**Local vs. non-local consonantal intervention in vowel harmony**

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In this paper I address the issue of consonantal intervention in vowel harmony. A consonant may be eligible to block harmony at the segmental level, by virtue of being highly placed in the sonority scale and also as a result of sharing some feature with the triggering segment. However, all attested cases of harmony blocking by consonants in a non-local position (in Assamese, Lango, Yucatec Maya, etc.) are prosodically governed in the coda. In all these languages, the presence of closed syllables results in the non-propagation of harmony because coda consonants are assigned a mora.

## 1. *Introduction*

Canonical vowel harmony is expected to spread from vowel to vowel without affecting[1] or being affected by intervening consonants. That is only an ideal state of affairs, which is violated in a significant number of vowel harmony languages. The core of this paper 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 paper is to show that in Assamese, local intervention by consonants and vowels is driven by sonority. But non-local blocking, i.e. intervention by consonants which are not segmentally adjacent is the result of prosodic requirements. Therefore this paper 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 paper will motivate a theory of segments that may stand between the trigger and target and that impede spreading of the relevant [αF] vocalic feature. By doing so, I hope to fill a void where there has been hardly any analysis of consonantal intervention, within Optimality Theory (henceforth OT, Prince and Smolensky, 1993, 2006) in vowel harmony, save a few (Ní Chiosaín and Padgett 1997, 2001). In this paper, along with consonantal blocking in Assamese, I also discuss vowel harmony blocking by consonants in Turkish, where harmonisation of vowels in terms of the feature [+back] is blocked by palatal consonants. It

[1]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.

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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 Assamese vowel harmony and its basic analysis within an OT framework. Section 1.2 presents the background to phonologically opaque vowels in Assamese and section 1.3 provides an OT analysis of phonological opacity caused by the vowel /ɑ/. Section 2 presents an in-depth account of nasals blocking harmony. This section is divided into three subsections in order to provide 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.

### *1.1. Assamese vowel harmony*

Assamese has an eight vowel inventory consisting of /i, u, ʊ, e, o, ɛ, ɔ, ɑ/. Assamese exhibits [Atr] harmony where the high vowels /i/ and /u/ regressively trigger harmony on the preceding [-Atr] vowels [ɛ] [ɔ] and [ʊ] resulting in [e] [o] and /u/. Harmony is regressive (neither stem controlled nor dominant-recessive) always extending till the initial syllable. Regressive harmony can only be triggered by the vowels /i/ and /u/ on the right side. Some examples of Assamese vowel harmony are presented below:

(1) Vowel harmony triggered by the /i/ suffix

| | Root | Gloss | Suffix | Derivation | Gloss |
|---|---|---|---|---|---|
| a. | $b^h$ɛkʊla | ‘frog’ | i | $b^h$ekuli | ‘frog’(dim) |
| b. | ʊpɔr | ‘above’ | i | upori | ‘in |
| c. | $k^h$ɔrɔs | ‘spend’ | i | $k^h$orosi | ‘prodigal’ |

In this section I present a basic OT analysis of Assamese vowel harmony and I define the relevant constraints below:

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

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

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

(5) *[+high, -ATR, -back]
The feature value [-ATR] is marked in [+hi] and [-back] vowels.
(Archangeli and Pulleyblank 1994)

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

(7) Vowel harmony in Assamese

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

The tableau above shows that the constraints IDENT [hi] and *[-ATR, +hi, -back] are undominated in Assamese. The constraint *[-ATR][+ATR] plays a crucial role in prohibiting output sequences with an [ATR] mismatch in their feature specifications. ID[ATR] protects [ATR] values but it is low ranked, therefore does not succeed in prohibiting vowel [ATR] harmony.

### *1.2. The opacity of the vowel /ɑ /*

It is commonly assumed that phonological opacity in vowel harmony arises as a result of vowels not bearing the features that harmony spreads. If a non-alternating vowel occurs between the target vowel and the trigger, the harmony span of the triggering vowel is blocked. Hence these non-alternating vowels are called opaque vowels. There are a staggering number of languages where /ɑ/ blocks harmony[2]. The data set below shows how /ɑ/ is opaque to vowel harmony in Assamese.

