a snack'	(mirjén)da	'medium'

molér	‘to grind’	(muljén)da	‘grinding’

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

(32) Centralising harmony in Tudanca

sɛ́kʊ	‘dry’(masc)	séka	‘dry’ (fem)
kɛ́sʊ	‘cheese’	késos	‘cheeses’
bjʊ́dʊ	‘widower’	bjúda	‘widow’
θʊ́rdʊ	‘left-handed’ (sg.masc)	θúrdos	‘left-handed’ (sg.plural)

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

(33) Harmony in Lena Bable

górdos	gúrdu	‘fat’	(m pl/m sg)
kordéros	kordɪ́ru	‘lamb’	(m pl/m sg)
(Spanish, gato)	gɔ́tu	‘cat’	(m sg)
(Spanish, blanco)	blɔ́nku	‘white’	(m pl/m sg)

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

Umlaut (Saussure 1915, Sapir 1921, Kiparsky 1971) and metaphony has been known to be akin to each other as both involve morphologisation of a phonological process. Germanic umlaut involves adjustments for backness and roundness whereas metaphony involves raising only. 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 all these processes can be analysed with the mechanisms that have been developed in this dissertation.

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.

(34) Blocking in Salentino

sing.	plural	
paréte	parı̃ti	wall
mése	mísi	months
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 cases of antepenultimate stress, a penultimate vowel is unaffected by harmony.

(35) Transparency in Lena

Masc. Sg.	Masc. Pl.	Fem. Sg.	
burwı̃banu	burwébanos		‘wild strawberry’
péšaru	pášaros	pášara	‘bird’
kékabu	kákabos		‘wreck’
kéndanu	kándanos		‘dry branch’
sébanu	sábanos	sábana	‘sheet’
trwı̃banu	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 propose that the domain of harmony ought to 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 vowel harmony proper, but only 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 harmony 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 plenty of metaphonic languages are word-based (Andalusian, etc.),

Restrictions on vowel harmony can hardly be called straightforward, and language specific interactions abound in all vowel harmonies. Universal constraints apply to these phonologies and lead to the emergence of crosslinguistically common properties. The exposition above shows that all these variations can only mean that various constraints which apply to harmony domains are not obvious *prima facie*, but show up in a language and can be explained in Optimality Theory (to be discussed in section 5.2) in terms of universal constraints. The point of interest is that these variations are also encountered in metaphonic systems. Variation in metaphony is constrained by its prosodic domain: either triggers, or targets, or both are distinguished by the stressed or the unstressed vowel. In the preceding sections I have argued why 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 solely confined to root/stem harmonic systems. Therefore, in the face of new data from a strictly directional system like Assamese and a strictly non-iterative harmony system like Bengali, it is eminently desirable from any theory of vowel harmony to be able to respond, cope and analyse them instead of considering them as exceptional cases of harmony.

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, 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. From section 4.2 to 4.7, I discuss various approaches within OT which have either adopted the approach of spread 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

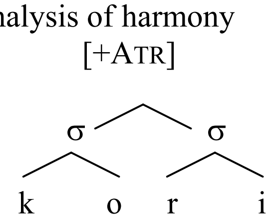
In standard derivational theory of the SPE type (Chomsky and Halle 1968), a rule of vowel harmony would be formulated as below:

(36) V→ [+F] / [+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[3].

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.

(37) Metrical analysis of harmony



[3] 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).

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.

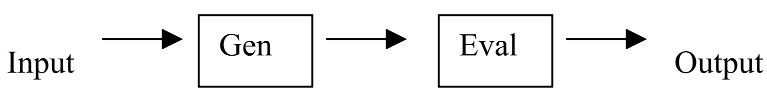
The most fundamental characteristic of Autosegmental theory (as well as metrical harmony) is that phonological representation can be postulated paradigmatically. In Autosegmental theory various features of the phonological process (tone, nasalisation process, harmony, etc.) are represented on independent 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.

(38) 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
(39) IDENT[F]
Input-Output segments have the same value for the feature [F]

Markedness Constraint
(40) 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 IDENT [F] ≫ AGREE[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.

(41) Schematic tableau

[-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/.

(42) Vowel harmony tableau

/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 Faithfulness ≫ Markedness 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 (42) 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 [+hi +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) 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).

(43) 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.

(44) Unbounded assimilation in AGREE

[-F][-F][+F]	AGREE-F	IDENT[F]
a. [-F][-F][+F]	*!	
b. [-F][+F][+F]	*!	*
c.☞ [+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 global constraint like AGREE is capable of showing the right result only when unbounded iterative assimilation is the predicted outcome. AGREE fails in a language like Assamese where it is only natural to come across input candidates like [-ATR][+ATR][-ATR] (this kind of data is discussed in the next chapter). 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.

(45) AGREE fails in the absence of total harmony[4]

[-F][+F][-F]	AGREE-F	IDENT[F]
a. [-F][+F][-F]	*!	
b.✯ [+F][+F][-F]	*!	*
c. 💣 [+F][+F][+F]		**

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:

(46) Sequential markedness constraints

*[+F][-F] - Output correspondents of [-F] segments may not be preceded by [+F] segments.

*[-F][+F] - Output correspondents of [+F] segments may not be preceded by [-F] segments.

Applying the constraint *[-F][+F] to the offending input of (45) [-F][+F][-F] we arrive at the right result in (47) below:

[4] 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.

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

[-F][+F][-F]	*[-F][+F]	IDENT[F]
a. [-F][+F][-F]	*!	
b. ☞[+F][+F][-F]		*
c. [+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 [hi] constraint which would demand obliteration of [ATR] or [hi] contrasts in all the vowels of a word. This kind of neutralisation is also impossible to analyse when harmony is viewed as autosegmental spreading instead of featural agreement. Spreading or alignment will demand association of the triggering autosegment to all the vowels present in a word, unless it is blocked by any other faithfulness constraint. Contextual markedness can alone capture the fact that faithfulness is not the issue in the facts at hand:

(48) Harmony in non-iterative assimilation

[-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 abandoning some substantive notions of linguistic theory like

FAITH ROOT ≫ FAITH AFFIX (McCarthy and Prince 1995). This will be effectively shown to be the case in Assamese, Pulaar and Karajá (see also Hansson 2002). 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: [+hi +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 [+hi +ATR] source is well-grounded and therefore prohibits neighbours which would surface with unassimilated feature combinations i.e., *[-ATR][+ATR] and *[+hi -ATR]. Essentially, this kind of featural prohibition constraint forbids disharmony in vowel sequences. In a similar vein, Pulleyblank (2004), proposed the following constraints in order to compel [ATR] vowel harmony:

(49) *<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.

(50) 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 VH 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.

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:

(51) Pos Faith in Shona harmony

I: /per-ira/	IDENT σ_1	*MID	*HIGH	IDENT (hi)
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. They can also restrict contrasts only indirectly, that is with the aid of lower ranked markedness constraints. 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. For the sake of argument, if a language allows /e/ and /o/ in a prominent position, albeit as a result of allophonic neutralisation: i.e. /e/→ /i/ and /o/ → /u/ only in the initial/stressed syllable (so called prominent positions), then obviously IDENT σ_1 will fail to account for the occurrences of these vowels. This is shown below:

(52) Failure of Pos Faith in quasi-Assamese

I: /per-ira/	IDENT σ_1	*MID	*HIGH	IDENT (hi)
a. 💣 perera		*		*
b. ☹ pirira	*!		*	

Neutralisation in Assamese follows roughly the behaviour demonstrated by the first syllable of the candidate (52) b in the evaluation above, and, 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]

CANDIDATES	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]

CANDIDATES	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)[5] (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
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.

[5] 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.

(57) Affix control with Integrity constraints (Krämer 2000)

a. Root control: INTEGRITY Affix ≫ INTEGRITY Root

b. Affix control: INTEGRITY 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[6] (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 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,

[6] See Hannson (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.

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[7]. In the 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

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

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[+lo,-ATR] and violation of *A-SPAN allows opacity

/sapɔr/+/i/	FTHHDSP [+ATR]	HD [+lo,-ATR]	*A-SPAN [ATR]	HD$_R$ ATR	HD$_L$ ATR
a.☞(sɑ̱)(porḭ)			*		*
b. (sɑpɔ̱)(rḭ)		*!	*		
c. (sɑ̱pɔ)(rḭ)			*	*!	
d. (sɑ̱)(po̱ri)	*!		*	*	

The difference between the candidates (65)a) and (65)b) lies in the latter's violation of the highly ranked HD[+lo,- 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 nature fails to curb.

But the same attribute lands us with trouble when we proceed to analyse consonant-vowel interaction using the tools available in this theory. Note that in Span Theory HD[+lo-ATR] would correctly predict low vowels blocking harmony in Assamese. While HD[+lo-ATR] can generate the right output where AGREE fails, this approach to blocking would generate unattested results for nasals blocking harmony in Assamese.

(66) HD[nasal] predicts nasal spans

/zɔhɔni/	FTHHDSP[+ATR]	HD[nasal]	*A-SPAN[ATR]
a. ☞(zɔhɔ̱)(ṉĩ)	*!		**
b. (zɔ̃hɔ̃ṉi)	*!		*

Consequently, if blocking is interpreted as the headedness of the segment which blocks spreading, it would result in spreading of the features of a consonantal element in vowel harmony. It is not uncommon to come across such occurrences in vowel harmony languages, and Span Theory would probably predict headship of the intervening consonant. There may be a way out of this problem by assuming autosegmental levels for vowels and consonants, but even then it will incorrectly predict blocking by nasals in all instances where the nasal occurs. However, in Assamese only the nasal in the onset position of the triggering syllable (i.e.immediately preceding the triggering segment) blocks harmony and nasals in any other position do not.

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[8], 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

[8] 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).

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.

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[9] 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

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[9] 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.

Tibeto-Burman influences stamping their discernible mark not only in loan words but 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[10].

[10] 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

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:

(67) [+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 (68)(a):

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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.

(68)

	(a) minimal pairs of Assamese			(b) non-minimal pairs	
(i)	bɛl	‘a kind of fruit’	(i)	bɛt	‘cane’
(ii)	bel	‘bell’(from English)	(ii)	d^{h}et	(interjective)
(iii)	bɑl	‘child’	(iii)	b^{h}ɑt	‘rice’
(iv)	bʊl	‘colour’	(iv)	b^{h}ʊk	‘hunger’
(v)	bɔl	‘strength’	(v)	b^{h}ɔr	‘fill’
(vi)	bol	‘let’s go’	(vi)	dot	‘monster’
(vii)	bul	‘proper name’	(vii)	buz	‘understand’
(viii)	bil	‘small lake’	(viii)	b^{h}ir	‘crowd’

Note that in the paradigm set in (68)(a. ii) /bel/[11] 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 (68)(b), which are not necessarily perfect minimal pairs. But even here /d^{h}et/ (interjective) and /rod/ ‘sunshine’ are members of an extremely limited set of 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

[11] 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.

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 (68), an acoustic study of these vowels was conducted with the help of PRAAT (Boersma and Weenick 1993 - 2007)[12]. 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 II):

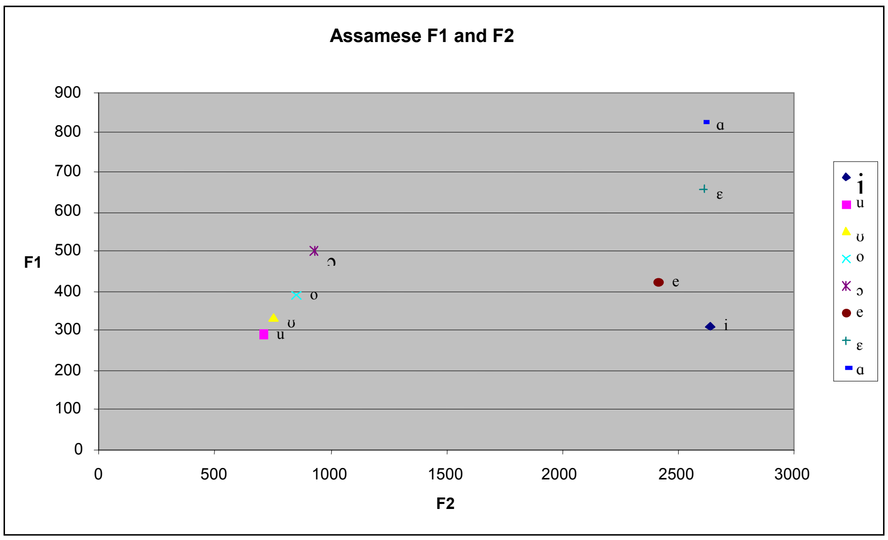
2. Table

	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	1547	2766

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.

[12] PRAAT is a software for phonetic analysis.

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 /ɒ̩/' was one of the subjects of Ladefoged's (1986) inquiry in the 'Sounds of the World's languages[13]'. 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.

(69) 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'	pɒ̩t	'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 /pɒ̩t/ '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 /ɒ̩/ (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

[13] 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".

higher frequencies for [ɔ] – an unusual situation in that higher vowels normally have lower first formant frequencies. The considerable rounding in [ɒ̹] 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.

(70) 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 [+hi +ATR] vowels in Assamese /i/ and /u/. From the tables in 1 and 2 we can formulate the following generalisations:

(71) 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[14], the distribution of [+ATR] in words containing /i/ and /u/ is 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 (72), (73) and (74) (75) below and the impossible sequences in (76).

(72) 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'

[14] '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.

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'

(73) Sequences of [+ATR +hi] 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[15]

(74)

(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

[15] 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	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'	

	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'

(75) 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[16]	
ɑ	muk^{h}ɑ	'mask'	zɑru	'broom'
	ug^{h}ɑ	'to wind thread'	ɑp^{h}u	'poppy
	xutɑ	'thread'	ɑŋur	'grape'
	k^{h}utɑ	'pole'	ɑtur	'thirsty'

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

(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

Notice that these co-occurrence restrictions only apply in the vicinity of

16/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.

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 +hi] stands out as the only vowel which combines precisely these two feature values. The examples in (77) show the distribution of /ʊ/ and its implication for the inventory.

(77) /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 (78) (79) (80) (81) (82) 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.

(78) 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’

(79) 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)

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

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

(See examples in section 1.4)

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

*V_1	V_2	*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).

(82) 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 (82) /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/

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/

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 (84) – (92) are possible, whereas the sequences in (85) and (86) are impossible.

(84) 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

	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’

(85) 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]
ε, ɔ	e,o	e,o	ε, ɔ

(86) 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	ε,ɔ	i,u

From the possible sequences in (84) (90) (91) and (92) and impossible sequences in (85) -(86)[17] 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 (84) iii and iv. These sequences show that mid vowels always agree to the [±ATR] specification of the vowel on the right and not

[17] 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.

vice versa. In the following paragraphs, we will discuss the distribution of the mid vowels /ɛ, ɔ, e, o/ in greater detail and try to evaluate their place in the inventory.

(87) 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'

(88) /ɛ/ occurs in all the positions of a word, [e] does not occur in final positions (cf (74))[18].

	e-initial	gloss	final
i	$zet^{h}i$	'lizard'	not attested
	beli	'sun'	
	$k^{h}eti$	'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 (87) & (88) 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.

(89) [+ATR] harmony in bisyllabic words (cf (74))

Word	Gloss
beli	'sun'
pelu	'worm'

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

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/.

(90) Possible sequences of mid vowels and low vowels

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

(see examples in section 1.5)

(91) 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)

(92) 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)

(93) [-ATR] harmony in bisyllabic words (cf.(84) and (87))

Word	Gloss
gɔrɔm	‘hot’
bɛlɛg	‘different’

pɔxɛk	'week'
bɛsɔn	'powdered pulse'

The illustrations in (89) and (93) show that the deciding factor behind the occurrence of [e] is the presence of a succeeding high vowel.

(94) Generalisations regarding [e]
(a) [e] is realised when there is a following [+high, +ATR] vowel.
(b) /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 (95) (96)and (97) 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.

(95) The distribution of /ɔ/

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

(96) Initial and final (cf. (84))

xɔrɔl	'simple-minded'
tɔpɔt	'hot'

(97) The distribution of [o] (cf. (74))

Initial	Gloss	Final
ok^hil	'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 +hi] vowel.

(98) [o] always needs a following [+ATR +hi] 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.

(99) a) As V_1 /ɑ/ does not regularly occur with [o] and [e]

b) As V$_2$ /ɑ/ does not regularly occur with [o] and [e]

c) /ɑ/ does occur with [o] and [e] in some loan words and historical remnants.

(100) V$_1$ V$_2$ b) V$_1$ V$_2$

[-ATR] [+ATR] [+ATR] [-ATR]

[+low] [+high] [+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'

(101) V$_1$ V$_2$ b) V$_1$ V$_2$

[-ATR] [-ATR] [-ATR] [-ATR]

[+low] [+high, -low] [+high, -low] [+low]

ɑ ʊ ʊ ɑ

(102) Possible sequences

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

(103) (a) V_1 V_2 (b) V_1 V_2

	(a) V_1	V_2	(b) V_1	V_2
	[-ATR]	[-ATR]	[-ATR]	[-ATR]
	[+low]	[-low,-high]	[+low]	[-low,-high]
	ɑ	ɛ, ɔ	ɑ	ɛ,ɔ
ɛ	pɑtʰɛk	'officer'	ɛlɑh	'laziness'
	xɑrɛŋ	'bird'	ɛŋɑ	'reluctance'
	pɑlɛŋ	'spinach'	tɛmɑ	'container'
	pʰɑtɛk	'jail'	zɛgɑ	'place'
ɔ	ɑsɔl	'real'	zɔlɑ	'hot'
	xɑgɔr	'sea'	mɔtɑ	'male'
	ɑtɔr	'perfume'	bɔtɑh	'wind'
	ɑkʰɔr	'letters'	bɔgɑ	'white'

(104)

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

Monosyllabic trisyllables and quadrisyllables are much less in Assamese and more abundant in derived environments. They also fit in 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[19] occur only in tri/quadrisyllables in the presence of a final high vowel. Examples are given below:

(105) Trisyllables	Gloss
e-initial	
tekeli	‘small earthen jar’
leteku	‘berry’
keŋeru	‘kangaroo’
zelepi	‘sweet’
keseru	‘tree’
bogoli	‘crane’
teteli	‘tamarind’

[19] 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.

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.

(106) 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.

(107) 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 ((108) 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:

(108) 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 ((108) 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 [+hi, +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 +hi] - /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 [+hi +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:

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

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

b. In the presence of a [-ATR] vowel on the right side of a word, the mid vowels on the left appear with their [-ATR] specifications.

Whether the nature of restrictions are 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

(110) Proposed generalisations of this chapter:

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.

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 (111), 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.

(111) 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

ii-	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)
siŋi	tear(inf)	bipul	abundance

i/u i-final		u-initial /u/-final	Gloss
puti	dump(inf)	guput	secret(from gʊpɔn-secretive’)
tuli	lift(inf)	bukut	
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.

(112) 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	' hon &3P)	not attested
	kinɛ	buy (2P hon & 3P)	
	zikɛ	win(2P hon &3P)	
	xikɛ	learn(2P hon &3P)	
	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	

[20] Loc stands for Locative case

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

(113) 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)[21]	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)

(114) Thus the following sequences are impossible:

i) V_1 V_2

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

[-ATR] [+ATR]
[-high, low][+high]
ɛ,ɔ i,u

ii) 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:

(115) 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 /ʊ…u/ sequences in the underived inventory. This gap does not exist in the derived part of the lexicon. The examples in (116) and (117) below show that /ʊ/ co-occurs with vowels bearing [-ATR] specifications.

