RESEARCH

Exceptionality in Assamese vowel harmony: A phonological account

Sören Eggert Tebay and Eva Zimmermann

Leipzig University, Leipzig, DE

Corresponding author: Eva Zimmermann (eva.zimmermann@uni-leipzig.de)

The complex pattern of exceptionality in Assamese vowel harmony is taken to be one of the strong empirical arguments for an OT-system with lexically indexed constraints that are locally restricted (e.g. Mahanta 2008; 2012; Pater 2010). In contrast, we argue that the two exceptionality patterns in Assamese are not an argument for the assumption of lexically indexed constraints but instead fall out as an epiphenomenon from well-known mechanisms of phonology. We present two possible purely phonological reanalyses, each assuming a different vowel feature system: One based on floating features and constraint ganging and another based on floating features and underspecification. These phonological reanalyses have important consequences not only for the argument of a strictly modular phonology that disallows any reference to morpho-syntactic features (e.g. Bermúdez-Otero 2012; Bye & Svenonius 2012), they also shed new light on the possible different sources of apparent exceptionality. More concretely, both reanalyses take the exceptional trigger for vowel harmony to be a standard instance of an unassociated feature that needs to dock to a host. An additional exceptional undergoer for another vowel harmony process receives two different interpretations that depend on the assumed vowel feature system: It is either predicted from simple underspecification that makes vowels without contrasting counterparts more prone to phonological changes or it is interpreted as a phonologically Derived Environment Effects that easily falls out from constraint ganging in Harmonic Grammar (Legendre et al. 1990; Smolensky & Legendre 2006; Potts et al. 2010).

1 Introduction

Vowel harmony in Assamese shows two layers of exceptionality that are challenging for a phonological account: The language employs both exceptional triggers and exceptional targets for vowel harmony. It can be seen in (1a) that Assamese employs a regular pattern of regressive [+ATR] vowel harmony. The data in (1b) illustrates that the only low vowel /ɑ/ of the language is opaque to this process. In the presence of two exceptional suffixes /–uwɑ/ and /–ijɑ/, however, any adjacent low vowel is unexpectedly raised to a mid vowel and undergoes [+ATR] harmony (1c). In addition, these derived mid vowels undergo progressive backness harmony with a preceding mid vowel (1d). Crucially, this additional backness harmony is exclusively found for derived mid vowels originating from a low vowel, never for any other pair of mid vowels.

There are hence two levels of exceptionality in Assamese vowel harmony: *First,* two lexically marked exceptional morphemes require that [+ATR] harmony applies in contexts where it is phonologically unexpected (1c) and, *second,* derived mid vowels undergo backness harmony (1d).

(1)   *Vowel harmony in Assamese and exceptionality (Mahanta 2008; 2012)*

a.	pɛt	'belly'	–u	petu	'pot bellied'
b.	bɛpɑr	'trade'	–i	bɛpɑri	'trader'
c.	misɑ	'lie'	–ijɑ	misolijɑ	'liar'
d.	ɛlɑh	'laziness'	–uwɑ	elehuwɑ	'lazy'

The OT-accounts for this pattern presented in Mahanta (2008) and Mahanta (2012) are based on lexically indexed constraints. In addition, the facts are taken to be a strong argument for a locality restriction on lexically indexed constraints (Pater 2000; 2010; Finley 2010) since the exceptional raising in Assamese can only be observed in close proximity to an exceptional suffix. We discuss two main arguments against an account based on lexically indexed constraints. For one, such an account is dispreferred from the perspective of theoretical economy and modularity between phonology and morphology. And second, it is in fact completely unnecessary in the case of Assamese vowel harmony. The exceptional raising in Assamese is a classic instance of an exceptional trigger that can be derived easily under autosegmental representations and standard floating features. These assumptions do not only account for feature-changing non-concatenative morphology but easily explain instances of apparent morpheme-specific phonology as in Assamese as well (e.g. Lieber 1992; Zoll 1994; Wolf 2007). We argue that the raising is not exceptional height harmony but vowel mutation triggered by certain suffixes. The locality of the exceptional raising is shown to be epiphenomenal and a direct consequence from standard assumptions about possible associations inside autosegmental phonological structures. No additional theoretical assumption as the locality restriction on lexically indexed constraints is necessary.

The exceptional backness harmony also falls out in a purely phonological account from independently motivated mechanisms. To make such a reanalysis more convincing, we consider two different vocalic feature systems for Assamese. One is based on full specification and another on contrastive specification. Exceptional undergoers for backness harmony turn out to be an epiphenomenon in both accounts. They fall out without any additional assumptions in an account based on a contrastive feature system since the exceptionally undergoing vowels are the only ones that are underspecified and consequently escape the scope of a relevant faithfulness constraint. On the other hand, under a fully specified feature system, the exceptional backness harmony is an instance of a phonologically Derived Environment Effect that straightforwardly falls out from constraint ganging in Harmonic Grammar (Legendre et al. 1990; Smolensky & Legendre 2006; Potts et al. 2010). Interestingly, the characterization as a phonologically Derived Environment Effect that results for a fully specified feature system makes it in fact impossible to predict this exceptionality from constraint indexation alone: Constraints are only indexed to morphemes and a phonologically Derived Environment is not a possible exceptional environment that can be identified by a lexically indexed constraint. The vowel harmony in Assamese is therefore under no interpretation an argument for assuming lexically indexed constraints.

These two reanalyses and their counterparts based on lexically indexed constraints are summarized in (2).

(2)   *Analyses for two exceptionality patterns in Assamese*

	Mahanta (2008, 2012)	This paper
exceptional trigger for raising	lexically indexed Constraints	floating features (§3.3)
exceptional undergoer of backness harmony	lexically indexed constraints	constraint ganging (§4.1) underspecification (§4.2)

The paper is structured as follows: In section 2, we present the empirical generalizations about the two levels of exceptionality in Assamese vowel harmony before we turn to our theoretical proposal. In section 3, we will present our reanalysis for the exceptional triggers in Assamese that is based on featural affixation. In section 4, we turn to an account of the exceptional undergoers of backness harmony. They will receive two possible reanalyses depending on the assumed feature system. Under a fully specified feature system, the exceptional undergoers fall out as a phonologically Derived Environment Effect from constraint ganging (subsection 4.1) and under a contrastive feature system, it follows as an Emergence of the Unmarked Effect that arises for underspecified vowels (subsection 4.2). After showing that a purely phonological reanalysis for the two exceptionality patterns in Assamese is possible and does not even hinge on a specific feature system, we turn to a critical discussion of the alternative account of the Assamese pattern with lexically indexed constraints presented in Mahanta (2012) in section 5. We argue that the assumption of lexically indexed constraints can indeed account for the exceptional triggers of raising but that lexically indexed constraints alone can not predict the exceptional undergoers of backness harmony in Assamese (under none of the two assumed feature systems). We conclude in section 7.

2 Data

Assamese is an Indo-Aryan language spoken by about 13.000.000 people (Census of India 2001), mainly in the Indian state of Assam. All empirical generalizations in the following are taken from Mahanta (2008) and Mahanta (2012) where Colloquial Assamese as spoken in the Eastern districts of the state of Assam is described. Before we turn to the empirical generalizations about the exceptionality in Assamese vowel harmony, the vocalic inventory and the facts about the regular [+ATR] harmony are given.

2.1 Regular [+ATR] harmony in Assamese

The language has 8 vowels which are given in (3). As can be seen, there is only a single low vowel /ɑ/ but high and mid vowels have a back and front counterpart. In addition, only /u/, /o/, and /e/ have a [–ATR] counterpart. The distribution of mid vowels in Assamese[1] follows best from assuming that there are no [+ATR] mid vowels underlyingly and that [e] and [o] exist only in derived environments.[2] In fact, we will see many mid vowels [e] and [o] as result of (exceptional) vowel harmony in section 2.2 and 2.3.

(3)   *Vocalic inventory (Mahanta 2012: 1111)*

	front	back
high	i	u
		ʊ
mid	e	o
	ɛ	ɔ
low	ɑ	

This asymmetric vowel inventory can be described with different feature systems and the choice for one or the other crucially influences the theoretical account of the exceptional vowel harmony. To strengthen the claim that a purely phonological account is easily pos-

---

[1] Cf. Mahanta (2008: ch.2.4) for a detailed discussion of the distributional facts for all vowels. One important observation is, for example, that there are no words with adjacent mid vowels with different [±ATR] values. As will become clearer below, analyzing all instances of [+ATR] mid vowels as the result of vowel harmony explains this fact straightforwardly (cf. especially the end of section 3.2).

[2] Footnote 11 briefly discusses how this fact is formally modeled in our account.

sible for Assamese that does not hinge on specific background assumptions, we will present accounts based on the two possible feature systems in (4) and (5). The first analysis relies on a full specification for all feature dimensions (4) whereas the second one relies on a contrastive feature system where only those features are assumed that are contrastive (5). More concretely, the fully specified system is based on the binary features [high, low, back, round] and [ATR][3] and assumes a specification for each of these features for all vowels. The low vowel /ɑ/ is hence both [–round], [–ATR], and [+back] although there is no [+round], [+ATR], or a [–back] low counterpart. That it is taken to be a back vowel is consistent with the assumption and the phonetic facts in Mahanta (2008) that show a lower F2 frequency for [ɑ] (1547) that is closer to the F2 frequencies of [u, ʊ, o, ɔ] (707-927) than to the ones of [i, e, ɛ] (2418-2642) (Mahanta 2008: 61 + 62). In contrast, the feature system in (5) only assumes feature values for each vowel that are minimally necessary to contrastively specify it. In addition to not being specified for [ATR], the low vowel /ɑ/ lacks a specification for both [±back] and [±round].

(4)   *Fully specified feature system*

	–back	+ back	+ round	
+ high,–low	i	u		+ ATR
		ʊ		–ATR
–high,–low	e	o		+ ATR
	ɛ	ɔ		–ATR
–high, + low		ɑ		–ATR

(5)   *Contrastive feature system*

	–back		+ back	
+ high	i		u	+ ATR
			ʊ	–ATR
–high,–low	e		o	+ ATR
	ɛ		ɔ	–ATR
–high, + low		ɑ		

We will return to a discussion of these different feature systems and their different theoretical consequences for an account of Assamese in section 4. For the first part of the analysis in section 3, both are perfectly equivalent since only height and [ATR]-features are relevant for the exceptional raising.

The language employs a pattern of regressive vowel harmony for the feature [+ATR] as can be observed in (6). If a [+ATR] vowel is present in a word, all preceding [–ATR] vowels are realized as their [+ATR] counterpart. This vowel harmony affects stem vowels (6a) as well as affix vowels (6b).[4]

---

[3] For the purpose of this analysis, only the height features have to actually be binary in order to allow reference to mid vowels as a natural class with the features [–high,–low]. The feature [–back] could be substituted with [CORONAL] and the [+back] feature by [DORSAL]. Rounding could be modeled with a privative [LABIAL] feature with only minor modifications of the analysis (cf. Clements 1991).

[4] When examples are taken from more than two different pages in the sources, the respective page number for every example is given at the end of its line. Mahanta (2008) is abbreviated as 'M8' and Mahanta (2012) as 'M12'.

(6)   *Suffix-triggered [+ATR] harmony (Mahanta 2008; 2012)*

a.	gʊl	'mix'	–i	guli	'to mix'	M12:1112
	pɛt	'belly'	–u	petu	'pot bellied'	M12:1112
	ʊpɔr	'above'	–i	upori	'in addition'	M8:100
	kɔr	'do'	–i	kori	'I do'	M8:156
	bɔsɔr	'year'	–i	bosori	'yearly'	M12:1113
b.	bɔx	'settle'	–ɔ–ti	boxoti	'settlement'	M12:1112
	mɔr	'die'	–ɔ–ti	moroti	'cursed to die'	M8:99
ɔ–	gʰɔr	'home'	–i	ogʰori	'homeless'	M12:1113

It can be seen in the data in (7) that this harmony system treats [+ATR] as the dominant feature. Here, vowels specified for [–ATR] do not trigger vowel harmony for preceding vowels. This excludes, for example, a [–ATR] harmonic form like *[bʰʊtɛ] for underlying /bʰut–ɛ/. The data also show that the harmony only proceeds leftwards and is therefore regressive: The [+ATR] vowels in (7) do not trigger a change for a following vowel excluding, for example, *[bʰute].

(7)   *No [–ATR] harmony or progressive harmony*

                                     (Mahanta (2008: 118), Mahanta (2012: 1113))

bʰut	'ghost'	–ɛ	bʰutɛ	'ghost' (ERG)	
kin	'buy'	–ɛ	kinɛ	'buy' (ERG)	
pʰur	'travel/roam'	–ʊ	pʰurʊ	'travel/roam' (1.PRS)	
buz	'understand'	–ɔ	buzɔ	'understand' (2.PRS)	

The examples in (6) and (7) all involve morphologically complex contexts but the vowel harmony also shows its effect as a morpheme structure constraint: there are no stems with a non-low [–ATR] vowel and a following [+ATR] vowels (cf. Mahanta (2008: 66f) and Mahanta (2012: 1111). Morphologically simplex stems with a [+ATR] vowel followed by a non-low [–ATR] vowel, on the other hand, are indeed attested (e.g. [xitɔl] 'cool' or [obʰinɔb] 'new, extraordinary', Mahanta (2008: 68 + 82)).

    The only low vowel /ɑ/ has no counterpart in the phonemic inventory that differs only in [±ATR] and does not undergo [+ATR] harmony. As can be seen in (8), it is in fact opaque to the harmony process and blocks a following [+ATR] feature from spreading to a preceding vowel. This opaque /ɑ/ can be in a stem (8a) or a suffix (8b).[5]

(8)   *Opaque low vowel /ɑ/ (Mahanta (2008: 197), Mahanta (2012: 1119)*

a.	kɔpɑh	'cotton'	–i	kɔpɑhi	'made of cotton'
	bɛpɑr	'trade'	–i	bɛpɑri	'trader'
	zʊkɑr	'shake'	–i	zʊkɑri	'shake' (INF)
	ʊgɑr	'burp'	–i	ʊgɑri	'burp' (INF)
b.	lɛkʰ	'write'	–ɑru	lɛkʰɑru	'writer'
	gɔz	'grow'	–ɑli	gɔzɑli	'sprout'
	zʊn	'silver'	–ɑli	zʊnɑli	'silvery'

---

[5] Some very interesting additional blocking factors for the vowel harmony are described in Mahanta (2008): [+ATR] harmony might also be impossible if a nasal is in onset position ([sɛkoni], *[sekoni] 'strainer'; Mahanta (2008: 171)) or a consonant cluster intervenes between trigger and expected target ([xɔbdit], *[xobdit] 'resounded'; Mahanta (2008: 188)). We will not discuss these facts here and refer the interested reader to the account in Mahanta (2008) based on moraic intervention.

2.2 Exceptional raising

There are two exceptional suffixes in Assamese that trigger an unexpected behaviour: /–ijɑ/ and /–uwɑ/.[6] whenever the closest preceding vowel to those two suffixes is the usually opaque /ɑ/, this vowel is unexpectedly raised to a mid vowel and undergoes [+ATR] harmony. As expected, any [–ATR] vowel potentially preceding this /ɑ/ undergoes [+ATR] harmony as well (9b).

(9) *Exceptional raising (Mahanta 2008; 2012)*

a.	sɑl	'roof'	–ijɑ	solijɑ	'roof-ed'	M12:1121
	dɑl	'branch'	–ijɑ	dolijɑ	'branch-ed'	M12:1121
	dʰɑr	'debt'	–uwɑ	dʰoruwɑ	'debtor'	M12:1121
	mɑr	'beat'	–uwɑ	moruwɑ	'beat' (CAUS)	M8:217
	misɑ	'lie'	–ijɑ	misolijɑ	'liar'	M8:216
	kʰitɑp	'title'	–ijɑ	kʰitopijɑ	'renowned/titled'	M12:1121
b.	kɔpɑl	'destiny'	–ijɑ	kopolijɑ	'destined'	M12:216
	dʰɛmɑli	'play'	–ijɑ	dʰemelijɑ	'playful'	M12:216
	ɛ–pɑt	'one leaf'	–ijɑ	epotijɑ	'one branch-ed'	M8:218
	sɔ–mɑh	'six month'	–ijɑ	somohijɑ	'six month old'	M8:218

Crucially, this unexpected raising can only be observed on an opaque vowel that is directly adjacent to one of the two exceptional suffixes. As can be seen in (10), low vowels that are separated by another (low or non-low) vowel from the exceptional suffix, remain unchanged and undergo neither raising nor [+ATR] harmony.

(10) *Only adjacent /a/'s as exceptional targets*

(Mahanta (2008: 219), Mahanta (2012: 1121)

patɔl	'light'	–ijɑ	patolijɑ	'lightly'
apɔd	'danger'	–ijɑ	apodijɑ	'in danger'
abɔtɔr	'bad time'	–ijɑ	abotorijɑ	'bad-timed'
ɑlɑx	'luxury'	–uwɑ	aloxuwɑ	'pampered'
ɑdʰɑ	'half'	–uwɑ	adʰoruwɑ	'halved'

In contexts without an adjacent opaque low vowel, the two exceptional suffixes behave as every other suffix with a [+ATR] vowel and trigger regular [+ATR] harmony for all preceding [–ATR] vowels as can be seen in the data in (11). This pattern gives us an example of an exceptional trigger: the two suffixes have the arbitrary lexical property of triggering a process (=raising) that is unexpected in this phonological context.[7]

---

[6] The two suffixes are derivational affixes whose meaning is not easily determinable. Often, it is category-changing and derives denominal adjectives. If /–uwɑ/ is added to verbs, it behaves like a causative suffix (Mahanta 2008: 100).