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

| | Root/Stem | Gloss | Suffix | Derivation | Gloss |
|---|---|---|---|---|---|
| a. | $B^h$ʊg | 'enjoyment' | ɑli | $b^h$ʊgɑli | 'enjoyable' |
| b. | Xʊn | 'gold' | ɑli | xʊnɑli | 'golden' |
| c. | $K^h$ɔr | 'dryness' | ɑli | $k^h$ɔrɑli | 'dry season' |
| d. | Bɛz | 'doctor' | ɑli | bɛzɑli | 'doctorship' |

In this paper, I propose that the opacity of /ɑ/ arises because of its high sonority. The standard treatment of phonological opacity is by using multiple feature markedness constraints (Baković 2000; Kiparsky 1981; Archangeli & Pulleyblank 1989). However, in many languages, vowels also alternate with other vowels which are not their exact harmonic counterparts in the inventory (e.g Turkish). In Assamese too, /ɑ/ alternates with /e/ and /o/

[2]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.

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 Mahanta 2007, 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 resolving phonological opacity. The constraint *[+ATR +low] is not able to prevent potential instances of [e] and [o] when /ɑ/ exceptionally undergoes harmony. To resolve the ambiguity that *[+ATR +low] gives rise to, we need another constraint IDENT[LOW] which is violated when /ɑ/ alters to other [+ATR] vowels in the inventory.

In an OT analysis, /ɑ/ opacity may also be cosidered to be the effect of a high ranking faithfulness constraint on low vowels, i.e. IDENT[low]. Intrinsic sonority of vowels has 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[3]:

(9) 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):

(10) Harmony-as-faithfulness:
FAITHLOW ≫ FAITHMID ≫ FAITHHIGH
a ≫ e,o ≫ i

### *1.3. ATR harmony and the low vowel – OT account*

As already stated in section 1.2, the presence of the vowel /ɑ/ blocks vowel harmony. The constraints which protects the [-ATR] values of low vowels from changing into [+ATR] are presented in this section. A faithfulness constraint preserving the low value of /ɑ/ is important due to considerations of sonority:

(11) [IDENT low]: Correspondent segments are identical with respect to the feature [Low] (McCarthy and Prince 1995)

The constraint which restricts the inventory to [-ATR] low vowels is:

(12) *[+ATR +low]
The feature value [+ATR] is marked in [+low] vowels.

(13) /ɑ/ remains unaltered

[3] While discussing the inapplicability of non-contrastive visibility to various cases 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. Although in this target-centric theory, opacity as such, is proposed to be non-existent.

| Input : /kɔpɑh/+/i/ | *[+ATR +low] | ID[low] | *[-ATR][+ATR] | *[-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 (13)-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 (12). However, such a motivation for blocking needs to be approached with some caution. In so far as blocking in [+ATR] harmony systems is concerned, a system where *[+ATR +low] is violated in order to avoid opacity[4] is non-existent, as far as I am aware. In this sense, standard OT overgenerates in that it predicts the existence of certain language types which are not attested [5]. 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 a proper examination and I cannot claim to have proffered an adequate analysis. Future research in this interesting area may shed more light on this phenomenon.

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.

## *2. Consonantal intervention: an introduction*

This paper argues that vowel harmony blocking by consonants is not an anomaly and consequently, one of the goals of this paper is to present a phonological explanation for these occurrences. I will not address the issue of feature spreading to all elements (in a certain domain) *per se*. Rather, I will show that in Assamese non-vocalic elements may *block* harmony. In other words, even though consonantal elements may allow harmony to spread 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 on a sonority scale; ii) similarity can also be apparent from features that both vowels and consonants could possibly share.

[4] Leaving aside systems where the complete ten-vowel inventory is already present, or where there are [+ATR +low] counterparts present in the inventory.