(116) Possible sequences of the vowel /ʊ/

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

bʊlʊ	say (1P)
kʰʊlʊ	open (1P)
tʊlʊ	lift (1P)
kʰʊsʊ	poke(1P)

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

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

pʊrɛ	fall (2Phon & 3P)	kʰɛlʊ	play(1P)
xʊwɛ	sleep(2P hon & 3P)	mɛlʊ	spread(1P)
kʰʊlɛ	open(2P hon & 3P)	sɛkʊ	strain(1P)
zʊrɛ	force(Erg)[22]	bɛsʊ	sell(1P)
pʊrɔ	burn (2P fam)	mɔrʊ	die(1P)
xʊwɔ	sleep (2P fam)	kɔrʊ	do(1P)
kʰʊlɔ	open (2P fam)	bɔhʊ	sit(1P)
sʊwɔ	touch (2P fam)	pɔrʊ	fall(1P)

The sequence in (118) shows that /i/ and /u/ can combine with /ʊ/ only when they precede /ʊ/ and the reverse of this sequence is not attested.

[22] Erg indicates ergativity.

(118) 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 (119) i), the [+ATR] mid vowels do not occur in either side of the /ʊ/. (119) ii) shows the high vowels /i/ and /u/ do not occur to the right of /ʊ/ in a stem suffix sequence.

(119) Impossible sequences with the vowel /ʊ/

i)	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

ii)	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:

(120) 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.

(121) 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^hɛlɔ	play(2P fam)	mɔrɛ	die(2P&3P hon)
sɛpɔ	squeeze(2P fam)	d^hɔrɛ	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^hɔrɔ	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:

(122) 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

(123) Possible sequences of mid-vowels

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

(124) Possible 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

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:

(125) Generalisations

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

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

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

v) 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 (126), it is evident that /ɑ/ combines with all the [-ATR] vowels in both V_1 and V_2 positions.

(126) Possible sequences of the vowel /ɑ/

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

a-initial/ a-final

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

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

a) V₁ [-ATR] [+low] ɑ; [-ATR] [-low +high] ɛ, ɔ — V₂ [-ATR] [-low -high] ɛ,ɔ; [-ATR] [+low] ɑ

	ɛ-initial	Gloss		ɑ-initial	Gloss
a	dɛk^hɑ	see (perf. conj.)	ɛ	pɑlɛ	get (2p hon & 3P)
	tɛpɑ	squeeze(perf. conj)		d^hɑlɛ	pour (2p hon & 3P)
	t^hɛlɑ	push(perf.conj)		gɑlɛ	sing (2p hon & 3P)
	ɛzɑk	lot		sɑlɛ	see (2p hon & 3P)

	ɔ-initial	Gloss		ɔ-final	Gloss
a	pɔlɑ	flee(imp)	ɔ	ɑsɔ	be (2P fam)
	mɔrɑ	dead (vn[23])		pɑsɔt	later (loc)
	kɔrɑ	do (vn)		pɑrɔ	can(2P fam)
	pɔsɑ	rot (perf conj)		pɑrɔt	side (loc)

(128) /ɑ/ also freely occurs with /ʊ/

a) V₁ [-ATR] [+low] ɑ; V₂ [-ATR] [-ATR] [+high, -low] ʊ

b) V₁ V₂ [-ATR] [+high, -low] ʊ; [+low] ɑ

[23] VN indicates a verbal noun

ʊ-initial	Gloss	a-initial	Gloss
k^hʊlɑ	open (perf conj)	pɑlʊ	got (1P)
gʊlɑ	mix (perf conj)	k^hɑlʊ	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 (113), it does not occur with the [+ATR -high -low] vowels (i.e. /e/ and /o/).

(129) 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/.

(130) 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.

(131) /i/ suffixation

Root	Gloss	Suffix	Derivation	Gloss(Derivation)
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)

(132) /ikɑ/ suffixation

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

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

Root	Gloss	Suffix	Derivation	Gloss(Derivation)
a. bɔx	'settle'	oti	boxoti	'settlement'
b. mɔr	'die'	oti	moroti	'cursed to die'
c. k^hozoti	'itch'	woti	k^hozuwoti	'itching sensation'
d. p^hɔl	'result'	woti	p^holowoti	'bearing fruit'

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

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

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

Root	Gloss	Suffix	Derivation	Gloss(Derivation)
a. lɔg	company	ori	logori	companion(fem)
b. lɔg	company	oriya	logoriyɑ	companion(neuter)
c. bɔn	jungle	oriya	bonoriyɑ	of the jungle
d. pɔlɑ	flee	oriya	poloriyɑ	run-away
e. k^hɑ	eat	oriya	k^hɑworiyɑ[24]	glutton

[24] 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 where the affixal vowel always agrees with the opaque vowel. Though this may give rise

f. nɔgɔr	town	oriya	nogoriyɑ	urban people

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

Root	Gloss	Suffix	Derivation	Gloss
a. bɔyɔx	age	iya	boyoxiyɑ	aged
b. kɛwɔl	only	iya	kewoliyɑ	unmarried
c. kɛtɛrɑ	gruff	iya	keteriyɑ	irritable
d. d^hʊl	drum	iya	d^huliyɑ	drummer

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

Root	Gloss	Suffix	Derivation	Gloss
a. pitɔl	brass	i	pitoli	made 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

(138) /-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)
f. gʊbor	dung	uwɑ	guboruwɑ	a fly living in dung

to concens about stem-control, this happens in underived words as well (see example (106)).

g. g^hɔr	house	uwɑ	g^horuwɑ	homely

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

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

All the suffixes from (131) to (139) 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 */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 (135)d) and (138)c) and (138)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 (140), I use /ɔ-/ and /prɔ/ to show how prefixes are affected by harmony triggered by either root vowels or suffixal vowels.

(140) 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'		porixim	'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 (140) 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 0.

(141) 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'.

(142) 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^hɑ	kɔr	xuŋ	xʊ	k^hɛl	kin
2P(ord)	k^hwɑ̃	kɔrɑ	xuŋɑ̃	xʊɑ̃	k^hɛlɑ	kinɑ̃
2P(hon)	k^hɑwɔk	kɔrɔk	xuŋɔk	xʊwɔk	k^hɛlɔk	kinɔk
Past Perfect						
1P	k^hɑlʊ	korilʊ	xuŋilʊ	xulʊ	k^helilʊ	kinilʊ
2P(fam)	k^hɑli	korili	xuŋili	xuli	k^helili	kinili
2P(ord)	k^hɑlɑ	korilɑ	xuŋilɑ	xulɑ	k^helilɑ	kinilɑ
2P(hon)&3P	k^hɑlɛ	korilɛ	xuŋilɛ	xulɛ	k^helilɛ	kinilɛ
Future						
1P	k^hɑm	korim	xuŋim	xum	k^helim	kinim
2P(fam)	k^hɑbi	koribi	xuŋibi	xubi	k^helibi	kinibi
2P(ord)	k^hɑbɑ	koribɑ	xuŋibɑ	xubɑ	k^helibɑ	kinibɑ
2P(hon) &3P	k^hɑbɔ	koribɔ	xuŋibɔ	xubɔ	k^helibɔ	kinibɔ
Present Progressive						
1P	k^hɑisʊ	korisʊ	xuŋisʊ	xuisʊ	k^helisʊ	kinisʊ
2P(fam)	k^hɑisɔ	korisɔ	xuŋisɔ	xuisɔ	k^helisɔ	kinisɔ
2P(ord)	k^hɑisɑ	korisɑ	xuŋisɑ	xuisɑ	k^helisɑ	kinisɑ
2P(hon) &3P	k^hɑisɛ	korisɛ	xuŋisɛ	xuisɛ	k^helisɛ	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 /kʰɑ/ '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 (143) below, I have fleshed out all the verbal inflections, so that their presence becomes evident.

(143) Morphological markers in verbal conjugations of Assamese

Tense Markers	
Present Tense	/-ɸ/
Past Tense	/-l/, /-il/
Future Tense	/-b/, /-ib/ /-m//-im/
Aspect Markers	
Perfective	/-ɑs/
Progressive	/-is/
Perfect Conjunctive	/-ɑ/
Conditional Conjunctive	/-lɛ/
Infinitive	/-loi/

(144) 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:

(145) 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 (146) 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.

(146) 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 (142). 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.

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

(147) Monosyllables - [o]

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

(148) Monosyllables [e]

dex	‘country’	zel	‘jail’	(from English)[25]
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)

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.

(149) Bisyllables with [e]

ɑpel	‘apple’	ɑk^hez	‘grudge’
ɑbeg	‘emotion’	ɑdex	‘order’
ɑmez	‘delectable’	bɑze	‘useless’

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

perɑ	'sweet'	nirdex	'command'
bidex	'foreign country'	ɔxex	limitless'
utk^hep	'launch'	udb^hed	'exposure'

(150) Bisyllables with [o]

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

(151) Trisyllables etc.

ɑbestɔn	'enclosure'	ɑbedɔn	'appeal'
od^hibexɔn	'conference'	niketɔn	'institute'
nibedɔn	'appeal'	bedɔnɑ	'pain'
ob^hixek	'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 (147) - (151) 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: *tadbhava* 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 (147). Kakati gives a vivid description of the transformation of these words from early Assamese

“In early Assamese[26], /ɔ/ followed by /i/ or /u/ (my transcription) were regularly diphthongized.

Old Indo Aryan	Middle Assamese	Modern Assamese	
kɔhitɔ	kɔitɔ	kot	‘where’
sɔittɔ	sɔit	sot	‘name of a month’
mayura	mɔira	mora	‘peacock’
dɔittɔ		dot	‘a tall ghost/spirit’
raudda	raudra	rod	‘sunshine’
cauraya		sora	‘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.

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.

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[26] 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.

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.

(152) 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/→	o-i	/ɔ/+/u/ →	o-u
/ʊ / + /i/→	u-i	/ʊ/ + /u/→	u-u

(153) [+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

(154) 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:

(155) Initial and medial vowel inventory

i	u		ʊ
e	o	ɛ	ɔ
ɑ			

(156) 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 in Chapter 1, I provided a background to vowel harmony in Chapter 2 and a theoretical background to vowel harmony in Chapter 3. This was followed by a presentation of the relevant data in Chapter 4. This 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 also shows how the same theoretical explanation can be used profitably in Pulaar, Bengali and Tripura Bengali, i.e. in those languages that were introduced in Chapter 2 of this dissertation. Therefore, the goal of this chapter is to arrive at the universal factors governing directionally oriented regressive vowel harmony.

This chapter is organised as follows: Section 1 provides a summary of the facts germane to the description of Assamese vowel harmony. Assamese harmony facts have been described in detail in Chapter 4, and therefore, the descriptive part of this chapter is restricted to a pre-theoretical introduction of relevant rather than the full 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 Assamese harmony facts in particular. These constraints have already been introduced in Chapter 3; therefore, this chapter provides their context of application in the broad spectrum of 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 as both the processes involve contextual neutralisation. Section 3 discusses Pulaar and Karajá and the use of sequential markedness constraints in their analyses. Section 4 takes up the formal analysis of Bengali and Tripura Bengali harmony and the section ends with a conclusion in 4.5.1.

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. 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 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, 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 outcome 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 it is marked to have a sequence of two vowels, such that if the preceding vowel is [-F], the following vowel cannot be [+F]. Succinctly, this precedence relation is

*[-F][+F], which will be satisfied by a [+F][+F] 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 such neutralisation, be it total regressive spreading or partial spreading as well as prosodically governed neutralisation.

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 (cf. Hansson 2002, forthcoming), and 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 the result of interleaving of contextual markedness constraints, which prevent sequential occurrence of certain feature combinations and articulatorily grounded substantive constraints, 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.

(157) /uwa/ harmony triggers

Root	Gloss	Suffix	Derivation	Gloss(Derivation)
a. pɔlɔx[27]	silt	uwɑ	poloxuwɑ	fertile land
b. mɛr	curl	uwɑ	meruwɑ	curled
c. gʊbɔr	dung	uwɑ	guboruwɑ	fly living in dung

(158) /i/ suffix

Root	Gloss	Suffix	Derivation	Gloss(Derivation)

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

a. b^hɛkʊla	frog	I	b^hekuli	frog (dim)
b. ʊpɔr	above	I	upori	in addition
c. k^hɔrɔs	spend	i	k^horosi	prodigal

Though harmony in Assamese derived words is triggered by suffixes[28], 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 suffixal vowels. The underived words presented below end in a high vowel and the preceding vowels all agree in their [+ATR] specifications:

(159) Agreement in underived words

a.	beli	'sun'
b.	pelu	'worm'
c.	teteli	'tamarind'
d.	leteku	'berry'

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

(160) Occurrences of /ɛ/ and /ɔ/

	Word	Gloss
a.	tɛrɔ	'thirteen'
b.	bɛtɔn	'salary'
c.	pɔxɛk	'week'

[28] 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 (157). Wim Zonneveld (p.c.) points out that /i/ is more unmarked than /u/, and that this is probably similar to languages with regressive voicing assimilation, where voiced obstruent suffixes are fewer than voiceless suffixes, again possibly because of markedness. Cf. Lombardi (1995) on Yiddish.

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.

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

Root	Gloss	Suffix	Derivation	Gloss(Derivation)
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)

(162) Non-existing Assamese words

a. *tero
b. *beton
c. *poxek
d. *$olek^h$

The words in (162) 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[29].

(163) To summarise the basic harmony facts:

a. Harmony is regressive (neither stem controlled nor dominant recessive) always extending till the initial syllable.
b. Regressive harmony is triggered by the vowels /i/ and /u/ on the right side.
c. 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 following [+hi +ATR,] vowel.

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[29] A near-exhaustive list of exceptions is provided in chapter 4.

2 Towards a Formal Analysis of Assamese: ATR Domain Inventory Governed by Markedness and Faithfulness Constraints

To recapitulate from 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. In that discussion I showed that though 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 below.

(164) Sequential markedness constraint (repeated from Chapter 3)
*[-F][+F] - Output correspondents of [+F] segments may not be preceded by [-F] segments.

Constraints like AGREE (also discussed in Chapter 3, sections 4.1 and 4.5) fail to capture the direction of a 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 (165) b) below:

(165) AGREE in assimilation

[-F][+F][-F]	AGREE	IDENT[F]
a. [-F][+F][-F]	*	
b. ☹ [+F][+F][-F]	*	*

The actually occurring output in regressive harmony of the Assamese type is (165), 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:

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

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

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

(167) *[-ATR][+ATR]
A [-ATR] segment may not be followed by a [+ATR] segment.

This constraint prohibits 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 of this constraint). The local character of this constraint, unlike a global AGREE constraint has far-reaching consequences in analysing unbounded systems.

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:

(168) 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 vowels retaining their underlying values in the absence of any harmony inducing high vowel.

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

In all harmony domains, segments do not change their height features. Only [ATR] features are subject to alternations. One of the relevant constraints is IDENT [hi] which preserves the height features of the input.

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

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 it is marked to have retracted tongue root and feature [front] together. This translates itself into an incorporation of the following two articulatory constraints in (171) to the one in (172):

(171) 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 occurrences of [+high] [-ATR][-back] features[30]. Therefore, an important requirement of this analysis is to allow

[30] See Archangeli and Pulleyblank (2000) for the inclusion of the grounded 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.

for a grammar in which the markedness constraint given below is ranked above the harmony constraint.

(172) *[+hi, -ATR, -back]: The feature value [-ATR] is marked in [+hi] and [-Back] vowels

Bringing all these assumptions together, we arrive at the following hierarchy:

(173) ID [hi], *[+hi, -ATR, -back][31] ≫ *[-ATR][+ATR] ≫ ID[ATR]

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

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

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

[31]The constraints in this strata remain unviolated in Assamese. Therefore, their relevance will be shown only in a few tableaux and excluded in succeeding hierarchies, since space is at an absolute premium here.

In the tableau above in (174), the input vowel /ɔ/ is not an underspecified vowel, but it is the vowel of the underlying form. The optimal surface form /kori/ is selected by the tableau in (174).

(175) Harmony even if underspecified vowels are assumed

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

In the tableau above in (175) the alternating vowel is assumed to be underspecified, and the tableau correctly generates the actually occurring output.

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

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

The three tableaux from (174) - (176) show that underspecification would not determine any crucial aspect of vowel harmony. The highly ranked feature co-occurrence constraint against [high] and [front] [ATR] vowels prevents any change in the height and [ATR] specification of high front vowels. Similarly, IDENT [high] prevents height alternation in vowels as Assamese harmony does not involve any change in the height of vowels in order to satisfy agreement.

2.1 ATR harmony in the presence of mid vowels

ATR harmony under conditions where there are only mid vowels is the focal interest of this section. 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 *[-hi +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]). Therefore, at this stage, another feature co-occurrence constraint becomes relevant.

(177) *[-hi +ATR]: The feature value [+ATR] is marked in [-hi] 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 there be inputs where all vowels are [-hi +ATR]. A highly ranked *[-ATR][+ATR] would try to enforce agreement, but *[-hi +ATR,] would prevent multiple occurrences of /e/ and /o/.

(178) Hypothetical input: /tero/

Input : /tero/	ID [hi]	*[+hi, -ATR, -back]	*[-ATR] [+ATR]	*[-hi +ATR]	ID [ATR]
a. tero				**!	
b. tɛro			*!	*	*
c. ☞ tɛrɔ					**

The tableau above in (178) shows that the constraint *[-hi +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 [-hi +ATR] values.

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 (174) to (176). But we have not yet brought into the scene candidates lacking either a /ɛ/ → [e] or a /ɔ/→ [o] alternation, precisely because of the regressive nature of harmony in Assamese. The occurrence of instances like /kinɛ/ which we will discuss shortly, involves feature co-occurrence restrictions along with sequential markedness restrictions, because [+hi -ATR] vowels do not occur in positions which are not followed [+hi +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 [-hi +ATR] in marked positions.

(179) *[+hi -ATR,] restricts [e] and [o] together with *[-ATR][+ATR]

Input: /kin/+/ɛ/	ID [hi]	*[+hi,-ATR]	*[-ATR] [+ATR]	*[-hi +ATR]	ID[ATR]
a. ☞kinɛ					
b. kine				*!	*
c. kɪne		*!	*	*	**
d. kɪnɛ		*!			*
e. kini	*!				*

The tableau above in (179) shows that the constraint *[-hi +ATR] clearly restricts the inventory for all unattested cases like */kine/ but cannot exclude real occurrences like /kori/, because of OT's nature of constraint ranking. The ranking of the constraint *[-ATR][+ATR] above the *[-hi

+ATR] constraint facilitates occurrence of 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 comprises the notion of Richness of the Base (henceforth RoB), which requires that all possible inputs must result in the actual occurring surface inventory of a language as an end-product of the same constraint hierarchy. In Optimality Theory, the principle of Lexicon Optimisation (Prince & Smolensky 1993/2004, Itô *et al* 1995), is a means of arriving at the correct underlying representation:

(180) *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, we ought to consider inputs with /e/ and /o/, which RoB might present in the generation of the optimal output candidate. The tableau below shows that *[-hi +ATR] effectively constrains all invalid surface occurrences of marked feature combinations even if RoB presents hypothetical inputs like */kine/.

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

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

The tableau above in (181) shows that the markedness constraint *[-hi +ATR] restrict output patterns like *[kine] where the [-hi +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 *[-hi +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.

