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Locality Restrictions on Exceptions to Vowel Harmony

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This paper argues that while the domain of regular vowel harmony processes applies over the entire lexical item, exceptions to vowel harmony apply to a domain that is locally bound to the exceptional morpheme. This has important consequences for distinguishing between two competing theories of lexical exceptions in Optimality Theory (Prince and Smolensky, 1993/2004): lexically-indexed constraints (e.g., Pater, 2000) and lexically-indexed rankings (e.g., Anttila, 2002). Lexically-indexed constraints are subject to a locality requirement in their locus of violation, forcing exceptions in harmony to have a local domain of application. Lexically-indexed rankings cannot apply in a local fashion, and are unable to account for locality of exceptions in vowel harmony.

1. Introduction

One important goal of generative phonology is to account for exceptional behavior in such a way that exceptions need not be thought of as unprincipled and idiosyncratic (Zonnefeld 1978). Research on the nature of exceptions, along with the development of Optimality Theory in phonology (Prince & Smolensky 1993/2004), has allowed for great advances in this vein, allowing researchers to study exceptions and variation in a principled way (Anttila 1995, 2002; Kraska-Szlenk 1996; Pater 2000, 2007, to appear). In Optimality Theory, the set of possible languages is determined by the set of possible rankings of universal constraints. Recent work has shown that in many cases, exceptions in language provide 'windows' into other possible grammars, i.e. constraint rankings.

Two methods for formalizing exceptions are considered in this paper: lexically-indexed rankings (Anttila 1997, 1995, 2002; Ito & Mester 1995) and lexically-indexed constraints (Fukazawa, Kitahara, & Ota 1998; Ito & Mester 1999; Kraska-Szlenk 1996, 1997; Pater 2007, to appear). Lexically-indexed rankings formalize exceptionality by allowing exceptional morphemes to select their own rankings. Lexically-indexed constraints are simply indexed versions of universal constraints, that is, versions of universal constraints that apply only to those lexical items picked out by their index. Both types of formalization necessarily constrain exceptionality because the same set of constraints is available to both regular and exceptional items. Constraining exceptionality in this way allows the phonologist to make predictions about

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the nature of lexical exceptions. The most obvious prediction is that exceptions should follow universal grammatical principles. However, the full extent of the principled nature of exceptions has yet to be discovered. Understanding exactly how exceptions in phonology are principled is critical for understanding the proper device for implementing a formal theory of exceptions.

Vowel harmony provides excellent ground for testing the principled nature of exceptions. For the purposes of this paper, I define vowel harmony as any process whereby consecutive vowel segments share some feature value. I consider two types of vowel harmony in this paper: stem-controlled and dominant-recessive (Aoki 1968a, b; Bakovic 2000; Halle & Vergnaud 1981; van der Hulst & van de Weijer 1995). In stem-controlled harmony, the harmonic feature value is determined by the feature value of the stem. In dominant-recessive vowel harmony, the harmonic feature is determined by the presence of a particular feature value (e.g., [+ATR]) in the input. If this dominant feature value is present, all vowels will change to match the dominant feature.

This paper focuses on two types of exceptions in vowel harmony: exceptional undergoers and exceptional non-undergoers. These are defined as all cases in which, for a select group of morphemes only, harmony either (i) fails to apply (exceptional non-undergoer), or (ii) applies (exceptional undergoer). In Turkish, a regular vowel harmony language, several suffixes (underlined) fail to undergo backness harmony, as illustrated in (1) below.

(1) Examples of exceptional non-undergoers in Turkish (Clements 1982, Polgardi 1999)

(a)	sekiz-gen-ler	'octogonals'
	tʃok-gen-ler	'polygonals'
(b)	ermen-istanɨ	'Armenian'
	mool-istanɨ	'Mongolian'
(c)	mest-ane	'drunkenly'
	dost-ane	'friendly'
(d)	gel-ijor-um	'I am coming'
	koʃujor-um	'I am running'

The underlined exceptional suffixes keep their underlying feature values despite the backness quality of the stem, but can spread their features to suffixes that follow.

This paper discusses the possibility of another, less frequent class of exceptions: triggers and non-triggers, in which a select group of morphemes either exceptionally spreads its feature value or exceptionally fails to spread its feature value. The paper provides some discussion of the rarity of exceptional triggers, and the lack of true examples of exceptional non-triggers (i.e., cases in which a select group of morphemes fails to spread the harmonic feature in an otherwise harmonic environment). The present proposal predicts that exceptional triggers and non-triggers should be the most rare form of exceptions to vowel harmony.

To be considered an exception, there must be no phonological explanation for a given morpheme's exceptional behavior; it is only the morpheme's identity that determines whether or not vowel harmony applies. This distinguishes phonologically motivated non-participating vowels from exceptional non-undergoers: all instances of a phonologically motivated non-participating vowel fail to participate, but in exceptional harmony, only a subset of vowels fail to participate. One example of phonologically motivated non-participation includes vowels that are opaque because they have no harmonic counterpart in the inventory (e.g., in Turkana, [–ATR] [a] has no [+ATR] counterpart in the inventory, and therefore blocks the spreading of [+ATR] (Bakovic 2000)).

This paper proposes that exceptionality in vowel harmony is captured through lexically-indexed constraints. For a given language with exceptional undergoers and non-undergoers, each morpheme is indexed as an undergoer (WEAK) or a non-undergoer (STRONG). The STRONG and WEAK indexations of the exceptional morphemes are co-indexed with STRONG and WEAK faithfulness constraints, respectively. In satisfying the locality requirement introduced in Pater (2007, to appear), indexed faithfulness constraints have a locus of violation that applies only to the morphemes that share the same indexation (e.g., STRONG constraints apply only to STRONG morphemes). STRONG faithfulness constraints are ranked above the harmony-inducing constraint, and WEAK faithfulness constraints are ranked below the harmony-inducing constraint. Because the locus of violation for the indexed faithfulness constraint only has scope over the indexed morpheme, there is no way for exceptions in harmony to apply outside its morphological domain.