[5] As Márton Sóskuthy kindly points out, this implies that there are two sets of languages: (i) where *[+ATR +low] is violated in the inventory as well as a means of avoiding opacity and (ii) where *[+ATR +LOW] is never violated, even as a means of avoiding opacity. However, the crucial point here is that *[+ATR +LOW] is always inactive in the second set of languages, which brings into question the primary motivation of lack of a counterpart as the driving force behind phonological opacity.

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.

### *2.1. Nasals blocking harmony in Assamese*

Vowel harmony is sometimes blocked by intervening nasal consonants. In (14) vowel harmony is blocked by an intervening nasal consonant:

(14) blocking in underived words

| | | | |
|---|---|---|---|
| a. | sɛkɔni | 'strainer' | (*sekoni) |
| b. | xɔmɔniɑ | 'colleague' | (*xomoniɑ) |
| c. | pʊtɔni | 'dumping ground' | (*putoni) |
| d. | $k^h$ɔmir | 'leavening agent' | (*$k^h$omir) |

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:

(15) blocking by nasals in derivations

| | Root | Gloss | Suffix | Derivation | Gloss |
|---|---|---|---|---|---|
| a. | $d^h$ɔr | 'hold' | ɔni | $d^h$ɔrɔni | 'support' |
| b. | mɔ$t^h$ | 'churn' | ɔni | mɔ$t^h$ɔni | 'churning stick' |
| c. | pʊr | 'burn' | ɔni | pʊrɔni | 'burn' |
| d. | pɛlɑ | 'throw' | ɔni | pɛlɔni | 'throw' |

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 of a syllable containing the triggering vowels /i/ or /u/, vowel harmony will not take place, see (14); 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 triggering vowel harmony it will not block harmony. In (16) 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:

(16)

| | Word | Gloss |
|---|---|---|
| a. | porinoti | 'consequence' |
| b. | ponoru | 'onion' |
| c. | somokit | 'frightened suddenly' |

Also note that only when a sequence of a high-mid back vowel /ɔ/ and a nasal occurs, is [ATR] harmony blocked.

### *2.2. 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[6]. For example, post-nasal voicing is often attributed to a coarticulation difficulty in devoicing following a nasal (Hayes & Stijvers 1995; Pater 1999). I assume that in the case of consonantal blocking in vowel harmony, the following (ad-hoc) principle plays a role:

(17) 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:

(18) 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 propose a sequential markedness constraint, *[oNi] which observes the principle of locality principle espoused in (17) and (18). This is the following constraint expressed as below:

(19) *[oNi]: Assign a violation mark to [+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] spreads leftward from one non-low vowel to the next until it reaches the beginning of the word or a low vowel. This process of regressive harmony can be arrested by an intervening nasal which immediately precedes the triggering vowel. The tableau below shows an OT analysis of nasal blocking.

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

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

[6]For an articulatorily 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 article I do not offer articulatory constraints for blocking. The reason for not adopting the articulatory explanation is because of its inability to tackle the local nature of blocking by nasals.

From the ranking above, it is evident that satisfying the constraint *[oNi] is more important than obeying 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 the examples in (16)). This constraint bars candidates with vowel harmony only if the nasal is in the immediately preceding position of the triggering vowel in a word from being the optimal candidate.

(21) *[oNi] is not violated when there is no long-distance blocking

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

*[oNi] does not choose between the candidates (21)-a and (21)-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 (21)-b, the harmonised candidate.

### *2.3. Nasalisation and harmony in other languages*

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

(22) [-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, but nasals might intervene because of their sonority. Some more interactions between nasals and oral vowel sequences have been identified in a variety of cases exemplified below.

Uffman (2006) shows that in epenthetic vowel assimilation in Shona loan words, sonority of the intervening consonants play a distinctive role in this language - vowel harmony only occurs across labial and coronal obstruents, not across sonorants.