2.1 ATR Harmony and the high vowel /ʊ/

We have not yet enumerated inputs where one of the vowels is the [+hi -ATR] vowel /ʊ/. The current constraint hierarchy does not make any reference to the input – output correspondence of [+hi -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 supported 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. In the upshot, /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 /ʊ/ and /u/ occurrences 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

The basic /ʊ/ → /u/ alternation can be captured by the following hierarchy:

(183) /ʊ/ → /u/ as a result of regressive vowel harmony

I /gʊl/ + u 'stir'1P	* [-ATR][+ATR]	*[+ hi -ATR]	ID[ATR]
a. gʊlu	*!	*	
c. gʊlʊ		*!*	*
b. ☞ gulu			*

The constraints as ranked in (183) show that a /ʊ/ → /u/ alternation can be captured by the ranking *[-ATR] [+ATR] ≫ *[+hi -ATR] ≫ ID[ATR], where the competitors /gʊlʊ/ and /gʊlu/ are ousted by the constraints *[-ATR][+ATR] and *[+hi -ATR] respectively.

However, this hierarchy is not sufficient to accurately predict all the outputs of Assamese. Specifically, for instance, this partial hierarchy will not be satisfactorily able to deal with an input like /p^{h}ur/+ /ʊ/.

(184) Faithfulness of /ʊ/ when there is no [+ATR] trigger

I /p^{h}ur/ + ʊ 'travel'1P	ID [hi]	* [-ATR] [+ATR]	*[+ hi -ATR]	ID[ATR]
b. ☹p^{h}urʊ			*!	
a. p^{h}ʊru		*!	*	**
c. p^{h}ʊrʊ			**!	*
d. 💣p^{h}uru				*

The tableau above in (184) demonstrates the shortcomings of the partial hierarchy in this particular context. The wrongly selected candidate

*/p^huru/ with complete assimilation cannot be checked by the constraint *[-ATR][+ATR]. */p^huru/ does not violate the markedness constraint *[+hi -ATR] either, so it is in fact chosen over the actual output /p^hurʊ/.

2.3 A new IDENT IO constraint : ID [+hi ATR]

In order to prevent the emergence of a non-underlying vowel /ʊ/ which may show up as a result of harmony (as in tableau (184)), as well as preserve /ʊ/ whenever there is no context for harmony, the constraint IDENT [ATR] needs to be modified. A way of dealing with this problem is to modify it in such a way that there are faithfulness conditions on both [ATR] and [hi] quality of vowels.

(185) IDENT [+ hi ATR]
Output elements are faithful correspondents to the [ATR] and [+hi] values in the input.

This constraint constrains [ATR] alternation in [+high] vowels. The combined forces of *[-ATR][+ATR] and IDENT [+hi ATR] facilitate limited assimilation in [+hi -ATR] vowels. But this constraint also protects the [+ATR] value among high vowels.

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

/p^hur/-ʊ/	*[-ATR] [+ATR]	ID [+ hi ATR]	*[+ hi -ATR]	ID[ATR]
b. ☞p^hurʊ			*	*
c. p^hʊru	*!	*	*	*
a. p^huru		*!		*
d. p^hʊrʊ		*!	**	**

In the evaluation above in (186), the two competing candidates */p^hʊrʊ/ */p^huru/ with regressive and progressive assimilation (respectively) incur violations of IDENT [+hi ATR] as both of them are not faithful to some value of [±ATR].

An admittedly striking feature of this proposed constraint is that it is a shift away from traditionally employed IDENT constraints which preserve the faithfulness of only one feature at a time. It is required however, in order to account for the asymmetry where /ʊ/ → /u/, but /u/ does not alter to /ʊ/. The new IDENT constraint makes reference to both the features [hi] and [ATR]. Superficially, this constraint may look like a constraint conjunction, but the important difference lies in the way this constraint evaluates input-output correspondences. Constraint conjunction requires the satisfaction of only one of the conjuncts, but violation of both the conjuncts leads to a violation of the entire conjunction. However, IDENT [+hi ATR] can only be satisfied when both the features [+hi] and [ATR] are faithful.

This new version of IDENT is required in order to account for harmony in languages where [ATR] among high vowels is only marginally contrastive. In this vein, another language where one could profit from an approach adopting multiple feature IDENT constraint is Kinande. Kinande, a Bantu language of Zaire, has a system of [ATR] harmony (Valinande 1984, Mutaka 1991, Schlindwein 1987, Hyman 1989, Archangeli and Pulleyblank 1994, Archangeli and Pulleyblank 2000). In this language, where [+ATR +high] vowels are the active triggering vowels, [ATR] occurs contrastively in high vowels only. On one hand non-high vowels are not contrastive for the feature [ATR] and on the other hand [+ATR +high] vowels do not undergo alteration under the influence of [-ATR] vowels. The basic phonological pattern of harmony in Kinande is the following:

(187) Left to right harmony in Kinande targets only high vowels:

húk	exterminate	húkira	cook for/at
lím	exterminate	lị́m-ira	exterminate for/at
lɪm	‘cultivate’	lɪm-ɪr-a	cultivate for/at
hʊm	‘beat’	hʊm-ɪr-a	beat for/at

(188) When vowels are non-high there is no [ATR] harmony

ɛ-ri-bɛ́rɛ	e-ri-bɛ́rɛ	breast
ɛ-ri-bɔndɔ	e-ri-bɔndɔ	wild palm

(189) [+ATR] roots trigger harmony in the adjacent suffixes

ɛ̀rîlɪ̋:má	[ɛ̀rîlɪ̆imɪ̋:rá]	‘exterminate/exterminate for’
ɛ̀ríhʊ̋:ká	[ɛ̀ríhù:kʊ̋lá]	‘cook/get food out of cooking pot’

(190) Suffix vowels are [-ATR] when a [-ATR] low vowel intervenes

[ɛ̀rȉlɪ̆ibɑ̋:nà] [ɛ̀rȉlɪ̆ibànɪ̋:nà] ‘disappear/disappear for someone’

Archangeli and Pulleyblank (2002) account for this discrepancy in the [ATR] values of the high vowels with the aid of a local conjunction[32] which protects [+ATR] values. The triggering vowel in right to left harmony is always [+ATR +hi]. These constraints are the following:

(191) MAX PATH [HI/ATR]
The local conjunction of MAX PATH [ATR] and HI/ ATR.

(192) MAX PATH [ATR]
Input anchor-path-[+ATR] representations have output anchor path [+ATR] correspondents.

(193) HI/ ATR
If [+high] then [+ATR].

MAX PATH[33] [HI/ATR] guarantees that high [+ATR] vowels that are present in the input do not change their [hi] values. The result of the

[32] In OT, constraints can be divided into basic constraints or constraints derived from the conjunction of these basic constraints. Constraint conjunction and its advantages and disadvantages have been at the heart of OT. For more on local conjunction of markedness and faithfulness, see Lubowicz 2002, Baković 2000, Itô & Mester 2003.

[33] MAX PATH (feature) and DEP PATH (feature) constraints are separate from MAX

constraint is that when an input contains both [+ATR] and [+high], it eliminates candidates that violate both conjuncts. That is, (191) serves to ensure that input [+hi +ATR] vowels are realised in the output. I will show that such a line of attack does not give us the right results in Assamese. To show this, I assume that the other possible solution in this environment is to introduce a similar (though not exactly the same because of the difference in the faithfulness conjunct in Archangeli & Pulleyblank) local conjunction of the constraints *[+hi -ATR] and the faithfulness constraint IDENT [ATR].

(194) *[+hi -ATR] & $_l$ID [ATR]
If a segment violates * [+hi -ATR] it must not violate ID [ATR] and vice versa.

The constraint *[+hi -ATR] & $_l$IDENT [ATR] would require an output [+hi -ATR] vowel to have a faithful input correspondent. The domain of this conjunction is the segment and the shared argument of the constraint conjunction is the feature [ATR]. The constraint * [+hi -ATR] & $_l$IDENT [ATR] requires an underlying [+hi -ATR] vowel to have an output correspondent which is identical to its input correspondent. This conjunction of markedness and faithfulness constraints prevents the occurrence of the marked segment /ʊ/ in derived environments. As a result of regressive harmony, vowels which are underlyingly specified as [+hi -ATR], but emerge as [+hi +ATR], violates this constraint.

(195) Local constraint conjunction fails to prevent /u/ → /ʊ/ alternation

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and DEP constraints. These constraints proposed in Pulleyblank (1996) ensure featural correspondence between the prosodic anchors of segment and mora and the input and the output.

I :/p^hur/+ /ʊ/ ‘travel’1P	*[+hi -ATR] $\&_l$ID[ATR]	*[-ATR] [+ATR]	*[+hi –ATR]	ID[ATR]
a. ☹ p^hurʊ			* !	
b. p^hʊrʊ	*!		**	*
c. p^hʊru	*!	*	*	*
d. 💣 p^huru				*

As the tableau above in (195) shows, constraint conjunction does not lead to the selection of the right output /p^hurʊ/, and instead leads to the candidate */p^huru/ which agrees with the [+ATR] value of the vowel on the left side. The candidate which has been marked with the symbolic bomb satisfies the markedness conjunct *[+hi -ATR] as well as the lower ranked constraint *[+hi -ATR]. This is where the designated output candidate fails because it violates *[+hi -ATR].

Such a situation can also be conceived for Kinande. Harmony can affect non-high vowels only when they occur to the left of a high advanced vowel, that is, only when the simultaneous satisfaction of ALIGN-L and *[+hi -ATR] forces the harmony domain to include instances of non-high vowels. I briefly show below, how this could work for Kinande without bringing in the powerful tool of local conjunction. For convenience, I assume from Archangeli and Pulleyblank that ALIGN-L[34] is operative as a high ranking constraint in Kinande.

(196) Kinande ALIGN-L
ALIGN L([+ATR], L; Word, L)
The left edge of every [+ATR] specification is aligned with the left edge of some word. (Archangeli and Pulleyblank: 144)

(197) IDENT [+hi ATR] gives the right results when the output is [+ATR]

[34] A sequential markedness constraint would also work equally in this context, but in order to keep the analysis as close as possible to the original one, I simply assume ALIGN-L.

kikali ‘woman’	ALIGN L	ID [+HI ATR]	*[+ATR +LOW]	*[+ hi - ATR]	ID[ATR]
a. kıka:li	*!			*	***
b. kıka:lı		*!*		**	****
c. ☞kikə:li			*		

In the tableau above IDENT [+hi ATR] protects all the ATR values of [+hi] vowels, which leads to the disqualification of the other candidates. The candidate in (197) a) violates the higher ranked ALIGN-L constraint as well.

(198) ID [+hi ATR] works even if the output consists of [+hi -ATR] vowels

rılibənır-a	ALIGN L	ID [+HI ATR]	*[+ATR +LOW]	*[+ hi -ATR]	ID[ATR]
a. rilibəni:ra		**!	*		***
b. rılıbani:ra	*!			**	***
c. ☞ rilibanıra		*		*	****

In (198) above, the IDENT constraint favours the preservation of input [ATR] values of [+hi] vowels so as to restrict their changes to the absolute minimum. (198) a) violates this constraint more than once and (198) b) violates the higher ranked ALIGN-L constraint. This tableau leads to the selection of (198) c) as optimal even though it is not the most faithful candidate. In the examples IDENT [+HI ATR] captures the fact that ATR changes only minimally in so far as high vowels are concerned in the language[35], and the use of a local conjunction can be avoided by invoking an IDENT constraint which applies to the ATR values of [+hi] vowels only.

[35] As earlier, I do not assume underspecified or floating input specifications for both the inputs because the resulting output would be the same.

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 all these constraints postulated till now.

(199) *[-ATR][+ATR] ≫*[-hi +ATR] ≫ ID[ATR]

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

In the tableau above in (199) the constraint *[-ATR][+ATR] crucially constrains non-optimal outputs in a trisyllabic harmony domain as well. In the example above, the optimal output in (199) d) shows that mid and high vowel combination 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.

(200) *[-hi +ATR] restricts non-allophonic mid vowels

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

The evaluation in (200) brings to light the importance of avoiding [-hi +ATR] specifications. While *[-hi +ATR] is a violable constraint, it plays a vital role when the constraint *[-ATR][+ATR] is vacuously satisfied by the candidates (200) c) and (200)d). The ranking decides in favour of the optimal candidate in (200) a) because this constraint passes the verdict in favour of /kihɛrɛ/ instead of */kiherɛ/ as the latter violates *[-hi +ATR].

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

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

The tableau above in (201) presents a crucial input candidate 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, *[-hi +ATR]. */koribo/ incurs more violations of *[-hi +ATR] and therefore the most optimal candidate is /koribɔ/. This candidate is crucial 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 crucially 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, these vowels require to be handled with additional constraints.

(202) mid-high trisyllables require the joint forces IDENT [+ hi ATR] and *[-ATR + hi]

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

In tableau (202), the evaluation of high-mid-high combination of input vowels shows the importance of the two highly ranked constraints *[-ATR][+ATR] and IDENT [+hi ATR]. The most faithful candidate (202)a) violates *[-ATR][+ATR] and the next candidate (202)b) violates IDENT [+hi ATR]. The winning candidate violates IDENT [+hi ATR] only once.

(203) high-high vowels in trisyllables

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

In the tableau above, we see a similar candidate as the mid-high combination in (202). 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 [+hi ATR] rejects (203)d) */surusu/, the decision between the two candidates /surusʊ/ and */sʊrʊsʊ/ is made by the constraint *[+hi -ATR].

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:

(204) Relative ranking of all the constraints proposed for Assamese in this Chapter:

*+[ATR –hi –back], IDENT [hi], *[+ATR, +Low] IDENT [low]

*[-ATR][+ATR]

IDENT[+hi ATR]

*[+hi –ATR]

*[+ATR –hi]

IDENT[ATR]

However, this is only a partial ranking and there will be further modifications to this hierarchy in the subsequent chapters.

3 Sequential Markedness Constraints in Regressive Harmony Across Languages

We have seen so far in this Chapter 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 working in Assamese, can be extended to other languages as well, namely Pulaar. Pulaar has already been discussed in Chapter 2 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, as already introduced in Chapter 1, there are seven vowels where 4 are ATR [i, u, e, o] and 3 are non-ATR vowels [ɛ, ɔ, a] represented in the following chart.

(205) 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 big chunk of the Pulaar vocabulary /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/.

(206) 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

(207) 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 set (206) and (207) show that harmony is regressive affecting the whole word, the examples below in (208) show that harmony is not progressive under any circumstance. This is also evident from the examples below:

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

dillɛrɛ	riot	*dillere
fuy-ɛrɛ	pimple	*fuyere
bin^{n}dɔɔwɔ	writer	*bin^{n}doowo

It is abundantly clear from the limited data on Pulaar that there is no way of determining whether Pulaar is restrictively a suffix driven process. All examples presented in Paradis (1992) are a result of affixation to monosyllabic stems. Hence, whenever a trigger is on the right hand side (which is always the suffix in the examples provided 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, paucity of data of this kind does not allow us to make any convincing argument in favour of suffix driven harmony in Pulaar.

3.3 Analysis of Pulaar

Over the years, there have been a multitude of approaches which were proposed to analyse Pulaar. 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 any explanatory adequacy 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). Coming to the affix controlled analysis, I will briefly recapitulate the basic analysis of Pulaar provided in Krämer (2003). In his work, Krämer explains right 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 neighbouring vowels.

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

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

In the tableau above in (209), the markedness constraints *[+hi -ATR], *[+lo, +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 discussed before, paucity of data prohibits us in 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 to this, the articulatorily grounded constraint *[+hi -ATR] also plays a significant role in Pulaar as shown by the tableaux below:

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

/sɔf-ru/	*[+hi -ATR]	[*+lo, +ATR]	*[-ATR][+ATR]	*[-hi +ATR]
a. sɔf-rʊ	*!			
b. sɔf-ru			*!	
c. ☞sof-ru				

The tableau above in (210) shows that *[-ATR][+ATR] drives regressive harmony in Pulaar. The candidate */sɔf-ru/ without harmony is rejected by this constraint

(211) *[-hi +ATR] plays a role in Pulaar

/lɛf-ɔn/	*[+hi -ATR]	[*+lo, +ATR]	*[-ATR][+ATR]	*[-hi +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 prevent [e] and [o] in non-harmony contexts. While the seqential markedness constraint *[-ATR][+ATR] prevents instances of disharmony like the one in (211) a., the constraint *[-hi +ATR] restricts the candidates */lefɔn/ and */lefon/ in the evaluation above.

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

However, 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. In addition to what we have seen so far, this 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.

(212) Class suffixes with e and o in Pulaar

gel	class suffix
gol	class suffix
fof	'all'
gorgol	'aunt'

ATR: gel, gol	nonATR: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^{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 requiring 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 side of a word and further that there are no [-ATR] floating features. I will not have anything original to add to the debate about whether /e/ and /o/ in these suffixes are floating or not.

However, it is eminently possible that /e/ and /o/ suffixes in Pulaar are exceptional and 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[36].

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[37] (Fukuzawa 1999, Itô and Mester 1999, 2001, Kraska-Szelenk 1997, 1999) IDENT[ATR]$_L$. The indexed constraint is cloned from one of the constraints. In Pulaar, the indexed constraint is ID[ATR] which is already present in the Pulaar hierarchy

(213) ID[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.

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

(215) Ranking: ID[ATR]$_L$ ≫ *[-A][+A] ≫ *[-hi +ATR] ≫ ID[ATR]

[36] 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 captures the generalisation that unfaithfulness to the value of the root is the exception and not the norm for harmony in Pulaar.

[37] 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 extensively dealt with in Chapter 7.

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

In the tableau above in (215), 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 proposed by Krämer, alongwith the constraints that have been proposed for the sequential markedness analysis will also give us the right results in Pulaar.

(216) Pulaar, using a positional constraint

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

The tableau above shows that IO-ID Right along with a sequential markedness constraint can also handle right controlled vowel harmony in Pulaar.

However, the analysis of these suffixes as exceptional is superior, as it explains an important fact of Pulaar harmony, 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. In the lines of the same argument, IO-ID Right needs to be invoked only for the analysis of harmony triggered by a few suffixes and therefore it is superfluous.

3.6 Affix control in Pulaar

For the exemplification of affix control, Krämer (2002) employs /bin^{n}d-ɔɔ-wɔ/ 'writer'. The use of this example 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. In 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 cited in McCarthy and Prince (1995). I replicate the tableau in (217) below from Krämer (2003: 144) for the sake of clarity.

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

/bin^{n}doowɔ/	*[+hi, -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 (217)d) is selected because the rival candidate (217) c) */bin^{n}d-oo-wɔ/ violates higher ranked INTEGRITY ROOT. The other candidates violate more higher ranking constraints.

Note that Krämer formulates constraints against prominence augmentation and they 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 the tableau below, 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 not be sufficient to capture the type of alternation in Pulaar.

(218) The failure of FAITH SUFFIX ≫ FAITH ROOT in Pulaar

/bin^{n}d-oo-wɔ/	*[+hi, -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 above in (218), the candidate (218) d) fails to win because it incurs multiple violations of FAITH SUFFIX. This shows that faithfulness to affixal values cannot predict the right results, though an additional or separate constraint allowing the spread of affixal values will lead to the correct output[38]. What this means is that spreading the values of the suffix need not be restricted to the morphological domain of the root. As I show in the tableau below, this re-ranking can be easily averted with the aid of constraints which have been already postulated for Pulaar, and does not need to burden the grammar with an additional machinery associated with INTEGRITY constraints.

[38] 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.