[7] It is reminiscent of but crucially different from the ATR-harmony systems of Maasai and Turkana (Bakovic 2000) where a participation of the only low vowel in the +ATR-harmony depends on its position: If the triggering [+ATR] vowel precedes a low vowel, the latter participates in the harmony and surfaces as [o]. However, the low vowel remains [ɑ] and blocks the harmony if the triggering [+ATR] vowel follows it. This interesting asymmetry is crucially different from Assamese where the participation of low vowels in the harmony process is solely lexical determined and hinges on the presence of one of the exceptional suffixes, not on linear position and morphological structure. We are grateful to an anonymous reviewer for pointing out this pattern.

(11)   *Exceptional suffixes as regular triggers*

(Mahanta (2008: 100), Mahanta (2012: 1120))

dʰʊl	'drum'	–ijɑ	dʰulijɑ	'drummer'
sɔr	'slap'	–ijɑ	sorijɑ	'to slap'
bɔjɔx	'age'	–ijɑ	bojoxijɑ	'aged'
gʊbɔr	'dung'	–uwɑ	guboruwɑ	'kind of beetle found in dung'
mɛr	'wind'	–uwɑ	meruwɑ	'wind' (CAUS)

2.3 Exceptional backness harmony

The second level of exceptionality in Assamese vowel harmony reveals itself with a closer look at the exceptionally raised low vowels. As can be seen in (12), those vowels always agree in backness with a preceding mid vowel. In all the contexts in (12), the opaque low vowel /ɑ/ is directly adjacent to one of the exceptional triggering suffixes /–ijɑ/ or /–uwɑ/ and is raised to a mid vowel and specified for [+ATR]. In the words in (12a), this vowel is preceded by back mid vowel and it surfaces as the back mid vowel [o]. In (12b), on the other hand, it is preceded by a front mid vowel and surfaces as the front mid vowel [e] as well. This therefore looks like a progressive vowel harmony pattern for the feature dimension [±back].[8] We will term this process 'exceptional backness harmony' in the following.

(12)   *Exceptional progressive backness harmony*

(Mahanta (2008: 216), Mahanta (2012: 1132))

a.	kɔpɑl	'destiny'	–ijɑ	kopolijɑ	'destined'	
	bɔzar	'marketplace'	–uwɑ	bozoruwɑ	'cheap'	
	pɔlɑx	'fertiliser'	–uwɑ	poloxuwɑ	'fertile'	
b.	dʰɛmɑli	'play'	–ijɑ	dʰemelijɑ	'playful'	*dʰemolijɑ
	ɛlɑh	'laziness'	–uwɑ	elehuwɑ	'lazy'	*elohuwɑ
	kɛsɑ	'raw'	–uwɑ	keseluwɑ	'rawness'	*kesoluwɑ
	dɛkɑ	'youth (male)'	–uwɑ	dekeruwɑ	'youthfulness'	*dekoruwɑ

This backness harmony is parasitic for height (Cole 1987; Krämer:2003): Two vowels only agree in backness if they are both mid vowels. This is illustrated with the data in (13). A preceding high front vowel does not trigger a change in the [–back] feature of a following derived mid vowel.

(13)   *No backness harmony after a high vowel*

(Mahanta (2008: 216), Mahanta (2012: 1121))

misɑ	'lie'	–ijɑ	misolijɑ	'liar'	*miselijɑ
kʰitap	'title'	–ijɑ	kʰitopijɑ	'renowned/titled'	*kʰitepijɑ
pixɑs	'evil spirit'	–ijɑ	pixosijɑ	'ill-natured'	*pixesijɑ

Crucially, this progressive backness harmony only targets phonologically derived mid vowels that result from an original low vowel, never for underlyingly mid ones. This can be seen in the data in (14) where underlyingly mid vowels with different values for

---

[8] Note that there is epenthesis to avoid a vowel hiatus in some data given below. As Mahanta (2012) mentions, there are some instances of epenthetic /l/ or /r/; the choice between them not being entirely clear (Mahanta 2012: 1121).

[±back] surface. The examples in (14a) are contexts where a suffix is added and potentially [+ATR] harmony applies and the examples in (14b) are monomorphemic roots.[9] The example /kɛwɔl–ijɑ/ (14a) is especially telling since it shows that even a disharmonic sequence of underlying mid vowels preceding one of the exceptional suffixes surfaces faithfully. The application of backness harmony thus crucially relies on vowel raising — only the presence of the exceptional trigger is not sufficient.

(14)　　*No backness harmony for underlying mid vowels*

(Mahanta 2008; 2012)

a.	pɔxɛk	'week'	–ɔt	pɔxɛkɔt	'week' Loc	M12:1113
	kʰɛtɔr	'evil spirit' (M)	–i	ketori	'evil spirit' (F)	M8:98
	xɛh	'last'	–ɔ–ti–jɑ	xehotijɑ	'recent'	M12:1112
	kɛwɔl	'only'	–ijɑ	kewolijɑ	'unmarried'	M8:100
	ɛ–kɔt	'inclining'	–ijɑ	ekotijɑ	'inclining to	M12:1113
b.	tɔbɛ	'therefore'			one side'	M8:73
	lɔkɛt	'locket'				M8:73
	bɛtɔn	'salary'				M8:73
	tɛrɔ	'thirteen'				M8:73

There are at least two possible characterization of these facts. One is to describe it as a phonologically Derived Environment Effect (=pDEE): Only vowels that are phonologically changed via raising can undergo fronting. On the other hand, one might argue that low vowels are simply representationally different from mid vowels and are consequently able to undergo more processes. Both these perspectives will be taken up in the two possible reanalyses in section 4.1 and 4.2 respectively.

A final restriction for the exceptional backness harmony is the fact that it is never triggered by prefixes. This is shown with the data in (15) where two mid vowels remain disharmonic for backness although the second vowel is derived from an underlying /ɑ/.

(15)　　*Fronting is never prefix-triggered*

(Mahanta (2008: 218), Mahanta (2012: 1132))

ɛ–pɑt	'one leaf'	–ijɑ	epotijɑ	'one branch-ed'
ɛ–sɑl	'one roof'	–ijɑ	esolijɑ	'one roof-ed'
ɛ–pɑt	'one leaf'	–uwɑ	epotuwɑ	'one leaf-ed'

We will not discuss this restriction any further and assume that this invisibility of prefixes is due to the morphological structuring. It is a well-known phenomenon attested in, for example, many Bantu languages that prefixes are often less phonologically integrated and fail to trigger/participate in processes that suffixes and roots easily engage in (Hyman 2008). Note that prefixes still undergo regressive [+ATR] harmony; i.e. the domains for the two harmony processes are different.

2.4 Summary of the empirical facts

The depictions in (16)–(19) summarize the crucial empirical facts about vowel harmony in Assamese. A regressive [+ATR] harmony pattern (16) is blocked by the opaque low vowel /ɑ/ (17). Two exceptional suffixes /–ijɑ/ and /–uwɑ/, however, trigger raising of an adjacent low /ɑ/ to a mid vowel that also undergoes [+ATR] harmony (18). These
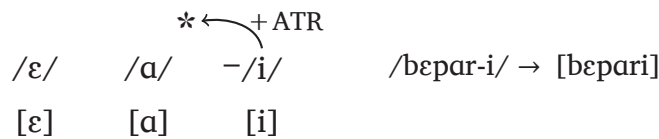
---

[9] As is emphasized in Mahanta (2012), underlying sequences of /ɛ-ɔ/ are very rare in the language (cf. the discussion below in section 5).

exceptionally raised mid vowels are also subject to an additional progressive backness harmony (19). Crucially, this latter process only applies between mid vowels if the second one is derived from an underlying low /ɑ/. Whereas the exceptional triggering for raising can therefore be described as a truly morpheme-specific process that only applies in immediate adjacency to certain lexical items, the exceptional undergoing of backness harmony is subtly different since it is restricted to vowels that were underlyingly low and are raised to mid vowels. Whereas all cases of exceptional backness harmony thus imply the presence of the exceptional suffixes since this is the only context for raising, the presence of the two exceptional suffixes does not imply exceptional backness harmony in all contexts. Most notably, an exceptional suffix that precedes underlyingly mid vowels does not trigger backness harmony. The exceptional backness harmony is therefore not an instance of an exceptional triggering for a process but involves exceptional undergoers: Only raised vowels undergo exceptional backness harmony.

(16)   *Regular [+ATR] harmony, cf. (6)*

+ATR

/ʊ/   −/i/   /gʊl-i/ → [guli]

[u]   [i]
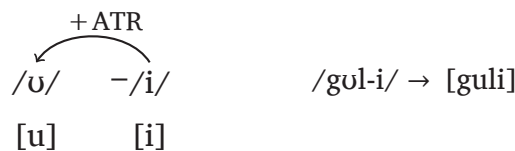
(17)   *Usually opaque low vowel, cf. (8)*

✻ ⟵ +ATR

/ɛ/   /ɑ/   −/i/   /bɛpɑr-i/ → [bɛpɑri]

[ɛ]   [ɑ]   [i]

(18)   *Exceptional raising, cf. (9)*

+ATR

/ɔ/   /ɑ/   −/i/ₐ   /kɔpɑl-ijɑ/ → [kopolijɑ]

−low

[o]   [o]   [i]

(19)   *Exceptional backness harmony, cf. (12)*

+ATR

/ɛ/   /ɑ/   −/u/ᵤwₐ   /ɛlɑh-uwɑ/ → [elehuwɑ]

−back   −low

[e]   [e]   [u]
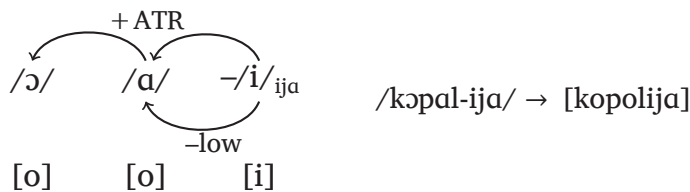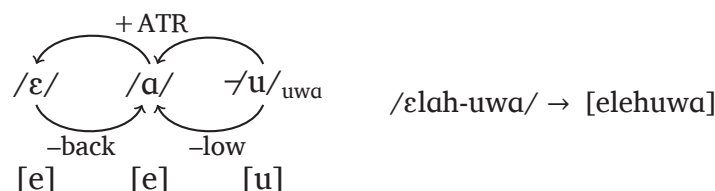
In the following section, we present a theoretical account of these patterns that is based on independently motivated purely phonological mechanisms. First, we present a floating features account for the exceptional raising (section 3) and, second, we show that the exceptional backness harmony falls out from either constraint cumulativity (section 4.1)

or underspecification (section 4.2), depending on the specific feature system one assumes for Assamese.

3 Analysis I: Exceptional triggers for raising

3.1 Background assumptions

The following analyses are implemented in the framework of Harmonic Grammar where violable constraints are weighted instead of ranked (= HG; Legendre et al. 1990; Smolensky & Legendre 2006; Potts et al. 2010). This assumption is vital for the proposed gang effect in subsection 4.1 whereas the remaining analyses in 3 and 4.2 could be implemented with the assumption of constraints in a fixed hierarchy (Prince & Smolensky 1993/2004).

The essential difference from classical Optimality Theory (= OT) with ranked constraints (Prince & Smolensky 1993/2004) is that constraints are assigned a numerical weight instead of being ranked with respect to each other. The evaluation of candidates in HG is based on a harmony score (= H) which is the sum of all its weight-violation products. This mechanism is briefly illustrated with the abstract toy example in (20): a constraint $Cons_A$ has a weight of 4, a lower-weighted constraint $Cons_B$ has only a weight of 3, and an even lower-weighted constraint $Cons_C$ has a weight of 2. An imaginable candidate $Cand_1$ violates $Cons_A$ once and a candidate $Cand_2$ violates $Cons_B$ and $Cons_C$. The harmony score for every candidate is calculated by taking all constraint violations times the weight of the respective constraint and summing up all these numbers. Since constraint violations are counted as negative numbers, the candidate with the highest harmony score is the optimal one: (20b) in our abstract example. One important prediction of HG that sets it apart from standard OT can already be seen in the toy example in (20): Multiple violations of lower-weighted constraints can gang up and result in a harmony score that is worse than the one of a candidate violating a higher-weighted constraint. More concretely, although $Cand_2$ violates only lower-weighted constraints $Cons_B$ and $Cons_C$ in (20), it has a worse harmony score than $Cand_1$ only violating a higher-weighted constraint $Cons_A$. The two lower-weighted constraints $Cons_B$ and $Cons_C$ 'gang up' against one higher-weighted constraints $Cons_A$. As is discussed in detail below, exactly this effect can predict pDEE — among other things — and will therefore be crucial in our account of exceptional undergoers in Assamese.

(20)　　*Abstract example: Harmonic Grammar*

		$Cons_A$	$Cons_B$	$Cons_C$	
	W =	4	3	2	H =
☞ a.	$Cand_1$	−1			−4
b.	$Cand_2$		−1	−1	−5

Our constraint set will be largely based on autosegmental representations for features inside Correspondece Theory (McCarthy & Prince 1995) where Max(F) and Dep(F) preserve feature specifications.[10] Schematic definitions are given in (21).

---

[10] An additional background assumption we make is pre-optimization of morphemes in a Stratal OT-model (cf. Trommer (2011); Bermúdez-Otero (in preparation)). This pre-optimization excludes morphemes with underspecified vowels or vowels specified for illicit feature combinations (which also includes /e/ and /o/, cf. footnote 2). For simplicity, each feature is linked to exactly one segment at the stem-level. Under the stem-level ranking, violations of the OCP are hence tolerated in order to avoid features associated to more than one host. This solves a potential Richness of the Base problem but is not central to our main claim otherwise.

(21)   a.   MAX(F)

Assign a violation for every [F] input feature without an output correspondent.

       b.   DEP(F)

Assign a violation for every [F] output feature without an input correspondent.

3.2 Regular [+ATR] harmony

Before we can turn to the analysis of the two exceptionality patterns in Assamese, an account for the regular [+ATR] vowel harmony needs to be established. For the account we present, it is in fact not crucial which constraint types derive such a well-attested system of dominant regressive vowel harmony. The only important fact is that the constraint interaction predicts that a [+ATR] feature spreads regressively and links to multiple vowels. Such a pattern can in principle easily be predicted by a constraint of the ALIGN-type (Kirchner 1993; Akinlabi 1994; Pulleyblank 1996), by a negative SPREAD constraint (Walker 1998; Padgett 2002), a positive SPREAD constraint in the Harmonic Serialism account of Kimper (2011), or by a constraint of the SHARE/AGREE-class (Bakovic 2000; Pulleyblank 2004; Mahanta 2012).

In the following, we adopt a constraint of the latter class since it is easily compatible with the assumption of autosegmental feature structures which is central to our proposal and since it easily predicts harmony which is parasitic on another feature. The specific SHARE constraint we adopt does not only explicitly refer to the linking of autosegmental features (in contrast to AGREE), it also easily allows us to specify a sub-class of participating vowels (McCarthy 2009; Mullin 2011; Zaleska 2018). More concretely, regular [+ATR] harmony is triggered by the SHARE constraint (22a) that demands all pairs of non-low vowels in adjacent syllables to share the same [ATR] feature. Given the vocalic feature specifications for Assamese in (4) and (5), this constraint refers to all mid and high vowels.

In contrast to simple SHARE constraints demanding sharing of a certain feature, this constraint has a context specification. Such a contextual markedness constraint predicts well-attested parasitic harmony patterns (cf., for example, Jurgec (2011; 2013): Only elements that are already similar with respect to some feature(s) strive to also agree in an additional feature value.[11] Another relevant markedness constraint is *[–ATR] (22b). Its weight ensures that SHARE(ATR)_{-low} only triggers a feature spread if this spread reduces markedness by keeping [–ATR] features from being realized. It predicts that [+ATR] is the dominant feature in the Assamese vowel harmony. We follow Bakovic (2000) in assuming that dominant-recessive vowel harmony systems can be construed of as assimilation to the unmarked feature value. Independent evidence on the markedness of [ATR] values in Assamese is inconclusive, going against the crosslinguistic tendencies observed in (Casali 2014) for the languages of Africa. For high vowels, [+ATR] seems to be the unmarked value (cf. the inventory gap for /ɪ/ and the additional restrictions on /ʊ/ (Mahanta 2008: 65)). As for the mid vowels, [–ATR] is less marked, since [+ATR] vowels only occur in

---

[11] Since Assamese does not have a [+ATR, +low]-vowel, an easy alternative would be the assumption of a general SHARE constraint that demands ATR-harmony for all vowels. The constraint *[+low, +ATR] (Archangeli & Pulleyblank 1994; Krämer 2003) would then simply exclude the unattested low vowel that participates in the harmony without raising. Nothing hinges on either implementation and we chose the parasitic harmony constraint mainly for reasons of consistency since another parasitic SHARE constraint will become relevant later on. Low vowels that do not participate in [+ATR] vowel harmony are very common, especially among languages of Africa (for overviews cf., for example, Casali 2003; 2008; Rose & Walker 2011). An example where the low vowel undergoes [+ATR] harmony is Diola-Fogny (Sapir 1969). In this language, a general SHARE(ATR) without any context specification would therefore be high-ranked.

derived environments. [–ATR] mid vowels and [+ATR] high vowels freely show up in affixes.