(23) Epenthetic vowels after a sonorants

| | | | | | |
|---|---|---|---|---|---|
| a. | aitemu | 'item' | d. | kirabhu | 'club' |
| b. | kiripi | 'clip' | e. | chifi | 'chief' |
| c. | timu | 'team' | f. | kirimu | 'cream' |

In Ijesa and Ekiti, (Przezdziecki 2005) pronouns with [+ATR] oral vowels undergo harmony, while those with [-ATR] or nasal vowels do not.

(24) [+ATR] [-ATR]

| | | | | | |
|---|---|---|---|---|---|
| a. | órígi | 's/he saw a tree.' | d. | ɔ́rɪ́lá | 's/he saw okra.' |
| b. | arígi | 'we saw a tree.' | e. | arɪ́lá | 'we saw okra.' |
| c. | ɛ̃rígi | 'you (pl) saw a tree.' | f. | ɛ̃rɪ́lá | 'you (pl) saw okra.' |

In Karajá (Ribeiro 2001), the vowels /ã/, /õ/, and /ẽ/ are opaque, systematically blocking the spread of regressive [ATR] harmony:

(25) 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 on 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 block harmony. With this background on other languages which have nasalised segments and which also intervene in vowel harmony, I now move on to show the implications of nasals blocking vowel harmony in a broader cross-linguistic perspective.

### *2.4. Implications of nasal intervention in vowel harmony*

Though cross-linguistically not common, nasals blocking/participating in harmony cannot be considered exceptional. Existing linguistic theories already presuppose that vowels and nasals interact more easily than other [continuant] segments. 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 (26). It is evident that the ranking in (26) also duplicates the effects of the sonority hierarchy:

(26) *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 likely to acquire nasal features than any other segment.

Similarly, consonantal intervention in vowel harmony involves blocking by segments which are more likely to acquire vocalic features. Nasals, laterals and palatalised segments are the only segments which block harmony because they are more sonorous (i.e. by virtue of being ranked higher in the sonority scale, the sonority threshold will be identified later in the article) and therefore they can potentially block to vocalic spreading. Cross-linguistically, nasals are regarded to be high sonority elements as they are capable of bearing the syllable nucleus. Nasalisation and nasal harmony are processes which lead to the articulation of the feature nasal on vowels as well as consonants. This means that consonants do take part in the process of harmony, and those features with a high degree of sonority, either primary or secondary, are eligible to be harmony blockers[7].

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

The hierarchy above only replicates the sonority scale which is supposed to be operative in Universal Grammar, but the property of being more sonorous is not the only criteria which is important in the blocking of harmony; featural compatibility is also required to be a consonantal blocker. This means that the motivation of a sonority scale does not imply that all the higher sonority elements in the scale will necessarily block harmony in the concerned language. The sonorous element blocking harmony will also have to be complemented by an additional featural requirement. The question which also needs to be answered here is regarding the necessity of having the dual requirements of sonority as well as featural compatibility in blocking vowel harmony. The answer to this lies in the fact that though voiced consonantal segments also show the requirement of a [-ATR] feature, their demonstrated ability to block vowel harmony has not been recorded so far.

### *2.4.1. The acoustic and articulatory dimension of blocking by nasals*

In this section I consider a number of phonetic and phonological factors in order to determine whether the features [ATR] or [High] that may be present 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 (1991) and Vaux (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 1996). 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 advancement of the tongue root. Trigo (in the case of Madurese, as shown in (22) notes some articulatory subtleties in the occurrences of [-ATR] vowels with nasals: (a) enhances the perception of nasality as their

[7] I assume that consonants do not trigger harmony and impose their consonantal features on vowels, as it is generally accepted as uncontroversial that imposing a consonantal place on a vocalic segment would lead to the undesirable consequence of prohibiting syllabification by converting a vowel into a consonant. (Ní Chiosaín and Padgett 1997 and others).

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. Furthermore, they 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 discussed 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.