This paper uses the terms 'localized' and 'morpheme-bound' interchangeably. By localized/morpheme-bound, I mean that morpheme-specific processes apply only to exceptional material. Unlike most phonological processes, vowel harmony applies iteratively, creating the potential for multiple loci of application within a lexical item. This long-distance nature of vowel harmony might lead one to expect that exceptions to vowel harmony should behave in a long-distance manner as well. However, this is not the case; exceptions in vowel harmony are localized to the exceptional morpheme (i.e., morpheme-bound), as documented in this paper. This fact has important consequences for distinguishing between the two theories of lexical exceptions introduced above: lexically-indexed constraints and lexically-indexed rankings. A major empirical difference between these two theories is the predicted locus of exceptionality. Lexically-indexed rankings allow a morpheme to select a unique constraint ranking that applies to the entire lexical item, predicting long distance effects of exceptionality. According to Pater (2007, to appear), lexically-indexed constraints have a locus of violation that prevents long-distance effects of exceptional morphemes. This locus of violation restriction makes the correct prediction that exceptions should be morpheme-bound, even for inherently long distance phenomena like vowel harmony. The fact that exceptions in vowel harmony are local fall in line with the typological generalization that morphologically-governed patterns tend to be local (Cole 1991; Lieber 1990), and adds to evidence introduced in Pater (2007, to appear) that indexed constraints are the most natural way to account for this locality principle.

This paper begins by discussing the present proposal for accounting for vowel harmony and lexical exceptions in Optimality Theory (Section 2). Next, the morpheme-bound predictions that are made by lexically-indexed constraints are discussed in terms of two additional languages: Korean and Nandi-Kipsigis Kalenjin (Section 3). This is followed by a discussion of alternative proposals, including underspecification and lexically-indexed rankings (Section 4). This is followed by a more general discussion of the predictions about exceptions in vowel harmony, specifically the status of exceptional non-triggers in vowel harmony (Section 5). Section 6 concludes.

2. The Proposal: Lexically-Indexed Constraints and Vowel Harmony

This paper proposes that exceptions in vowel harmony are optimally accounted for using lexically-indexed faithfulness constraints. In order to understand how lexically-indexed faithfulness constraints are utilized in these analyses, and how they are able to make predictions about the nature of exceptions in phonological vowel harmony, some discussion of the nature of lexically-indexed constraints is warranted.

Lexically-indexed constraints are in most ways identical to standard constraints, particularly in that indexed constraints must be drawn from the universal set of constraints. What makes indexed constraints different is that whether or not an indexed constraint applies depends on the input. Indexed constraints apply if and only if both the input and the indexed constraint are co-indexed. For example, FAITH_I applies only to $/\text{input}/_I$. In all other cases, the indexed constraint does not apply (it cannot be violated; it is vacuously satisfied). Note that multiple morphemes, classes of morphemes, or individual morphemes each may all have the same indexation.

The restriction on application of indexed constraints can be derived through a restriction on the locus of violation for indexed constraints. According to Pater (2007, to appear), the locus of violation for indexed constraints must include that indexed morpheme. For example, for input $/\text{Root} + \text{Suff}_I/$, the indexed constraint is violated only if the I-indexed suffix contributes to the violation. For a given indexed constraint, if there is no matching indexation in the input, then that indexed constraint is vacuously satisfied.

The locus of violation for indexed faithfulness is derived from the locus function for unindexed faithfulness constraints. This function assigns a correspondence relation $\Re$, that maps the input to the output such that there is a faithfulness violation if the output differs from the input (McCarthy and Prince 1995), and is defined in (2) (Lubowicz 2005). Each segment in the input is compared to its corresponding segment in the output. For each input segment that differs from its corresponding output segment (in the manner specified by the specific faithfulness constraint), that segment contains a locus of violation for the faithfulness constraint, which is added to the set of violations.

(2) Loc Function for Faithfulness (Lubowicz 2005, adapted from McCarthy 2003)
$\text{LOC}_{\text{FAITH}}(\Re(\text{input, output})) \rightarrow \{\text{locus}_1, \text{locus}_2, \dots \text{locus}_j\}$, where locus_j is an out-locus of $\Re$ whose ordered input-output pair violates FAITH.

For example, the faithfulness constraint ID[VOICE] is violated by the input-output pair /pad/ → [bad], but only for the initial segment. Applying this input-output pair through the locus function provides this information, given below.

(3) Loc Function for Faithfulness (Lubowicz 2005, adapted from McCarthy 2003)
$\text{LOC}_{\text{ID[VOICE]}}(\Re(p_1a_2d_3, b_1a_2d_3)) \rightarrow \{(p_1, b_1)\}$ where (p_1, b_1) violates ID[VOICE]

The locus of violation for ID[VOICE] for the input/output pair /pad/ → [bad] is the set containing the ordered pair (p_1, b_1) because this input-output relation is the only one that violates ID[VOICE]. Extending the locus function for unindexed faithfulness constraints to indexed faithfulness constraints involves combining the function in (2) with Pater's (2007, to appear) definition of constraint violation for indexed markedness constraints (given in (4) below).

(4) $*X_I$ (Pater 2007, to appear)
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as I.

The combination of (2) and (4) yields the locus function for indexed faithfulness constraints, given in (5), below.

(5) Loc Function for IDENT[F]$_I$
LOC$_{IDENT[F]I}$($\mathfrak{R}_I$(input$_L$, output)) → {locus$_1$, locus$_x$ … locus$_j$}, where locus$_j$ is an out-locus of $\mathfrak{R}_I$ whose ordered input-output pair violates FAITH, and contains a phonological exponent of a morpheme specified as L.

Only co-indexed input-output relations that violate the faithfulness constraint are part of the locus of violation for the indexed constraint. This has the effect that only violations of the indexed morphemes are counted.

With the locus function for indexed constraints established, I will now demonstrate how constraint indexation works for vowel harmony. For the purposes of this paper, I assume that harmony is induced by an M >> F ranking, in which the harmony-inducing constraint outranks featural identity (ID[F]). A dichotomy is created between undergoing and non-undergoing morphemes. Exceptional non-undergoing morphemes are indexed with high-ranked faithfulness (STRONG), and the exceptional undergoers are indexed with low-ranked faithfulness (WEAK). For a language with both undergoers and non-undergoers, all morphemes are indexed. In this sense, there is no formal distinction between the exceptional and regular pattern. Because indexation is a tool for differentiating undergoers from non-undergoers, there is no need to index morphemes when a language has no exceptions.

Notice that indexation of STRONG and WEAK is not necessarily constrained by stem/affix status, making it possible for a stem to have be indexed to a lower-ranked faithfulness constraint than an affix. Because in general, stem faithfulness outranks affix faithfulness (McCarthy & Prince 1995b), we expect that the majority of stems should be indexed to higher-ranked faithfulness constraints than affixes. However, the presence of affixes that fail to undergo harmony provides evidence that in some cases, affixes faithfulness may outrank stem faithfulness.