(219) leftward harmony in Pulaar with sequential constraints

/bin^{n}d-oo-wɔ/	*[+hi, -ATR]	[*+lo, +ATR]	*[-ATR] [+ATR]	*[-hi +ATR]	ID [ATR]
a. bin^{n}d-ɔɔ-wo				*	**
b. bin^{n}d-oo-wo				**!*	*
c.bin^{n}d-oo-wɔ				**!	
d. ☞ bin^{n}d-ɔɔ-wɔ					**

The tableau above in (219) shows that the relevant constraints which prevents the non-occurring candidates from being successful in the evaluation are *[-ATR][+ATR] and *[-hi +ATR]. The winning candidate /bin^{n}d-ɔɔ-wɔ/ does not incur faithfulness or markedness violations of the higher ranking constraints and therefore emerges victorious. The closest rival candidate is (219)c) which incurs two violations of *[-hi +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. However, the need for a lexically indexed faithfulness constraint emerges because of the few exceptional suffixes, which appear at the right edge of a word, and which also trigger harmony in Pulaar. Finally, I show that the general principle of harmony behind Pulaar does not involve reversal of ROOT FAITH ≫ SUFFIX FAITH, and 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).

(220) Vowel harmony in Karajá

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 what is dubbed 'value control' – a ranking where IDENT[+ATR] ≫ IDENT[−ATR]. This ranking results in directional harmony, where harmony propagating from the segment with the [+ATR] value to that with the value [−ATR]. Hansson presents the following tableau to secure value control in Karajá[39].

[39] Hansson discusses another type of directionality, viz – one where both the values can trigger harmony. Analysing consonant harmony in Chumash, he shows that directional

(221) Value control in Karajá I

/rɪɗɔre/	*[−A][+A]	IDENT [+A] IO	IDENT [-A]-IO
a. rɪɗɔre	*!		
☞b. riɗore			**
c. rɪɗɔrɛ		*!	

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

(222) Value control in Karajá II

/rɪkɔrɛ/	*[-A][+A]	IDENT[+A] IO	IDENT [-A]IO
a. rɪkɔre	*!		
b. rikore			*!**
☞c. rɪkɔrɛ			

The tableau above in (222) 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].

Therefore Karajá shows up as a language where directional harmony does not perpetuate to obliterate [±ATR] contrasts, as the outputs of harmony are contrastive. Contextual neutralisation in Karajá is then to perpetuate 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

systems where both the values can trigger harmony requires targeted constraints (Wilson 2002, 2006). However, no known vowel harmony system behaves in this way.

prevent the rich base from presenting them as inputs. Thus the co-occurrence restriction *[-hi +ATR], which plays a substantial part in Assamese allophonic harmony, does not play a decisive role in Karajá.

4 Non-Iterative Harmony in Bengali and Tripura Bengali

In Chapters 1 and 3, it was stated that one of the goals of this dissertation is to show that non-iterative harmony processes also qualify to be considered to be at 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[40] and Tripura Bengali. These two languages have already been 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/ /u/ /e/ /o/ and /a/ occur in all positions, /ɛ/ and /ɔ/ can occur in stressed positions only.

(223) Distribution of /ɔ/ and /o/

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

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

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 (occurs only in stressed syllables) and morphological restrictions (do not occur in suffixes).

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 alter to /e/ and /o/.

(224) 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	glad	ʤoyi
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[41]. In Standard Colloquial Bengali there is no iterativity in vowel harmony. Consider the following forms:

(225) Non-iterative harmony in Bengali

[41] 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.

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				

4.3 Analysis of the basic harmony pattern

As shown in the examples in (224) and (225) above, in Bengali, /i/ and /u/ 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 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 in this chapter till now, the three directional harmony systems 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 with [-ATR] values will try to satisfy the constraint inducing harmony. Like Karajá, the following ranking of IDENT constraints will result in [ATR] dominance.

(226) ID[+ATR] ≫ ID[-ATR]

These constraints function in the following way in the constraint hierarchy:

(227) *[-ATR][+ATR] ≫ ID[+ATR] ≫ ID[-ATR]

This hierarchy shows us the results in the following way:

(228) Partial and Incorrect Bengali harmony

kɛʃ + i	*[+hi -ATR]	*[-ATR] [+ATR]	ID [+ATR]	ID [-ATR]
a. kɛʃi		*!		
b. ☞ keʃi				*
d. kɛʃɛ			*!	
f. kɛʃɪ	*!		*	

The candidate exhibiting vowel harmony in (228) b) is chosen over the fully faithful candidate in (228) 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 (225) that we need to reconsider the constraint *[-ATR][+ATR] that has been used in the tableau above. As the examples in (225) 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][+hi +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 [+hi +ATR] is. This constraint can be defined as below:

(229) *[-ATR][+hi +ATR]

A [-ATR] vowel may not be followed by a [+hi +ATR] vowel

(230) Non-iterative harmony in Bengali

pɔd + ɔbi	*[-ATR] [+hi +ATR]	ID[+ATR]	ID[-ATR]
a. ☞pɔdobi			*
b. podobi			**!
c. pɔdɔbi	*!		
d. podobe		*!	
e. podɔbi	*!		

The constraint *[-ATR][+hi +ATR] rejects candidates (230)c) and (230)e), but the lower ranked faithfulness constraint IDENT[-ATR] also gives 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

So 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 alternation in verbs demonstrate a chain shift. This will be seen to require a constraint conjunction. Further, 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 process of harmony 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). The following examples show the problem where the root vowel can be assumed to be indeterminate (for the time being):

(231) Examples from the verbal paradigm

Nominal	/-i/ 1st person Present	/-un/ 2nd person Honorific	Gloss
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 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 frequently show up only with their alternations[42].

Following Ghosh (1996), I assume that the underlying verb roots are /e/ /ɛ/ /o/ and /ɔ/, and that these forms undergo raising which result in

[42] One can postulate multiple hypotheses to account for the underlying representation of Bengali verbal roots. Ghosh presents another possible alternative: Assume that the verb roots have the underlying forms /i/ (/kin/ instead of /ken/), /e/ (/dekʰ/ instead of /dɛkʰ/), /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 Sanyal p.c.), which is to assume that Bengali Verb 'roots' do not occur independently without their inflectional markers and each surface form always appear with their tense, aspect or nominalising extensions. Perhaps an elaboration of this idea will then be akin to an allomorphy analysis proposed in OT by Kager(1999) etc.

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 in the language. Ghosh argues also 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/ do not appear anywhere independently. The unmarked imperatives are shown to be basic and uninflected and the raised vowels to be their counterparts under alternation. I will follow Ghosh in assuming that the underlying verbal inventory of Bengali comprises only of the vowels /ɛ/, /e/, /ɔ/, /o/ and /a/, and these vowels undergo raising under the influence of following high vowels. The systematic raising of Bengali verbs do not qualify their treatment as agreement involving only the feature [ATR]. 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.

(232) 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-	dek^h-c^h-i-l-i

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 proposed till now. To recapitulate the hierarchy proposed for nouns in Bengali, we have the following hierarchy of constraints:

(233) *[-ATR][+hi +ATR] ≫ ID [+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.

(234) Sequential markedness constraint in Bengali

Input: /kɔr/+/i/	*[-ATR] [+hi +ATR]	ID[+ATR]	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][+hi] values in a following vowel. The other candidates incur violations of IDENT [+ATR] 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 that there is another constraint responsible for height alternations in Bengali:

(235) *[-hi][+hi]
[-hi] vowels may not be followed by [+hi] vowels.

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. The local conjunction C_1 & C_2 is violated if and only if both C_1 and C_2 are violated in some domain.

(236) ID[hi] &ID [ATR]
Output values of both [ATR] and [hi] must be faithful to the input

This constraint conjunction prevents the alteration of /ɔ/ → /u/ and /ɛ/ → /i/, because it will involve violation of both ID[ATR] and ID[hi] as a result of it. This will ensure that when there is an input like /kɔr/ as in (234) above, any change from /kɔr/ to */kur/ will involve violation of this conjunction.

(237) Sequential markedness constraint in Bengali

Input: /dʰo/+ /ccʰi	ID [hi] & ID [A]	*[-A] [+hi +A]	ID[hi] &ID [A]	ID [+A]	ID [-A]	*[-hi] [+hi]	ID [+hi]	ID [-hi]
a. dʰoccʰi						*!		
b. ☞ dʰuccʰi								*
c. dʰoccʰe							*!	
d. dʰuccʰe							*!	*

In the height-based alternations displayed by the verbal morphology in Bengali, the lower ranked set of height related constraints take care of the all the attested forms. All the competing candidates vacuously satisfy the highest ranking *[-ATR][+hi +ATR], but the active constraints here are *[-hi][+hi], IDENT[+hi] and IDENT[-hi]. The winning candidate /$d^{h}ucc^{h}i$/ violates IDENT[-hi] but that is not a fatal violation. The candidate (237) a) violates *[-hi][+hi]. The other candidates violate higher ranked IDENT [+hi] and loses to the candidate in (237) b) and the winning candidate violates low ranked IDENT [-hi].

4.4 Tripura Bengali

The 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:

(238) TB vowel inventory

i		u
e		o
ɛ		ɔ
	a	

Here again (like Pulaar and the 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, 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 restructuring of vowels which has taken place in TB:

(239) 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^{h}eʈ	ɸ^{h}ir	‘return’	g^{h}er	g’ir	‘surround’

(240) Restructuring in TB

SCB	TB	Gloss
bodʒ^h	buz	‘understand’
g^{h}or	g’ur	‘turn around’
oʈ^h	uʈ	‘get up’
k^{h}õʈ	k^{h}uʈ	‘erase with nail’

The process of supplanting /e/ with /i/ and /o/ with /u/ is seen by Das as a progression towards having a vowel inventory which falls in line with universally unmarked tendencies[43]. Therefore Das considers 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 obvious 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 /ɛ/ → /e/ and /ɔ/ → /o/ alternation:

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[43] Das points out that there are a few word-initial syllables where /e/ and /o/ occur independently. Das argues that the word-initial syllable is itself the ‘legitimate licensor’ in order to allow the occurrence of this marked vowel (as medial non-peripheral vowels are known to be universally marked). ‘Faithfulness to prosodic heads’ drives this kind 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.

(241) Harmony in TB verbal roots

Verb Roots	Suffix		
lɛk	i	lehi[44]	'write, 1P, Pres.'
dɛk	i	dehi	'see, 1P, Pres.'
bɛs	i	besi	'sell, 1P, Pres.'

(242) Nominal paradigms

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

(243) 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'
lɔr	i	lori 'waver, 1P, Pres'

Till now, we have been looking only at disyllables. 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:

[44] 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.

(244) 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 be attempting to do in this section. Most of the data provided here are collected 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 becomes clear that at least for this group of languages it is a matter of cross-linguistic variation which results in differences in the iterativity of assimilation. The ability of sequential markedness to handle cases of non-iterativity will be shortly exemplified for TB as well. However, unlike Bengali, but just like Assamese the outputs of harmony are allophonic in TB.

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

(245) *[-ATR][+hi +ATR]
A [-ATR] may not be followed by a [+hi +ATR] vowel.

Like Assamese, allophonic agreement in TB involves the co-occurrence constraint *[-hi +ATR].

(246) *[-ATR][+hi +ATR] ≫ *[-hi +ATR] ≫ ID[ATR]

dɛʃ + i	*[-ATR][+hi +ATR]	*[-hi +ATR]	ID[ATR]
a. dɛʃi	*!		
b. ☞ deʃi		*	*

Non-iterativity is analysed to be the non-availability of the context for neutralisation, and therefore there is no violation of the constraint which drives neutralisation, whenever harmony does not occur in the whole word.

(247) *[-ATR][+hi +ATR] ≫ *[-hi +ATR] ≫ ID[ATR]

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

As we have already discussed, an all-inclusive constraint like AGREE would have driven all the vowels to harmonise, leading to the selection of /podobi/ as the output. On the other hand, a sequential constraint is not violated even if there is only partial assimilation. In (247) 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 co-existence with all its neighbours, so that /ɔ/ and /o/, the first and second vowels can remain as a disharmonic sequence. /ɔ/ and /o/ do not agree because /o/ does not provide /ɔ/ the context for agreement, thereby producing partial assimilation. The constraint *[-ATR][+hi +ATR] allows agreement in the example in (246) 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[45] – 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 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 sequences 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), Karajá (section 3.7) and Pulaar (section 3). 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 factorial typology shows the ranking of constraints in regressive harmony languages:

(248) Types of regressive harmony systems
a. Iterative and allophonic harmony in Assamese and Pulaar

*[-ATR][+ATR] ≫ *[-hi +ATR] ≫ ID[ATR]

b. Iterative and contrastive harmony in Karajá

*[-ATR][+ATR] ≫ ID[+ATR] ≫ ID[-ATR]

[45] TB exemplifies ternary rhythm and Das (2002) analyses it as binary parsed. Even with a different parsing, foot would not be a relevant harmony domain here.

c. Non-iterative and contrastive in Bengali

*[-ATR][+hi +ATR] ≫ ID[+ATR] ≫ ID[-ATR]

d. Non-iterative and allophonic in Tripura Bengali

*[-ATR][+hi +ATR] ≫ *[-hi +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. Further, sequential markedness constraints imply that agreement proceeds locally and iterativity affects one possible target after another. But this iterative agreement can be terminated by multiple featural requirements (in our case in Bengali and Tripura Bengali, in section 4) which results in local agreement only.

Finally, a word about the typological relevance of *[-ATR][+ATR]. Instantiated in so many languages accounted for in this chapter, it can be easily argued for the universal significance of this constraint. However, to assume that similar markedness sequences of all other features, for instance *[-back][+back] or *[-round][+round], exists in Universal Grammar is far-fetched. I suggest that future research can effectively restrain such constraints because only [±ATR] is involved in regressive processes.

Chapter 6

Harmony Blocking by Vowels and Consonants

1 Introduction

In Chapter 5, I characterised phonological harmony in a language such as Assamese to be the result of a sequential markedness constraint *[-ATR][+ATR] which together with other faithfulness and markedness constraints converge 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 that, typically, more sonorous elements are involved in blocking harmony.

Canonical vowel harmony is expected to spread from vowel to vowel without affecting[46] or being affected by intervening consonants. That is only an ideal state of affairs, which 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. But non-local blocking, i.e. intervention by consonants which are not segmentally adjacent is the result of prosodic requirements. Therefore this chapter 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

[46]Under the strict locality condition (Ní Chiosaín and Padgett 1997, 2004, Walker 1998), it is expected that vowel harmony will influence all the intervening segments, without resulting in distinctive featural changes.

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 transparency should not be considered as a drawback of the analysis, as the driving force behind the chapter is opacity and not transparency[47]. By doing so, I hope to fill a void where there has been hardly any analysis of consonantal intervention within OT in vowel harmony, save a few (Ní Chiosaín and Padgett 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 [-front] is blocked by palatal consonants. It will be shown that such a 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 corroborate more evidence for a 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 comes to an end 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) demonstrated 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 this problem needs to be tackled with a

[47] Further, there are no transparent vowels in Assamese.

locality convention. The section is summed up 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. Under circumstances where a non-alternating vowel occurs between the target vowel and the trigger, the harmony span of the triggering vowel is blocked. Hence these non-alternating vowels are called opaque vowels. There are a staggering number of languages where /ɑ/ blocks harmony[48].

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 Kiparsky 1981 Archangeli & Pulleyblank 1989, etc). However, in many languages, vowels also alternate to other vowels which are not their exact counterparts in the inventory (For ex. Turkish). 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 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]. Therefore, it is argued here that 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 ambivalence that *[+ATR +low] gives rise to,

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48 This has been reported to be the case of [±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.

we need another constraint IDENT[LOW] which is violated when /ɑ/ alters to other [+ATR] vowels in the inventory.

In an OT analysis, /ɑ/ opacity can be shown to be the impact of a high ranking faithfulness constraint on low vowels, i.e. IDENT[low]. Intrinsic sonority of vowels have been widely accepted to vary according to the following hierarchy, and I propose that the need for this highly ranked faithfulness constraint arises in order to protect more sonorous elements[49]:

(249) sonority hierarchy of vowels:

LOW ≫ MID ≫ HIGH

a ≫ e, o, ≫ i, u

I follow approaches which express the sonority scale in terms of faithfulness constraints (see Howe and Pulleyblank 2004):

(250) Harmony-as-faithfulness:

FAITHLOW ≫ FAITHMID ≫ FAITHHIGH

a ≫ e,o ≫ i

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

[49] While discussing the inapplicability of non-contrastive visibility (this is discussed in detail in 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, and written Manchu etc., where despite the presence of contrastive vowels, only the non-contrastive ones are opaque. Though in this target-centric theory, opacity as such, is proposed to be non-existent.

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 by 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 in a sonority scale; ii) similarity can also be apparent from features that both vowels and consonants could possibly share. 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, mainly adopting 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. In (251) (a-d) vowel harmony is blocked by an intervening nasal consonant.

(251)	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:

(252) 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 (253) (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 (253) (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:

(253)	Word	Gloss
a.	porinoti	‘consequence’
b.	ponoru	‘onion’
c.	somokit	‘frightened suddenly’

Also note that only when a sequence of the high-mid back vowel /ɔ/ and a nasal occurs, [ATR] harmony is 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[50]. For example, post-nasal voicing is often attributed to a coarticulation difficulty in devoicing following a nasal

[50]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.

(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:

(254) Let *a* > *b* > *c* be a string of segments in the input, for any agreement relation R 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.

The criteria of locality which is to be executed with the principles stated above must incorporate the following:

(255) Let *a* and *b* be segments in the output, such that:
(a) *a* linearly precedes *b* in the output
(b) And there is no element *c* which intervenes between *a* and *b*.

I assume that this principle plays a role in the GEN component of UG. For an OT account of nasals blocking harmony, I assume a sequential markedness constraint, *[oNi], instead of a featural markedness constraint *[+ATR Nasal]. The constraint expressed as below:

(256) *[oNi]: There are no [+ATR –hi +back] vowels in the presence of an immediately following Nasal consonant and a high vowel.

As I will argue in the following section, the motivation for a featural markedness constraint is not satisfactory.

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.

(257) *[oNi] blocks the spread of the feature [+ATR]

Input: /mɔni/ 'pearl'	*[o]N[i]	*[-ATR] [+ATR]	*[-hi +ATR]	ID [ATR]
a.☞mɔni		*		
b. moni	*!		*	*

From the ranking above, it is evident that satisfying the constraint *[oNi] is more important than obeisance to the *[-ATR][+ATR] constraint. Note that this 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 (253)). This constraint also effectively bars a candidate with a nasal in other positions in a word from being the optimal candidate.

(258) *[oNi] does not prevent harmony in the presence of a nasal distally

Input: /pɔnɔru/ 'onion'	*[oNi]	*[-ATR] [+ATR]	*[-hi+ATR]	ID[ATR]
a. pɔnɔru		*!		
b. ☞ponoru			**	**

*[oNi] does not choose between the candidates (258)a) and (258)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 therefore it chooses (258)b), the harmonised candidate.

2.2 Nasalisation and harmony in other languages

Trigo (1987, 1991) shows that in Madurese, a [+ATR] specification spreads from a voiced obstruent but not from a voiceless obstruent and nasal, something which Trigo expresses as below:

(259) [-ATR] specification of nasals

[+ATR]

[-nas] [-nas, +son]

While this shows that nasals are [-ATR], the relevance of this feature for nasals is not so straightforward in a vowel harmony context. However, nasals might intervene because of their inherent vowel-like quality. 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.

(260) [+ATR] [-ATR]

órígi 's/he saw a tree.'	ɔ́rɪ́lá 's/he saw okra.'
arígi 'we saw a tree.'	arɪ́lá 'we saw okra.'
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:

(261) Blocking by nasal vowels in Karajá

a. rɛhãɖere	'I hit (it).'
b. rakɔhɔdɛkõre	'He/she didn't hit.'
c. rɛmẽre	'I caught (it).'