Linear phonology required certain rules to apply to non-adjacent segments, but the advance of non-linear phonology allowed a hierarchical set of features within a segment and made it possible to view long-distance rules as rules operating between segments adjacent 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 in the autosegmental analysis of intervening elements. The well-known NCC operating within autosegmental theory can be stated as below:

(28) Association lines may not cross on a plane
(Clements 1990)

The NCC prohibits the 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 the 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):

(29) The elements related by a phonological rule or constraint must be adjacent on some tier.

The Prosodic Licensing Hypothesis (Itô 1986) proposed that features can be surface-true only when they are incorporated into the prosodic structure. The prosodic model by Hyman (1985) McCarthy and Prince (1986, 1990), Hayes (1989) and Itô (1988, 1989) proposes that features are aligned to prosodic structure, either by being incorporated into moras or into syllables.

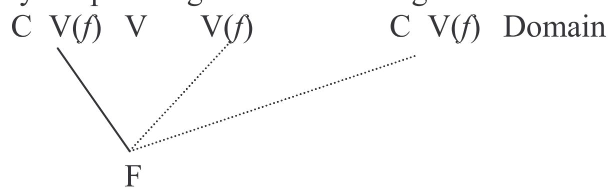
The length of long vowels, and coda consonants, are eligible to be counted as extra moras. In line with this tradition, Archangeli and Pulleyblank (1994) also propose that features ought to have prosodically defined anchors, which are (i) non-head moras, (ii) syllable head moras, (iii) non-head and head moras as well. 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 the discussion in the preceding section on approaches to opacity and neutrality of vowels). Vowel Place Theories (Clements 1985, 1987, 1989) segregate vocalic and consonantal Place features.

Clements (1980) and Goldsmith (1976, 1979), propose that segments which undergo a change under harmony are possible targets because they can bear the harmonising feature. Segments that do not show any featural change under vowel harmony do not have any corresponding features and may therefore emerge unaffected by the process. Schematically, such assumptions can be represented as in (30) below where the harmonising feature F propagates only to those segments which are 'legitimate feature bearers' indicated by (*f*) here.

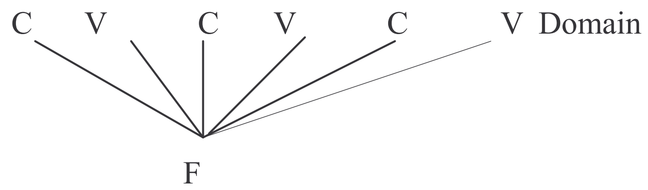
(30) Vowel Harmony as spreading of a harmonising feature F




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 1996). 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 shown below schematically:

(31) 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.

(32) 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 et al. 2000). Halle (1995) shows that the reason why vowel features spread across intervening consonants is that vowel features are executed by dorsal and coronal articulators and Labial and Dorsal are non-contrastive among consonants. In this regard, Halle (1995) discusses the vowel copy rule in Ainu. In Ainu, suffix vowels are copied from the stem vowel. However, there is no vowel copying once the glides [y w] intervene between the stem and the suffix.

(33) vowel-copying in Ainu

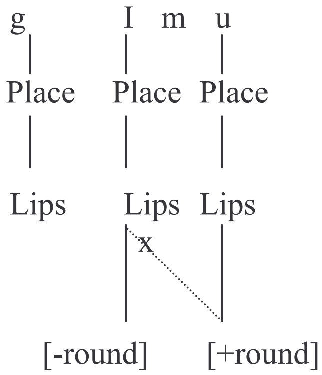
| | | | | | | |
|---|---|---|---|---|---|---|
| a. | mak-a | 'open' | tas-a | 'cross' | ray-e | 'kill' |
| b. | pop-o | 'boil' | tom-o | 'concentrate' | poy-e | 'mix' |
| c. | pis-i | 'ask' | nik-i | 'fold' | eiw-e | 'sting' |

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 et al. 2000), henceforth RAT, which is very much like the AT, feature spreading is seen as an operation affecting only the terminal nodes of the feature tree. Terminal nodes are dominated by the place nodes, thereby allowing feature spreading only in the terminal nodes. According to the principles of terminal spreading, terminal features can spread individually and simultaneously. Halle et al. (2000) furnishes various arguments as to how RAT is superior to other theories: it replicates the actual functioning of the articulatory mechanism by assuming a representational hierarchy of features/designated articulators which correspond to their actual place in the vocal tract.