The general ranking for harmony is therefore F_{STRONG} >> M >> F_{WEAK}, where undergoers are indexed as WEAK, and non-undergoers are indexed as STRONG. I will illustrate this with Turkish, a regular harmony language in which the majority of affixes participate in harmony, but a number of affixes fail to undergo harmony. Turkish displays both round and back harmony, with several conditioning factors. First, only high vowels undergo round harmony; non-high round vowels are licensed only in stems, and only suffixes containing high vowels are affected by round harmony (Bakovic 2000; Clements & Sezer 1982; Cole & Kisseberth 1994). Second, non-high vowels are opaque to round harmony, but all vowels undergo back harmony (Clements & Sezer 1982; Erdal 2004; Kirchner 1993; Polgardi 1999). Third, stems may be disharmonic to both round and back vowel harmony. The (less restrictive) word initial vowel inventory is given in (6) below.

(6) Turkish (Initial) Vowel Inventory (Clements & Sezer 1982; Polgardi 1999)

	Front		Back	
	Non-round	Round	Non-round	Round
High	i	y	ɨ	u
Non-High	e	ø	a	o

Harmonic suffixes alternate in both [BACK] as well as [ROUND] features. This is illustrated in (7) below, in which the high suffix vowel becomes [ROUND] if the stem vowel is [ROUND], and all vowels agree in [BACK].

(7) Vowel Harmony in Turkish (Clements & Sezer 1982; Polgardi 1999)

	Nom Sg	Gen Sg	Nom Pl	Gen Pl	Gloss
a.	[ip]	[ip-in]	[ip-ler]	[ip-ler-in]	'rope'
b.	[kɨz]	[kɨz-ɨn]	[kɨz-lar]	[kɨz-lar-ɨn]	'girl'
c.	[jyz]	[jyz-yn]	[jyz-ler]	[jyz-ler-in]	'face'
d.	[pul]	[pul-un]	[pul-lar]	[pul-lar-ɨn]	'stamp'
e.	[el]	[el-in]	[el-ler]	[el-ler-in]	'hand'
f.	[sap]	[sap-ɨn]	[sap-lar]	[sap-lar-ɨn]	'stalk'
g.	[køj]	[køj-yn]	[køj-ler]	[køj-ler-in]	'village'
h.	[son]	[son-un]	[son-lar]	[son-lar-ɨn]	'end'

The genitive singular suffix /-in/ has four allomorphs, depending on the [ROUND] and [BACK] specification of the root vowel. The nominative plural suffix /-ler/ has only two allomorphs, front ([ler]) and back ([lar]), because non-high vowels do not participate in round harmony.

In Turkish, both stems (e.g., [maʃina] 'car') and suffixes may be disharmonic. I assume that the harmonic high vowel occurring before the progressive suffix is epenthetic, and therefore not part of the underlying form of the suffix (Bakovic 2000). Evidence for the epenthetic nature of this part of the suffix comes from the fact that this initial vowel only appears after stems ending in a consonant (e.g., /iste –jor/ → [istijor] 'he wants', [gel-ijor-um] 'I am coming' (Underhill 1976)).

(8) Disharmonic suffixes in Turkish (Clements and Sezer, 1982, Polgardi 1999)

a. N-Forming /-gen/

sekiz-<u>gen</u>-ler	'octagons'
ytʃ-<u>gen</u>-ler	'triangles'
tʃok-<u>gen</u>-ler	'polygons'
altw-<u>gen</u>-ler	'hexagons'

b. N-Forming /-istan/

ermen-istanɨ	'Armenian'
mool-istanɨ	'Mongolian'
tyrk-istan-ɨ	'Turkestan'
arab-istan-ɨ	'Arabia'

c. Adv-Forming /-ane/

mest-ane	'drunkenly'
dost-ane	'friendly'
bilgitʃ-ane	'in a know-all fashion'

d. Progressive /-jor/

gel-ijor-um	'I am coming'
koʃ-ujor-um	'I am running'
gyl-yjor-um	'I am laughing'
bak-ɨjor-um	'I am looking'

The disharmonic vowels (underlined) fail to harmonize with the stem vowel. The vowel in (a) remains front in a back context, while suffix vowels in (b) and (c) are disharmonic with each other, and neither vowel alternates to conform to the stem vowel. The suffix vowel in (d) remains back despite a front vowel context. The suffixes that follow the disharmonic suffixes still undergo harmony by agreeing in [BACK] and [ROUND] with the disharmonic suffix. These data demonstrate the morpheme-bound nature of exceptions in Turkish because the presence of an exceptional non-undergoer does not prevent harmony from applying in undergoing morphemes.

The existence of exceptional morphemes is a robust phenomenon, as it is also documented in Old Turkic (Anderson 1996; Erdal 2004). In (9) below, the disharmonic suffixes (underlined) still trigger rounding and backness harmony with the suffixes that follow them.

(9) Morpheme-bound nature of disharmony in Old Turkic (Anderson 1996; Erdal 2004)

a.	øt-im-in	'my advice –acc.'
b.	olur-sɨq-ɨm	'possible-nec.'
c.	øl-sik-in	'die-nec.'
d.	iniji-gyn-ym	gloss unavailable

The suffixes that appear word-finally in (9) harmonize with the disharmonic morphemes; they are round when the disharmonic suffix is round and unround when the disharmonic suffix is unround. This demonstrates that disharmony in Old Turkic is bound to the disharmonic morpheme, and harmony will apply to any morpheme that allows it.

In Turkish, the morphemes marked as WEAK will undergo harmony, while the stem vowels will determine the harmonic feature. Other morphemes, marked as STRONG will have high-ranked faithfulness, and therefore not undergo harmony. This is shown below, by the locus of violation function for each faithfulness constraint for candidate (b) (for simplicity, only the vowels are shown). The input-output correspondence of /jor-im/ → [jorum] (/i o i/ → [i o u]) produces the relation ($\Re(i_{1STRONG}, o_{2STRONG}, i_{WEAK}), (i_1, o_2, u_3)$). In (10), there are no violations of ID are incurred by lexical items marked as STRONG.