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 does not directly translate into a featural configuration of a nasal as [-ATR], it can be deduced that there are articulatory constraints in nasals and non-low vowels occurring together. However, postulating a [-ATR] feature for nasals does not help us in Assamese, because nasals only in the onset position of a triggering syllable blocks harmony. With this background on other languages which have nasalised segments which intervene in vowel harmony, I now move on to show the implications of nasals blocking vowel harmony in the broader cross-linguistic perspective.

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 presupposed that vowels and nasals interact more easily than other [continuant] features. 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 (262). It is evident that the ranking in (262) also duplicates the effects of the sonority hierarchy:

(262) *Nasalised segment harmony scale*
a. nasal sonorant stop > nasal vowel > nasal glide > nasal liquid > nasal fricative > nasal obstruent stop

Walker in her implicational hierarchy observes that a vowel is more compatible to acquiring nasal features than any other segment. Similarly, consonantal intervention in vowel harmony involves blocking by segments which are more compatible to acquiring vocalic features. Nasals, laterals and palatalised segments are the only segments which block harmony because they are more sonorous and therefore more compatible 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 (may or may not share some featural specification with the trigger), either primary or secondary, are eligible to be harmony blockers[51].

[51] I assume that consonants do not trigger harmony and impose their consonantal 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).

Therefore the phonological sonority hierarchy can be reliably assumed to operate for consonantal blocking in vowel harmony as well:

(263) glides > nasal > liquid > fricative > obstruent stop

2.3.1 The acoustic and articulatory dimension of blocking by nasals

In this section, I consider a host of 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].

It has also been observed by Trigo and Vaux (1992, 1996) 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 1992). According to Vaux, voiced stop production increases pressure in the subglottal area ensuring continuous vibration of the vocal folds, resulting in an expansion of the pharyngeal cavity and concomitant advancing of the tongue root. Trigo (in the case of Madurese, as shown in (259)) notes some articulatory subtleties in the occurrences of [-ATR] vowels with nasals: (a) enhances 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 historically nasalisation developed 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”.

3 A Broad Outlook on Consonant-Vowel Relationships

Having shown how nasal consonants can create disharmony in Assamese and how nasals behave in harmony processes in the preceding sections, I will now give a bird’s eye view of how previous theories have proposed to deal with consonant-vowel interactions. After that I will explicitly state my own view regarding this phenomenon.

While linear phonology required 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. Locality 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 phonological rule (Jensen 1974). In autosegmental theory (Goldsmith 1976, 1979), Potential feature Bearing Units (PBU) 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:

(264) 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 classified over 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. 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):

(265) 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 (1986, 1989) proposes that features are aligned to prosodic structure, either into moras or into syllables. The length of long vowels, and coda consonants, are eligible to be counted as extra moras. In line with this tradition, Archangeli and Pulleyblank (1994) also propose that features ought to 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. Piggott (1996) proposed that harmony is a relation which holds either between segments or between suprasegmental units.

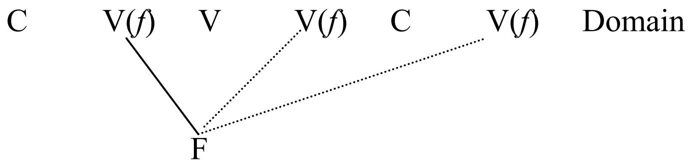
With this background on the paradigmatic relationships which have been proposed to exist between segments in a harmony domain, I move on to discuss some feature theories which have also contributed to the understanding of consonant-vowel relationships.

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 1989, 1991, 1993, Ní Chiosaín and Padgett 1993, Clements and Hume 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 (266) 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).

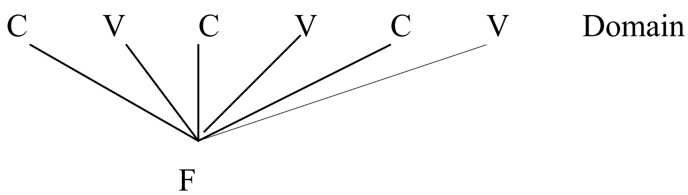
(266) Vowel Harmony as spreading of a harmonising feature F



Intervening segments are regarded as non-participants in the vowel harmony process (see above).

On the other hand, in the unified Feature Theory (Clements 1989), a single set of Place features for both consonants and vowels has been proposed. Others like the advocates of strict locality propose ‘No segment skipping’ (Ní Chiosaín & Padgett 1997, Gafos 1998, Flemming 1995). These approaches (also Walker (1998) and Ní Chiosaín & Padgett (1997, 2001) see spreading of features as strictly and segmentally local, i.e., according to them, harmony affects the intervening segments as well, even though this may not have an audible effect. This is schematically shown below:

(267) 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. Singular noun class prefix /gI-/, where /I/ represents a high vowel whose roundness and ATR qualities are determined by the following vowel.

(268) Nawuri Labial harmony

a. gɪ-sɪbɪta	'sandal'	b. 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, Vaux and Wolfe 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, there is no vowel copying once the glides [y w] intervene between the stem and the suffix.

(269) 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 actually high vowels and therefore possess a full complement of dorsal features that will prevent the spreading of the vowel features.

In the Revised Articulator Theory (Halle, Vaux, Wolfe 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 and simultaneously. Halle *et al* (2000) furnishes various arguments 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' 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 Nawuri blocking by labial vowels 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:

(270) Spreading in Nawuri according to RAT

```
g       I       m       u
        |       |       |
    Place    Place   Place
        |       |       |
        Lips    Lips    Lips
                |   x   |
                |       |
         [-round]      [+round]
```

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:

(271) 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 consider 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, but argues that 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 /k^j/ spread their palatalised quality to following suffix vowels.

(272) /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, and on the other hand nasals are never syllabic in the language as predicted by the syllable head theory. Stepping aside from all the proposals in the previous sections, and as already stated in the introduction, I propose that vowel harmony blocking by consonants is driven by the principle of 'similarity' in the appropriate local domain. I consider two factors which can determine similarity[52] : similarity can be measured by a consonant's proximity to vowels in a sonority scale. Similarity 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 de Weijer and van der Hulst 1995, Krämer 2003 Piggott 1999). The high sonority of nasals and their degree of closure may also make them suitable to have access to 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 are compatible to vowels in vowel harmony to the extent that they can bear the spreading feature in some way. The main idea is that nasals are more compatible with vocalic segments than any other consonantal segment. If a segment blocks vowel harmony, all less compatible segments will be far less affected by harmony, and if a segment is targeted by vocalic

[52] Walker and Rose (2004) examines Long Distance Consonant Agreement (LDCA), raise and formally analyses 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) – which 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.

spreading, all more compatible segments will also be targeted. The notion of compatibility as used here should be understood as those elements, which have a higher sonority, or are eligible to share some feature specification and therefore cross-linguistically show properties which are universally attributed to vowels. Nasals in Assamese can block harmony and palatal features in Turkish can block harmony because they are compatible with vocalic segments. In this way, I offer a maximally simple characterisation of harmony obstruction by consonantal segments. The following is a partial list of consonants which have been known to have non-prosodically 'blocked' the spread of vowel features:

(273) 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 in languages:

(274) Turkish

<u>*glides+round</u> ≫ *nasal+ round ≫ **<u>*liquid+round</u>** ≫ fricative, round ≫ *obstruent stop

(275) Assamese, Karajá

*glides+ATR ≫ ***<u>nasal+ATR</u>*** ≫ *liquid+ATR ≫ *fricative+ATR ≫ *obstruentstop +ATR

(276) Turkish

*glides+round ≫ *nasal+ round ≫ **<u>*liquid+round</u>** ≫ fricative, round ≫ *obstruent stop.

The constraint hierarchies above are nothing more than a suggestion about the role of the sonorant hierarchy in blocking vowel harmony across languages. 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. Obviously in this context, it is easy to see that feature sharing also plays a role in Turkish. Typologically, there are no attested systems of voiceless obstruents blocking harmony. This only goes to show that more sonorous segments would block harmony more easily than less sonorous segments. 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 create 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 appear between the vowel which is responsible for spreading harmony and the preceding vowels,[53] and this is shown below in (277):

(277) Disharmony in the presence of two intervening consonants

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[53] There are also some exceptions: /bostu/ ‘object’, /osru/ ‘tears’ /bonduk/ ‘gun’ /xotru/ ‘enemy’ /zontu/ ‘animal’ /bond^{h}u/ ‘friend’, /xendur/ ‘vermilion’ /endur/ ‘rat’.

Word	Gloss
(a) bɔnti	‘lamp’
(b) xɔkti	‘strength’
(c) kɔlki	‘last incarnation of Vishnu’
(d) xɔrɔswoti	‘Hindu goddess of learning’
(e) xɔndʰi	‘junction’
(f) gʊstʰi	‘clan’
(g) kɛtli	‘kettle’
(h) kɛrketuwa	‘squirrel’
(i) sɔnduk	‘box’
(j) kʰɔnzori	‘small tambourine’

Similarly, in derivations too, whenever there are two intervening consonants, vowel harmony is blocked. This is shown below in (278):

(278) 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.	kʰɔndɔ	‘fragment’	it	kʰɔndit	‘severed’
e.	xɔbdɔ	‘sound’	it	xɔbdit	‘resounded’
f.	gɔrbʰɔ	‘uterus’	woti	gɔrbʰowoti	‘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 two the concerned vowels. (Krämer 2001 discusses similar facts of Yucatec Maya).

Consonants in a coda or a final position sometimes lend weight to the syllable so that more elements imply that stress is drawn to that syllable by virtue of its weight. These weight bearing elements are called mora (represented as μ, see also (280)). 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. In section below in 4.1 I will discuss this fact of Assamese and also use this prosodic factor to explain blocking in Assamese in section 4.2.

4.1 Stress and Weight to Position in Assamese

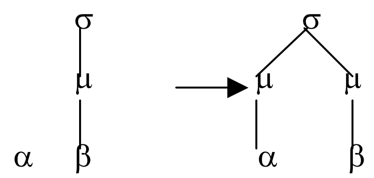
Within the Assamese word stress system, main stress is always assigned to the initial syllable (Mahanta (2001), see also Chapter 6). Morphologically, stress shifts to the initial syllable under prefixation. Stress is not sensitive to affixation and the initial syllable is always the main stress bearing syllable regardless of its morphological status. In a sequence of open syllables, stress assignment is in the following manner:

(279) 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, by the following schema:

(280) 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 (281) 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 (We have excluded CVV's from our discussion as length distinctions are not phonemic in Assamese). This measure also keeps the prohibited *(**L**H)[54] 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.

(281) Stress in Assamese

(**L**L)	Gloss	L(**H)**	
a. [só.ku]	'eye'	e. [zi.bɔ́n]	'life'
b. [rɑ́ti]	'night'	f. [bɑ.gɑ́n]	'garden'
(**L**L)L		(**L**L)(**H**)	
a. [gɔ́.hɔ.nɑ]	'jewellery'	c. [mɔ́.rɔ.mɔ̀r]	'loved'
b. [z ɔ́.hɔ.ni]	'cholera'	d. [zɑ́.zɑ.bɔ̀r]	'vagabond'
L(**H)**L		L(**H**)H	
e. [ɑ.nɔ́n.dɔ]	'happiness'	g. [ɑ.rɔ́m.bɔr]	'luxury'
f. [gu.rút.tɔ]	'importance'	h. [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

[54] The *(**L**H) foot is the marked foot structure for trochaic systems.

the initial syllable. Further coda consonants are moraic in the language and therefore all VC / CVC / CVCC syllables are labelled heavy (H). This factor (Weight by position) renders codas stress bearing units. Mahanta also (2002) shows that in an (**L**L) 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 fact of the language requires 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.

(282) $*[-\text{ATR}]_{\mu}[+\text{ATR}]$

A [-ATR] vowel may not be 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.

(283) Schematic representation of agreement between vocalic moras

#CV ←—— CV#	#C V 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][55]. As a result of this constraint only adjoining vocalic units will agree with each other, but will be blocked elsewhere when there are intervening consonantal units.

(284) Harmony blocking by consonantal moras:

Input: /ɔk/+/ti/ 'do'+1P	ID [hi]	*[-ATR +hi-back]	*[- ATR]$_{\mu}$ [+ATR]	*[-hi +ATR]	ID [ATR]
a. ☞xɔkti					
b. xokti			*!	*	*
c. xɔktɪ		*!			*
d. xukti	*!				*

In the tableau above, the faithfulness constraint IDENT [hi] and the constraint *[-ATR +hi -back] prevent selection of the candidates */xukti/ and */xɔktɪ/, respectively. These constraints practically winnow down the candidate set to the two candidates /xɔkti/ and */xokti/. The candidate selected in the evaluation i.e. /xɔkti/, is the unassimilated and therefore the fully faithful candidate. Significantly, the candidate */xokti/ fails because it agrees with the feature value of the triggering vowel, despite the presence of an intervening consonantal mora.

4.3 Prosodically Determined Blocking in Lango

This kind of prosodically determined harmony, just arrived at 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]:

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[55] Just to keep things simple, I will refrain from using the moraic version of this constraint in all further instantiations of Assamese vowel harmony.

(285) Lango harmony

cìŋ	‘hand’	cíŋә́	‘my hand’
wòt	‘son’	wòdә̀	‘my son’
ŋèt	‘side’	ŋètә́	‘my side’

However, rightward [+ATR] spreading is blocked when two consonants intervene, as seen in the examples below:

(286) Lango harmony in closed syllables

dòk	‘cattle’	dòkka	‘my cattle’
ñә̀ŋ	‘crocodile’	ñә̀ŋŋá	‘my crocodile’
gwèn	‘chickens’	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:

(287) Lango blocking

píg	‘juice’	píggә́	‘my juice’
òpúḱ	‘cat’	òpúkkә	‘my cat’

Archangeli and Pulleyblank treat this blocking by appealing to prosodic structure, where harmony progresses from mora to mora, and the moraicity of coda consonants blocks spreading.

Thus 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 blocking of harmony in closed syllables is a result of the moraic nature of syllable final consonants in Assamese. The other course one could take in analysing these examples is to assume that there is a structural constraint which prohibits [+ATR] vowels from surfacing in closed syllables. But either way it is evident from the data presented in (277) and (278) that there is a prosodic restriction in the occurrence of [+ATR] vowels in closed syllables. Though 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]. This constraint requires agreement between moraic vowels because it relates the prosodic factor of stress, weight and harmony blocking in closed syllables in a straightforward way.

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. But then, the presence of [+ATR] in examples like /kus.tʰi/ 'horoscope' etc. may give rise to concerns about the grandfather effect of McCarthy (2003), where a new markedness constraint blocks a general phonological process, but does not change marked structures that are already present.[56] In Assamese, by positing a constraint on syllable structure, like *[+ATR]C, one will also have to account for the presence of such marked structures which already exist[57]. 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/.

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[56]However, assuming that only mid [+ATR] vowels are disallowed in closed syllables may be a way out of the problem. But the typological motivation for such a constraint would be less than convincing.

[57] 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.

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 alter in special morphemic environments, therefore its non-alteration in all other environments cannot be attributed to the lack of an appropriate counterpart, as assumed in most approaches to blocking (see section 1.1). Further, 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 (see also chapters 1 and 3, for a description of these goals) 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 of 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. Therefore, /ɑ/ behaves as an opaque vowel. Examples are presented below:

(288) Assamese trisyllables/ quadrisyllables with medial /ɑ/

	Word	Gloss
a.	kʊlɑhɔl	'commotion'
b.	xɔdɑgɔr	'merchant'
c.	xɔnɑtɔn	'eternal'
d.	sɔlɑsɔl	'act of moving'

In the examples in (288) above, 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.

(289) Assamese trisyllables with final /ɑ/

Word	Gloss
a. thɔpɔrɑ	roundish'
b. dɔgɔdʰɑ	'heavy'
c. ɛsɛrɛɳɑ	' beam of sunlight'
d. mɛkʰɛlɑ	'Assamese skirt'

In the examples in (289) above are 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/.

(290) 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 (290) above 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/.

(291) /ɑru/ - A nominalising suffix which normally implies a profession related to the root word.

Root/Stem	Gloss	Suffix	Derivation	Gloss(Derivation)
(a) lɛkʰ	'write'	ɑru	lɛkʰɑru	'writer'
(b) xʊdʰ	'ask'	ɑru	xʊdʰɑru	'enquirer'
(c) xʊn	'gold'	ɑru	xʊnɑru	'tree with golden flowers'
(d) zuz	'fight'	ɑru	zuzɑru	'fighter'

(292) /ɑri/ is also a nominalising suffix

Root/Stem	Gloss	Suffix	Derivation	Gloss(Derivation)
(a) zuwɑ	'gambling'	ɑri	zuwɑri	'gambler'
(b) xʊn	'gold'	ɑri	xʊnɑri	'gold jeweller'
(c) pɛt	'belly'	ɑri	pɛtɑri	'covered cane chest'
(d) puzɑ	'prayer'	ɑri	puzɑri	'priest'

(293) /ɑli/ is an adjectival or nominal suffix which means 'having the quality of'

Root/Stem	Gloss	Suffix	Derivation	Gloss(Derivation)
(a)bʰʊg	'enjoyment'	ɑli	bʰʊgɑli	'enjoyable'
(b) xʊn	'gold'	ɑli	xʊnɑli	'golden'
(c) kʰɔr	'dryness'	ɑli	kʰɔrɑli	'dry season'
(d) bɛz	'doctor'	ɑli	bɛzɑli	'doctorship'

(294) /ɑl/ - Suffixes with this ending means 'possessing/ pertaining to'

Root/Stem	Gloss	Suffix	Derivation	Gloss (Derivation)
(a) tɛz	'blood'	ɑl	tɛzɑl	'energetic'
(b) nɛz	'tail'	ɑl	nɛzɑl	'tailed'
(c) gɔp	'proud (n)'	ɑl	gɔpɑl	'proud' (adj)
(d) bʰɔr	'to fill up'	ɑl	bʰɔrɑl	'store-house'

In the examples in (291), (292) and (293) 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 (294), 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 below:
A faithfulness constraint preserving the low value of /ɑ/ is important due to considerations of sonority:

(295) [IDENT low]: Correspondent segments are identical in feature [Low]
(McCarthy and Prince 1995)
The constraint which restricts the inventory to [-ATR] low vowels is:

(296) *[+ATR +low] : low vowels must not be [+ATR]

(297) /ɑ/ remains unaltered in the presence of a following trigger

Input : /kɔpɑh/+/i/	*[+ATR +lo]	ID[low]	*[-A] [+A]	*[-hi +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 (297) 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 as the one in (296). However, such a 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 +Lo] is violated in order to avoid opacity[58], 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 of sonority and corresponding faithfulness also cannot be held to account for all the complexities of blocking in vowel harmony. The problem of opacity and repairs needs proper examination and I cannot clam to have proffered an adequate analysis. Future research in this interesting area will shed more light on this phenomenon.

5.3 'The Sour Grapes' Problem

In this dissertation, I argue for 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.

(298) 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'	hi	pɑlehi	'reach' (3P present perfect)
(d)	k^hɑlɛ	'eat'	hi	k^hɑlehi	'eat' (3P present perfect)

These are examples of the 'sour-grapes' problem discussed in Chapter

[58] 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.