Contrastiveness in the sense of Calabrese (1995), plays a significant role here. Contrastiveness in this theory is related to the notion of markedness. Some feature combinations are marked and in languages where the marked combination exists, the two values of the feature are contrastive. According to RAT, only contrastive features are *visible* to the harmony rule. In the authors' (Halle et al. 2000:412) words: 'In the AT account the interaction or non-interaction of consonant and vowel places is determined solely by the contrastiveness or markedness of features…' In RAT 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:

(34) Spreading in Nawuri according to RAT




The rule of spreading is blocked in this case, but the rule applies successfully in other cases where segments without the relevant contrast intervene. Thus the singular noun-class prefix /gI/ becomes round before a round vowel in a following syllable.

In Turkish, on the other hand, the palatal lateral blocks harmony if it is in word-final position, where it can also occur contrastively:

(35) 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 lateral's 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. She concludes that harmony interacts with all segments which have the appropriate features, independent of their nuclear or syllabic status.

### *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 claim 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. They argue that vocalic content even in non-head positions may participate directly in harmony. The impetus for consonant-vowel interactions have thus been shown to be subject to some intervening secondary articulatory phenomenon. As for vowel harmony languages, the interaction between vowels and consonants was noticed primarily in Turkish, where secondary place features trigger harmony, initiating rounding harmony in Turkish. Clements and Sezer (1982) report Turkish words where palatalised /$k^j$/ spreads its palatalised quality to following suffix vowels.

(36) /$k^j$/ 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 1964), 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 the 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 nasals are never syllabic in the language as predicted by the syllable head theory. Stepping aside from all the proposals in the previous sections, 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:[8] similarity can be measured by a consonant's proximity to vowels on 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

[8] Walker and Rose (2004) examine Long Distance Consonant Agreement (LDCA), and formally analyse it as a relationship of similarity between the participating segments. For their computation, they use similarity scales as proposed by Frisch *et al* (in press) – 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.

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 is commonly assumed 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 on one of the tiers of the prosodic hierarchy. Locality construed in these prosodic terms is paradigmatic and therefore segments can be adjacent to each other at a specific prosodic level even though at the level of segmental structure they are not strictly speaking adjacent.

I argue that consonantal segments can block vowel harmony to the extent that they can bear the spreading feature in some way. The notion of 'similarity' as used here should be understood in the sense of elements, which have a higher sonority (at least nasal and higher), and at the same time can share some feature specification of the triggering vowel. Nasals in Assamese can block harmony because while the nasal is sonorous it also interacts with [-ATR] feature in the language. The following is a partial list of consonants which have been known to have non-prosodically 'blocked' the spread of vowel features:

(37) Non-prosodic blockers in languages

| Glides, | Nasals | liquids |
|---|---|---|
| Turkish | Assamese, Karajá | Turkish, Warlpiri |

An implicational hierarchy assuming the following sonority scale can be constructed for all these cases of consonantal blocking. The result of this hierarchy would produce the following relevant constraints regarding consonantal blocking across languages:

(38) Turkish
***glides+round** ≫ *liquid+round ≫*nasal+ round ≫ fricative, round ≫ *obstruent stop

(39) Turkish
*glides+round ≫ ***liquid+round** ≫*nasal+ round ≫ fricative+round ≫ *obstruent stop.