(10) Locus function for ID[BACK]$_{\text{STRONG}}$
$\text{LOC}_{\text{ID}}[\text{BACK}]_{\text{STRONG}}\ (\Re(i_{1\text{STRONG}}, o_{2\text{STRONG}}, i_{3\text{WEAK}}), (i_1, o_2, u_3)) \rightarrow \text{LOC}_{\text{ID}}[\text{BACK}]_{\text{STRONG}}\ (\{(i_{1\text{STRONG}}, i_1), (o_{2\text{STRONG}}, o_2), (i_{3\text{WEAK}}, u_3)\}) \rightarrow \emptyset$

In (10), there are no ordered pairs indexed as STRONG with a change in backness from input to output. This means that there is no violation of the identity constraint, and therefore no possibility for a locus of violation (hence the null set). In (11), the locus function is applied to the WEAK constraint. Here, there is a violation of ID, incurred by the medial vowel, indexed as WEAK, which is the sole contribution to the locus of violation for this constraint.

(11) Locus function for ID[BACK]$_{\text{WEAK}}$
$\text{LOC}_{\text{ID}}[\text{BACK}]_{\text{WEAK}}\ (\Re(i_{1\text{STRONG}}, o_{2\text{STRONG}}, i_{3\text{WEAK}}), (i_1, o_2, u_3)) \rightarrow \text{LOC}_{\text{ID}}[\text{BACK}]_{\text{STRONG}}\ (\{(i_{1\text{STRONG}}, i_1), (o_{2\text{STRONG}}, o_2), (i_{3\text{WEAK}}, u_3)\}) \rightarrow \{(i_{3\text{WEAK}}, u_3)\}$

The final vowel incurs a violation of ID[Back]. Because the input for this segment is co-indexed with the identity constraint, the locus of violation for this constraint is on this final vowel.

For the majority of this paper, I will use ALIGN (Akinlabi 1994, 1997; Archangeli & Pulleyblank 2002; Kirchner 1993; Orie 2003) as the harmony-inducing constraint defined in (12) below. While ALIGN may not be the most ideal harmony-inducing constraint (McCarthy 2004, Wilson 2000, 2003), ALIGN provides the simplest, least problematic account of the data presented in this paper. Unfortunately, there is no single harmony-inducing constraint that provides a simple, unproblematic account of vowel harmony. For the purposes of this paper, however, ALIGN allows for the most straightforward demonstration of indexed constraints in vowel harmony. I will return to the issue of the harmony-inducing constraint following a demonstration of how the ALIGN constraint works with indexed faithfulness constraints.

(12) ALIGN ([αF], R, PrWd, R):
Align the rightmost edge of a featural autosegment to the rightmost edge of the prosodic word.
For a given [αF] autosegment, assign one violation to each vowel not associated with that [αF] autosegment between the rightmost edge of the word to the rightmost edge of the autosegment.

There are four violations of ALIGN-R for the output [– – + + –], three associated with the first [–F] autosegment, and one associated with the [+F] autosegment. For the [–F] autosegment, there are three vowels from the right edge of the word that the autosegment failed to spread to. For the [+F] autosegment, there is one vowel that the autosegment failed to spread to. Following Archangeli and Pulleyblank (2002), I assume that gapped representations like the one in (13) below are illicit, and not produced by GEN. This means that for any pair of adjacent vowels that disagree in feature values, there will always be at least one violation of ALIGN.

(13) Impossible structure: non adjacent segments sharing the same autosegment (not produced by GEN)

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*e   a   e
 |       |
 [+ATR]
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In this paper, bidirectional harmony is derived via two ALIGN constraints (i.e., ALIGN-R, ALIGN-L). Note that the ALIGN constraint is output oriented- the constraint can be satisfied by spreading of a non-underlying feature. In the analysis presented below, the undergoing morpheme /-in/ is indexed as WEAK, but the non-alternating morphemes are indexed as STRONG.

To save space, I will only show back harmony. This analysis is adapted from previous analyses of Turkish, showing alternation of the suffix vowel in backness and rounding induced by the stem vowel [o], shown in (14) below. The standard finger-point (☞) is used for tableaux that predict the correct output. For tableaux that make faulty predictions, a frown face (☹) is used for the incorrectly predicted outcome and a checkmark (✓) is used for the intended outcome.

(14) Regular Back Harmony in Turkish

/√son-in$_{\text{WEAK}}$ / 'end' Gen-Sg.	ID [BACK] STEM	ALIGN [BACK]-R	ID [BACK] WEAK
a. [sønin]	*!	*	
b. ☞[sonun]			*
c. [sonin]		*!	

Tableau (14) above shows regular vowel harmony in Turkish. A high, front unrounded vowel becomes round and back in order to agree with the stem [son]. Tableau (15) below shows the effect of high-ranked morpheme-specific constraints on harmony. From Bakovic (2000), the progressive suffix /-jor/ is opaque to back harmony. High-ranked faithfulness to this morpheme makes it impervious to harmony. Because stem faithfulness is ranked higher than affix faithfulness (as well as ALIGN), stem vowels will not alternate in order to satisfy the agreement constraints.

(15) Morphologically Opaque Harmony: Back Harmony (Bakovic 2000)

/√ist-i<u>jor</u>/ 'want' <u>STRONG</u>	ID [BACK] <u>STRONG</u>	ID [BACK] STEM	ALIGN [BACK]-R	ID [BACK] WEAK
a. [isitijer]	*!			
b. [ustujor]		*!		*
c. ☞ [istijor]			*	

Notice that the ranking of ID[BACK]-STEM must be ranked above ALIGN, otherwise the disharmonic suffix will spread backwards. There are two possible ways to account for harmony in stems. One is to follow Bakovic (Bakovic 2000, 2005) and assume that harmony in stems is derived via cyclicity. Another option is a high-ranked NO-SPREAD-L constraint that penalizes backwards spreading. I remain agnostic as to which avenue is most appropriate for this case.

When there is a suffix following the opaque suffix, that suffix will harmonize to the opaque suffix, following the morpheme-bound nature of exceptions in harmony. This is entirely straightforward by the present analysis, as shown in (16) below.