3. These instantiations of ‘sour-grapes’ above clearly show that harmony progresses till it meets the blocking segment /ɑ/. In other words, the relationship of harmony is formed from one vowel to the next till 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 of them. This is shown below:

(299) Assamese ‘sour grapes’ problem

Input : /sɑpɔr/+/i/ ‘bend’	*[+ATR +lo]	ID[low]	*[-A] [+A]	*[-hi +ATR]	ID [ATR]
a. 💣 sɑpɔri			*		
b. ☹sɑpori			*	*!	*
c. sopori		*!		*	*
d. sæpori	*!			*	*

The optimal candidate is (299) b) but because it is harmonically bounded[59] by (299) a), it cannot surface under any other ranking as well. 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 standard non-derivational OT assumed so far in this dissertation[60] (apart from Span Theory which was discussed in Chapter 3. Span Theory is not

[59] In OT, if two structures, A and B are harmonically bounded, then A (i) incurs less violations than B of one or more constraints (ii) but incurs the same number of violations as B of some other constraint.

[60] A way out of this problem may be to posit a blocking constraint *[+ATR low][+ATR]. However, as McCarthy notes such a blocking constraint does not capture the core generalisation of OT that simple typologically motivated constraints result in complex patterns. The postulation of context-specific blocking constraints would not show how typological variation can be achieved.

accepted here because, as shown there, it overgenerates in so far as consonantal intervention in harmony is concerned).

Here, I will show a possible direction, that of Harmonic Serialism, that this dissertation can take 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 hardly 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 and any account of this phenomenon has to take this factor into consideration. It is obvious that candidate (299)b) is more harmonic than candidate (299)a)as it partially satisfies the harmony constraint. Vowel harmony in Assamese is iterative, there is no long distance blocking to be observed here. Harmony spreads till 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 OT that has been proffered by McCarthy (2006 a 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 a b), 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 a) 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.

(300) 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 regards 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.

(301) 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 more stringent ranking where FTBIN ≫ ALIGN-R (MWord, σ) to show that epenthesis in Lardil proceeds serially, where /ɽil/ → /ɽil.a/ → /ɽil.ta/. Each step in this derivation is a harmonic progression over the most faithful /ɽil/[61]. However, /ɽil.ta/ → /ɽil.t/ violates FT-BIN.

(302)

[61] However, /ɽil.ta/ → /ɽil.t/ violates FT-BIN

/ʈil/	FTBIN	ALIGN-R (MWord, σ)	DEP
→ ʈil.a			*
ʈil	*		

The intermediate output candidate /ʈila/ 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 / ʈil.ta/ over /ʈil.a/.

(303) Selection of the most harmonic candidate / ʈil.ta/

ʈil.a	FTBIN	ALIGN-R(Mword, σ)	DEP
ʈil.a			*
→ʈil.ta		*	

In the final evaluation ALIGN-R (Mword, σ) selects /ʈil.ta/ and no more improvements are possible.

McCarthy points out that spreading in alignment frameworks (Archangeli and Pulleyblank 2002, etc.) is mostly shown to be the result of gradient constraints for exactly the reason that gradualness cannot be captured by global constraints. Any spreading constraint will have to account for the fact that [-F][-F][+F] ≫ [-F][+F][+F] ≫ [+F][+F][+F], where spreading continues till the end or till it meets a blocking segment. A gradient constraint will successfully distinguish between the candidates [-F][-F][+F] and [-F][+F][+F], whereas a global 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 (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 *[-F][+F] will not tolerate *any* instance of *[-F][+F], in its quest for total assimilation.

Thus, in order to account for the 'sour grapes' problem in (299), what is required here is an additional locality convention which can account for the fact that (299)b is more harmonic than (299)a. because the locality convention applies successfully in the former[62]. We will assume the following definition of locus of violation of a constraint:

(304) *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.

The solution to the problem in (299) is based on the observation that the medial segment participates in a distinct loci of violation of *[-ATR][+ATR] in (299) a) and (299) b):

(305) *A locality convention for harmonic serialism*
Let X be an input representation to which Gen applies an operation, and Y be 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 (305), we avoid the 'sour grapes' problem for Agree-type constraints discussed by McCarthy (2004) and Wilson (2000, 2006).

The locality convention in (305) allows (299)b to escape harmonic bounding[63], as shown in (306), where the final derivation is

[62] This was a joint presentation with Joe Pater in the LOT sound circle. See also Pater(2006)
[63] In OT, if two structures, A and B are harmonically bounded, then A (i) incurs less violations than B of one or more constraints (ii) but incurs the same number of violations as B of some other constraint.

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.

(306) 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 is indeed desirable but it 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 (298).

However, this is only an instantiation of the stringency introduced by the locality requirements that the candidate set in Harmonic Serialism may be subject to. Its broader typological implications, given the fact that locality is already a requirement in the application of Harmonic Serialism remains to be seen.

5.5 Conclusion

One of the important thesis statements of this chapter is that I do not assume that consonants are not able 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 is the 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 anymore, because of the intervening mora.

The imperative, then, is that there are some conditions on the systematic intervention of consonants in a vowel harmony domain.

i) If a consonant triggers or blocks harmony non-prosodically that consonant has to be vocalically compatible.

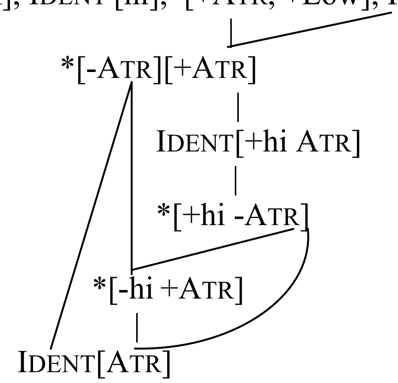
ii) All other consonants can intervene due to structural or prosodic factors. Non-compatible interveners may not be segmentally adjacent, but they will be constrained by prosodic factors.

I also dealt with blocking by the vowel /ɑ/. I showed that blocking by /ɑ/ is also the 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 it will be shown there how IDENT LOW is subject to violations under the influence of two affixes /-iyɑ/ and /-uwɑ/.

Furthermore, this chapter includes more constraints to the hierarchy that was developed in Chapter 5. The hierarchy argued for thus far is as represented as a Hasse diagram below:

(307) Partial Hierarchy of Assamese

*[oNi] *[+ATR –hi –back], IDENT [hi],*[+ATR, +Low], IDENT [low]



Apart from new additions to the hierarchy, I also show 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. But for our present purposes the adoption of Harmonic Serialism adequately justifies the contention that harmony involves local iterative agreement.

Clearly, in the account in this chapter I had to summon the technology offered by a non-standard version of OT. It still shows that what is important here is to capture the local iterative nature of assimilation. Thus its contents are certainly supportive in important respects. Whether we import tools available in other versions of OT or not are mainly a matter of execution. More future research area in the 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. Theoretically, 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 drives 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 [+hi ATR], and the substantively grounded markedness constraints *[+hi -ATR] and *[-hi +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 *[-hi +ATR]. In this chapter, I will show how candidates which exceptionally bear [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. But /ɑ/ exceptionally undergoes harmony under the influence of the morphemes /-iyɑ/ and /-uwɑ/. These instances of exceptionality are 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 in 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 expresses itself on the otherwise non-participating vowel /ɑ/. Expressed in traditional terms, this function of the morpheme can be seen as an overapplication of harmony, which otherwise applies only to [+hi -ATR] - /ʊ/ or [-hi -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 the harmony driving feature is retrievable from the root vowel. The [+ATR] value of the deleted morpheme is preserved by expressing the feature value on the vowel of the root morpheme. 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 faithfulness constraints can also lead to the satisfactory handling of non-surface true underlying instances of morphemes, which exhibit local behaviour in Assamese. Overall then, the analyses in this chapter goes to 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 of Kalenjin and Turkana[64] with a positional faithfulness constraint DOMINANT -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 & Hall 1980, Kiparsky 1982). In this language, the vowels are divided into a dominant class of vowels that consist of the [-ATR] vowels /ɔ ɑ/ and a recessive class where the [+ATR] vowels are /i, æ, u/. Nez Perce examples:

(308) Recessive vowels

næʔmæq	næʔmæχ

[64] 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.

paternal uncle-1 POSS	‘my paternal uncle’
mæqæʔ	mæqæʔ
paternal uncle	‘paternal uncle!’-VOC

(309) Dominant root/suffix

næʔtɔ:t	nɑʔtɔ:t
father-1 POSS	‘my father’
cæqæ:tʔɑjn	cɑqɑ:t’ʔɑjn
raspberry-for	‘for a raspberry’
sɔ: jæ:pu	sɔ:jɑ:pɔ:
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.

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.

(310) 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.)’ 2sg

c. /kɪ ɑkɛre/ 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[65].

[65] See Finley (2006) for discussion on exceptional undergoers and non-undergoers in harmony systems, which are also shown to be local.

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, it is only unique as far as exceptionality in vowel harmony is concerned. Such cases of local exceptionality are to be found in other morpheme specific phonology as well – in Finnish for instance, which is also going to 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 alter 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 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[66]. 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 normally opaque vowel /ɑ/ to undergo harmony 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

[66] This does not imply that I am arguing for a structure preserving (Kiparsky 1973) approach for 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.

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 occurrences of vowel harmony in a regular derived environment domain. In the examples in (311) and (312) below, the high vowels in the suffixes trigger [+ATR] harmony in the preceding root/stem.

(311) 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'

(312) 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 to [e], /ɔ/ alternates to [o] and /ʊ/ alternates to /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[67]. Blocking in Assamese has already been extensively discussed in chapter 6. For the sake of clarity, I will briefly repeat some examples:

(313) 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 (313) above are 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 these examples in (291), we see the regular examples where /ɑ/ blocking occurs. See examples below:

(314) /-ɑru/ and /ɑli/ block harmony

Root	Gloss	Suffix	Derivation	Gloss
(a) lɛk^{h}	'write'	-ɑru	$\text{lɛk}^{h}\text{ɑru}$	'writer'
(b) gɔz	'grow'	-ɑli	gɔzɑli	'sprout'

Opaque vowels of this kind are supposed to reflect gaps in the language's vowel inventory that have been analysed in the past to be a result of multiple-feature markedness constraints. However, as I have argued in Chapter 6, the opacity of /ɑ/ probably does not have anything to do with 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/ makes it resistant to harmony and therefore opaque to spreading.

[67] Though not all stem-final vowels undergo adaptation. See the discussion under the examples in (318).

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 alters to are [e] and [o], but not [ɐ] and [æ], the vowels that *[+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 alters to /e/ and /o/, the [-hi +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/ alters to [e] or [o]. As a result of /ɑ/'s alternation to [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, though '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. Though nothing extraordinary hinges on this choice of nomenclature, it simply makes the point that if /ɑ/ re-pairing would have been the strategy, it would have shown up in the regular phonology as well[68].

In /ɑ/ adaptation, the preceding stem vowel ([-low, +front] or [-low, -front]) determines the [±front] 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 changes its [-ATR] specification, the preceding vowel also receives the harmonious

[68] 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 [-LO, -BK] with the [+LO, +BK] 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.

[+ATR] value of the span. Thus, the reason this process is dubbed /ɑ/ adaptation in this dissertation lies 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: the data and the 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 [$\pm$back] feature that /ɑ/ assumes for adaptation is determined by the preceding vowel. In contrast, /ɑ/ in a root/stem position never alters the [$\pm$back] quality of the prefixal vowel. An /ɑ/ following a prefixal position always alters to /o/.

(315) /ɑ/-adaptation triggered by /–uwɑ/

(316) /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.

(317) /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 simply deletes itself).

(318) no-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, there is nothing more to this phenomenon, which would affect 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 and that it 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

(319) 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 (315), (316) and (317), applies when /ɑ/ belongs to the root and /ɛ-/ or /ɔ-/ are prefixal vowels.

(320) /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 (320) the root /ɑ/ does not change its value for the feature [±front] 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 [±front] value that the vowel /ɑ/ must assume depends on the [+back] value of /ɑ/, so that it invariably changes to /o/ instead of /e/. 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 (319) and (320) where the [+ATR] value spreads to the entire word. However, the data below show that /ɑ/-adaptation is restricted only to the vowel adjacent to the triggering morpheme. All other instances of harmony in the examples in (320), are the result of regular harmony, to wit, /ɑ/ adaptation does not occur when /ɑ/ is not adjacent to the triggering vowel:

(321) /ɑ/ does not alter 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. ɑdʰɑ	'half'	-uwɑ	ɑdʰoruwɑ	'halved'

In the examples above from (321) a – c, in examples with the composition /CɑCɔ../, 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 (315) (316) and (317)). They would all produce the same result. The local triggering behaviour of /-iyɑ/ and /-uwɑ/ is exemplified very clearly in the examples in (321) 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:

(322) Environments for /ɑ/-adaptation

[CɑC$_{root}$]] iyɑ$_{sfx}$]]] → /ɑ/-adaptation locally

[mɑr$_{root}$]] iyɑ$_{sfx}$]]] → /moriya/

X

[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.

There is another facet of locality in exceptionality which needs further elaboration here. If we recall the examples in section 2.2 ((315) (316) and (317)), where it was shown that the [±back] value of /ɑ/ depends on the preceding /ɛ/ and /ɔ/ (if they are not prefixal), then what emerges from this behaviour is that the stem-initial vowel is responsible for initiating a type of progressive front harmony which is not exactly dependent on the triggers /-iyɑ/ and /-uwɑ/, though the morphological environment for this exceptional front/back harmony is provided by those two morphemes. The highlight of this process is also that this morpheme-specific front/back harmony focusses on a local domain, like that of /ɑ/ adaptation; in this case this local domain is 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 exceptionalities.

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 morphemic interferences in phonology can be modelled (Pater 2000, Anttila 2002, Inkelas and Zoll 2003, Pater 2006). It is of special interest in an OT framework given its orientation, where all constraints are universal and individual grammars are a result of permutation of these constraint rankings. 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 a difficult road to hoe if morpheme specific constraints are regarded universal[69]. 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, references for such particulars include Antilla (2002) and Inkelas and Zoll (2003), for an elaboration of the framework and Pater (2003, 2006, 2007) for arguments against the constraint ranking approach and in favour of constraint indexation. Again among the diacritic approaches[70], the ones favouring faithfulness constraint indexation are many and varied (e.g. Fukuzawa 1999, Itô and Mester 1999, 2001, Kraska-Szelenk 1997, 1999; see also Benua 2000, Alderete 2001).

[69] Though see McCarthy and Prince (1995) , which relies on morpheme specific constraints. (for instance, for the analysis of Tagalog /um/ affixation).

[70] 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 called [-vowel harmony].

Pater (2006, 2007) 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 the 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 hand is the situation in Finnish, a language in which the stem final low vowel /-a/ either deletes or alternates 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:

(323) 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:

(324) $*[ai]_L$

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 would be violated only when the specified string *[ai] occurs in the output. The application of this constraint is however concentrated on that part of the morpheme which contains a part of the suffix. Therefore, this constraint would be 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 in Pater.

(325) Grammar: *[ai]-$_{L1}$ ≫ MAX-$_{L2}$, IDENT-$_{L3}$ ≫ MAX, IDENT ≫ *[ai]

(326) 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] is not deemed to apply in an unbounded manner. It only applies to that fraction 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[71]. 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 provide an answer to a process which triggers a phonological change. The prediction of the right results by indexation of a markedness constraint 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.

[71] There is also some variation to be accounted for here: as in /itaroissa/ ~ /itarissa/ (example in (323)), 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 those details of Finnish. See Anttila (2001) and Pater (2006, 2007) on how those variations can be accounted in cophonology and constraint indexation approaches respectively.

Unbounded application of this markedness constraint is also prohibited and therefore any non-local instantiations of the parts of this string will be deemed as violations. In this way, the constraint indexation approach offers a maximally simple way of accounting for morpho-phonological 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 concentration of a phonological process to the 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 alters 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(322)). The local effect schematically represented in (322) can be captured by adapting the locally applicable markedness constraint (in (324)) to Assamese. The constraint which I propose as active here is the indexed version of the contextual markedness constraint *[-ATR][+ATR]$_{L1}$.

(327) *[-ATR][+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 (2007):

(328) *[-ATR][+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 go to show that exceptional triggering in Assamese observes a locality premise which is not violated in the 'minimal domain' as expressed by Pater in (328). The full ranking of Assamese exceptional triggering case is given below in (329) and the corresponding tableau exemplifying the analysis is in (330):

(329) Ranking: $*[-ATR][+ATR]_{L1}$ ≫ ID[Low] ≫ *[-ATR][+ATR] ≫*[+ATR-hi] ≫ ID[ATR]

(330) Indexed morphemes in the Lexicon: $/\text{-iyɑ}/_{L1}$ $/\text{-uwɑ}/_{L1}$

(331) /ɑ/ harmonises in the presence of /-iyɑ/

Input: $/\text{mɑr}/+/\text{iyɑ}/_{L1}$	$*[-ATR][+ATR]_{L1}$	IDENT [low]	*[-ATR] [+ATR]	*[-hi +ATR]	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. (331) a) is ousted because of violating the highly ranked lexically indexed constraint. The choice between the two candidates (331) b & c) is determined by the faithfulness constraint IDENT[low] which is violated twice by the failed candidate in (331) 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.

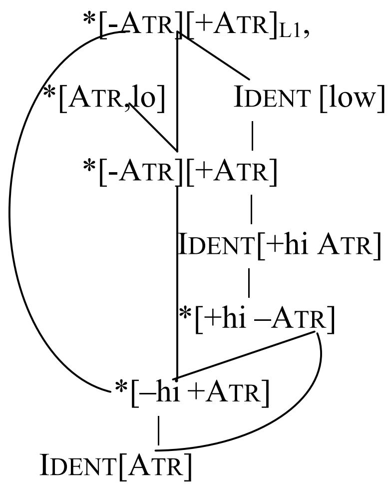
(332) Local alternation of /ɑ/ when followed by /iyɑ/ or /uwɑ/

Input: /ɑlɑx/+/uwɑ/$_{L1}$	*[-ATR][+ATR]$_{L1}$	IDENT [low]	*[-ATR][+ATR]	*[-hi +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/. (332) a) violates the top ranked *[-ATR][+ATR]$_{L1.}$ Multiple violations of the faithfulness constraint IDENT [low] leads to the disqualification of the candidates (332) c).

Before moving on to the discussion more exceptional occurrences in Assamese, here I present the changes to the constraint hierarchy of Assamese which has been introduced by the exceptional occurrences. As a result of /ɑ/ alternation, the constraint IDENT [LOW] which was shown to be highly ranked till the last chapter, must be now demoted. This change is reflected in the hasse diagram below:

(333) Constraint ranking shows IDENT [low] is not undominated in Assamese



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; it is also the [±back] quality of the vowel /ɑ/ which undergoes alternation. Under circumstances where 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:

(334) /ɑ/ is faithful to IDENT[+back]

Input: /mɑr/+/iyɑ/$_{L1}$	*[-A] [+A]$_{L1}$	ID [-ba]	ID [+ba]	ID [lo]	*[-A] [+A]	*[-hi +ATR	ID [A]
a. mɑriyɑ	*!				*		
b. ☞moriyɑ				*		*	*
c. meriyɑ			*!	*		*	*

The example above also shows that the change of the [±back] specification of the low vowel is not influenced by the [±back] quality of the triggering morpheme. /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. This accounts for the failure of candidate (334) c. because of its [back] value alteration.

However, to analyse cases where the [±back] specification of the low vowel undergoes alteration under the influence 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.

(335) [-ba -hi][+ba -hi]$_{L1}$
No instance of [-back -high] followed by [+back -high] includes *any* phonological component of a morpheme lexically specified as L1.