(40) Assamese, Karajá
*glides+ATR ≫ *liquid+ATR ≫ ***nasal+ATR** ≫ *fricative+ATR ≫ *obstruentstop +ATR

The constraint hierarchies show how the notion of the sonority hierarchy in blocking vowel harmony across languages can be incorporated. The typological prediction that this hierarchy makes is that in [ATR] harmonies[9], nasal segments would more easily block harmony than any other segment. In front/round harmonies, glides and liquids would be the most preferred opaque cosonantal segments in harmony than other consonants. In this context, it is easy to see that feature sharing also plays a role in blocking vowel harmony. Typologically, there are

[9] Sometimes it may also appear as a height-related feature, as in Shona (Uffman 2006)

no attested systems in which voiceless obstruents block harmony. This only goes to show that more sonorous segments (in the sonority hierarchy, the cut off point being the nasal segments) would block harmony more easily than less sonorous segments. I also assume, as far as the data presented from various languages in this chapter is concerned, that blocking by sonorous elements follow a sonority threshold which does not exceed that of the nasals. In other words, consonantal blocking is predicted to occur only when there are elements as sonorous as nasals or more sonorous than nasals.

Furthermore, in vowel harmony, it is not important whether primary or secondary features interact with harmony. The relevant attribute of an intervening consonantal segment is whether it is compatible with the harmonising vowels, 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 there are more than one consonants intervening between the triggering vowel and the target vowel. The existence of two or more consonants in the given position creates an impediment in spreading of the harmonising feature values in Assamese. There are no morphemic factors which regulate 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.[10] This is shown below in (41):

(41) Disharmony in the presence of two intervening consonants

| | Word | Gloss |
|---|---|---|
| a. | bɔnti | ‘lamp’ |
| b. | xɔkti | ‘strength’ |
| c. | kɔlki | ‘last incarnation of Vishnu’ |
| d. | xɔrɔswoti | ‘Hindu goddess of learning’ |
| e. | 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 (42):

(42) Derived words where harmony is absent due to two intervening consonants

| | Root | Gloss | Suffix | Derivation | Gloss |
|---|---|---|---|---|---|
| a | sɔkrɔ | ‘circle’ | ika | sɔkrikɑ | ‘platelet’ |
| b. | kɔrmɔ | ‘work’ | i | kɔrmi | ‘active person’ |

[10] There are also some exceptions: /bostu/ ‘object’, /osru/ ‘tears’ /bonduk/ ‘gun’ /xotru/ ‘enemy’ /zontu/ ‘animal’ /bondʰu/ ‘friend’, /xendur/ ‘vermilion’ /endur/ ‘rat’.

| | | | | | |
|---|---|---|---|---|---|
| c. | kɔlpɔ | ‘wish’ | i | kɔlpi | ‘one who imagines'(fem) |
| d. | $k^h$ɔndɔ | ‘fragment’ | it | $k^h$ɔndit | ‘severed’ |
| e. | xɔbdɔ | ‘sound’ | it | xɔbdit | ‘resounded’ |
| f. | gɔr$b^h$ɔ | ‘uterus’ | woti | gɔr$b^h$owoti | ‘pregnant’ |
| g. | tɛz | ‘strength’ | swi | tɛzɔswi | ‘powerful’ |

The derived examples above show once 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 moras (represented as μ, see also (44)). 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.

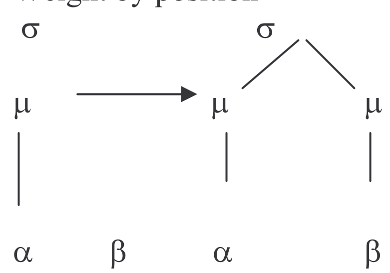
### *4.1. Stress and weight to position in Assamese*

Within the Assamese word stress system, main stress is always assigned to the initial syllable (Mahanta 2002). 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 happens in the following manner:

(43) 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:

(44) 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 (45) 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)[11] 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.