(16) Morphologically Opaque Harmony: Back Harmony (Bakovic 2000)

/√ist-ijor-im/ 'want' STRONG	ID [BACK] STEM	ID [BACK] STRONG	ALIGN [BACK]-R	ID [BACK] WEAK
a. [isitijerim]		*!		
b. [ustujorum]	*!			**
c. ☞ [istijorum]			**	*

This derives the morpheme-bound nature of lexically-indexed faithfulness constraints. A final note should be made about the use of an alignment constraint in an analysis of the locality of exceptions in vowel harmony. While ALIGN is essentially a non-local constraint (McCarthy 2003; Wilson, C. 2003), ALIGN is the simplest, least problematic constraint, as for as accounting for exceptional undergoers and non-undergoers. Constraints like AGREE suffer from a problem referred to as 'sour-grapes' spreading (McCarthy 2004; Wilson, C. 2003, 2005). Sour-grapes spreading occurs when a disharmonic segment blocks spreading to other segments. For example, if a language with ATR harmony does not allow low vowels to become [+ATR] because of inventory constraints against [+ATR] low vowels, a non-low [–ATR] segment intervening between the source and the low vowel may pathologically fail to undergo harmony. This is because the presence of a disharmonic segment creates a mandatory AGREE violation. Therefore, whether or not the intervening vowel undergoes harmony can not depend on the number of AGREE violations. If it does undergo, it is unfaithful, and therefore less harmonic than the non-undergoing candidate. This is given below; the stem is marked with √ (Bakovic 2000, 2005):

(17) *F/G >> AGREE >> ID : Sour Grapes

/√bin-ɪ-a/	*[+ATR]/ [–HIGH]	ID[ATR] STEM	AGREE[ATR]	ID[ATR]
a. ☹ [binɪa]			*	
b. [biniæ]	*!			**
c. [bɪnɪa]		*!		*
d. ✓ [binia]			*	*!

This becomes crucial in accounting for exceptional non-undergoers. Unless one adopts a cyclic approach using stem-affix (SA) faithfulness (Bakovic 2000, 2005)[1], under an AGREE analysis, the presence of an exceptional non-undergoer can incorrectly block spreading to a regular undergoer. Ironically, this local constraint makes the most serious non-local predictions. I acknowledge that neither ALIGN nor AGREE may be the best harmony-inducing constraint, and that ALIGN may be problematic in other aspects of exceptions to harmony not yet uncovered. It is beyond the scope of this paper to devise the ideal harmony constraint, but I will now show that

[1] This cyclic approach assumes that all morphemes are mono-syllabic and therefore cannot handle blocking cases for polysyllabic morphemes.

the general STRONG/WEAK faithfulness dichotomy is independent of the harmony-inducing markedness constraint. In (18)-(21), below, I show the Turkish analysis using, a SPREAD constraint, a headed feature domain constraint (*HD) (Smolensky 2006) and an AGREE (Bakovic 2000) constraint, all yielding the same result.

(18) Turkish Vowel Harmony with SPREAD

/√ist-ijor-im/ 'want' STRONG	ID [BACK] STEM	ID [BACK] STRONG	SPREAD-R [BACK]	ID [BACK] WEAK
a. [isitijerim]		*!		
b. [ustujorum]	*!			**
c. ☞ [istijorum]			**	*

In (18) above, the BACK feature spreads to the suffix vowel because faithfulness to the suffix vowel is ranked lower than the harmony constraint. In (19), below, Turkish is analyzed using headed feature domains. Each span of a feature value constitutes a feature domain, with a head, marked with the symbol ˚. Each head incurs a violation of *HD, encouraging harmonic forms by giving the smallest penalty for harmony. Because this constraint operates as an M >> F relationship, the indexed constraints have no problem adapting to the different constraint.

(19) Turkish Vowel Harmony using *HD

/√ist-ijor-im/ 'want' STRONG	ID [BACK] STEM	ID [BACK] STRONG	*HD [BACK]	ID [BACK] WEAK
a. [i˚sitijerim]		*!	*	
b. [ustujoru˚m]	*!		*	**
c. ☞ [i˚sti][jo˚rum]			**	*

In (21), the AGREE constraint is violated if two adjacent segments disagree in their feature value.

(20) AGREE[F] (Bakovic 2000):
Adjacent segments must have the same value of the feature [F].

(21) Turkish Vowel Harmony with AGREE

/√ist-ijor-im/ 'want' STRONG	ID [BACK] STEM	ID [BACK] STRONG	AGREE [BACK]	ID [BACK] WEAK
a. [isitijerim]		*!		
b. [ustujorum]	*!			**
c. ☞ [istijorum]			*	*

While this paper focuses on the effects of indexation of faithfulness constraints, it is possible that the harmony-inducing markedness constraint could be indexed. A high-ranked harmony-inducing markedness constraint will induce an exceptional trigger. Because this markedness constraint will be subject to Pater's locality function in (4), the same locality effects for indexed faithfulness constraints are predicted. In general, the relationship between the lexicon and the grammar is mediated through faithfulness constraints (e.g., input-output relations). The most natural extension of relations of lexical information to the grammar would therefore be through faithfulness, implying that lexical exceptions should be mediated through indexed faithfulness. While it is possible for a relationship to be established between the lexicon and markedness constraints, this relationship requires a greater extension of the machinery for relating the lexicon to the grammar. I therefore assume that indexed faithfulness constraints are unmarked relative to indexed markedness constraints, which predicts that exceptional triggers should be typologically rare. This is indeed the case, as I have found a relatively small number of true examples of exceptional triggers. Further, because the locus of violation is different for different harmony-inducing constraints, the effect of indexed harmony constraints may vary from constraint to constraint. For example, the local, birdirectional nature of AGREE may make different predictions than the long-distance, directional ALIGN. This issue is discussed in further detail in Section 5 of this paper.

Another important point concerns the locus of violation for lexically-indexed constraints. Because this paper analyses exceptional morphemes, I assume that the domain of an index is an exceptional morpheme. This is what localizes indexed violations to a specific morpheme. However, it is conceivable that an entire lexical item, stem and affixes, might bear a single index. In this case, the entire lexical item would be subject to an indexed constraint, and the specific stem-affix combination would be exceptional. This indexation would require the assumption that the entire indexed combination is stored in the lexicon. Since I am aware of no cases of specific exceptional stem-affix combinations in vowel harmony, I assume that affixes are stored independently of their stems, and indexation of an entire lexical item is not an option.

This does not eliminate the possibility that a domain smaller than a morpheme, such as an individual syllable or segment, could be indexed. Such an indexation would occur for a morpheme in which one subset of the segments behaves in accordance with one indexation, and another subset behaves in accordance with a different indexation. For example, the progressive suffix in Turkish (/-ijor/ [gel-ijo̲r-um] 'I am coming') has one undergoing vowel and one non-undergoing vowel. In these cases, the indexation of the vowels in the exceptional morpheme would be /-$i_{\text{WEAK}}o_{\text{STRONG}}$/ where [i] would undergo harmony, but [o] would not. However, I assume that these cases are rare, and that the majority of indexation occurs at the morpheme-level.