[+ATR] harmony in Assamese is always regressive. This finally follows from the fact that the directionality constraint *SPREAD-R$_{ATR}$ that prohibits rightwards spreading of ATR features has a very high weight.[12] In the following, we refer to these constraints penalizing spreading in a certain direction as faithfulness constraints. Its counterpart constraint *SPREAD-L$_{ATR}$ (22d), on the other hand, has a very low weight in Assamese. Since spreading of an [ATR] feature results in deletion of an underlying [ATR] feature, MAX(ATR) (22e) is also relevant and will be violated by all spreading processes. All constraints are given with their assumed weight in Assamese. It has be kept in mind that these numbers are of course only one exemplifying weight assignment and the crucial assumption are the relative weighting arguments of constraints to each other. Those are given below each tableaux in the following.

(22)　a.　SHARE(ATR)$_{-low}$　　　　　　　　　　　　　　　　　W = 15
　　　　　Assign a violation for every pair of [–low] vowels in adjacent syllables that are not linked to the same token of [ATR].

　　　b.　*[–ATR]　　　　　　　　　　　　　　　　　　　　　　W = 10
　　　　　Assign a violation for every [–ATR] feature in the output.

　　　c.　*SPREAD-R$_{ATR}$　　　　　　　　　　　　　　　　　　W = 100
　　　　　Assign a violation for every feature [ATR]$_a$ and segment S$_1$ that are associated in the output but not in the input if S$_1$ is the rightmost segment [ATR]$_a$ is associated to.

　　　d.　*SPREAD-L$_{ATR}$　　　　　　　　　　　　　　　　　　W = 5
　　　　　Assign a violation for every feature [ATR]$_a$ and segment S$_1$ that are associated in the output but not in the input if S$_1$ is the leftmost segment [ATR]$_a$ is associated to.

　　　e.　MAX(ATR)　　　　　　　　　　　　　　　　　　　　　W = 15
　　　　　Assign a violation for every [ATR] input feature without an output correspondent.

An example evaluation of how these constraints and their weight predict regular regressive ATR-harmony is given in (23) for a stem with a [–ATR] vowel to which a suffix with a [+ATR] vowel is added. The faithful candidate (23a) violates both SHARE(ATR)$_{-low}$ and *[–ATR] since the two vowels are associated to different [±ATR] features and one [–ATR] feature is present. The spreading candidate (23b) violates both MAX(ATR) and *SPREAD-L$_{ATR}$ since it deletes one underlying [–ATR] feature and spreads [+ATR] leftwards to a new vowel. The combined weight of SHARE(ATR)$_{-low}$ and *[–ATR], however, outweighs the combined weight of these two faithfulness constraints and (23b) emerges as the optimal candidate. Candidate (23c) where [–ATR] spreads progressively is sub-optimal because it

---

[12] We therefore assume that directionality in vowel harmony is not always epiphenomenal (contra the claim in, for example, Walker (1998); Finley & Badecker (2009) and similar to Bakovic (2000)) but is ensured by specific directionality constraints (reminiscent of, for example, SPANHEADL/R-constraints in span theory McCarthy (2004)). Alternatively, [+ATR] harmony could also be triggered by an alignment constraint that demands alignment of every [+ATR] features with the left edge of a prosodic word instead of SHARE. No directionality constraint would then be needed since rightward spread would not help avoiding a violation of ALIGN-L. It has to be emphasized that our account of the exceptionality is compatible with many different implementations and does not crucially rely on one or the other formal implementation.

violates not only MAX(ATR) and *[–ATR] but also the very high-weighted *SPREAD-R$_{ATR}$. The relevant weighting arguments established here are the ones in (24).

In all following tableaux, autosegmental structures are simplified and all relevant features are simply associated to an IPA symbol representing the resulting sound.[13] To keep the autosegmental structures in the following as readable as possible, we excluded correspondence-theoretic indices but marked all inserted (non-underlying) association lines as dotted lines and all epenthetic material with a grey background. To make the morphological structure clearer, all affix material is given in boldface.

(23)   *Regressive [+ATR] harmony*

–low –**low** –ATR +**ATR** p ɛ t – **u** W =	*SPREAD-R$_{ATR}$ 100	MAX(ATR) 15	SHARE(ATR)$_{–low}$ 15	*[–ATR] 10	*SPREAD-L$_{ATR}$ 5	H =
a. –low –**low** –ATR +**ATR** p ɛ t **u**			-1	-1		-25
☞ b. –low –**low** +**ATR** p e t **u**		-1			-1	-20
c. –low –**low** –ATR p ɛ t ʊ	-1	-1		-1		-125

(24)   *Weighting arguments*
   a.   w(SHARE(ATR)$_{–low}$) + w(*[–ATR]) > w(MAX(ATR)) + w(*SPREAD-L$_{ATR}$)
   b.   w(*SPREAD-R$_{ATR}$) + w(*[–ATR]) > w(*SPREAD-L$_{ATR}$)

Tableau (23) illustrates the [+ATR] harmony for a mid stem vowel, but it is clear that the same effect is predicted for high vowels. In an underlying form like /gʊl-i/ (cf. (6)), for example, a non-low [–ATR] vowel again precedes a non-low [+ATR] vowel and SHARE(ATR)$_{–low}$ is violated if both are not linked to the same [ATR] feature.

Note that in (23), both the directionality constraint *SPREAD-R$_{ATR}$ and *[–ATR] disfavour candidate (23c). Tableau (25) proves the relevance of both constraints and their respective weights independent of each other. In (25), a [+ATR] vowel precedes a [–ATR] vowel, a violation of SHARE(ATR)$_{–low}$ hence arises (25a). Regressive spreading of [–ATR] (25b) avoids this violation but does not help reducing the markedness of [–ATR] vowels — *[–ATR] is still violated. The crucial weighting argument (26a) thus shows a gang

---

[13] This IPA symbol abbreviates the segmental root node. Various views about the concrete nature of the feature-geometric representation of a segment can be implemented into the present account. For example, the question whether this 'root node' is an abstract timing slot or a phonological feature in itself is left open since both views are perfectly compatible with the analysis. In addition, if more than one feature is given for a segment, all features are simply associated to this segmental 'root node' leaving aside any questions of the internal hierarchical organization of the features. Cf., for example, Clements (1985); McCarthy (1988) or Clements & Hume (1995).

effect: SHARE(ATR)$_{-low}$ alone is not sufficient to trigger ATR-spreading in Assamese. Only the combined force of SHARE(ATR)$_{-low}$ and *[–ATR] can justify the faithfulness violations that arise from spreading the feature (cf. the weighting argument (24a)). The second spreading option (25c) avoids both violations of SHARE(ATR)$_{-low}$ and *[–ATR] but induces a new violation of the very high weighted *SPREAD-R$_{ATR}$ since spreading is regressive. In a context where only progressive [+ATR] harmony or regressive [–ATR] spreading are possible, a disharmonic structure violating SHARE(ATR)$_{-low}$ (25a) thus surfaces as optimal.

(25)　　*No progressive [+ATR] or regressive [–ATR] harmony*

	*SPREAD-R$_{ATR}$	MAX(ATR)	SHARE(ATR)$_{-low}$	*[–ATR]	*SPREAD-L$_{ATR}$	
−low −low +ATR −ATR b ú z – ɔ　　W =	100	15	15	10	5	H =
☞ a.　−low −low +ATR −ATR b ú z ɔ				-1	-1		-25
b.　−low −low −ATR b ʊ z ɔ			-1		-1	-1	-30
c.　−low −low +ATR b ú z o		-1	-1				-115

(26)　　*Weighting arguments*
　　　a.　w(MAX(ATR)) + w(*SPREAD-L$_{ATR}$) > w(SHARE(ATR)$_{-low}$)
　　　b.　w(MAX(ATR)) + w(*SPREAD-R$_{ATR}$) > w(SHARE(ATR)$_{-low}$) + w(*[–ATR])

So far, we have shown how the regressive dominant vowel harmony pattern follows in HG from a simple interaction of two markedness and standard faithfulness constraints. Since *SPREAD-R$_{ATR}$ has such a high weight and is never violated in any optimal structure of Assamese, we will not consider candidates spreading [±ATR] rightwards in the following tableaux anymore.

　Tableau (27) shows that the [+ATR] the analysis matches the data in producing iterative harmony in the output in Assamese and changing all non-low [–ATR] vowels preceding a [+ATR] vowel to [+ATR]. Here, a stem with two [–ATR] vowels precedes a suffix with a [+ATR] vowel. In candidate (27a), three non-low vowels are present, all associated to a [ATR]-feature on their own: Two violations of SHARE(ATR)$_{-low}$ arise. Since two of the vowels are [–ATR], two violations of *[–ATR] arise as well. Spreading the [+ATR] feature to only one of the vowels as in candidate (27b) already improves the harmony score since one violation of *[–ATR] is avoided. Similarly, spreading of [–ATR] avoids one SHARE(ATR)$_{-low}$ and one *[–ATR] violations (27c). However, these candidates still violate SHARE(ATR)$_{-low}$ once since there is still a pair of adjacent non-low vowels with different [±ATR] specifications. Candidate (27d) where [+ATR] harmony proceeds iteratively

through the word avoids this fatal violation and has the best harmony score. The relevant weighting argument (28) is identical to the one we established in (24): Every pair of SHARE(ATR)$_{-low}$ and *[–ATR] violations is worth another pair of MAX(ATR) and *SPREAD-L$_{ATR}$ violations.

It has to be noted that an additional candidate with association of [–ATR] to all three vowels would also avoid all SHARE(ATR)$_{-low}$ violations but would induce an additional violation of *[–ATR] and would replace one *SPREAD-L$_{ATR}$ violation with *SPREAD-R$_{ATR}$ which has a considerable higher weight (cf. tableau (23)). Spreading of [–ATR] hence always results in a worse harmony score than spreading of [+ATR].

(27)   *Iterative [+ATR] harmony*

	MAX(ATR)	SHARE(ATR)$_{-low}$	*[–ATR]	*SPREAD-L$_{ATR}$	
–low –low **–low** –ATR –ATR +**ATR** b ɔ s ɔ r – ɪ W =	15	15	10	5	H =
a. –low –low **–low** –ATR –ATR +**ATR** b ɔ s ɔ r ɪ		-2	-2		-50
b. –low –low **–low** –ATR +**ATR** b ɔ s o r ɪ	-1	-1	-1	-1	-45
c. –low –low **–low** –ATR +**ATR** b ɔ s ɔ r ɪ	-1	-1	-1	-1	-45
☞ d. –low –low **–low** +**ATR** b o s o r ɪ	-2			-2	-40

(28)   *Weighting argument*
       w(SHARE(ATR)$_{-low}$) + w(*[–ATR]) > w(MAX(ATR)) + w(*SPREAD-L$_{ATR}$)

The opacity of the low vowel /ɑ/ with regard to the [+ATR] harmony is a straightforward consequence of the definition of the SHARE(ATR)$_{-low}$ constraint that only demands parasitic sharing of an [ATR] feature if two vowels have matching [–low] feature specifications (cf. (22a)). The tableau (29) shows a relevant (abbreviated) context where a vowel /ɑ/ is followed by a [+ATR] vowel. Crucially, this configuration does not violate SHARE(ATR)$_{-low}$ since one of the vowels is [+low] and therefore excluded from the scope of the constraint. The faithful candidate (29a) consequently only violates *[–ATR]. This violation is avoided by spreading the [+ATR] feature in (29b). The violations of MAX(ATR) and *SPREAD-L$_{ATR}$ induced by this repair, however, induce a worse harmony score than the faithful candidate.

(29)　　/ɑ/ *does not undergo [+ATR] harmony*

+low　−low −ATR／ +ATR／ ɑ　−　i W =	Max(ATR)	Share(ATR)−low	*[−ATR]	*Spread-L_ATR	
	15	15	10	5	H =
☞ a. +low　−low −ATR／ +ATR／ ɑ　　i			-1		-10
b. +low　−low +ATR／ ɑ⋯⋯i	-1			-1	-20

(30)　　*Weighting argument*
　　　　w(Max(ATR)) + w(*Spread-L_ATR) > w(*[−ATR])

The important weighting argument established here is that only a violation of *[−ATR] is not a good enough reason to induce violations of Max(ATR) and *Spread-L_ATR, only a combination of *[−ATR] and Share(ATR)−low (24). This is yet again an instance of constraint ganging, i.e. a cumulative constraint interaction in HG.

　　Low vowels thus never undergo [+ATR] harmony in Assamese due to the context specification for Share(ATR)−low. Crucially, this also implies that they will always block [+ATR] harmony for any vowel further right in a word as in, for example /bɛpɑr–i/ (cf. (8)). For one, a [+ATR] feature can not associate to another preceding vowel across an intervening low vowel since association lines may never cross (Goldsmith 1976; Sagey 1986). Second, turning a vowel preceding a low vowel into a [+ATR] vowel as in *[bepɑri] would not help to avoid a Share(ATR)−low violation since the two now [+ATR] vowels are not in adjacent syllables.

　　Our account also predicts straightforwardly that monomorphemic stems in Assamese mirror the distribution of [±ATR] vowels we find in morphologically complex forms (cf. section 2.1): A stem with a disharmonic sequence of a non-low [−ATR] vowel followed by a [+ATR] vowel is predicted to be neutralized to a harmonic [+ATR] sequence (cf. tableau (23)) whereas a non-low [−ATR] vowel followed by a [+ATR] vowel followed by a non-low [−ATR] vowel is realized faithfully (cf. tableau (25)).

3.3 Exceptional raising and floating features

The exceptional triggers in Assamese are taken to be representationally different from regular non-triggers in Assamese. More concretely, the two exceptional affixes /–ijɑ/ and /–uwɑ/ triggering exceptional raising contain a floating [−low] feature that strives to associate to a preceding segment. Association of the floating feature is ensured by a set of constraints adapted from Wolf (2007). *Float (31b) penalizes any unassociated feature in the ouput whereas MaxFl (31a) penalizes deletion of an underlyingly floating element. Since an underlying [+low] specification is potentially overwritten by this floating feature, the Max constraint (31c) preserving an underlying [±low] feature is also relevant.[14]

---

[14] In Wolf (2007), underlying feature values are preserved by Ident constraints. However, it is emphasized that the paper 'attempt[s] to remain as agnostic as possible regarding whether Max(Feature) or Ident

(31) a. MAXFL $W = 100$
          Assign a violation for every floating input feature without an output
          correspondent.

      b. *FLOAT $W = 100$
          Assign a violation for every floating feature in the output.

      c. MAX(low) $W = 15$
          Assign a violation for every [low] input feature without an output
          correspondent.

If this underlyingly floating feature associates to a preceding vowel, it makes simultaneous realization of an underlying [–low] feature on this vowel impossible: A low vowel is raised and can now undergo regular [+ATR] harmony. This floating feature will only have an effect for a preceding low vowel: Preceding mid and high vowels are underlyingly already specified for [–low] and realization of the floating feature is possible without any surface effect. As is discussed in more detail below, there are in fact multiple autosegmental structures that will result in the same absence of a surface effect for a non-low vowel that precedes the floating [–low] feature.

An example derivation for an exceptional trigger is given in (32). The exceptional suffix /–ijɑ/ contains an additional unassociated feature [–low] that precedes all other phonological structure of this morpheme. Candidate (32a) is excluded because the floating feature is not associated to any vowel under violation of *FLOAT. Candidate (32b), on the other hand, is sub-optimal because the floating feature has been deleted which incurs a violation of the high-weighted constraint MAXFL. Candidate (32c) consequently wins even though the [+low] feature of the underlying /ɑ/ is deleted under violation of MAX(low). This tableau illustrates the high weight of MAXFL and *FLOAT that is crucially higher than the weight of MAX(low): overwriting of underlying features will therefore always be optimal since not realizing the floating feature results in a far worse harmony score.

(32) *Exceptional raising*

	MAXFL	*FLOAT	MAX(low)	
+low –low –low +low | | | s ɑ l – i j ɑ <div align=right>$W=$</div>	100	100	15	$H =$

a.   +low –low –low +low
       | | |
     s ɑ l   i j ɑ
		-1		-100

b.   +low   –low +low
      | | |
     s ɑ l   i j ɑ
	-1		-1	-115

☞ c.   –low   –low +low
     ⋮ | |
     s ö l   i j ɑ
			-1	-15

govern faithfulness to features underlyingly linked to segments' (p.324). We also do not imply a principled argument for MAXF or IDENTF constraints but adopt the former mainly for reasons of consistency: the adoption of MAXFLT already implies the general MAXF constraint schema. We hence follow proposals like Walker (1997) or Lombardi (1999). Arguments against MAXF, on the other hand, can be found in, for example, Keer (1999) or Struijke (2000).

(33)   *Weighting argument*
        w(*Float) > w(Max(low))

If the floating feature follows a vowel that is already [–low], four surface-identical options arise: The floating feature could overwrite the preceding [–low] feature (34a), it could associate to the vowel resulting in a redundant double specification (34b), it could remain floating (34c), or it could delete (34d), briefly illustrated in (34).

(34)   *Four surface-identical outputs: Floating [–low] and a non-low vowel*
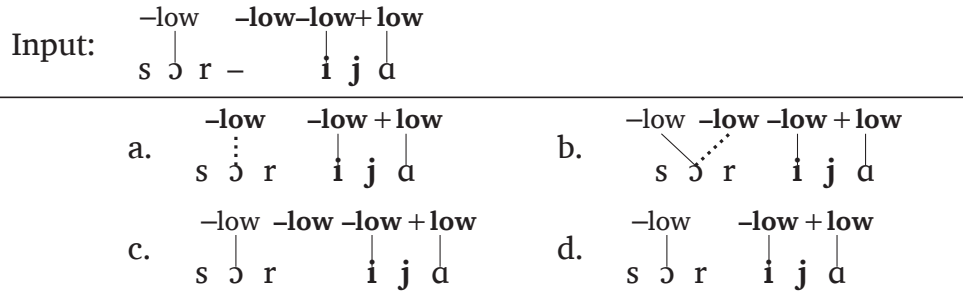
The choice between these strategies mainly depends on the weighting of the markedness constraint against multiple specifications for the same feature. We assume for now that it has a lower weight than MaxFl, *Float, and Max(low) which results in redundant double association. However, nothing hinges on this assumption and a weighting resulting in any of the other surface-identical options would also correctly predict the Assamese pattern.