(45) Stress in Assamese

| | | | | | |
|---|---|---|---|---|---|
| | ( **L**L) | Gloss | | L(**H**) | Gloss |
| a. | [só.ku] | 'eye' | c. | [zi.bɔ́n] | 'life' |
| b. | [rɑ́ti] | 'night' | d. | [bɑ.gɑ́n] | 'garden' |
| | (**L**L)L | | | (**L**L)(**H**) | |
| e. | [gɔ́.hɔ.nɑ ] | 'jewellery' | g. | [m.rɔ́.mɔ̀r ] | 'loved' |
| f. | [zɔ́.hɔ.ni ] | 'cholera' | h. | [zɑ́.zɑ.bɔ̀r] | 'vagabond' |
| | L(**H**)L | | | L(**H**)H | |
| i. | [ɑ.nɔ́n.dɔ ] | 'happiness' | k. | [ɑ.rɔ́m.bɔr ] | 'luxury' |
| j. | [gu.rút.tɔ ] | 'importance' | l. | [ɔ.hɔ́ŋ.kɑr ] | 'pride' |

Assuming foot structures, it becomes clear from the examples above that the words have been parsed under strict binarity. Thus Assamese follows a strong – weak rhythmic profile, in which a foot is always bimoraic, as prominence always requires a bimoraic minimum, limiting the domain to the mora only. This factor limits foot shapes to either [σ(μμ)] or [σ(μ)σ(μ)], i.e. minimally and maximally two elements of identical status or two moras. The language also displays considerable sensitivity to quantity in all positions, unless there is a possibility of evading it by the occurrence of stress clash.

As already stated, Assamese follows a Trochaic (strong-weak) rhythm at the left edge of the word, and therefore invariably stresses the initial syllable. 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 (2002) also 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. Vocalic agreement between a heavy syllable and a light syllable violate 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.

(46) *[-ATR]$_{\mu}$ [+ATR]
Assign a violation mark to a [-ATR] vowel followed by a [+ATR] vowel in an adjoining vocalic mora.

---

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

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.

### *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]. As a result of this constraint only adjoining vocalic units will agree with each other, but will be blocked elsewhere.

(47) Harmony blocking by consonantal moras

| Input: /xɔk/+/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 the 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 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]:

(48) Lango harmony

| | | | | |
|---|---|---|---|---|
| a. | cı̀ŋ | 'hand' | cíŋə́ | 'my hand' |
| b. | wòt | 'son' | wòdə̀ | 'my son' |
| c. | ŋèt | 'side' | ŋètə́ | 'my side' |

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

(49) Lango harmony in closed syllables

| | | | | | |
|---|---|---|---|---|---|
| a. | dòk | 'cattle' | d. | dòkka | 'my cattle' |
| b. | ñə̀ŋ | 'crocodile' | e. | ñə̀ŋŋá | 'my crocodile' |
| c. | gwèn | 'chickens' | f. | gwènná | 'my chickens' |

In Lango the restriction is that in the presence of two consonants, the source of harmony must be the [+high] vowels /i/ and /u/. So the process of harmony is not affected in the following words with intervening geminates:

(50) Lango blocking

| | | | | | |
|---|---|---|---|---|---|
| a. | pɪ́g | 'juice' | c. | pɪ́ggə́ | 'my juice' |
| b. | òpúḱ | 'cat' | d. | òpúkkə | 'my cat' |

Archangeli and Pulleyblank analyse 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 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 route take in analysing these examples is to assume that there is a structural constraint which prohibits the [+ATR] vowels from surfacing in closed syllables. But either way it is evident from the data presented in (41) and (42) that there is a prosodic restriction in the occurrence of [+ATR] vowels in closed syllables. However, in section 4.3 I present an analysis which shows that the markedness constraint which drives this 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.t$^{h}$i/ '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.[12] In Assamese, by positing a constraint on syllable structure, like *[+ATR]C, one will also have to

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[12]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.

account for the presence of such marked structures which already exist[13]. However this is not a problem for the present analysis.

## 5. Conclusion

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

(i) If a consonant triggers or blocks harmony non-prosodically that consonant has to be above or equal to the sonority threshold of a nasal and also share featural attributes of the (non)harmony domain.

(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 are more opaque, because they tend to be more faithful.

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[13] 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.

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