Finally, some discussion is warranted on the learnability of lexically-indexed constraints. Coetzee and Pater (2006) and Pater and Coetzee (2006) have proposed an algorithm for learning indexed constraints. Their proposal draws on the assumption, built into Tesar and Smolensky's (1998) algorithm, that when the learner detects an error in the grammar, they automatically index the relevant constraints and lexical item. When this is combined with the Biased Constraint Demotion (Prince & Tesar 2004) algorithm, it is possible to learn the relevant indexed constraint ranking. Further, there is good reason to believe that proposal here does not suffer from intractable learnability problems.

This concludes the general discussion of lexically-indexed constraints. The next section provides further examples and analyses of exceptions in vowel harmony.

3. Exceptions in Vowel Harmony are Morpheme-Bound

In order to understand what it means for a theory to make predictions about the morpheme-bound nature of exceptional behavior, one must define the difference between local (morpheme-bound) and non-local (non-morpheme-bound) exceptions in vowel harmony. In this section, I will provide examples from different types of vowel harmony: stem-controlled and dominant-recessive harmony. These two types of harmony refer to how the harmonic feature is determined in an underlyingly disagreeing sequence. In stem-controlled harmony, the harmonic feature value of the output is determined by the feature value of a stem vowel. In dominant-recessive harmony, the harmonic feature value is determined by the presence or absence of the dominant feature in the input. For example, in dominant-recessive [+ATR] systems, if a [+ATR] vowel is in the input, all vowels will become [+ATR], including the stem vowel; otherwise, all vowels are [–ATR].

The Turkish example in Section 2 provided an example of stem-controlled vowel harmony with exceptional non-undergoers. Korean provides an example of a language that has only a small fraction of morphemes undergoing harmony. Nandi-Kipsigis Kalenjin is an example of a dominant-recessive vowel harmony language with exceptional non-undergoers.

The local nature of exceptionality means that the behavior of the exceptional morpheme does not affect the behavior of its surrounding morphemes; the exceptional behavior is morpheme-bound. The presence of an exceptional undergoer creates a harmonic environment, but does not affect the harmonic status of its surrounding morphemes. For example, an otherwise disharmonic stem, or disharmonic affix will stay disharmonic in the presence of the undergoer. The presence of an exceptional non-undergoer creates disharmony only in the immediate environment of the exceptional morpheme; harmony is not blocked outside the domain of the non-undergoer. Morpheme-bound exceptions are the norm (indeed the only attested pattern, as far as I know)[2].

While there are several cases of exceptional vowel harmony that do not necessarily prove the morpheme bound nature of harmony, there are many examples that clearly demonstrate the morpheme-bound nature of exceptions to harmony. In these ambiguous cases, undergoers in regressive (right to left) vowel harmony occur word-initially, including Bijago (Wilson, W. A. A. 2000/2001) and Yucatec Maya (Krämer 2001). These cases of exceptional undergoers are morpheme-bound because they do not induce harmony throughout the lexical item. Because of their position at the left edge of the lexical item, it may be possible to treat this effect as due to directionality, rather than localization. It is unclear whether this failure to spread is due to the localized nature of exceptions, or simply to their location at the word's left edge. The presence of this type of harmony exception does not adequately demonstrate the morpheme-bound nature of harmony exceptions, but it does not contradict it either. Therefore, they will not be discussed further. The remainder of this section will provide evidence of the morpheme-bound nature of exceptions from Korean and Nandi-Kipsigis Kalenjin.

In order for non-participating morphemes to be resistant to harmony, faithfulness to the underlying vowels in these morphemes must be ranked higher than the constraints driving harmony. A STRONG faithfulness constraint that applies to all non-participating morphemes, ranked above ALIGN[+ATR] induces non-participation of these morphemes. Because lexically-indexed constraints apply only to the indexed morpheme, morpheme-bound behavior is predicted.

In this section, I further explore lexically-indexed constraints with further examples. As in Section 2, I assume that vowel harmony is induced by the ranking ALIGN[F] >> ID[F], but as

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[2] Except for morphemes that are realized via vowel harmony (morphemic harmony (Finley 2009), analyzed differently from regular phonological harmony), non-local behavior does not seem to occur.

shown above, lexical indexation works in the same way for other harmony-inducing markedness constraints such as AGREE (Bakovic 2000), and theories of headed feature domains/spans (e.g., Cole and Kisseberth 1994; McCarthy 2004; Smolensky 1997, 2006).

3.1 Exceptional Harmony in Non-Harmony Languages: Korean

Korean is not generally considered a vowel harmony language, but the verbal morpheme[3] behaves as an exceptional undergoer, alternating between [ə] and [a]. Whether the vowel surfaces as [ə] or [a] depends on the vowel immediately to the left of the verbal morpheme. The alternation between [ə] and [a] is a distinct property of the verbal morpheme; other morphemes do not share the [ə]/[a] alternation. For example, the re-locative suffix [-t'əra] [namt'əra] 'remain (collectively)' (Cho 1994; Lee 1998) has both [ə] and [a] in the same morphological context[4]. The verbal morpheme will surface as [a] if the vowel to its left is [a] or [o]. All other vowels trigger [ə].

(22) Verbal Harmony in Korean (Cho 1994; Kim 2000; Lee 1998):

a.	[məg-ə]	'eat'
b.	[ki-ə]	'crawl'
c.	[nɨdʒ-ə]	'be late'
d.	[tʃab-a]	'grasp'
e.	[noh-a]	'put'

The left-adjacent vowel always determines the feature value of the verbal marker, even when the stem vowel alone triggers [ə], as in [məg]. For example, when the negative marker [an] intervenes between the stem [məg] and the verbal marker, [a] surfaces on the verbal morpheme:

(23) The Morpheme-Bound Nature of Vowel Harmony in Korean

a.	[məg-dʒi-an-a-t'a]	'eat-neg-past'
b.	[məg-ə-t'a]	'eat-past'

The vowel that determines the allomorph is adjacent to the morpheme. The presence of the exceptional undergoer doesn't cause the entire lexical item to undergo harmony. The vowel immediately following the verbal morpheme is not affected by harmony. In the same example, the past tense morpheme's vowel is [a], regardless of whether the verbal morpheme [ə] immediately precedes this vowel: [məg-ə-t'a] vs. [məg-dʒi-a-t'a]. Harmony in Korean is therefore bound to the one exceptional verbal morpheme, whose allomorphs vary between [ə] and [a]. Thus, exceptional undergoers in Korean are morpheme-bound.