    It follows that only an /ɑ/ adjacent to a triggering suffix can be raised since the suffix and its floating feature follow all base material and any reordering is excluded by high-weighted Linearity. We hence assume that morphemes are linearized in the input and the constraint Linearity penalizing metathesis demands preservation of this order (McCarthy & Prince 1995; Horwood 2002; McCarthy 2003b). Linearity constraints exist for all tiers of the phonological representation. The relevant one for Assamese is one preserving the order of height features (35). Tableau (36) shows briefly how its high weight ensures local realization of the floating feature. In candidate (35a), the floating [–low] feature is in its original position where it follows all height features of the stem and can only associate to the stem-final vowel.[15] In candidate (36b), however, it shows up in a linear position before the stem-final height feature and induces a fatal Linearity violation.

(35)   Lin(low)
        For every pair of output [low]-features $[low]_1$ and $[low]_2$ corresponding to the input features $/low/_1$ and $/low/_2$, assign a violation if $/low/_1$ precedes $/low/_2$ but $[low]_2$ precedes $[low]_1$.

---

[15] In addition, the floating feature can never associate to the vowel of the suffix /–ijɑ/ or /–uwɑ/. This can fall out from an explicit constraint against tautomorphemic docking of floating features (Wolf 2007: 317) or a more general constraint banning any homomorphemic new associations (cf. Alternation in van Oostendorp 2007; Wolf 2007; van Oostendorp 2012). Since [+ATR] is indeed assumed to spread homomorphemically (cf. 2.1), feature-specific versions of Alternation are assumed and only Alternation$_{low}$ is high-weighted and Alternation$_{ATR}$ has a relatively low weight in Assamese.
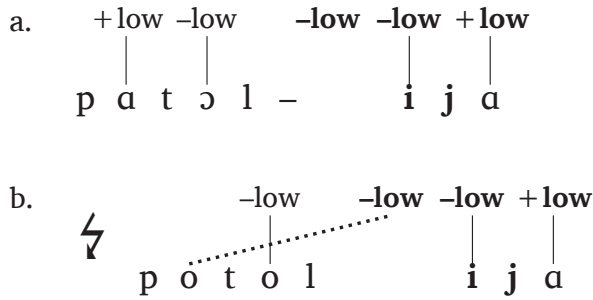
(36)   *Local realization of the floating [–low]*

	LIN(LOW)	MAXFL	*FLOAT	MAX(low)	
$+low_1 +low_2 \quad -low_3 \; -low_4 +low_5$ ɑ l ɑ x – u w ɑ $\hspace{8cm} W =$	100	100	100	15	H =
☞ a. $+low_1 -low_3 \quad -low_4 +low_5$ ɑ l ö x u w ɑ				-1	-15
b. $-low_3 +low_2 \quad -low_4 +low_5$ ö l ɑ x u w ɑ	-1			-1	-115

Since LINEARITY is a violable constraint, languages are predicted where floating features have non-local or infixing effects. Morphological labialization in Chaha is one example where such non-locality is apparently borne out (McCarthy 1983; Akinlabi 1996; Rose 2007; Banksira 2013). The third person object in Chaha is marked by labialization of the rightmost labial or dorsal consonant. It potentially skips several non-labializable coronal consonants. In contrast to the Assamese grammar with a very high-weighted LINEARITY, the markedness constraints against labialized coronal consonants will hence have a higher weight than LINEARITY in Chaha. However, it is apparent that in the typology of featural affixation (Akinlabi 1996; Zoll 1996), edge-realization is by far the most frequent pattern and Chaha is one of few examples for non-local realization of features. A more restrictive theory would assume that phonologically-driven reordering of elements concatenated in the morphology is inherently impossible. Infixation then results from affixation to a certain anchor or pivot position of a base that might potentially be inside the base (Yu 2002; 2007). It has been argued in Zimmermann & Trommer (2013) and Zimmermann (2017) that this restricted theory is empirically correct for affixation of prosodic nodes.

We will leave this issue for future research and assume for now that LINEARITY ensures that the [–low] feature cannot leave its base position. It also cannot dock to a non-final vowel of its base from this underlying position. This follows from an inviolable ban on crossing association lines (Goldsmith 1976; Sagey 1986); a well-motivated principle about well-formed autosegmental associations (Goldsmith 1976). The depiction in (37) illustrates this for an exceptionally triggering suffix that follows a bisyllabic stem with an initial low vowel. Raising of this initial vowel triggered by the floating feature of the exceptional suffix implies that the [–low] associates across an intervening [–low] specification of a vowel (37b).[16]

---

[16] Realizing the floating [–low] on the penultimate vowel but not on the final without violating LINEARITY or crossing association lines implies that the [±low] specification of the final vowel is deleted. Such a deletion of the intervening feature implies not only a violation of MAX(low) but also one of either HAVE(low) demanding a [±low] specification for every vowel or of DEP(low) penalizing insertion of epenthetic [±low] features. Both these constraints are never violated in a winning candidate and consequently have a very high weight.

(37)   *Non-local exceptionality results in crossing association lines*

    a.   +low –low   **–low** **–low** +**low**

        p ɑ t ɔ l –   i j ɑ

    b.   –low   **–low** –low +low

                p o t o l   i j ɑ

The locality restriction that only a vowel which is adjacent to the exceptional suffix is ever raised in Assamese hence straightforwardly falls out from the high weight of Linearity and standard assumptions about autosegmental structures in our account. This point will become important again in section 5 where we emphasize that this locality restriction follows from an additional assumption specific to locality in the alternative account based on lexically indexed constraints.

We propose a representational solution to the exceptional raising in Assamese: The two suffixes are exceptional triggers for raising a low vowel since their underlying representation is different from non-triggering suffixes and contains additional phonological material that needs to be realized. Such an account is reminiscent of the many arguments that morphological feature mutation is due to floating or unassociated phonological material (Lieber 1992; Zoll 1996; Akinlabi 1996; Wolf 2007). This makes this account purely phonological in the sense that the phonological grammar or constraint ranking makes no specific reference to these exceptional morphemes: The constraint inventory refers solely to phonological information.

A reviewer points out that under this assumption it is entirely accidental that the suffixes triggering exceptional raising are of a rather similar shape. Both end in a sequence of a glide and /ɑ/ and — more importantly — both start with a high vowel. One might therefore be tempted to analyse this pattern as an exceptional raising harmony triggered by those high vowels. In contrast, we are convinced that the floating feature account is warranted in general and hence reasonable for Assamese if one considers the broader typological picture. There does not seem to be a general correlation between the segmental content of an affix and its potential to trigger an exceptional feature change (cf., for example, Lieber (1987) or Gleim et al. (in progress). In the closely related language Bengali, for instance, the perfect participle suffix -/e/ exceptionally raises mid vowels (e.g. in [ʃon-a] 'to hear') to high vowels (cf. [ʃun-e] 'heard' (David 2015)), even though it does not contain a high vowel itself. Furthermore, this exceptional raising can be triggered by consonantal suffixes that do not include any vowel at all. A prime example is the future tense suffix -/b/ that derives the third person future tense form [ʃun-b-e] from the third person present tense form [ʃon-e].

The more general typological picture also confirms this picture. A quick survey of exceptional vowel raising/lowering in thirteen language (excluding Assamese) reveals that in the majority of nine languages the triggering affix does not necessarily contain a vowel specified for the feature value that the process triggers on a neighbouring vowel. The triggering suffix can also include only vowels specified for the opposite feature value. This is the case in three of these languages which can be classified as morpheme specific dissimilations. In only one language, it is generally true that the triggering affix includes a vowel

with the feature value it triggers on a neighbouring vowel.[17] Even though the sample size is very small, it confirms the claim that morphologically conditioned exceptional height changes can be idiosyncratic with respect to the vowel specifications of the triggering affix. Since a mechanism like featural affixes is needed for those languages in any case, it is only natural to extend this proposal to cases like Assamese.

4 Analysis II: Exceptional undergoers of fronting

The tableau (32) was only a first illustration of the basic mechanism of floating feature realization that ignored the concomitant feature changes which are necessary if the float-ing [–low] feature associates. Which additional feature changes are necessary if a low vowel is raised to a mid vowel and surfaces as [e] or [o] depends on the choice between a fully specified or contrastive feature system (cf. 2.1). Since we want to emphasize the generality of a phonological reanalysis for this pattern, we will now present one possible reanalysis for the exceptional undergoers in Assamese for each of these possible feature systems: Under a fully specified vocalic feature system, the exceptional undergoers can be interpreted as a phonologically Derived Environment Effect and fall out from constraint ganging 4.1 and under a contrastive feature system, they are a simple Emergence of the Unmarked Effect for underspecified vowels.

4.1 Fully specified feature system: A gang effect

The first possible feature system describing the Assamese vowels we introduced in 2.1 is repeated in (38): It assumes a value for each of the 5 features for each vowel. It is a substantive feature system that assumes a full specification for each articulatorily defined feature (Kiparsky 1965; Chomsky & Halle 1968).

(38)   *Fully specified feature system (cf. (4))*

	high	low	back	round	ATR
i	+	–	–	–	+
u	+	–	+	+	+
ʊ	+	–	+	+	–
e	–	–	–	–	+
ɛ	–	–	–	–	–
o	–	–	+	+	+
ɔ	–	–	+	+	–
ɑ	–	+	–	–	–

Under this feature specification, if the [+low] value of /ɑ/ is overwritten with [–low], a mid non-round back vowel [ɤ] would result which is illicit in Assamese (cf. (3)). Rais-ing of a mid vowel thus implies a change of either the [±back] specification resulting in [e] or the [±round] specification resulting in [o], illustrated in (39). We argue in the following that the latter realization as [o] is the default strategy but that the alternative

---

[17] Our sample includes ⁕Basáa (Niger-Congo, Africa, Hyman 2003), ⁕Bengali (Indo-European, Asia, David 2015), ⁕Nzadi (Niger-Congo, Africa, Crane et al. 2011), ⁕Kisi (Niger-Congo, Africa, Childs 2011), ⁕Lakota (Siouan, North America, Paschen 2018), ⁕Lele (Boettger 2015), ⁕Fox (Algic, North America, Paschen 2018), ⁕Tauya (Trans-New Guinea, Oceania, Macdonald 2011), ⁕Kulina (Pano-Tacanan, North America, Paschen 2018), ⁼Kele (Austronesian, Oceania, Ross 2002), ↪Yeri (Nuclear Torricelli, Oceania, Wilson 2017), ↪Hua (Trans-New Guinea, Oceania, Haiman 1980) and ↪Tamashek Berber (Afro-Asiatic, Africa, Bye & Svenonius 2012). ↪marks dissimilatory patterns and ⁼marks assimilatory patterns. Mixed patterns are marked with an ⁕.

realization as [e] follows if additional backness harmony with a preceding mid vowel can be achieved.

(39)   *Concomitant feature changes after raising of low vowels*
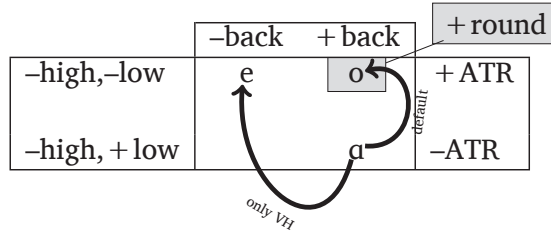
If a missing feature [+round] or [–back] must be provided, there are two basic strategies: Epenthesis under violation of DEP or spreading under violation of *SPREAD-R/L$_\text{F}$. Additionally, both these operations violate MAX(F) since an underlying feature specification is overwritten. The full set of these three relevant faithfulness constraints for the features [±round] and [±back] are given in (40) together with their weight in our account of Assamese.[18] Both these strategies imply of course an additional violation of MAX constraints (40f + g). It is shown in the following that Assamese in fact employs different strategies for providing different features: New specifications of [±round] can only be provided via epenthesis whereas new specifications of [±back] can only be provided by rightwards spreading. This asymmetry is already apparent in the constraint weights: Whereas DEP(round) has a lower weight than *SPREAD-R$_\text{round}$, *Spread-R$_\text{back}$ has a lower weight than DEP(back).

(40)   a.   *ɤ   W = 100
              Assign a violation for every vowel specified for [–low, –round, +back].

        b.   DEP(round)   W = 10
              Assign a violation for every [round] output feature without an input correspondent.

        c.   DEP(back)   W = 100
              Assign a violation for every [back] output feature without an input correspondent.

        d.   *SPREAD-R$_\text{round}$ W = 100
              Assign a violation for every feature [round]$_a$ and segment S$_1$ that are associated in the output but not in the input if S$_1$ is the rightmost segment [round]$_a$ is associated to.

        e.   *SPREAD-R$_\text{back}$ W = 15
              Assign a violation for every feature [back]$_a$ and segment S$_1$ that are associated in the output but not in the input if S$_1$ is the rightmost segment [round]$_a$ is associated to.

        f.   MAX(back)   W = 15
              Assign a violation for every [back] input feature without an output correspondent.

---

[18] Only rightwards spreading is considered and leftwards spreading is taken to be excluded for [±back] and [±round] (= both *SPREAD-L$_\text{back}$ and *Spread-L$_\text{round}$ have a weight of 100). This of course different from the [+ATR] feature that can only spread leftwards in Assamese.

g. MAX(round)   W = 10
    Assign a violation for every [round] input feature without an output corre-
    spondent.

A first illustration of the default state for [o] as the default after vowel raising is illustrated
in tableau (41) where the context (32) of a monosyllabic stem with the low vowel /ɑ/
preceding an exceptional triggering suffix is shown again. Since no vowel precedes the
raised vowel, rightwards spreading of either [−back] or [+round] is trivially not an option
in such a case and the decision for which mid vowel is realized is made by the weightings of
MAX(back) and DEP(back) as well as MAX(round) and DEP(round) respectively. Realizing
the newly created mid vowel as [o] in candidate (41b) implies violations of MAX(round)
and DEP(round) and realization as [e] in (41c) the mirror violations of MAX(back) and
DEP(back). Since the former constraints have a lower weight sum than the latter two,
(41b) wins the competition. The crucial weighting argument that insertion of an epenthetic
[±round] is less costly than insertion of an epenthetic [±back] is given in (42). Note that
we omit the feature specifications of final low vowels in the following to ease readability
since those vowels are not expected to trigger or undergo any processes in our analysis.

(41)   *Exceptional raising: Back round vowel as default*

(42)   *Weighting argument*
        w(MAX(back)) + w(DEP(back)) > w(MAX(round)) + w(DEP(back))

Given that epenthesis for [−back] and spreading of [+round] are penalized by constraints
with such a high weight, we will disregard these options in the following tableaux. We
will also exclude the candidate (42a) that creates the illicit vowel [ɤ] — it should be clear

from the high weight of *ɤ that this is always a sub-optimal option and only [o] or [e] can result from raising.

An insightful context that illustrates whether [o] or [e] surface as default vowel for a raised mid vowel is (43) where a high front vowel precedes a low vowel. It can be seen that epenthesis of [+round] resulting in [o] (43a) is indeed the default strategy to form new mid vowels that is preferred over spreading of [–back] (43b). This default state of [o] is an argument that the combined relative weightings of MAX(back) and *SPREAD-R$_{back}$ are higher than the ones of MAX(round) and DEP(round), cf. (44).

(43)　　*Epenthesis of [+round] rather than spreading of [–back]*

	*ɤ	MAX(back)	*SPREAD-R$_{back}$	MAX(round)	DEP(round)	
W =	100	15	15	10	10	H =
☞ a.				-1	-1	-20
b.		-1	-1			-30

(44)　　*Weighting argument*
　　　　w(MAX(back)) + w(*SPREAD-R$_{back}$) > w(MAX(round)) + w(DEP(back))

We argue that spreading of [–back] to provide a licit new mid vowel is only possible in a single context in Assamese, namely when additional backness harmony with a preceding mid vowel can be achieved for a low vowel that is raised to a mid vowel.

The one context where spreading of [–back] applies to ensure backness harmony is in fact the pDEE we identified in 2.2: Only a low vowel that is raised to a mid vowel and follows a mid vowel with another [±back] specification undergoes backness harmony. This additional backness harmony as pDEE follows in our HG account from constraint cumulativity when a very low-weighted constraint demanding additional backness harmony gangs up with the faithfulness constraints MAX(round) and DEP(round) that are violated by the default strategy to provide a new mid vowel. A structure that is disharmonic with respect to backness in mid vowels is thus expected in most contexts, namely in all contexts where a low vowel is not raised to a mid one.

The relevant constraint favoring parasitic backness harmony is a SHARE constraint that requires mid vowels to agree in backness SHARE(back)$_{-lo,-hi}$ (45). As we can see in the tableaux (46), its weight is relatively low and it consequently never triggers backness harmony for underlying mid vowels. More concretely, the combined respective weights of MAX(back) + *SPREAD-R$_{back}$ and MAX(round) + DEP(round) are higher than the weight of SHARE(back)$_{-lo,-hi}$. All these four faithfulness constraints are violated if backness spreading applies (46b) since in addition to the change of [–back] into [+back], the vowel also needs to change its [+round] into [–round] to form a licit vowel [e]. As was established above, this additional change can only happen via epenthesis and implies a violation of MAX(round) and DEP(round). The candidate (46a) that violates SHARE(back)$_{-lo,-hi}$ is therefore the optimal one.