Note that this constraint 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 all the preceding vowels. No tangible portion of /-iya/ and /-uwɑ/ respect or violate this constraint. This constraint is locally applicable only to the [± back] values of the vowels in the root. Note that this constraint requires the additional requirement of [-hi] from the participating vowels. This is so because [+hi] vowels do not participate in this front /back harmony. This kind of exceptionality is also restricted to the mid vowels /ɛ/ and /ɔ/. The domain-oriented nature of exceptional front/back harmony in Assamese can be exemplified as below:

(336) *[-back -hi][+back -hi]

$$\left(*[\text{-b -hi}][\text{+b -hi}]_{\text{root}}\right)_{L1}$$

No instance of [-back] followed by [+back] *in the domain of the bisyllabic root* includes any phonological component of a morpheme lexically specified as L

Thus, a further elaboration of this constraint requires that we posit more domain-related issues to this phenomenon. Recall from section 2.5, that the Finnish *[ai] constraint successfully eludes the root because *[ai] does not include any part of the root. Such a situation is exclusive of vowel harmony, because the process is normally iterative and therefore unmercifully includes all the vowels in its harmony domain. This of course excludes the /ɑ/-adaptation case because /ɑ/ is 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-/ respectively, then it is interesting that another exceptionality shows up in its wake. 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 morpheme /-uwɑ/ in order to surface with simultaneous [front] harmony. Despite these dual exceptionalities, the process remains local and exceptional and therefore 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 morpheme /-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 [$\pm$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 (2006, 2007) gives examples of possible long distance effects that an unconstrained theory of morpheme specific phonology can 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.

(337) /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. Further, 'emergent' front/back harmony does require a phonological element of the suffix

/-iyɑ/ or /uwɑ/ - to be precise, the phonological feature [+ATR] contributed by /-uwɑ/. Under all other circumstances, however, the sequential constraint *[-back][+back] is normally lower ranked in the phonology of Assamese as front/back harmony does not form an integral part of the vowel harmony landscape of Assamese. The constraints *[-A][+A]$_{L1}$ and *[-b][+b]$_{L1}$ are ranked together and any optimal candidate has to respect these constraints equally.

(338) Co-dependent *[-A][+A]$_{L1}$ and *[-b -hi][+b -hi]$_{L1}$ I

Input: /ɛlɑh/+/uwɑ/$_L$	*[-A] [+A]$_{L1}$	*[-b -h] [+b -h]$_{L1}$	ID [-ba]	ID [+ba	ID [lo]	*[-A] [+A]	*[-hi +A]	ID [A]
a. ɛlɑhuwɑ	*!					*		**
b. elɑhuwɑ		*!				*	*	
c. ☞elehuwɑ				*	*		**	**
d. elehuwe				**!	**		***	***
e. olohuwɑ			*!		*			**
f. elohuwɑ		*!						**
g. olehuwɑ			*!	*			**	**

The tableau above in (338) 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 *[-b -hi][+b -hi]$_{L1}$. It also simultaneously satisfies *[-A][+A]$_{L1}$. Strikingly both these processes require the same environment, i.e. exceptional triggering by the vowels /-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 (338)b and (338)f because they violate *[-b -hi][+b -hi]$_{L1}$. Candidates (338) e and (338)g are barred from being optimal in this evaluation because of their multiple violations of IDENT[-back].

The tableau below shows an input which contains a /CɔCɑ-/ sequence.

(339) Co-dependent *[-A][+A]$_{L1}$ and *[-b -hi][+b -hi]$_{L1}$ II

Input: /bɔzɑr/ +/uwɑ/$_{L1}$	*[-A] [+A]$_{L1}$	*[-b -hi] [+b -hi]$_{L1}$	ID [-b]	ID [+b]	ID [lo]	*[-A] [+A]	*[+A -hi]	ID [A]
a. bɔzɑruwɑ	*!					*		
c. bozɑruwɑ	*!					*	*	*
b. ☞bozoruwɑ					*		**	**
c. bozoruwo					**!			***
d. bezeruwɑ				*!*	*		**	
e. bozeruwɑ				*!	*		**	
f. bezoruwɑ		*!		*	*		**	

The constraint hierarchy is able to generate the right output /bozoruwa/ because the selected output neither violates *[-b -hi][+b -hi]$_{L1}$ 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

As pointed out earlier in this chapter, in this section, I show how other theories of indexation (which might be thought to be applicable to these 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 (341)a) and b)

(340) Constraint ranking in the Grammar:

*[+ATR +low] ≫ IDENT[low], *[-ATR][+ATR]

(341) 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 straightforward that the indexed constraint ranking approach would then generate */oloxuwɑ/ for the input /alax-uwɑ/ as a result of the following indexed ranking in the lexicon. The tableau above shows how ranking indexation would predict the wrong results for local /ɑ/-adaptation.

(342) ɑlɑx-uwɑ $_{\text{*[-ATR][+ATR]} \gg \text{IDENT[low]}}$

Input: /alɑx/+/uwɑ/	*[+ATR +low]	*[-ATR] [+ATR]	ID [low]	*[+ATR -hi]	ID [ATR]
a. ɑlɑxuwɑ		*!			
b. ☹ɑloxuwɑ		*!	*	*	*
c. 💣oloxuwɑ			**	**	**

The candidate in (342)c. would be the predicted outcome in ranking indexation. The actual output in (342) 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 any provide 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:

(343) Grammar: MAX$_L$, IDENT$_L$ ≫*[-ATR][+ATR] ≫ MAX, IDENT

Lexicon: /-iyɑ/ /-uwɑ/ $_L$

Input: /ɑlɑx/+/uwɑ/	MAX L	ID L	*[-ATR] [+ATR]	*[-hi +ATR]	IDENT [ATR]	MAX	ID
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 and that is the candidate (343)c. The desired output candidate in (343)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 that the output of this process is variable between one which chooses [ATR] harmony and the other which opts for front/back harmony. The unranked constraints *[-A][+A]$_{L1}$ and *[-b -hi][+b -hi]$_{L1}$ will go to show in ranking indexation that there is variation between /elehuwa/ and */ɛlɛhuwa/.

When morphological presence 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 like, German plural formation where [Palast] singular – [Paläste]Plural (*Pälaste, *Päläste) Wiese 1996 b: 183-184). This notion of locality is tackled in a theory of constraint indexation by specifying a morpheme which will trigger or undergo a process in as restricted a manner 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 presence of 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.

With this discussion on the requirement for markedness constraints to account for Assamese exceptionalities, I will now move on to discuss a similar requirement in Bengali.

2.8 Exceptional Triggering in Bengali

Recall from Chapter 5 that in Bengali verbal phonology a difficult question was relating to the underlying quality of vowels in roots. 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:

(344) 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:

(345) 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 Continuous	ʃon-a-c-c^h-i ken-a-c-c^h-i	ʃon-a-c-c^h-iʃ ken-a-c-c^h-iʃ	ʃon a-c-c^h-o ken a-c-c^h-o
Past	ʃon-a-c-c^h-i-l-am ken-a-c-c^h-i-l-am	ʃon-a-c-c^h-i-l-i ken a-c-c^h-i-l-i	ʃon-a-c-c^h-i-l-e ken-a-c-c^h-i-l-e
Future	ʃon-a-b-o ken-a-b-o	ʃon-a-b-i ken-a-b-i	ʃon-a-b-e ken-a-b-e

The causative /-a-/ in the table above do not undergo any visible alteration. This might lead one to conjecture that /a/ is consistently opaque in Bengali. But in the examples below, alternation in the verbal root is induced by the perfective /-e/. The perfective only affects the vowel /a/ by raising it to /-e/.

(346) 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 causa	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/ alternates to /e/[72]. 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 it for Assamese in the preceding sections.

(347) *[-ATR][+ATR]$_{perf}$
No instance of [-ATR] followed by [+ATR] includes a phonological component of the morpheme lexically specified as $_{perf}$

This constraint is placed at the top of the constraint hierarchy of Bengali that was postulated in Chapter 5:

(348) Ranking: *[-ATR][+ATR]$_L$ ≫ ID[ATR]&ID[hi] ≫ *[-ATR][+ATR,+hi] ≫ ID[+ATR] ≫ ID[-ATR]

(349) Indexed Morpheme in the Lexicon: perf /e/$_L$

(350) high ranking *[-ATR][+ATR]$_{perf}$ leads to exceptionality

[72]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 in a different morphological level.

Input: /nam/+/le/ perf	*[-ATR] [+ATR] perf	ID[hi]&ID[ATR	* [-ATR] [+ATR, +hi]	ID [+A]	ID [-A]	*[-A] [+A]
a. namle	*!					*
b. nɛmle	*!					*
c. nimle		*!				
d. ☞nemle					*	

The lexically indexed constraint *[-ATR][+ATR]$_{perf}$ prohibits */namle/ and */nɛmle/, i.e. the candidates (350) a. and (350) 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 (350) c. is optimal because it also respects the local conjunction ID[hi] & ID[ATR]. This ranking prohibits */nimle/ in (350) d. because Bengali demonstrates a chain shift in terms of height and [ATR].

Though I tried to capture 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 triggering of 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.

3 Exceptional Faithfulness in the Verbal Morphology

I will now move on to a type of morphemic triggering 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. /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 new instances of morpho-phonemic alteration that I am going to deal with, there is no violation of IDENT [low]. The /ɑ/ in the verbal root

/k^hɑ/ 'eat' for instance, does not undergo alteration 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 be also 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 present the status of NO HIATUS as a constraint operative in the phonology of Assamese.

3.3 NO HIATUS in Assamese

In this section, I show with examples from the nominal paradigm that in the presence of vowel-initial suffixes, vowels undergo deletion. Though there are no [+ATR] harmony triggering affixes in the example set in (351), the set shows 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.

(351) [-ATR] initial suffixes

Root	Erg-ative /ɛ/	Acc-usative /k/ /ɔk/	Dative /loi/ /ɔloi/	Gen itive /r/ /ɔr/	Locat ive /t/ /ɔt/	Instru-mental /rɛ/ /ɛrɛ/
b^hɑt	b^hɑt-ɛ	b^hɑt-ɔk	b^hɑt-ɔloi	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 a 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 phonology is sensitive to morpho ological extensions and preserves morphemes that are under threat of deletion.

It is a well-observed phenomenon that segments are deleted in order to resolve hiatus, by linking two adjacent vowels, which may be present at the edges of a morphological domain (For instance, French liaison, /r/ insertion in Boston English, McCarthy 1994, etc.)[73].

It should also be noted that though NO HIATUS is operative in the nominal examples in (351), 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 NO HIATUS is present in the phonology of Assamese, independent of vowel harmony. NO HIATUS 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 in 3.4, NO HIATUS is not an undominated constraint and may present itself as a relevant constraint only in specific morpho-phonological interactions.

For our purposes in this chapter, I define the constraint as below:

(352) NO HIATUS
"Avoid vocalic sequences across heterosyllables"

[73] The status of NO HIATUS in OT is controversial. In McCarthy (1993) NO HIATUS is only mentioned as a probable constraint and it is shown that /r/ insertion in Boston English is the result of 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 functional words) and in all places except phrase-medially. It is possible that in Assamese the relevant constraint here is ONSET which requires deletion and epenthesis so as to provide for syllable-initial onsets. But, 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 NO HIATUS as a cover constraint for the processes of hiatus resolution in Assamese for the time being,, till further research is able to establish any convincing proof in favour of or against any alternative motivation.

The constraint NOHIATUS is a prohibition on heterosyllabic vowel-vowel sequences. On one hand NOHIATUS 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 phenomenon where harmony induced by [+ATR] vowel-initial suffixes interacts with NO HIATUS.

3.4 Exceptional Faithfulness and /i/ deletion

The relevant process of these sections will be /i/ deletion, which will be shown to call for the treatment of the morpheme responsible for exhibiting this characteristic as a type of lexically indexed faithfulness 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' undergoes harmony as a result of the addition of /il/ ought to produce /roil/. The existence of the apparently impossible sequences /rol/ /gol/ (after the deletion of /i/)[74], etc. is therefore unpredictable, given the regular phonology of the language. This situation emerges because the eventually occurring surface output forms /rol/ and /gol/ surfaces with the harmonised segment even though the triggering segment is deleted. This shows that the deleted segments influence the surface structure of morphosyntactic words, as morphological information will not be preserved without such an influence. I argue that a lexically indexed faithfulness constraint for the feature [+ATR] solves the problem of a non-surface true alternation without resorting to an analysis based on as one might expect floating features or morpheme realisation. The analysis is spelled out in the next section.

[74]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 (faithfulness constraint protecting lexical words) would produce a deletion pattern, as the one instantiated in Assamese. However, resolving various typological issues, as the ones raised by Casali is outside of the scope of this chapter.

3.5 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 slice of the vowel harmony pattern displayed in verbs (repeated from Chapter 4, section 4.3):

(353) 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	il + ʊ	il + ʊ	il + ʊ
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	im	im	im
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 [+hi +ATR] vowel /i/ always trigger a change in the preceding [-ATR] vowels /ɛ/ /ɔ/ and /ʊ/. Verbs inflect in the following order:

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

The pattern of inflection of the open monosyllables /d^hʊ/ ‘wash’, and /k^hɑ/ ‘eat’, deserve attention because only open monosyllables provide the context for vowel deletion. Therefore, only such instances 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 /i/’s 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/. (350). However, the paradigm in (353) 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 chapter 4, section 4.3, with different examples):

(355) affixation of /-is/

Root	kʰɑ	rɔ	dʰʊ
Present Progressive			
1P	kʰɑisʊ	roisʊ	dʰuisʊ
2P(fam)	kʰɑisɔ	roisɔ	dʰuisɔ
2P(ord)	kʰɑisɑ	roisɑ	dʰuisɑ
2P(hon)&3P	kʰɑisɛ	roisɛ	dʰuisɛ
Past-Progressive			
1P	kʰɑisilʊ	roisilʊ	dʰuisilʊ
2P(fam)	kʰɑisili	roisili	dʰuisili
2P(ord)	kʰɑisilɑ	roisilɑ	dʰuisilɑ
2P(hon)&3P	kʰɑisilɛ	roisilɛ	dʰuisilɛ

The set of examples above shows 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 MAX constraint demanding the preservation of the entire morpheme which is ranked higher than the NO-HIATUS constraint.

3.6 /i-deletion/ in the verbal paradigm and ID[+ATR]$_{L2}$

Turning to the faithfulness of a deleted morpheme in verbs, we will see that an indexed faithfulness constraint along with a higher ranked NO HIATUS constraint determines the emergence of vowel patterns hitherto unattested until this chapter. I formulate this lexically specified faithfulness constraint as below:

	Constraint	Lexicon
(356)	ID[+ATR]$_{L2}$	/il/ /ib/ /im/

Output correspondents contain a phonological [+ATR] component of the input in the smallest domain of a morpheme lexically specified as L2.

The analysis to be presented holds that ID[+ATR]$_{L2}$ is crucial in determining the output candidate when the triggering segment is deleted because of surface well-formedness constraints. The solution proposed exhibits that the output representation is an enriched one as it already contains morphological information of the relevant output form. MAX is a constraint which requires input elements to have output correspondents. However, the output of harmony incurs violations of MAX as it involves deletion of the entire segment. There is no deletion of consonantal segments in hiatus resolution, therefore a constraint requiring faithfulness to a consonantal segment remains unviolated, forcing realisation of all consonants in the base as well as the in the affix:

(357) MAX- IO - V-STEM (McCarthy & Prince 1995:370)
Every base vowel of the input surface representation in S_1 has a correspondent in the output. MAX IO –V evaluates entire segments
("No deletion of stem vowels")

The constraint which prevents the deletion of affixal vowel is:

(358) MAX- IO- V-AFFIX (McCarthy & Prince 1995:370)
Every affixal vowel of the input surface representation in S_1 has a correspondent in S_2.
("No deletion of affix vowels")

As a result of independent principles of grammar (where NO HIATUS is present even when there is no harmony, as shown by the instances of hiatus resolution in case affixation in the previous section), NO HIATUS 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.

The tableau below shows that IDENT[+ATR]$_{L2}$ mediates to faithfully preserve the harmony value of the triggering [+ATR] value of the morpheme.

(359) ID[+ATR]$_{L2}$ and the faithfulness of the deleted morphemic feature

/rɔ/+/im/$_{L2}$	NO HIATUS	MAX-IO -V-S	ID[+ATR]$_{L2}$	*[-A][+A]	MAX - IO-V-A	*[-hi + ATR]
a. roim	*!					*
b. rɔim	*!		*	*		
c. rim		*!				
d. rɔm			*!		*	
e.☞ rom					*	*

In the tableau above, if IDENT[+ATR]$_{L2}$ had not been operative, the candidate in (359) d) could also have been selected as the surface output. The candidate in (359) d) does not incur any violation of other constraints, save MAX- IO- V-A(FFIX) which the selected output also violates. The optimal output candidate however, violates *[-hi +ATR] but this constraint is ranked quite low in this hierarchy. The two candidates (359)a) and (359)b) violate highly ranked NO-HIATUS.

Recall that Assamese phonology prohibits occurrences of [e] and [o], unless there is an immediately following [+hi +ATR] vowel. This might seem problematic, in the sense that the constraint hierarchy above produces the optimal output because of the existence of a higher ranking constraint ID[+ATR]$_{L1}$, which preserves the morpheme's content via assimilation, though *[-ATR][+ATR] the harmony driving constraint does not trigger this alternation. The constraint hierarchy motivated in the preceding chapters 5 and 6 would not have resulted in the output candidate /rom/. Therefore, it is essential that we evaluate this constraint in the purview of other inputs as well. NO HIATUS induces deletion in sequences of heterosyllabic vowels. This constraint is ranked above the constraint ID[ATR]$_{L2}$ which preserves a morphemic feature, and in this case even after deletion (See tableau (361) for the lower ranking of ID[+ATR]$_{L2}$ vis-à-vis NO HIATUS and MAX- IO - V-STEM).

By evaluating another candidate which has a suffix of the shape /VCV/, we can see that the same process applies throughout the verbal morphology, as a result of addition of the morphemes indexed as L2. The [+ATR] content of the /i/ in the input is preserved in the output as a result of a lexically indexed faithfulness constraint preserving the harmony driving value. While hiatus resolution drives deletion, requirements of harmony result in the expression of the morpheme's [+ATR] feature on the preceding vowel. In the tableau below, while the high-ranking NO HIATUS requires vowel deletion, the constraint ID[+ATR]$_{L2}$ demands morpheme preservation, resulting in the optimal candidate which satisfies both constraints.

(360) ID[+ATR]$_{L2}$ drives realisation of the underlying [+ATR] value

/rɔ/+ /-ilɑ/$_{L2}$	NO HIATUS	MAX-IO - V-STEM	ID[+ATR] L2	*[-ATR] [+ATR]	MAX-IO- V-AFFIX
a. roilɑ	*!				
b. rɔilɑ	*!				
c. rɔil	*!		*	*	
d. roil	*!	*			
e. rɔlɑ			*!		*
f.☞ rolɑ					*

In the evaluation in the tableau above, the resultant output form /rolɑ/ is a product of the combined forces of ID[+ATR]$_{L2}$ and NO HIATUS. Candidate (360) e) does not violate the two higher ranked constraints, but violates the significantly important indexed constraint ID[+ATR]$_{L2}$. Candidates (360) a) - (360) d) violate NO HIATUS. Candidate (360) e) violates ID[+ATR]$_{L2}$, which demands faithfulness to the value of the deleted morpheme, resulting in a failed candidate.

The evaluation till now does not show why we have a ranking logic where NO HIATUS » MAX- IO - V-STEM » ID[ATR]$_{L2}$. The input candidate /k^hɑ/+/ilɑ/$_{L2}$ below shows how this ranking is obtained.