[3] This morpheme is typically referred to as an infinitive marker (Lee 1998), but it also appears in tensed forms.

[4] Ideophones in Korean also undergo an alternation. However, because these alternations involve morpheme realization through vowel harmony, a morphemic harmony analysis is required (Finley 2006).

[a] is typically thought of as the [–ATR]/[+LOW] counterpart to [ə] (note that [ə] in Korean is [+ATR]). Evidence in favor of this interpretation is that [ə] is closer to [o] in vowel quality and does not serve as the epenthetic vowel. Thus, it seems logical to assume that the harmonic feature for verbal harmony is [ATR] or [LOW]. The only vowel to trigger [a] (besides [a] itself) is [o]. While there is controversy over whether [o] can be analyzed as [–ATR], I assume the simpler analysis, with [o] treated as [–ATR] for the purposes of demonstrating localization effects in exceptions. For a more thorough analysis, see Finley (2004).

I will assume that the harmonic feature governing harmony is [ATR], and this is controlled by the constraint ALIGN[ATR]-R. Because vowel harmony only affects the verbal morpheme, faithfulness to [ATR] for stems and STRONG affixes will be ranked above the harmony constraint. Faithfulness to the WEAK verbal affix will be ranked below the harmony constraint. This is shown in the tableau below.

(24) Verbal Morphology in Korean:

/tʃuk + a + ta/ WEAK 'die-past'	ID [ATR] STRONG	ALIGN [ATR]-R	ID [ATR] WEAK
a. [tʃukata]		**!	
b. ☞ [tʃukəta]		*	*
c. [tʃukətə]	*!		*

Candidate (c) spreads past the verbal marker, violating the STRONG ID constraint. Candidate (a) has two violations of ALIGN-R because there are two [–ATR] vowels following the initial [+ATR] vowel. Candidate (b) has a single violation of ALIGN-R, but no violations of the strong ID constraint, making it optimal. The tableau (25) is a hypothetical richness of the base example with /ə/ as the underlying form of the verbal marker.

(25) Verbal Morphology in Korean:

/tʃak + ə + ti/	ID [ATR] STRONG	ALIGN [ATR]-R	ID [ATR] WEAK
a. [tʃakəti]		**!	
b. ☞ [tʃakati]		*	*
c. [tʃəkəti]	*!		
d. [tʃakatɪ]	*!		*

Candidates (c) and (d) violate the STRONG ID constraint. Candidate (a) violates the spread constraint twice because two [+ATR] vowels are right-adjacent to the [–ATR] stem. Candidate (b) has one violation of the ALIGN constraint, but no violations of the strong ID constraint, making it the optimal candidate.

This section has provided an account of exceptional undergoers. Crucially, the analysis presented above shows that the presence of an exceptional undergoer does not induce harmony throughout the lexical item.

3.2 Exceptional Non-Undergoers in Dominant-Recessive Languages: Nandi-Kipsigis Kalenjin

Nandi-Kipsigis Kalenjin, a Southern Nilotic language, (Hall et al. 1973; Lodge 1995; Martin 1985) has a dominant-recessive [ATR] harmony system, where [+ATR] is dominant.

(26) Vowel inventory ([–ATR] vowels are the rightmost member of each pair):

i, ɪ		u, ʊ
e, ɛ		o, ɔ
	æ, a	

Because of the symmetrical inventory, the presence of a [+ATR] vowel in the input will cause all underlyingly [–ATR] vowels to assimilate to the [+ATR] vowel in the output, as shown in (27). Roots are marked with a √ (Bakovic 2000).

(27) Vowel harmony in Nandi-Kipsigis Kalenjin:

a.	/√pa:n-a:n/	[pa:na:n]	'that walk'
	/√tjæ:n -a:n/	[tjæ:næ:n]	'that beast'
b.	/√ke:r-ʊn/	[ke:r-un]	'see it from here'
	/√kʊt-ʊn/	[kʊt-ʊn]	'blow it here'
c.	/√sal-ɔ/	[sal-ɔ]	'painting'
	/√sal-u:t/	[sæl-u:t]	'a paint job'
d.	/ka-a-√kʊ:t-ʊn /	[ka:ɣʊ:ntʊn]	'I blew it'
	/ka-a-√kʊ:t-e/	[kæ:ɣu:te]	'I was blowing'

In (a) and (b), the [ATR] specification of the affix varies by the [ATR] value of the root. In (c) and (d), the [ATR] value of the root may change in the presence of some affixes, showing the dominant-recessive nature of Kalenjin vowel harmony. Because of the symmetry of the inventory, we should not expect any phonologically motivated non-participation of vowels. This is generally the case, except that there is a set of affixes that are opaque to harmony (Hall et al. 1973; Local & Lodge 1996; Lodge 1995)[5].

(28) Non-Participating Affixes (underlined) in Nandi-Kipsigis Kalenjin (Local & Lodge 1996; Lodge 1995)

a.	/kɪ-a-√un-<u>kɛ</u>j/	[ki-æ-un-<u>gɛ</u>j]	'I washed myself'
b.	/ka-<u>ka:-</u>kɔ-√ke:r-a/	[ka-<u>ɣa:</u>-ɣo-ɣe:r-æ]	'he had seen me'
c.	/ka-<u>ma</u>-a-√ke:r-ak/	[ka-<u>ma</u>-æ-ɣe:r-æk]	'I didn't see you'

When a non-undergoer occurs in a lexical item, harmony still occurs. In the form in (28b) above, the [+ATR] vowel in /ker/ spreads to the [–ATR] vowels in [kɔ] and [a]. If the effects of

[5] The vowel in the opaque morpheme is always [–ATR]. This has to do with the dominant-recessive nature of vowel harmony. An underlyingly [+ATR] vowel will never undergo a change in feature value to undergo harmony, and is inherently a non-undergoer.

exceptions in harmony were not morpheme-bound, one possible output would be that the presence of the exceptional morpheme to prevent harmony altogether, producing *[kaɣa:ɣɔɣe:ra], but this does not happen. Rather, disharmony is bound to the exceptional morpheme.

The analysis pursued here is drawn from the insights made by previous analyses of dominant-recessive vowel harmony in Optimality Theory (Bakovic 2000; Orie 2003; Pulleyblank 1998). The dominant-recessive nature of harmony is captured by the asymmetry of faithfulness to [+ATR] elements with the asymmetric featural correspondent constraint MAX[+ATR][6]. In order to avoid mixing MAX and ID, indexed MAX will be used in this analysis.