(45)   SHARE(back)$_{-lo,-hi}$ W = 15
         Assign a violation for every pair of [–high, –low] vowels in adjacent syllables
         that are not linked to the same token of [back].

(46)   *Preservation of the backness specification for underlying mid vowels*

	MAX(back)	*SPREAD-R$_{back}$	SHARE(back)$_{-lo,-hi}$	MAX(round)	DEP(round)	
W =	15	15	15	10	10	H =
☞ a.			-1			-15
b.	-1	-1		-1	-1	-50

(47)   *Weighting argument*
         w(MAX(back)) + w(*SPREAD-R$_{back}$) + w(MAX(round)) + w(DEP(round)) >
         w(SHARE(back)$_{-lo,-hi}$)

In a context where an underlyingly low vowel is exceptionally raised to a mid vowel, however, the situation is crucially different. As was shown in (41), the expected default mid vowel for the exceptionally raised low vowel is the back round vowel [o] that results from epenthesis of [+round] and implies a violation of MAX(round) and DEP(round). If the raised mid vowel is preceded by a front mid vowel, however, this default strategy

implies an additional violation of SHARE(back)$_{-lo,-hi}$. This violation was avoided in all previous tableaux since the raised mid vowel was either not preceded by a vowel (cf. (41)) or preceded by a high front vowel (cf. (43)). The tableau (48) now adds the crucial final context of a raised mid vowel preceded by a mid front vowel. Candidate (48a) that undergoes the default strategy of [+round] insertion has two mid vowels with different backness specifications [e] and [o] and violates SHARE(back)$_{-lo,-hi}$ in addition to MAX(round) and DEP(round). The alternative strategy of spreading [–back] (48b) avoids this violation and becomes optimal.

(48)　　*Exceptional backness harmony*

	MAX(back)	*SPREAD-R$_{back}$	SHARE(back)$_{-lo,-hi}$	MAX(round)	DEP(round)	
W =	15	15	15	10	10	H =
a.			-1	-1	-1	-35
☞ b.	-1	-1				-30

(49)　　*Weighting argument*
　　　　w(SHARE(back)$_{-lo,-hi}$) + w(MAX(round)) + w(DEP(back)) >
　　　　w(MAX(back)) + w(*SPREAD-R$_{back}$)

Since SHARE(back)$_{-lo,-hi}$ is parasitic on height, no additional backness changes are predicted if an exceptionally raised low vowel is preceded by high vowel. For underlying /misɑ–ijɑ/ (13), for example, only association of the floating [–low] feature and regressive [+ATR] harmony is predicted: SHARE(back)$_{-lo,-hi}$ is not violated by winning [misolijɑ]. The trigger for the exceptional backness harmony is absolutely parallel to the trigger for regular [+ATR] harmony: It is a SHARE constraint demanding parasitic vowel harmony for vowels that share certain features. As for the [+ATR] harmony, the backness harmony is consequently predicted to be potentially iterative since every pair of adjacent mid vowels with different backness specifications violate the constraints. The weights of constraints in Assamese, however, predict that this change is only possible if the mid vowel that is expected to change is a derived mid vowel — and those only appear in the very restricted context preceding one of the two suffixes that contain an additional floating [–low] feature. The non-iterativity of backness harmony is therefore a simple epiphenomenon following from the pDEE in Assamese.

The crucial difference between an underlying mid vowel (48) and an underlying low vowel that is raised in the context of an exceptional suffix (49) is the fact that the latter has to change either its frontness or its backness anyway to be a well-formed mid vowel of the language. In such a case, the low-weighted constraint demanding a harmonic sequence with respect to backness is crucial and prefers the harmonic sequence.

All the constraint weights of this first possible analysis of Assamese based on a fully specified feature system are summarized again in (50). It is important to keep in mind, however, that these are only some exemplary weights that illustrate the relevant weighting arguments we discussed throughout the preceding subsections. Though the final number of constraints looks rather large, it merely includes many specific versions of general constraint types. There are, for example, only the three general types of faithfulness constraints MAX(F), DEP(F), and *SPREAD (=for L and R respectively) for every relevant feature.

(50)　　*All constraint weights*

*ɣ	100
*FLOAT	100
MAXFL	100
*SPREAD-R$_{ATR}$	100
*SPREAD-L$_{back}$	100
*SPREAD-R$_{round}$	100
*SPREAD-L$_{round}$	100
DEP(back)	100
SHARE(back)$_{-lo,-hi}$	15
SHARE(ATR)$_{-low}$	15
*SPREAD-R$_{back}$	15
MAX(back)	15
MAX(low)	15
MAX(ATR)	15
MAX(round)	10
DEP(round)	10
*[–ATR]	10
*SPREAD-L$_{ATR}$	5

In our analysis, the regressive [+ATR] harmony follows from a SHARE(ATR)$_{-low}$ constraint and the fact that [+ATR] is the dominant feature from the markedness constraint *[–ATR]. The exceptional raising was analysed as an instance of featural affixation: The exceptional suffixes contain a floating [–low] feature in their lexical representation (cf. section 3).

If a fully specified feature system is assumed, the exceptional backness harmony is a pDEE that is predicted by constraint ganging. The core weighting arguments for the exceptional targets are repeated in (51). First, we established that [o] is in principle the default option for deriving a mid vowel after raising (51a). If this option would result in a newly created disharmonic sequence of mid vowels not agreeing in their backness specification, an [e] is created instead (51b).

These weighting arguments illustrate a gang effect: Whereas MAX(round) and DEP(round) together have a lower weight than MAX(back) and *SPREAD-R$_{back}$ together, the combination of MAX(round), DEP(round), and SHARE(back)$_{-lo,-hi}$ overtakes the combination of MAX(back) and *SPREAD-R$_{back}$. Consequently, the relevant markedness constraint SHARE(back)$_{-lo,-hi}$ only has an effect in derived environments and never causes a change for disharmonic sequences of underlyingly mid vowels (51c). This follows since

the derived mid vowel has to violate one of the relevant faithfulness constraints anyway: Since a violation of MAX(back) and *SPREAD-R$_{back}$ or of MAX(round) and DEP(round) is unavoidable in such a context anyway (cf. (41)), the derived mid vowel is free to satisfy the lower-weighted markedness constraint SHARE(back)$_{-lo,-hi}$: An emergence of the unmarked effect (McCarthy & Prince 1994; Becker & Flack Potts 2011) in a derived environment results.

These gang effects are apparently rather intricate since they involve the combination of two and three constraints respectively. In HG, such an interaction is straightforwardly predicted since all constraint violations contribute to the harmony score for a candidate.

(51)　　*Gang effects*
　　　a.　*Back vowel as default for raised mid vowel (cf. (41))*
　　　　　w(MAX(back)) + w(*SPREAD-R$_{back}$) > w(MAX(round)) + w(DEP(round))

　　　b.　*Backness harmony for derived mid vowels (cf. (48))*
　　　　　w(SHARE(back)$_{-lo,-hi}$) + w(MAX(round)) + w(DEP(round))
　　　　　> w(MAX(back)) + w(*SPREAD-R$_{back}$)

　　　c.　*No backness harmony for underlying mid vowels (cf. (46))*
　　　　　w(MAX(back)) + w(*SPREAD-R$_{back}$) + w(MAX(round)) + w(DEP(round))
　　　　　> w(SHARE(back)$_{-lo,-hi}$)

The depiction in (53) visualizes this effect. Whereas an underlying mid vowel cannot become fronted to fulfill the vowel harmony constraint, a derived mid vowel resulting from an original low vowel can indeed undergo fronting. On its path to become a licit mid vowel, this originally low vowel has to change some features anyway, it can hence use this feature change as a free ride to fulfill the vowel harmony demand.

(52)　　*Possible paths to change a vowel*
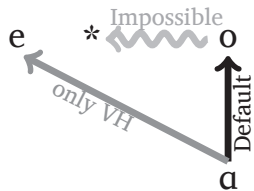
A comparable account with ranked constraints cannot predict the Assamese pattern under the assumptions we made. This is apparent from the weighting arguments in (51). If they were understood as ranking arguments, it is clear that they result in a ranking paradox for MAX(round) and DEP(round) as well as MAX(back) and *SPREAD-R$_{back}$. The faithfulness constraints for [±back] must outrank those for [±round] to ensure the [o] is the default vowel for a raised low vowel (53a). Furthermore, to allow backness harmony for derived mid vowels, SHARE(back)$_{-lo,-hi}$ must outrank MAX(back) and *SPREAD-R$_{back}$ (53b). But given these ranking arguments, transitivity excludes that any pair of these faithfulness constraints can dominate SHARE(back)$_{-lo,-hi}$ to block backness harmony for an underived mid vowel. Either MAX(back) and *SPREAD-R$_{back}$ or MAX(round) and DEP(round) on their own would be sufficient to exclude this unattested vowel harmony, but both these rankings (53c) result in a ranking paradox.

(53)　　*Ranking paradox without HG*
　　　a.　*Back vowel as default for raised mid vowel*
　　　　　MAX(back), *SPREAD-R$_{back}$　≫　MAX(round), DEP(round)

　　　b.　*Backness harmony for derived mid vowels*
　　　　　SHARE(back)$_{-lo,-hi}$　≫　MAX(back), *SPREAD-R$_{back}$

    c.   *No backness harmony for underlying mid vowels*
        MAX(back), *SPREAD-R$_{back}$ ≫   SHARE(back)$_{-lo,-hi}$ ⚡vs. a. + b.
                                or
        MAX(round), DEP(round)   ≫   SHARE(back)$_{-lo,-hi}$ ⚡vs. b.

The constraint ganging in (51) involves a markedness (= SHARE(back)$_{-lo,-hi}$) and two faithfulness constraints (= MAX(round) + DEP(round)) that together outweigh two other faithfulness constraints (= MAX(back) + *SPREAD-R$_{back}$). It has already been argued in Farris-Trimble (2008b) that faithfulness constraints can gang up and predict non-derived environment blocking. The Assamese pattern is interestingly different since the weights of faithfulness and markedness constraints gang up. The relation of the pDEE in Assamese to DEE's as cumulative effects in general is discussed in more detail in 6.1.

4.2 Contrastive feature specification: Emergence of the Unmarked

In this subsection, we now turn to an alternative possible feature system for Assamese and its consequences for the theoretical account. The account in the last section is based on the fully specified feature system in (54) where all vowels are underlyingly specified for [±high], [±low], [±ATR], [±back], and [±round]. Under the contrastivist hypothesis that the phonology only operates on those features that are necessary to distinguish the phonemes of a language (Dresher et al. 1994; Hall 2007; Dresher 2009), the vowel system in Assamese is represented with fewer underlyingly specified features. Either [±back] or [±round] is sufficient to distinguish the non-low vowels /e, ɛ, i/ and /o, ɔ, u, ʊ/ respectively since there are no unrounded back vowels or round front vowels. Moreover, since there is only a single low vowel, /ɑ/ could only be specified for being low and lack any frontness or [±ATR] specification.[19] One possible contrastive feature system for the Assamese vowels is given in (54).

(54)   *Contrastive feature system (cf. (5))*

	high	low	back	ATR
i	+		−	+
u	+		+	+
ʊ	+		+	−
e	−	−	−	+
ɛ	−	−	−	−
o	−	−	+	+
ɔ	−	−	+	−
ɑ	−	+		

Interestingly, the account for exceptional fronting in Assamese more or less falls out without any additional assumptions or constraints under this contrastive feature system. This mainly follows from the fact that the only low vowel /ɑ/ is radically underspecified in such a contrastive feature system. That only /ɑ/ undergoes exceptional fronting in case it is raised to a mid vowel then follows as an Emergence of the Unmarked: The faithfulness constraints preserving fronting for other vowels are irrelevant for this underspecified vowel. This account is briefly illustrated below.

    Our illustration of the account starts — as in 4.1 — with a closer investigation of the concomitant feature changes that are relevant if a low vowel is raised because a floating [−low] feature needs to be realized (cf. (39)). In such a context, the vowel is also provided

---

[19] A more radical underspecified feature system would presumably even lack a [−high] specification for the mid and low vowels. The following argumentation is perfectly compatible with this further underspecification. This alternative more radical underspecification account would just need some additional constraint(s) ensuring that a raised low vowel becomes mid and not high.

with a [+ATR] specification since SHARE(ATR)$_{-low}$ demands independent ATR-harmony. We end up with a mid vowel that is specified for [–high,–low, +ATR] and has no value for backness. Since backness is contrastive for mid vowels, such a specification is necessary in Assamese, ensured by (55a). Again mirroring the account proposed in 4.1, we assume that the default mid vowel is back [o]. Under the contrastive feature system, this is simply ensured by the relative weightings of *e (55b) and *o (55c). Both have a relatively low weight and only show their effect in this context where a choice between the two mid vowels must be made.

(55)   a.   HAVE(BK)$_{-lo,-hi}$ W = 100
               Assign a violation for every vowel specified for [–high, –low] that has no specification for [±back].

         b.   *e   W = 5
               Assign a violation for every vowel specified for [–high, –low, –back].

         c.*   o   W = 1
               Assign a violation for every vowel specified for [–high, –low, +back].

How these weights predict the default realization of a raised low vowel as [o] is shown in tableau (56). Only realization of [–low] and spreading of [+ATR] fatally violates HAVE(BK)$_{-lo,-hi}$ (56a) (the underspecified mid vowel is notated as [O] for reasons of simplicity). The choice between inserting [–back] (56b) and [+back] (56c) is then made in favor of the latter due to the fact that *e has a higher weight than *o. For completeness, DEP(back) is also given which is violated in both candidates that insert [±back] (56b) + (56c). As in all other autosegmental structures, the [±high] feature is omitted to make the depictions more readable.

(56)   *Exceptional raising: Back vowel as default*

	HAVE(BK)$_{-lo,-hi}$	DEP(back)	*e	*o	H =
W =	100	10	5	1	
a.	-1				-100
b.		-1	-1		-15
☞ c.		-1		-1	-11

(57)   *Weighting arguments*
    a.   w(HAVE(BK)$_{-lo,-hi}$) > w(DEP(back)) + w(*o)
    b.   w(*e) > w(*o)

The trigger for fronting is taken to be absolutely identical to the one assumed in 4.1: SHARE(back)$_{-lo,-hi}$ demands that adjacent mid vowels should be associated to the same [±back] feature. As in the account in 4.1, leftward spreading of [±back] is taken to be excluded by a very high weight for *SPREAD-L$_{back}$ (=100). Backness harmony is hence always progressive in Assamese and we won't consider candidates in the following that spread the feature regressively.

(58)   SHARE(back)$_{-lo,-hi}$ W = 15
    Assign a violation for every pair of [–high,–low] vowels in adjacent syllables
    that are not linked to the same token of [back].

The first crucial weighting argument ensures that underlying mid vowels never undergo fronting, shown in (59). The weight of MAX(back) is higher than the weight of SHARE(back)$_{-lo,-hi}$ and the faithful candidate (59a) wins over the harmonic candidate (59b).[20]

(59)   *Preservation of the backness specification for underlying mid vowels*

(60)   *Weighting argument*
    w(MAX(back)) + w(*e) > w(SHARE(back)$_{-lo,-hi}$) + w(*o)

---

[20] The additional violations of *e and *o are not really relevant: Even if a back mid vowel is initial and spreading results in a less marked [ɔ–ɔ] sequence (e.g. /tɔbɛ/–> *[tɔbɔ] 'therefore' (14)), backness harmony is still sub-optimal due to the high weight of MAX(back) ([tɔbɛ] = 21; *[tɔbɔ] = 22).

In the context of an underlyingly low vowel that is raised to a mid vowel and therefore potentially subject to SHARE(back)$_{-lo,-hi}$, however, MAX(back) is irrelevant simply because this vowel never had an underlying [±back] specification. It is an automatic consequence of the contrastive feature system that all low vowels are maximally underspecified and escape the scope of certain faithfulness constraints. Backness harmony is an Emergence of the Unmarked Effect (McCarthy & Prince 1994; Becker & Flack Potts 2011) under this interpretation: SHARE(back)$_{-lo,-hi}$ has no effect for all the vowels which are subject to the general faithfulness constraints but suddenly shows its effect if certain vowels are exempt from faithfulness. This is shown in tableau (61).

As was established in tableau (59), we expect a back mid vowel [o] as the default after a floating [–low] is realized on a low vowel: The vowel needs a specification for [±back] and the lower weight of *o prefers the insertion of [+back]. If a mid front vowel precedes the underlyingly low vowel, however, this strategy induces an additional violation of SHARE(back)$_{-lo,-hi}$ since the two mid vowels are disharmonic. Crucially, the harmonic candidate (61b) can avoid this violation of SHARE(back)$_{-lo,-hi}$ without inducing an additional violation of MAX(back) since the vowel undergoing backness harmony never had an underlying [±back] specification. In addition, spreading even avoids a violation of DEP(back) since no epenthetic feature needs to be inserted. Backness harmony consequently emerges as optimal for an underlyingly underspecified originally low vowel.