(361) Inertness of /ɑ/ under morpheme deletion

/kʰɑ/+ /ilɑ/$_{L2}$	ID [low]	NO HIATUS	MAX IO V STEM	ID [+ATR]$_{L2}$	*[-A] [+A]	MAX-IO-V-AFFIX
a. kʰoilɑ	*!	*				
b. kʰolɑ	*!					*
c. kʰoil	*!	*				
d. kʰɑilɑ		*!			*	
e. kʰɑil		*!		*	*	
f. kʰilɑ			*!			
g.☞ kʰɑlɑ				*		*

The output candidate /kʰɑlɑ/ violates ID [+ATR]$_{L2}$ as it does not preserve the features of the deleted morpheme faithfully. This explains the lower ranking of ID[+ATR]$_{L2}$ vis-à-vis NO HIATUS. But the higher ranked status of IDENT[low] prevents the generation of candidates (361)a) b) and c)

3.7 Local application of Faithfulness constraint Indexation

ID[+ATR]$_{L2}$ 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 (362) shows above 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].

(362) Unbounded harmony due to *[-ATR][+ATR]

nɔ+rɔ+ilɑ$_{L2}$	NO HIATUS	MAX-IO - V-STEM	ID[+ATR]L2	*[-ATR] [+ATR]	MAX-IO- V-AFFIX
a. noroilɑ	*!				
b. nɔrɔilɑ	*!		*		
c. norɔil	*!				*
d. nɔrɔlɑ			*!		*
e. nɔrolɑ				*!	
f.☞ norolɑ					*

The candidate (362)e) is not the correct output because it violates *[-ATR][+ATR], even though it locally satisfies ID[+ATR]L2. This candidate can be compared to the candidate which does not violate this constraint and (362)f) emerges as the winner. The optimal candidate violates only the lower ranked *[-hi +ATR].

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 though 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:

(363) 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. However, this unboundedness is not the result of IDENT[+ATR]L2, which functions only locally. More evidence of the local manifestation of IDENT[+ATR]$_{L2}$ comes from instances where the root vowel is /ɑ/. Interestingly, similar to the examples in (363), there are other instances where the NEG element attaches to a root with /ɑ/, and the vowel that the NEG assumes, varies between /ɑ/ and /ɛ/. In the formal register, the vowel of the verbal root is copied, but in informal or colloquial Assamese, /ɛ/ is also frequently used. Therefore, when the root is /k^{h}ɑ/ 'eat', the second person negation of the verb can be either /nɑk^{h}ɑlɑ/ or /nɛk^{h}ɑlɑ/.

(364) nV+k^{h}ɑ+il+ɑ → nɑk^{h}ɑlɑ ~ /nɛk^{h}ɑlɑ/
NEG + eat + past + 2P fam

The locality of IDENT[+ATR]$_{L2}$ is apparent from the behaviour of the deleted morpheme in the variable output form /nɛk^{h}ɑlɑ/ in (364) above. The feature [+ATR] now does not dock itself on the [-ATR] mid vowel of the NEG element. In other words, */nek^{h}ɑlɑ/ is not the optimal output, even though IDENT[low] remains unviolated as a result of this output. IDENT[+ATR]$_{L2}$ applies only to the smallest possible domain, and in this case does not apply at all because the segment in the immediate vicinity is /ɑ/. Therefore the constraint *[-ATR][+ATR] is satisfied when harmony is iterative in words such as the examples in (363).

3.8 Exceptional violation of NO-HIATUS

As discussed in section 2.5 on the verbal morphology, a part of the verbal morphology does not show any tendency to satisfy the constraint NO-HIATUS and this section presents an analysis of these facts of the verbal morphology. The hierarchy proposed till now can be ranked as below:

(365) NO HIATUS ≫MAX- IO-V-STEM ≫ID[+ATR]$_{L2}$ ≫ *[-ATR][+ATR]
≫MAX- IO- V-AFFIX

However, the examples of /roisʊ/, etc. which incur fatal violation of NO-HIATUS also needs to be accounted for in this analysis. Consequently, these instances of exceptional blocking of hiatus are protected by a MAX(V)[75]$_L$ constraint protecting all the vowels indexed to the morpheme /-is/. Hence this constraint needs to be ranked higher than NO-HIATUS, so that it correctly predicts blocking of hiatus resolution as a result of indexation to the morpheme /-is/.

(366) Exceptional violation of NO-HIATUS

rɔ+is$_{L3}$ + - il$_2$ + ɑ	MAX$_{L3}$	NO HIA TUS	MAX- IO - V- STEM	ID [+ATR]$_{L2}$	*[-A] [+A]	MAX- IO- V- AFFIX
a. rɔisilɑ		*			*!	
b. ☞ roisilɑ		*				
c. rɔsilɑ	*!				*	*
d. rosilɑ	*!				*	*
e. roislɑ		*		*!		*

In the tableau above, the lexically indexed faithfulness constraint produces exceptional non-occurence of hiatus under conditions where hiatus should have been resolved i.e, the additon of a VC suffix. In the tableau in (366) candidate (366)a) which is the most faithful candidate violates *[-ATR][+ATR], the harmony driving constraint. Candidate (366)b) is the most optimal candidate, though it violates NO-HIATUS, it emerges victorious because it satisfies MAX$_{L3.}$ ID[+ATR]$_{L2}$ penalises the candidate in (366)e) because even though the indexed morpheme is deleted, there is no way of realising its [+ATR] value.

4 Exceptional Occurrences in the Underived Lexicon

[75] In the McCarthy & Prince (1995) framework, MAX constraints duplicate the effects of ROOT FAITH ≫ AFFIX FAITH. However, in an analysis like the one presented here with a suffix indexed faithfulness constraint ranked higher than the MAX- IO - V-STEM constraint, predict the exact reversal of ROOT FAITH ≫ AFFIX FAITH. However, it is only exceptional Assamese and not the normative to exhibit suffix driven harmony.

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 (367). 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 /abedɔn/ which straightforwardly violates the constraint *[-ATR][+ATR] as well as the markedness constraint against *[+hi -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 L4, and the constraint ID[+ATR]$_{L4.}$

(367) ID[+ATR]$_{L4}$
Input specifications of [+ATR] are preserved in the output.

(368) Grammar: ID[+ATR]$_{L3}$ ≫ *[-ATR][+ATR] ≫
*[+hi –ATR] ≫ ID[+ATR]

(369) 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:

(370) IDENT[+ATR]$_{L4}$ governs lexical items which bear [e] and [o] without any alternation

I: abestɔn$_{L4}$	ID[+ATR] L4	*[-A] [+A]	*[-hi +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 (370)b) violates the markedness constraint *[-hi +ATR] twice and therefore it is not chosen as the optimal output. Candidate (370)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 *[-hi +ATR]. The lexical item bearing the indexation L4 violates this constraint only minimally. The same goes for all the items in the list provided in (369) above and in section 5 in Chapter 4. All other instances of violation of *[-hi +ATR] are the result of vowel harmony (see /ob^{h}ixek/ in the list in (369) for instance).

(371) Multiple instances of *[-hi +ATR] violation is as a result of harmony

I: ɔb^{h}ixek$_{L4}$	ID[+ATR] L4	*[-A] [+A]	*[-hi +ATR]	ID [+ATR]
a. ɔb^{h}ixek		*!	*	
b. ☞ob^{h}ixek			**	*
c. ɔb^{h}ixɛk	*!	*		*

The tableau above shows all exceptional occurrences violate *[-hi +ATR] only minimally. *[-hi +ATR] prevents multiple occurrences of the allophonic vowels [e] and [o].

5 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 though 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 learner-friendly to boot.

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 ID[+ATR]$_{L2}$ is an indexed version of the constraint ID[+ATR] which mandates the preservation of the [+ATR] 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 NO-HIATUS 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 IDENT[+ATR]$_{L2}$. Finally therefore, violation of the constraint *[-ATR][+ATR] and enforcement of higher ranked IDENT[+ATR]$_L$ 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[76]. 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 (2006 2007) 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 ‘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 (2007) 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

[76] See Wolf (2004) for an analysis of local effects in mutation using structural constraints. And Horwood (1999) for locality in anti-faithfulness.

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 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 Assamese vowel harmony in great detail and shown some of the implications that it may have for a broader typological characterisation of vowel harmony systems. Among the many empirical observations about Assamese vowel harmony, I show that Assamese displays iterative regressive vowel harmony, a process which was not shown to be a feature of this language. I also show that the outputs of harmony [e] and [o] are allophonic in the language. Further, I explore the phonological status of the vowel /ʊ/ in Assamese, and show that the way /ʊ/ participates in vowel harmony is important to its phonological characterisation. I also offer an acoustic experiment to establish that /ʊ/ is a [+high] [+back] [-ATR] vowel in the language, which is juxtaposed to the findings in Ladefoged (1996, 2001, 2003). I have argued in Chapter 4 that Ladefoged did not take notice of the persistent vowel harmony in his own set of examples and therefore did not rely on this phonological fact while conducting his experiment. The findings of my experiment also endorse the phonological characterisation of /ʊ/ in Assamese. This much is about the descriptive facts of Assamese vowel harmony. Apart from that, this dissertation demonstrates some of the far-reaching theoretical significance of the various facets of vowel harmony in Assamese (and to a lesser extent Bengali and Tripura Bengali).

I will briefly evaluate the goals of this dissertation and the measure of success that I have been able to achieve in the targets that I had set out in the beginning of the dissertation. In section 2, I will discuss my findings about directionality. 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 a standard non-derivational theory of OT faces when accounting for locality, and that a solution to the problem can only be found in introducing the concept of a 'minimal distinct locus of violation' in Harmonic Serialism. 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 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.

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 may not 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 to be the case for Assamese, Karajá and Pulaar. Stepping aside from earlier analysis 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 problems 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. Therefore, 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 +hi] in order to account for absolutely local and minimal application of harmony in Bengali and Tripura Bengali. As discussed above, this is the gist of Chapter 5 in the dissertation. In Chapter 6 I show that locality of harmony domains emerge 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, Karajá, Pulaar and Bengali 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 [-hi +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. Therefore summoning the tools of Harmonic Serialism was essentially considered to be a difference in execution.

Finally, Chapter 7 shows that exceptional triggering by morphemes /-iyɑ/ and /-uwɑ/ induces a change only in the preceding /ɑ/, though /ɑ/ in all other circumstances remain opaque. The highlight of this process is that this process 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 constraint indexation (Pater 2006 a,b) 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.

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?

The way the so-called weak positions participate in vowel harmony processes give rise to important questions regarding the function of a trigger in a non-prominent in languages[77]. The important question is why the vowel on the right side in regressive harmony systems is a trigger if it is a high [+ATR] vowel and why is it resistant to harmony if it is a [-ATR] vowel – in other words, are there any functional reasons for the existence of absolute, non-epiphenomenal directionality? This is where the expositional statement on weak triggers is of significance – because in a very basic and oblique way, Assamese vowel harmony bears resemblance to metaphony where a high final vowel or a high unstressed vowel triggers propagation of harmony in the entire word or only till the stressed syllable (Zubizarretta 1979, Hualde 1989, 1998 Calabrese 1985, 1989, Walker 2006 and others).

As a case in point, is Central Veneto, as 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

[77] If weak trigger harmony is supposed to be restricted to the geographic spread of metaphonic systems of the Mediterranean alone, or if there is a broader typological motivation is a question that I will not explore here.

generally affected only when raising is triggered by a post-tonic unstressed vowel.

(372) Stressed vowel raising[78]

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.)'

(373) 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/[79], 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 may also cause raising of mid vowels preceding the stressed vowel. The latter is dubbed '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 do not proceed beyond the stressed syllable.

(374) 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.)'

[78]This pattern is called stressed vowel raising because the stressed vowels are subject to raising as opposed to unstressed vowel lowering.

[79] /u/ does not trigger harmony in Veneto.

In the positional licensing analysis advocated by Walker (2006), the grammatical imperative to induce stressed vowel raising versus unstressed vowel lowering arises from the need to avoid more sonorous vowels in unstressed vowels. Walker (2006) analysis of Veneto, the primacy of the weak trigger[80] 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:

(375) 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 data in (375), hence she proposes a faithfulness constraint on the final triggering position, ID[FINAL]. The faithfulness constraint ID[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).

The pattern observed for Veneto in (375) 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[81]. 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

[80] The term 'post-tonic' in Walker (2006) is used for the position of a triggering vowel which is always in the weak position, and never in a syllable bearing the main stress.

[81] See Mahanta (2006) for an analysis of Assamese vowel harmony relating to its stress facts.

language. This is perhaps a less than a 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.

I will now proceed to discuss the details of stress and prominence in Assamese, as also to explore its place in the so-called weak trigger harmony systems.

4.1 Stress, accent and the harmony trigger in Assamese

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:

(376) Stress in Assamese

[bɔ́ga] 'white' [bósori] 'yearly'

Secondly, however, accent is on the first syllable if the second one is light and 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 2002). There are no other phonetic correlates of prominence like duration or intensity.

4.2 Perceptual weakness of the trigger?

In Walker 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[82]. 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. As was shown clearly by 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 recruit one 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.

I do not adopt the licensing approach developed by Walker as the

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[82] If there is any perceptual difficulty it is probably between the /ɛ/ ~ /e/ and /ɔ/ ~ /o/ alternations. Harmony can also be seen as the grammatical means to produce these alternations and the allophonic occurrences of /e/ and /o/ can then be seen as grammatically conditioned. In this sense, harmonic occurrences here can be understood as the production and extension of a perceptually difficult contrast by favouring the marked feature combination in the stressed and adjoining syllables but never in the final syllable. Even though unfalsifiable in Assamese, this would run the risk of making a circular argument; therefore the adoption of the positional markedness contraint is chosen to be the correct one.

primary and salient property of the triggering vowels /i/ and /u/ do not qualify them to be regarded as vowels with diminished perceptual prominence. The acoustic evidence discussed above does not lend support to Walker's analysis based on the fact that high vowels have low amplitude and therefore they are 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. Harmony is triggered by the vowel in a weak position either because certain marked feature combinations are prohibited in unstressed positions or because of the faithfulness of the triggering segment. Under the circumstances it is the faithfulness of the weak trigger which determines the direction of assimilation. The results obtained in Walker can be alternatively derived from independent principles suggesting that features in weak positions may be unyielding to alternation because of their primary nature rather than perceptual markedness. Walker shows that raising in the stressed syllable is the outcome of a multiplicity of factors relating to perceptual markedness of the unstressed high vowel as well as avoidance of unstressed syllable lowering.

"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)

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.

Further, constraints of the LICENSE type presents a “too many solutions” problem. 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 discusses the typology of such segmental processes which are determined by prosodic structure. Blumenfeld points out that such interaction always proceeds unidirectionally and changes segmental structure instead of conditioning the construction of prosodic structure. It is shown in Blumenfeld that implicational constraints in OT allows for a too many ways to resolve the marked structure in environments where prosody conditions segmental repairs.

In sum, therefore, 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. Further, licensing as a potential approach to weak trigger harmony in general is beset with theoretical problems.

4.3 Concluding remarks

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.

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Appendix I

Data Collection and Experiments

I confirmed my judgements with native speakers and recorded multiple iterations 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, it was taken care that the surroundings were suitable for good recordings. There were 4 informants- 2 male and 2 female. All speakers were educated (at least graduate) and in the age group 20-30. They were all brought up in the eastern district of Jorhat in Assam and they speak the representative standard Colloquial dialect of Eastern Assam. Two speakers had to be removed because of a lot of 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 sentence in order to avoid word boundary effects. The informants were then requested to read and repeat the sentences thrice. However, no instrumental measurements have been carried out and the recordings were also carried out in a normal setting (taking care to avoid as much perturbation 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/ /d^henu/ /potu/ /zet^{h}i/ /k^heti/ /mezi/ /bohi/ /soki/ /g^hori/ /renu/ /beni/ /porinoti/ /ponoru/ /somokit/

(3) Blocking by /ɑ/
/pɛtɑri/ /pʊhɑri/ /mɔdɑhi/ /kɔpɑhi/ /gɔzɑli//p^hɑguni/

(4) Blocking by consonant clusters
/kɔlki/ /xɔkti/ /bɔnti/ /kɔlki/ /gʊst^{h}i/ /kɛtli/ /kɛrketuwa/ /kɔrmi/ /gɔrb^hɔwoti/

(5) Blocking by a nasal
/sɛkɔni/ /xɔmɔniɑ/ /pʊtɔni/

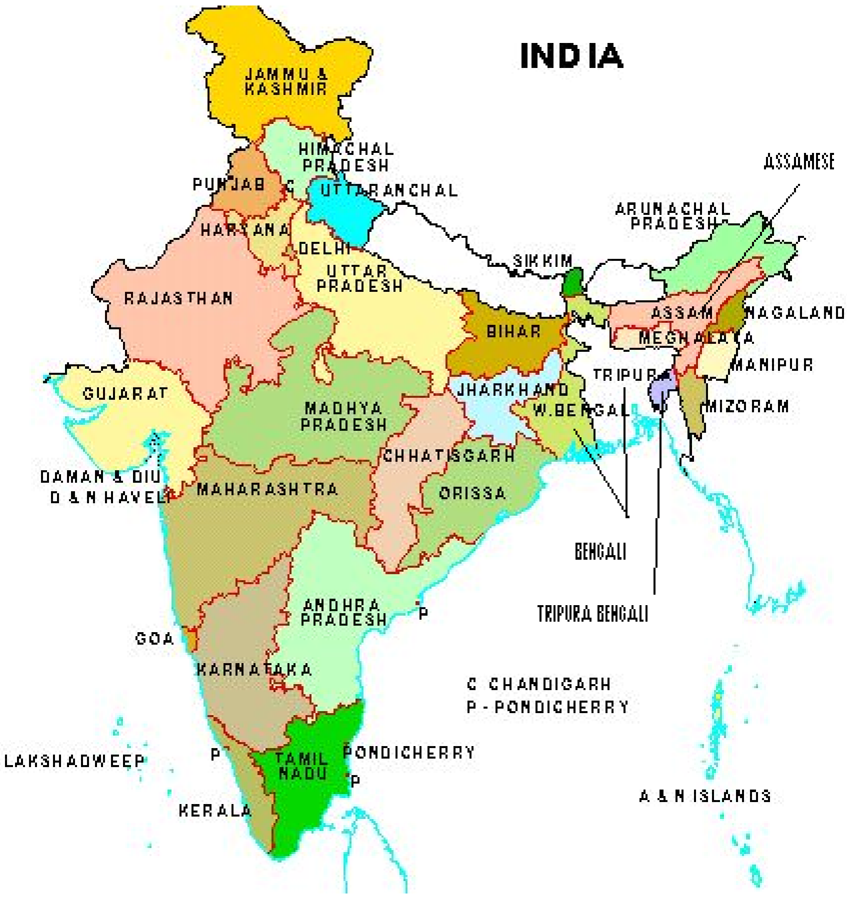
(6) High-Mid sequence
/igɔl/ /sitɔl/ /utɔl/ /surɔt/ /pitɔl/ /ʊk^hɔ//xɔpʊn/

(7) High-High sequece
/tumi/ /uki/ /mʊkʊt//zʊrʊn/

(8) Mid-mid sequence
/gɔnɔk/ /gɔrɔm/ sɛtɛp/ /bɛlɛg/

(9) Mid-Low sequence
/bɔgɑ/ /dɛkɑ/ /bɔtɑh/ /bɑpɛk//ɑnarɔs/

Appendix II



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NAGALAND
MEGHALAYA
MANIPUR
TRIPURA
MIZORAM
BIHAR
JHARKHAND
W.BENGAL
GUJARAT
MADHYA PRADESH
CHHATISGARH
ORISSA
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MAHARASHTRA
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TRIPURA BENGALI
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