(61)   *Exceptional backness harmony*

	HAVE(BK)$_{-lo,-hi}$	MAX(back)	SHARE(back)$_{-lo,-hi}$	DEP(back)	*e	*o	H =
W =	100	20	15	10	5	1	
a.			-1	-1	-1	-1	-31
☞ b.					-2		-10

(62)   *Weighting argument*
w(SHARE(back)$_{-lo,-hi}$) + w(DEP(back)) + w(*o) > w(*e)

4.3 Exceptional undergoers: Summary

The preceding two subsections showed two possible analyses for the exceptional undergoers of backness harmony in Assamese. Under the assumption of a fully specified feature system, exceptional undergoers are analysed as a pDEE that follows from constraint gang-

ing in HG (4.1), and under a contrastive feature system, the exceptional undergoers fall out as a simple Emergence of the Unmarked Effect arising from underspecification (4.2). Importantly, the account for the exceptional triggers of raising in section 3.3 is completely independent of either one of these feature systems. Only height features and [±ATR] are relevant for this account and the specification differences which distinguish the two feature systems in 4.1 and 4.2 are not relevant. Under both feature systems, we assume that exceptional raising is due to a floating feature in the representation of certain morphemes. These reanalyses are summarized in (63).

(63)   *Phonological analyses for exceptionality in Assamese*

	Exceptional trigger Raising (§2.2)	Exceptional undergoers Backness harmony (§2.3)
Full feature specification	Floating [–low] (§3.3)	pDEE and constraint ganging (§4.1)
Contrastive feature specification		Emergence of the Unmarked Effect and underspecification (§4.2)

We crucially do not aim to make an argument for either one of these feature systems that would rely on general claims about contrastivity or underspecification (Archangeli 1988; Itô et al. 1995; Dresher 2009). The important conclusion for us is that there are two reasonable different accounts for the Assamese exceptional backness harmony that avoid the assumption of lexically indexed constraints (cf. 5) and are based on purely phonological mechanisms. In contrast to the alternative account that is discussed in the following section, the analysis proposed here is hence compatible with a strict modularity between phonology and morphology. Our interim conclusion is therefore that the assumption of lexically indexed constraints is completely unnecessary for an account of vowel harmony in Assamese.

5 An alternative based on lexically indexed constraints

Mahanta (2008) and Mahanta (2012) present slightly different accounts of the vowel harmony in Assamese that are based on lexically indexed constraints. One main claim there is that the exceptionality in Assamese is a strong argument for lexical constraint indexation which is locally restricted (=LCI, Pater 2000; 2010; Finley 2010). We have already shown in sections 3 and 4 that the pattern in fact easily follows in a purely phonological account that employs the notion of floating features — the assumption of LCI is therefore unnecessary for Assamese. In this section, we add the argument that a LCI account is in fact even unable to predict the generalization that only derived mid vowels undergo backness harmony. Since the Assamese pattern is taken as a strong argument for LCI (cited as such in, for example, Finley 2009; 2010; Pater 2010; Gouskova & Linzen 2015; Buckley 2017), this systematic problem with one empirical generalization is quite relevant for proposals arguing for LCI in general. We return to a discussion of the theoretical economy and predictive power of such an account in section 7.

The existence of exceptional triggering morphemes as in the Assamese raising is straightforwardly predicted under the assumption of indexed constraints that are only violated if the penalized structure is created by elements affiliated with morphemes of a

certain class. This is briefly shown in (64) where we reimplemented our constraint system in a LCI account.[21] To mirror the account in Mahanta (2008) and Mahanta (2012), the SHARE(ATR) constraint is not parasitic and demands ATR-harmony for all vowels. Low vowels are opaque. This simply follows from the fact that there is no [+low, +ATR] vowel and MAX(low) is ranked above SHARE(ATR), excluding harmonizing (64ii-b). Under this account, there is now an indexed version of the triggering constraint SHARE(ATR)$_x$ that is only violated if one of the two suffixes /–ija$_x$/ or /–uwɑ$_x$/ are part of the marked configuration. If this specific SHARE(ATR)$_x$ is ranked above MAX(low), exceptional raising for a low vowel is predicted as in (64iii-b): In the presence of those two suffixes, it is simply so important to have [+ATR] harmony, that even raising is a price that is paid.

(64)   *Assamese vowel harmony and* LCI

		SHARE(ATR)$_x$	MAX(low)	SHARE(ATR)	MAX(ATR)
i.	*Regular [+ATR] harmony:* /pɛt/ + /u/				
	a. pɛtu			*!	
☞	b. petu				*
ii.	*Opaque low vowels:* /kɔpɑh/ + /i/				
☞	a. kɔpɑhi			*	
	b. kopohi		*!		**
iii.	*Exceptional triggers for raising:* /ɑlɑx/ + /uwɑ$_x$/				
	a. ɑlɑxuwɑ	*!		*	
☞	b. ɑloxuwɑ		*	*	*

In this LCI account, the fact that the exceptional suffixes only trigger exceptional raising of an immediately preceding low vowels can be derived since the SHARE(ATR) constraint demanding vowel harmony is defined locally about pairs of vowels in adjacent syllables and since there is an additional locality restriction for indexed constraints. This restriction (65) states that a morphologically indexed constraint is only sensitive to contexts that contain at least some phonological material affiliated with the morpheme it is indexed to. The initial [ɑ] in (64iii), for example, is not adjacent to [uwɑ$_x$] and does not induce a violation of high-ranked SHARE(ATR)$_x$ in (64iii-b), only of general SHARE(ATR). This interplay of both a locally defined harmony driving constraint and a locality restriction for indexed constraints is discussed in more detail in, for example, Finley (2010).

(65)   *X$_L$ (Pater 2010: 10)*
      Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L.

---

[21] The account in Mahanta (2008) and Mahanta (2012) is crucially different since it is based on the markedness constraint *[–ATR][+ATR] penalizing adjacent vowels with different [±ATR] specifications. We use an indexed version of our SHARE constraint here for reason of consistency and to ease comparability with our account. We also believe that the account based on *[–ATR][+ATR] has two specific problems. First, there is the sour grapes problems that in the presence of a usually opaque vowel /ɑ/, one violation of *[–ATR][+ATR] is unavoidable and an input like /patɔl–ija/ is never predicted to surface as empirically correct [patolija] (cf. (10)) but will remain *[patɔlija] since both candidates violate *[–ATR][+ATR] once but the latter also induces a faithfulness violation. Second, the account has no mechanism to ensure directionality and mispredicts that an illicit *[–ATR][+ATR] sequence could be repaired via progressive feature spreading. These problems can easily be solved under alternative constraint implementations and are no general problems arising from the assumption of LCI.

A systematic problem for LCI is the exceptional fronting for derived mid vowels in Assamese. This point is discussed in two steps, focussing on the two possible feature systems that were adopted in section 4.1 and 4.2 respectively.

We start with a discussion of a LCI account based on a contrastive feature system. As was shown in section 4.2, the exceptional fronting falls out without any additional assumptions under the assumption of a contrastive feature system. Whether the exceptional raising is caused by the realization of a floating feature or by a high-ranked indexed constraint is irrelevant for this point: No additional assumption is necessary for this putative additional layer of exceptionality. The ranking of constraints in (66) that simply adds the ranking arguments (60) hence predicts that derived mid vowels undergo backness harmony but underlying ones never do.

(66)   *LCI account: Contrastive feature system (5)*
      a.   *ATR-harmony and exceptional raising*
          SHARE(ATR)$_x$ ≫ MAX(low) ≫ SHARE(ATR) ≫ MAX(ATR)

      b.   *ATR-harmony and exceptional raising*
          MAX(back) + *e ≫ SHARE(back)$_{-lo,-hi}$ + *o

Crucially, however, the fact that the exceptional backness harmony in Assamese can be explained in this LCI account is not an argument for LCI. No indexed constraint is responsible for the backness harmony, it is simply a result of underspecification. The ranking in (66) merely shows us that a LCI account is compatible with an account where exceptional undergoers are predicted from underspecification but the assumption of indexed constraints itself adds nothing new to this explanation. The only motivation for indexed constraints in (67) is in fact the exceptional triggering: A pattern that can easily be reanalysed as an instance of floating features and therefore pure phonology (cf. 3.3). The assumption of LCI is thus completely unnecessary for an account of Assamese given a contrastive feature system.

Under the full feature system adopted in section 4.1, on the other hand, a LCI account is systematically unable to predict the pattern from constraint indexation alone. This follows since indexation allows no reference to phonologically derived contexts. As was argued above, the exceptional backness harmony is a pDEE, where application of one process in a context C is crucially bound to the application of another process that created C. Accounts based on LCI offer no new insight for pDEE's and as such suffer from the same undergeneration problem as standard OT accounts with ranked constraints (cf. 6.1). To illustrate this, we will briefly discuss the account of exceptional backness harmony in Mahanta (2012).

In this analysis, the exceptional backness harmony results from the markedness of back mid vowels. The relevant markedness constraint is LICENSE[–high,–low,+back] (Mahanta 2012: 1138), given in (67a).[22] However, it is clear that the interpretation of LICENSE[–high,–low,+back] as a simple markedness constraint against sequences of mid vowels with different [±back] specifications wrongly predicts fronting for non-derived mid vowels. Most importantly for our argument that constraint indexation alone can't predict the exceptional backness harmony, LICENSE[–high,–low,+back] is not even an indexed constraint but a general constraint. An alternative account of the exceptional

---

[22] Unfortunately, the assignment of violation marks for this crucial constraint is not entirely clear: It is described in the text as having the 'effect that a mid back vowel must be in the root, and it must be associated with a following [+high +ATR] vowel as in /bohi/' (Mahanta 2012: 1138) but in a different place as prohibiting 'a sequence of two adjacent front and back mid vowels' (Mahanta 2012: 1138). We are not sure how these two descriptions are compatible with each other and the definition in (67a) that refers to the position of /o/ in the root and in initial position and makes no reference to adjacent high or mid vowels.

backness harmony that is indeed based on constraint indexation is presented in Mahanta (2008). There, a markedness constraint penalizing sequences of a front and a back mid vowel are penalized, indexed to the exceptional suffixes /–ijɑ/ and /–uwɑ/ (67b).

(67)   a.   LICENSE[–high,–low,+back] *(Mahanta 2012: 1138)*
             [–high,–low,+back] is licensed in the root and/or in the root-initial position.

       b.   *[–back, –high][+back, –high]$_{L1}$ *(Mahanta 2008: 228)*
             No instance of [–back –high] followed by [+back –high] includes any phonological component of a morpheme lexically specified as L1.

A first problem with this LCI solution to exceptional backness harmony is the fact that the strict locality restriction of LCI (Mahanta 2012) in fact excludes the possibility that the exceptional suffix can have any influence on a fronting process between two vowels preceding it: None of the two relevant vowels is indexed to the exceptional suffix as is illustrated in (68).

(68)   *Exceptional derived targets and strict locality*
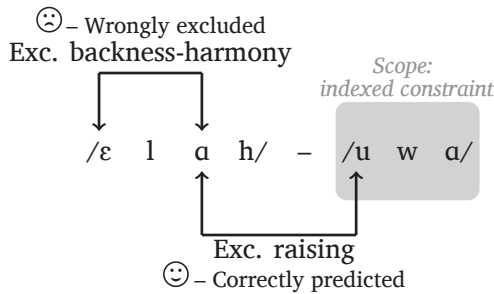
In Mahanta (2008), this problem is avoided via assuming a second degree of locality within LCI theory. More concretely: The definition (68b) refers to '*any* phonological component of a morpheme' which is lexically specified. Spreading of [+ATR] from the affix vowel to the stem-final vowel is assumed to extend the scope of the suffix morpheme. The [+ATR] stem vowel is consequently also visible for the indexed constraint and is treated as if it were part of an indexed morpheme underlyingly. Though this assumption makes the right prediction for instances where an exceptional suffix follows a low vowel like in /ɛlɑh/ + /uwɑ/, it runs into a fatal overgeneration problem in cases where an exceptional suffix follows two underlying mid vowels with different backness specifications. If [+ATR] spreads in an underlying form /kɛwɔl–ijɑ/, we incorrectly expect backness harmony as well *[kewelijɑ] (cf. (14)), given that the exceptional suffix extended its domain via [+ATR]-spreading, briefly illustrated in (69).

(69)   *Scope extension and underlying targets*
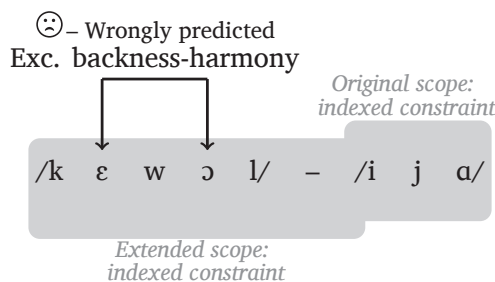
This serious problem is simply related to the nature of the backness harmony in Assamese: It is in fact not bound to the presence of the two exceptional suffixes, it is bound to low vowels that are raised to a mid vowel. In addition, the assumption of this second degree locality enriches the predictive power of LCI even further since any markedness constraint is now assumed to exist in at least three versions: one general markedness constraint, one lexically indexed version (to in principle any class of morphemes) under the strict locality condition, and one lexically indexed version (to in principle any class of morphemes) under the less restrictive locality condition.

In general, a locality restriction on LCI is not uncontroversial. Flack (2007), for instance, assumes that lexically indexed markedness constraints are 'generally understood to apply to entire outputs in which the indexing morpheme occurs' (Flack 2007: 754). An argument against a locality restriction for indexed constraints can be made based on empirical undergeneration: If one employs a powerful theoretical tool like lexical constraint indexation, at least all the instances of morpheme-specific phonological processes should be predicted by this theory. Assuming the locality restriction (65) (or the modification in Mahanta (2008)), however, makes a unified account of morpheme-specific phonology impossible since there are instances where no phonological material of an exceptionally triggering morpheme can be part of the locus of a triggering markedness constraint. Examples involve suffix-triggered vowel lengthening of the stem-initial vowel in most Wakashan languages (e.g. in Nuu-chah-nulth (Rose 1981; Nakayama 2001)) or suffix-triggered additional H-tone realization on a vowel that is not always adjacent to the suffix in Sierra Juarez Zapotec (Bickmore & Broadwell 1998). Another problematic pattern are exceptional suffixes in Russian that ensure that a preceding stem loses its exceptional behaviour of blocking vowel deletion for a preposition preceding the word (Gouskova & Linzen (2015); cf. also Jurgec & Bjorkman (2018) for more examples along these lines). On the other hand, giving up the locality restriction altogether would then mispredict non-local raising in the Assamese account. A LINEARITY-based locality account as we proposed it in 3.3 seems more empirically adequate.

Furthermore, as was discussed above, even an account assuming a modification of the locality restriction is not able to predict the pDEE for exceptional undergoers in Assamese. As before, the LCI account is perfectly compatible with the account we proposed in 4.1 based on constraint ganging. It is hence not impossible to have a LCI account based on a full feature specification that can predict both the exceptional triggers and the exceptional undergoers — but the latter exceptionality would not be predicted from constraint indexation, it would fall out from a mechanism completely orthogonal to constraint indexation, namely constraint ganging.

In conclusion, the assumption of LCI is not necessary to account for the two patterns of exceptionality in Assamese since they can fall out from the independently motivated mechanisms of featural affixation and underspecification or constraint ganging respectively in a purely phonological model. An account based on LCI can do away with the assumption of featural affixation and predict the exceptional triggers raising from constraint indexation but it cannot explain the exceptional undergoers of backness harmony from constraint indexation alone. To account for this additional layer of exceptionality, underspecification or constraint ganging (depending on the assumed feature system) have to be assumed in addition to the assumption of indexed constraints. Since these mechanisms already predict the exceptional undergoers on their own without the assumption of LCI, the additional assumption of featural affixation to account for the exceptional triggers results in a preferable and far less powerful system that obeys modularity between phonology and morphology.

6 Phonologically Derived Environment Effects and Cumulativity

Under the full feature account, the exceptional backness harmony in Assamese is characterized as a pDEE that easily falls out as a cumulative effect in HG (cf. 4.1). In this section, we briefly zoom out of this specific case study and discuss pDEE's and their account more generally.

6.1 HG and Derived Environment Effects

The existence of pDEE's is notoriously challenging for theoretical accounts of phonology. In rule-based phonology, for example, they only follow if rules can be explicitly marked for applying only in a derived environment. This is exactly the claim made in Lexical Phonology where cyclic rules only apply in morphologically or phonologically derived contexts (=Strict Cycle Condition; Kiparsky 1982). In Assamese, the rule triggering progressive backness harmony has been taken to be cyclic to correctly exclude backness harmony for non-derived mid vowels.

For parallel OT based only on standard markedness and faithfulness constraints (McCarthy & Prince 1995), pDEE's are a serious problem and are inherently impossible to predict. If a high-ranked markedness constraint *X excludes a surface structure X in a language and a change into another surface structure Y is predicted, this repair is expected irrespective of whether X was underlyingly present or is derived in the phonology. No standard markedness- or faithfulness constraint can restrict the change to the latter context (Lubowicz 2002; Burzio 2011). Two proposals that argue for an extension of a basic OT system to account for pDEE are the proposal of comparative markedness (McCarthy 2002; 2003a) and of constraint conjunction (Smolensky 1993; 2006). The former theory assumes that all markedness constraints exist in two versions and one explicitly bans a 'new' marked configuration that was not yet present in the input. For Assamese, only a newly created sequence of mid vowels disharmonic for their backness specification would be penalized. The mechanism of constraint conjunction, on the other hand, creates new constraints via conjoining two existing constraints into a new one that is only violated if both source constraints are violated in a single locus. PDEE then follow under conjoining a markedness and a faithfulness constraint basically predicting that a marked configuration can be worse if it arises after changing an underlying specification (Lubowicz 2002; 2003). In Assamese, a high-ranked conjunction of IDENT(high) and SHARE(back)$_{-high,-low}$ would then exclude a sequence of disharmonic mid vowels if the offending second vowel is also unfaithful to its [±high] specification (cf. 6.2 for more details).

The account proposed here models the same intuition as such an account based on Local Constraint Conjunction (=LCC). Both predict the pDEE from cumulativity: Whereas a single violation of a markedness constraint M is tolerated in order to satisfy a faithfulness constraint F_1, the conjoined effect of the markedness constraint M and another faithfulness constraint F_2 overrides F_1 and a process applies. In section 6.2, we further justify the choice of HG over LCC to model cumulativity.

The HG account of a pDEE in Assamese presented here can easily be generalized to other pDEE's (Kiparsky 1973; Lubowicz 2002; Burzio 2011) as well. An example is diphthongization in Slovak that only affects derived long mid vowels (/čel+μ/→ [čiel] 'forehead'; Lubowicz 2002: 10) whereas underlyingly long vowels are realized faithfully (/dceːr+a/ → [dceːra] 'daughter'; Lubowicz 2002: 10). In an account absolutely parallel to our proposal for Assamese, the combination of having a marked long vowel and adding an association line between a mora and a vowel to lengthen it is too much and diphthongization is optimal. Only being a long vowel is therefore not a sufficient trigger for the repair and underlying long vowels surface faithfully. Only the combination of being a marked vowel and undergoing the unfaithful operation of vowel lengthening results in a worse harmony score than a candidate undergoing another repair operation avoiding the marked structure.

On the other hand, constraint ganging is by no means a general account of all pDEE types. It is crucially restricted to a certain sub-class where applying one phonological process to one target element induces additional faithfulness or markedness violations which could be avoided by changing it to another element altogether by applying a second process.[23] This second process, however, is blocked in isolation on another target element. Apart from the Slovak example, the famous case of Polish spirantization (Rubach 1984) and palatalization in Kinyamwezi (Kula 2008) are further examples of pDEE's that can fall out as gang effects in HG. The present account is not generalizable, however, to other famous cases of pDEE's like Finnish assibilation (Kiparsky 1973; 1993) or Makassarese /ʔ/-epenthesis (Aronoff et al. 1987; Basri et al. 1997; McCarthy 2002). In both these examples, a process derives the context for a second process, it does not derive the target of the process. Both these patterns have, however, received a reanalysis or reinterpretation of the data (Hammond (1992) and Jukes (2006) respectively). In general, convincing examples of pDEE's seem to be rather rare which is in line with the claim that there should be no special mechanism in phonological theory that explicitly predicts pDEE's since such a mechanism would apparently overgenerate. Conversely, the relative rarity of pDEE's strengthens our claim for HG that predicts a subset of pDEE's as epiphenomena. Future research needs to reveal the real typology of pDEE's and the question whether it can fall out completely as the subset of pDEE's predicted as ganging in HG.

6.2 An alternative: Local Constraint Conjunction

Our account of exceptional backness harmony in Assamese as a pDEE in 4.1 is formally based on a ganging between faithfulness and markedness constraints (cf. type i. and j. in Farris-Trimble 2008a: 6). It is not a new claim that the cumulativity of markedness and faithfulness constraints can predict Derived Environment Effects. As was already mentioned in 6.1, the proposal in Lubowicz (2002) argues explicitly that the mechanism of LCC predicts phonological and morphological Derived Environment Effects. LCC is an approach to cumulative effects in OT brought forwards by Smolensky (1995), similar to Harmonic Grammar. By conjoining two lower ranked constraints *A and *B, a higher ranked constraint *C (= *A&$_D$*B) is created. This higher ranked constraint is violated iff A and B are violated in a certain local domain D.

(70)   Local conjunction within a domain D (Smolensky 2006: 43)
        *A&$_D$*B is violated if and only if a violation of *A and a (distinct) violation of *B both occur within a single domain of type D.

For illustration, an LCC account for the exceptional backness harmony in Assamese is given in (71) and (72). The first crucial difference to the HG account in 4.1 is that all constraints are strictly ranked and not weighted. The second important difference is the existence of the constraint DEP(round)&$_V$SHARE(back)$_{-lo,-hi}$: The constraint that results from locally conjoining the backness harmony constraint on mid vowels and the constraint against epenthetic [round] features for the domain of a vowel.[24] Whenever a

---

[23] See also the discussion of saltation patterns in Hayes & White (2015) and Smith (2018), who argue that LCC can derive all saltation patterns, whereas HG can only derive a certain subclass.

[24] We are not entirely sure how unproblematic it is to specify the correct domain for the Assamese backness harmony since the constraint triggering harmony necessarily involves reference to a pair of vowels but only the second one is a possible target. Stating that DEP(round)&$_V$SHARE(back)$_{-lo,-hi}$ is violated if at least one of the vowels in the domain of SHARE(back)$_{-lo,-hi}$ also violates DEP(round) might in fact be an instance of problematic non-locality. We think that this points to a more global problem of LCC that we will not discuss in detail for reasons of space, but see Walker (2017) for some discussion.

vowel now induces a violation of both constraints, DEP(round)&$_V$SHARE(back)$_{-lo,-hi}$ is also violated.

In (71), a non-derived context of two mid vowels that are disharmonic for [±back] is optimized. The general constraint SHARE(back)$_{-lo,-hi}$ is violated in the candidate in which all [back] values surface faithfully (71a). Backness harmony as in (71b) avoids this violation but since MAX(back) is ranked higher than SHARE(back)$_{-lo,-hi}$, this option is suboptimal. Only the need to be harmonic for backness is therefore not a good enough reason to violate MAX(back).

(71)   *LCC: No backness harmony for underlying mid vowels*

	SHARE(back)$_{-lo,-hi}$ &$_V$DEP(round)	MAX(back)	SHARE(back)$_{-lo,-hi}$	*SPREAD-R$_{back}$	MAX(round)	DEP(round)
x ɛ h – ɔ – t ɨ – j ɑ (–rd –low –bk / +rd –low +bk / –rd –low –bk; –ATR –ATR +ATR)						
☞ a. x e h o t ɨ j ɑ (–rd –low –bk / +rd –low +bk / –rd –low –bk; +ATR)				*		
b. x e h e t ɨ j ɑ (–rd –low –bk / –rd –low / –rd –low –bk; +ATR)			*!			

In (72), on the other hand, a front mid vowel precedes an underlyingly low back vowel that is raised to a mid vowel (ensured by independent mechanisms/constraints; cf. 3). Candidate (73a) that raises the low vowel to /o/ under epenthesis of [+round] not only violates general SHARE(back)$_{-lo,-hi}$ and DEP(round) but also the conjoined constraint SHARE(back) &$_V$DEP(round). In this case, the backness harmony candidate (73b) is optimal. Crucially, each individual violation of SHARE(back)$_{-lo,-hi}$ or DEP(round) would not be fatal for a candidate since the individual constraints are ranked lower than MAX(back). The locally conjoined constraint SHARE(back)$_{-lo,-hi}$ &$_V$DEP(round), however, is ranked higher than this faithfulness constraint. Absolutely parallel to the constraint ganging in HG, only the combination of violating two lower ranked constraints outweighs the violation of a higher ranked constraint.

(72)   *LCC: Exceptional backness harmony for derived mid vowels*

Input: ɛ l ɑ h – u w ɑ	SHARE(back)$_{-lo,-hi}$ &$_V$ DEP(round)	MAX(back)	SHARE(back)$_{-lo,-hi}$	*SPREAD-R$_{back}$	MAX(round)	DEP(round)
a. e l o h u w ɑ	*!		*		*	*
☞ b. e l e h u w ɑ		*				

If we compare this account with the HG account of the pDEE in 4.1, it is apparent that the LCC account is apparently simpler. Whereas the HG account has rather complex ganging arguments involving two and three constraints (cf. (51)), the LCC account only involves a constraint that conjoins two other constraints. The assumption of recursive constraint conjunction (e.g. Itô & Mester 2003) that would mirror a complex ganging effect involving three constraints is hence not necessary. As we already discussed at the end of section 4.1, this is mainly due to the fact that all constraints that are violated by a candidate contribute to a potential ganging effect.

It is a matter of ongoing debate that ganging in HG and LCC can in principle predict the same type of effect but still differ in their concrete predictions. One main argument against HG is often the missing locality restriction. On the other hand, Pater (2009; 2016) argue that HG is more restrictive than LCC and can avoid overgeneration problems. Walker (2017) makes the converse argument in favour of HG in showing that HG can predict some attested patterns that are at least problematic to capture with LCC. The local domain in Constraint Conjunction has to be stipulated for each conjunction and can — in principle — be broadened to derive certain non-local patterns. Pater (2016) argues that corelevance restrictions in HG, on the other hand, are inherent. Another central argument often cited in favor of HG is the fact that there is no learning algorithm for local conjunction (Pater 2009).

7 Conclusion

We argued that the two patters of exceptionality in Assamese vowel harmony fall out in a purely phonological model from independently motivated mechanisms. Firstly, morphemes that are exceptional triggers for raising are assumed to contain floating features in their underlying representation. And secondly, that only low vowels which were raised to

mid vowels undergo are exceptional undergoers for backness harmony follows from either underspecification under a contrastive feature system or from constraint ganging under a fully specified feature system. This latter reanalysis classified the pattern as a pDEE: A change that was too costly in one environment can be optimal in a derived environment where another change is unavoidable for independent reasons.

The existence of these reanalyses has important consequences for accounts based on LCI that usually cite Assamese as one prime example of two exceptionality types predicted by constraints indexed to specific morphemes. Our paper can hence be understood in a similar spirit as Zimmermann (2013) where a phonological reanalysis of morpheme-specific vowel deletion in Yine is presented; another empirical pattern that is often cited as an important argument for LCI. On the contrary, we argue that LCI adds nothing to the account of exceptionality in Assamese. Although lexically indexed constraints can indeed account for the exceptional triggers of raising in Assamese, they can not predict the exceptional undergoers of backness harmony. A LCI account can of course be enriched with the additional assumptions of underspecification or constraint ganging to account for both patterns of exceptionality in Assamese. Since these mechanisms alone together with the independently motivated mechanism of floating features easily accounts for both layers of exceptionality, there is no motivation for LCI in Assamese.

The assumption of LCI is a powerful addition to a phonological model in at least two dimensions. It implies that the phonological component of grammar has direct access to specific morphological information that goes beyond the categories 'stem' and 'affix' or category-information like nominal and verbal (i.a. Smith 2011). For Assamese, for example, a constraint specifically refers to the two exceptional suffixes /–uwɑ/ and /–ijɑ/. For one, this is problematic from the viewpoint of a modular architecture of the grammar (Bermúdez-Otero 2012). On the other hand, it potentially multiplies the complexity of the system given that in principle every single markedness constraint exists in numerous versions indexed to every single possible class of morphemes of a specific language. This runs at least counter the OT-assumption that constraints should be universal, if either the indexes or the indexed constraints are language specific (cf Becker 2009).

It is considerably difficult to compare the assumption of HG which is essential to our proposal to LCI with regard to their predictive power, since the two theories do not conflict. Even though both undermine strict domination between constraints, they do so in very different ways. HG allows for ganging effects based on phonology, LCI allows for lexical effects. In a way, HG allows for different 'preferences' in different phonological contexts, whereas LCI allow for different rankings based on the morphological/lexical context. The predictive power of one or the other cannot be argued to be greater or smaller in general. In specific areas, however, they make very different predictions. An example are the pDEE's we discussed in this paper. Whereas they fall out from cumulativity in HG, LCI theory does not make any predictions about them. On the other hand, LCI allows for morphologically derived environment effects, where HG does not make any independent predictions. Some researchers have even proposed combinations of these approaches (Moore-Cantwell & Pater 2016), see also the scaling factors indexed to certain morphemes in Coetzee & Pater (2011); Linzen et al. (2013).

The LCI account of Assamese in Mahanta (2012) is crucially based on a locality restriction (cf. (65)). Without this additional assumption, every low vowel is expected to be exceptionally raised to a mid vowel in the presence of /–uwɑ/ and /–ijɑ/, contra to fact (cf. (10)). We discussed in section 5, that this restriction is potentially problematic from a cross-linguistic perspective. In the present approach, this additional locality restriction is a straightforward consequence of standard assumptions about autosegmental structure, more concretely the ban on crossing association lines. The scope of the exceptional trigger hence receives a purely phonological explanation as well.

Abbreviations

CAUS	Causative
ERG	Ergative
F	Feminine
INF	Infinitive
M	Masculine
PRS	person
H	harmony score
HG	Harmonic Grammar
LCI	lexical constraint indexation
LCC	Local Constraint Conjunction
OT	Optimality Theory
pDEE	phonologically Derived Environment Effect

Acknowledgements

Funding Information

Competing Interests

The authors have no competing interests to declare.

References

Akinlabi, Akinbiyi. 1994. Alignment constraints in ATR harmony. *Studies in Linguistic Sciences* 24. 1–18.

Akinlabi, Akinbiyi. 1996. Featural affixation. *Journal of Linguistics* 32. 239–289. DOI: https://doi.org/10.1017/S0022226700015899

Archangeli, Diana. 1988. Aspects of underspecification theory. *Phonology* 5(2). 183–207. DOI: https://doi.org/10.1017/S0952675700002268

Archangeli, Diana & Douglas Pulleyblank. 1994. *Grounded phonology*. Cambridge, MA: MIT Press.

Aronoff, Mark, Azhar Arsyad, Hassan Basri & Ellen Broselow. 1987. Tier conflation in Makassarese reduplication. In A. Bosch, B. Need & E. Schiller (eds.), *CLS 23: Papers from the Parasession on Autosegmental and Metrical Phonology*, 1–15. Chicago Linguistic Society.

Bakovic, Eric. 2000. *Harmony, dominance, and control*. New Brunswick, NJ: Rutgers University dissertation.

Banksira, Degif. 2013. Chaha labialization and palatalization as coalescence. *Brill's Annual of Afroasisatic Languages & Linguistics* 5. 159–190. DOI: https://doi.org/10.1163/18776930-00501005

Basri, Hasan, Ellen Broselow & Daniel Finer. 1997. Clitics and crisp edges in Makassarese. *Proceedings of AFLA 97*, 25–36.

Becker, Michael. 2009. *Phonological trends in the lexicon: The role of constraints*. Amherst: University of Massachusetts dissertation.

Becker, Michael & Kathryn Flack Potts. 2011. The emergence of the unmarked. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The blackwell companion to phonology*, Oxford: Wiley Blackwell.

Bermúdez-Otero, Ricardo. 2012. The architecture of grammar and the division of labour in exponence. In Jochen Trommer (ed.), *The morphology and phonology of exponence: The state of the art*, 8–83. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199573721.003.0002

Bermúdez-Otero, Ricardo. in preparation. *Stratal optimality theory*. Oxford: Oxford University Press.

Bickmore, Lee & George Aaron Broadwell. 1998. High tone docking in Sierra Juárez Zapotec. *International Journal of American Linguistics* 64. 37–67. DOI: https://doi.org/10.1086/466346

Boettger, Juliane. 2015. *Topics in the grammar of Lele: a language of Manus Island, Papua New Guinea*. Cairns: James Cook University dissertation.

Buckley, Eugene. 2017. Global effects in Kashaya prosodic structure. In Vera Gribanova & Stephanie Shih (eds.), *The morphosyntax-phonology connection: Locality and directionality at the interface*, 113–140. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780190210304.003.0005

Burzio, Luigi. 2011. Derived environment effects. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The blackwell companion to phonology*, Oxford: Wiley Blackwell. DOI: https://doi.org/10.1002/9781444335262.wbctp0088

Bye, Patrick & Peter Svenonius. 2012. Non-concatenative morphology as epiphenomenon. In Jochen Trommer (ed.), *The morphology and phonology of exponence: The state of the art*, 426–495. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199573721.003.0013

Casali, Roderic F. 2003. [ATR] value asymmetries and underlying vowel inventory structure in Niger-Congo and Nilo-Saharan. *Linguistic Typology* 7. 307–382. DOI: https://doi.org/10.1515/lity.2003.018

Casali, Roderic F. 2008. ATR harmony in African languages. *Language and Linguistics Compass* 2/3. 496–549. DOI: https://doi.org/10.1111/j.1749-818X.2008.00064.x

Casali, Roderic F. 2014. Assimilation, markedness and inventory structure in tongue root harmony systems. Unpublished ms.

Census of India. 2001. Ministry of Home Affairs, Government of India; online available at http://www.censusindia.gov.in.

Childs, G Tucker. 2011. *A grammar of Kisi: a southern Atlantic language*. Berlin: Walter de Gruyter.

Chomsky, Noam & Morris Halle. 1968. *The sound pattern of English*. New York: Harper & Row.

Clements, G. N. 1991. Place of articulation in consonants and vowels: a unified theory, in 'Working Papers of the Cornell Phonetics Laboratory', Vol. 5, Cornell University, Ithaca, pp. 77–123. *Presented at NELS 21, UQAM*, Montreal.

Clements, George N. 1985. The geometry of phonological features. *Phonology Yearbook* 2. 225–252. DOI: https://doi.org/10.1017/S0952675700000440

Clements, George N. & Beth Hume. 1995. The internal organization of speech sounds. In John Goldsmith (ed.), *The handbook of phonological theory*, 245–306. Cambridge: Blackwell.

Coetzee, Andries W. & Joe Pater. 2011. The place of variation in phonological theory. In *The handbook of phonological theory*, 401–434. Oxford: Wiley-Blackwell. DOI: https://doi.org/10.1002/9781444343069.ch13

Cole, Jennifer S. 1987. *Planar phonology and morphology*. Cambridge, MA: MIT dissertation.

Crane, Thera Marie, Larry M. Hyman & Simon Nsielanga Tukumu. 2011. *A grammar of Nzadi [b865]: A Bantu language of Democratic Republic of Congo*. Berkeley, CA: University of California Press.

David, Anne Boyle. 2015. *Descriptive grammar of Bangla*, vol. 2. Berlin: Walter de Gruyter. DOI: https://doi.org/10.1515/9781614512295

Dresher, B. Elan. 2009. *The contrastive hierarchy in phonology*. Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511642005

Dresher, B. Elan, Glyne L. Piggott & Keren D. Rice. 1994. Contrast in phonology: Overview. *Toronto Working Papers in Linguistics* 13. iii–xvii.

Farris-Trimble, Ashley W. 2008a. *Cumulative faithfulness effects in phonology*. Bloomington: Indiana University dissertation.

Farris-Trimble, Ashley W. 2008b. Cumulative faithfulness effects: Opaque or transparent? In Ashley W. Farris-Trimble & Daniel A. Dinnsen (eds.), *IUWPL6: Phonological opacity effects*, 119–145. Bloomington: IULC.

Finley, Sara. 2010. Exceptions in vowel harmony are local. *Lingua* 120. 1549–1566. DOI: https://doi.org/10.1016/j.lingua.2009.10.003

Finley, Sara & William Badecker. 2009. Right-to-left biases for vowel harmony: Evidence from artificial grammar. In A. Shardl, M. Walkow & M. Abdurrahman (eds.), *Proceedings of the 38th north east linguistic society annual meeting*, 269–282. Amherst, MA: GLSA.

Finley, Sarah. 2009. Locality restrictions on exceptions to vowel harmony. *University of Rochester Working Papers in the Language Sciences* 5. 17–48.

Flack, Kathryn. 2007. Templatic morphology and indexed markedness constraints. *Linguistic Inquiry* 38. 749–758. DOI: https://doi.org/10.1162/ling.2007.38.4.749

Gleim, Daniel, Katie McCann, Sören E. Tebay, Jochen Trommer & Eva Zimmermann. in progress. Database on morphological affixation with mutation/phonological features (mampf). database, Leipzig University.

Goldsmith, John. 1976. *Autosegmental phonology*. Cambridge, MA: MIT dissertation.

Gouskova, Maria & Tal Linzen. 2015. Morphological conditioning of phonological regularization. *The Linguistic Review* 32. 427–473. DOI: https://doi.org/10.1515/tlr-2014-0027

Haiman, John. 1980. *Hua, a Papuan language of the eastern highlands of New Guinea*. Amsterdam: John Benjamins Publishing. DOI: https://doi.org/10.1075/slcs.5

Hall, Daniel Currie. 2007. *The role and representation of contrast in phonological theory*: University of Toronto dissertation.

Hammond, Michael. 1992. Deriving the strict cycle condition. In G. Chan, J. Denton & C. Canakis (eds.), *CLS 28: The parasession on the cycle in linguistic theory*, 126–140. Chicago: Chicago Linguistic Society.

Hayes, Bruce & James White. 2015. Saltation and the P-map. *Phonology* 32(2). 267–302. DOI: https://doi.org/10.1017/S0952675715000159

Horwood, Graham. 2002. Precedence faithfulness governs morpheme position. In Line Mikkelsen & Christopher Potts (eds.), *Proceedings of WCCFL 21*, 166–179. Somerville, MA: Cascadilla Press.

Hyman, Larry M. 2003. Basaá (a43). In Derek Nurse & Gérard Philippson (eds.), *The Bantu languages*, 257–282. London: Routledge.

Hyman, Larry M. 2008. Directional asymmetries in the morphology and phonology of words with special reference to Bantu. *Linguistics* 46(2). 309–350. DOI: https://doi.org/10.1515/LING.2008.012

Itô, Junko & Armin Mester. 2003. *Japanese morphophonemics: Markedness and word structure*. Cambridge, MA: MIT Press. DOI: https://doi.org/10.7551/mitpress/4014.001.0001

Itô, Junko, Armin Mester & Jaye Padgett. 1995. Licensing and underspecification in optimality theory. *Linguistic Inquiry* 26(4). 571–613.

Jukes, Anthony. 2006. *Makassarese (basa Mangkasara')*. Melbourne: University of Melbourne dissertation.

Jurgec, Peter. 2011. *Feature spreading 2.0: A unified theory of assimilation*. Tromsø: University of Tromsø dissertation.

Jurgec, Peter. 2013. Two types of parasitic assimilation. *Nordlyd* 40. 108–135. DOI: https://doi.org/10.7557/12.2503

Jurgec, Peter & Bronwyn M. Bjorkman. 2018. Indexation to stems and words. *Phonology* 35(4). 577–615. DOI: https://doi.org/10.1017/S0952675718000210

Keer, Edward W. 1999. *Geminates, the OCP and the nature of CON*. Rutgers dissertation.

Kimper, Wendell. 2011. *Competing triggers: Transparency and opacity in vowel harmony*. Amherst, MA: University of Massachusetts dissertation.

Kiparsky, Paul. 1965. *Phonological change*. Cambridge, MA: MIT dissertation.

Kiparsky, Paul. 1973. Abstractness, opacity, and global rules. In Osamu Fujimura (ed.), *Three dimensions of linguistic theory*, 1–135. Tokyo: TEC.

Kiparsky, Paul. 1982. From cyclic phonology to lexical phonology. In Harry van der Hulst & Norval Smith (eds.), *The structure of phonological representations*, 131–175. Dordrecht: Foris.

Kiparsky, Paul. 1993. Blocking in nonderived environments. In *Studies in lexical phonology*, vol. 4 (Phonetics and Phonology), 277–313. San Diego: Academic Press. DOI: https://doi.org/10.1016/B978-0-12-325071-1.50016-9

Kirchner, Robert. 1993. Turkish vowel harmony and disharmony: An optimality theoretic account. *Presented at Rutgers Optimality Workshop I*, October 22, 1993.

Krämer, Martin. 2003. *Vowel harmony and correspondence theory*. Berlin: Mouton de Gruyter. DOI: https://doi.org/10.1515/9783110197310

Kula, Nancy. 2008. Derived enviroment effects: A representational approach. *Lingua* 118. 1328–43. DOI: https://doi.org/10.1016/j.lingua.2007.09.011

Legendre, Geraldine, Yoshiro Miyata & Paul Smolensky. 1990. Harmonic grammar – a formal multi-level connectionist theory of linguistic well-formedness: Theoretical foundations. *Proceedings of the 12th annual conference of the cognitive science society* 388–395.

Lieber, Rochelle. 1987. *An integrated theory of autosegmental processes*. Albany, NY: SUNY Press.

Lieber, Rochelle. 1992. *Deconstructing morphology*. Chicago: University of Chicago Press.

Linzen, Tal, Sofya Kasyanenko & Maria Gouskova. 2013. Lexical and phonological variation in Russian prepositions. *Phonology* 30(3). 453–515. DOI: https://doi.org/10.1017/S0952675713000225

Lombardi, Linda. 1999. Positional faithfulness and voicing assimilation in optimality theory. *Natural Language and Linguistic Theory* 17. 267–302. DOI: https://doi.org/10.1023/A:1006182130229

Lubowicz, Anna. 2002. Derived Environment Effects in Optimality Theory. *Lingua* 112. 243–280. DOI: https://doi.org/10.1016/S0024-3841(01)00043-2

Lubowicz, Anna. 2003. Local conjunction and comparative markedness. *Theoretical Linguistics* 29. 101–112. DOI: https://doi.org/10.1515/thli.29.1-2.101

MacDonald, Lorna. 2011. *A grammar of Tauya*. Berlin: Walter de Gruyter.

Mahanta, Shakuntala. 2008. *Directionality and locality in vowel harmony*. Utrecht: Utrecht University dissertation.

Mahanta, Shakuntala. 2012. Locality in exceptions and derived environments in vowel harmony. *Natural Language and Linguistic Theory* 30. 1109–1146. DOI: https://doi.org/10.1007/s11049-012-9173-5

McCarthy, John J. 1983. Consonantal morphology in the Chaha verb. In Michael Barlow, Daniel Flickinger & Michael Wescoat (eds.), *Proceedings of WCCFL 2*, 176–188. Stanford, CA: Stanford Linguistics Association.

McCarthy, John J. 1988. Feature geometry and dependency: A review. *Phonetica* 43. 84–108. DOI: https://doi.org/10.1159/000261820

McCarthy, John J. 2002. Comparative markedness (long version). In Angela Carpenter, Andries Coetzee & Paul de Lacy (eds.), *Papers in Optimality Theory II [University of Massachusetts occasional papers in linguistics 26]*, 171–246. Amherst: MA: GLSA Publications.

McCarthy, John J. 2003a. What does comparative markedness explain, what should it explain, and how? *Theoretical Linguistics* 29. 141–155. DOI: https://doi.org/10.1515/thli.29.1-2.141

McCarthy, John J. 2003b. OT constraints are categorical. *Phonology* 20(1). 75–138. DOI: https://doi.org/10.1017/S0952675703004470

McCarthy, John J. 2004. Headed spans and autosegmental spreading. Ms., University of Massachusetts, ROA 685-0904.

McCarthy, John J. 2009. Harmony in harmonic serialism. *Linguistics Department Faculty Publication Series* 41.

McCarthy, John J. & Alan Prince. 1994. The emergence of the unmarked: Optimality in prosodic morphology. In Mercé González (ed.), *Proceedings of NELS 24*, 333–379. Amherst: GLSA.

McCarthy, John J. & Alan Prince. 1995. Faithfulness and reduplicative identity. In Jill Beckman, Laura Dickey & Susanne Urbanczyk (eds.), *University of Massachusetts occasional papers in linguistics*, 249–384. Amherst, MA: GLSA.

Moore-Cantwell, Claire & Joe Pater. 2016. Gradient exceptionality in maximum entropy grammar with lexically specific constraints. *Catalan Journal of Linguistics* 15. 53–66. DOI: https://doi.org/10.5565/rev/catjl.183

Mullin, Kevin. 2011. Strength in harmony systems: Trigger and directional asymmetries. *Ms., University of Massachusetts Amherst.*

Nakayama, Toshihide. 2001. *Nuuchahnulth (Nootka) morphosyntax*. Berkeley: University of California Press.

Padgett, Jaye. 2002. Feature classes in phonology. *Language* 78(1). 81–110. DOI: https://doi.org/10.1353/lan.2002.0046

Paschen, Ludger. 2018. *The interaction of reduplication and segmental mutation: A phonological account*. Leipzig: Universität Leipzig dissertation.

Pater, Joe. 2000. Nonuniformity in English stress: the role of ranked and lexically specific constraints. *Phonology* 17(2). 237–274. DOI: https://doi.org/10.1017/S0952675700003900

Pater, Joe. 2009. Weighted constraints in generative linguistics. *Cognitive science* 33(6). 999–1035. DOI: https://doi.org/10.1111/j.1551-6709.2009.01047.x

Pater, Joe. 2010. Morpheme-specific phonology: Constraint indexation and inconsistency resolution. In Steve Parker (ed.), *Phonological argumentation: Essays on evidence and motivation*, 123–154. London: Equinox.

Pater, Joe. 2016. Universal grammar with weighted constraints. In Joe Pater & John J. McCarthy (eds.), *Harmonic grammar and harmonic serialism*, 1–46. London: Equinox.

Potts, Christopher, Joe Pater, Karen Jesney, Rajesh Bhatt & Michael Becker. 2010. Harmonic grammar with linear programming: From linear systems to linguistic typology. *Phonology* 27(1). 77–117. DOI: https://doi.org/10.1017/S0952675710000047

Prince, Alan & Paul Smolensky. 1993/2004. *Optimality theory: Constraint interaction in generative grammar.* [first circulated as Prince & Smolensky (1993) Technical reports of the Rutgers University Center of Cognitive Science]. Oxford: Blackwell.

Pulleyblank, Douglas. 1996. Neutral vowels in Optimality Theory: A comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* 41. 295–347. DOI: https://doi.org/10.1017/S0008413100016601

Pulleyblank, Douglas. 2004. Harmony drivers: No disagreement allowed. In *Proceedings of the twenty-eighth annual meeting of the Berkeley linguistics society*, 249–267. Berkeley: Berkeley Linguistic Society. DOI: https://doi.org/10.3765/bls.v28i1.3841

Rose, Sharon. 2007. Chaha (Gurage) morphology. In A. Kaye (ed.), *Morphologies of of Asia and Africa*, 399–424. Winona Lake, Indiana: Eisenbraums.

Rose, Sharon & Rachel Walker. 2011. Harmony systems. In John Goldsmith, Jason Riggle & Alan C. L. Yu (eds.), *The handbook of phonological theory*, 240–290. Oxford: Wiley Blackwell. DOI: https://doi.org/10.1002/9781444343069.ch8

Rose, Suzanne Maria. 1981. *Kyuquot grammar.* Victoria: University of Victoria dissertation.

Ross, Malcolm. 2002. Kele. In John Lynch, Malcolm Ross & Terry Crowley (eds.), *The Oceanic languages*, 123–147. Richmond: Curzon.

Rubach, Jerzy. 1984. *Cyclic and lexical phonology: The structure of Polish.* Dordrecht: Foris. DOI: https://doi.org/10.1515/9783111392837

Sagey, Elizabeth. 1986. *The representation of features and relations in non-linear phonology.* Cambridge, MA: MIT dissertation.

Sapir, David. 1969. *A grammar of Diola-Fogny: a language spoken in the Basse-Casamance region of Senegal.* Cambridge: Cambridge University Press.

Smith, Jennifer L. 2011. Category-specific effects. In *The blackwell companion to phonology*, 2439–2463. Oxford: Wiley Blackwell. DOI: https://doi.org/10.1002/9781444335262.wbctp0102

Smith, Jennifer L. 2018. Feature change is not like deletion: Saltation in harmonic grammar. *Talk, given at LSA 2018*.

Smolensky, Paul. 1993. Harmony, markedness, and phonological activity. *Paper presented at the Rutgers Optimality Workshop 1*, New Brunswick, NJ (ROA-87).

Smolensky, Paul. 1995. On the structure of the constraint component Con of UG. *Handout of talk at UCLA, ROA-101, Rutgers Optimality Archive*, http://roa.rutgers.edu/.

Smolensky, Paul. 2006. Optimality in phonology II: Harmonic completeness, local constraint conjunction, and feature-dominant markedness. In Paul Smolensky & Geraldine Legendre (eds.), *The harmonic mind 2: Linguistic and philosophical implications*, 27–160. Cambridge, MA: MIT Press.

Smolensky, Paul & Geraldine Legendre. 2006. *The harmonic mind 2: Linguistic and philosophical implications*. Cambridge, MA: MIT Press.

Struijke, Caro. 2000. *Existential faithfulness. a study of reduplicative TETU, feature movement, and dissimilation.* College Park: University of Maryland dissertation.

Trommer, Jochen. 2011. Phonological aspects of Western Nilotic mutation morphology. Habil. University of Leipzig.

van Oostendorp, Marc. 2007. Derived environment effects and consistency of exponence. In Sylvia Blaho, Patrik Bye & Martin Krämer (eds.), *Freedom of analysis?*, 123–148. Berlin: Mouton de Gruyter. DOI: https://doi.org/10.1515/9783110198591.123

van Oostendorp, Marc. 2012. Stress as a proclitic in Modern Greek. *Lingua* 122. 1165–1181. DOI: https://doi.org/10.1016/j.lingua.2012.05.006

Walker, Rachel. 1997. Faith and markedness in Esimbi feature transfer. *Phonology at Santa Cruz 5,* 103–115.

Walker, Rachel. 1998. *Nasalization, neutral segments, and opacity effects*. University of California dissertation.

Walker, Rachel. 2017. Cumulative constraint interactions: Violations and domains encompassing segmental spans. In Aaron Kaplan et al. (ed.), *Proceedings of the 34th west coast conference on formal linguistics*, 1–15. Somerville, MA: Cascadilla Proceedings Project.

Wilson, Jennifer. 2017. *A grammar of Yeri: a Torricelli language of Papua New Guinea*. Buffalo: State University of New York dissertation.

Wolf, Matthew. 2007. For an autosegmental theory of mutation. In Leah Bateman, Michael O'Keefe, Ehren Reilly, & Adam Werle (eds.), *UMOP 32: Papers in optimality theory III*, 315–404. Amherst, MA: GLSA.

Yu, Alan. 2007. The phonology-morphology interface from the perspective of infixation. In Matti Miestamo & Bernhard Wälchli (eds.), *New challenges in typology: Broadening the horizons and redefining the foundations*, Berlin: Mouton de Gruyter.

Yu, Alan C. L. 2002. Understanding infixes as infixes. *Talk, given at NAPhC* 2.

Zaleska, Joanna. 2018. *Coalescence without coalescence*. Leipzig: Leipzig University dissertation.

Zimmermann, Eva. 2013. Vowel deletion as mora usurpation: the case of Yine. *Phonology* 30. 125–163. DOI: https://doi.org/10.1017/S0952675713000055

Zimmermann, Eva. 2017. *Morphological length and prosodically defective morphemes*. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/oso/9780198747321.001.0001

Zimmermann, Eva & Jochen Trommer. 2013. The linearization of morphological weight. In Fabian Heck & Anke Assmann (eds.), *Rule interaction in grammar* 90. 123–161. Leipzig: University of Leipzig.

Zoll, Cheryl. 1994. Subsegmental parsing: floating features in Chaha and Yawelmani. In Jason Merchant, Jaye Padgett & Rachel Walker (eds.), *Phonology at Santa Cruz 3*, 47–56. Santa Cruz, CA: University of California at Santa Cruz.

Zoll, Cheryl. 1996. *Parsing below the segment in a constraint-based framework*. Berkeley: University of California dissertation.