In the example of dominant-recessive [+ATR] vowel harmony from Nandi-Kipsigis Kalenjin, below, asymmetric featural faithfulness MAX[+ATR] outranks MAX [–ATR] (Orie 2003; Walker 2001). The harmony-inducing constraints ALIGN-L and ALIGN-R outrank featural faithfulness MAX[–ATR]. Because dominant-recessive harmony is bidirectional, the alignment constraints are unranked with respect to each other.

(29) Dominant-recessive [ATR] harmony in Nandi-Kipsigis Kalenjin

/√sal-u:t/ 'a paint job'	MAX[+ATR]	ALIGN [+ATR]-R	ALIGN [+ATR]-L	MAX[–ATR]
a. [salu:t]			*!	
b. ☞ [sælu:t]				*
c. [salʊ:t]	*!			

The disharmonic input /√sal-u:t/ surfaces as [+ATR] harmonic because of high-ranked ALIGN. The [+ATR] harmonic candidate is chosen over the [–ATR] harmonic candidate because of the asymmetric MAX feature constraint; changing a [+ATR] vowel to a [–ATR] vowel is worse than changing a [–ATR] vowel to a [+ATR] vowel.

The above analysis of regular dominant-recessive harmony must be revised to account for exceptional behavior, specifically with the introduction of indexed constraints, MAX[ATR]STRONG and MAX[ATR]WEAK. As in Section 2, non-undergoers are indexed as STRONG, and undergoers are indexed as WEAK. WEAK faithfulness constraints are ranked below the harmony-inducing constraints, whereas STRONG faithfulness constraints are ranked above the harmony-inducing constraints. For the purposes of space, only the STRONG morphemes and constraints are marked in the tableaux (underlined). Additionally, low-ranked MAX[–ATR] is omitted from the tableaux.

In the first example, below the [+ATR] root [√ke:r] spreads to the left and right, stopping at the exceptional non-undergoer [ka:]. High-ranked MAX[–ATR]STRONG prevents the exceptional non-undergoer from undergoing harmony, and high-ranked MAX[+ATR] prevents the [+ATR] stem from reversing to [–ATR] to preserve harmony.

[6] This can also be accounted for using the local conjunction *[–ATR] & ID[ATR] (Bakovic 2000).

(30) Morpheme-bound Exceptions in Nandi-Kipsigis Kalenjin

/ka-ka:-kɔ-√ke:r-a/ Strong 'he had seen me'	Max [–ATR] Strong	Max [+ATR]	Align [+ATR]-R	Align [+ATR]-L	Max [–ATR] Weak
a. [kæɣæ:ɣoɣe:ræ]	*!				
b. [kæɣa:ɣoɣe:ra]			*!****	**	**
c. ☞ [kaɣa:ɣoɣe:ræ]				**	*
d. [kaɣa:ɣɔɣɛ:ra]		*!			
e. [kaɣa:ɣɔɣe:ræ]				***!	*

The fully harmonic candidate (a) violates the identity constraint for the opaque morpheme. Candidate (d) is also fully harmonic, but forces the dominant vowel to become [–ATR], causing a fatal violation of Max[+ATR]. Candidate (c) surfaces because it is fully faithful to the non-participating morpheme and incurs the fewest agreement violations. Candidate (b) shows the Strong morpheme as transparent, but has more alignment violations than the opaque candidate. This is because the initial vowel is [+ATR] but fails to spread to the opaque morpheme, causing one extra violation of Align[+ATR]. In general, accounting for transparent vowels in vowel harmony is a major difficulty for Optimality Theory. Transparent exceptional morphemes should in principle be possible (though I am unaware of any specific cases). However, an account of these would not only require more complex machinery for the Align constraint, but would also require specific interactions with the markedness constraints that regulate which vowels are transparent or opaque (Bakovic & Wilson 2000; Kiparsky & Pajusalu 2003; O'Keefe 2007). The predictions made for lexical exceptions may depend on the theory of transparency rather than the present theory of lexical exceptions. Without empirical data, such speculation is beyond the scope of this paper.

The dominant-recessive nature of vowel harmony in Nandi-Kipsigis Kalenjin is not compromised by opaque morphemes. If a [+ATR] morpheme is adjacent to an opaque ([–ATR]) morpheme, it remains [+ATR]. This is shown in (31).

(31) Morpheme-bound Exceptions in Nandi-Kipsigis Kalenjin: Opaque morphemes don't spread [–ATR]

/√tugæ-tʃa:-gaj-ga-tʃwa:k/ Strong 'those cows of ours of yesterday'	Max [–ATR] Strong	Max [+ATR]	Align [+ATR]-R	Max [ATR]
a. ☞[tugætʃægajgatʃwa:k]			***	*
b. [tugætʃægæjgætʃwæ:k]	*!*			**
c. [tʊgatʃagajgatʃwa:k]		*!*		**

The disharmonic candidate (a), surfaces in order to preserve the dominant-nature of [+ATR] vowels. For dominant-recessive harmony, opaque morphemes with the recessive vowel will not spread harmony; they simply fail to undergo. While the ranking of Align and Max[+ATR] has played no role so far in the discussion, in this example, Max[+ATR] crucially outranks ALIGN. If ALIGN were to outrank MAX[+ATR], the [–ATR] harmonic candidate would be optimal. This outcome, (referred to as 'dominance reversal' (Bakovic 2000)), occurs where an exceptional non-undergoer reverses the direction of spreading, and is found in the Turkana language.

In this section, I have shown that indexed constraints provide a straightforward account of the morpheme-bound nature of exceptions to vowel harmony in Nandi-Kipsigis Kalenjin. In the next section, I consider alternatives. Specifically, I show how lexically-indexed rankings make the wrong predictions for the localized nature of exceptions in vowel harmony in Nandi-Kipsigis Kalenjin.

4. Alternatives

This section addresses alternative approaches to exceptions in vowel harmony: underspecification and lexically-indexed rankings. I show that the assumptions required for an underspecification analysis make the wrong predictions about representations of undergoers and non-undergoers in vowel harmony, and that lexically-indexed rankings make the faulty prediction that an exceptional morpheme should have global scope over the entire lexical item.

4.1 Underspecification

Rather than resorting to lexically-indexed rankings or constraints at all, it might be possible to account for exceptionality through underspecification of vowels[7] (Archangeli 1984; Inkelas et al. 1997; Kiparsky 1985; Local & Lodge 1996; Lodge 1995). Some may argue that an underspecification approach is more parsimonious than lexical indexation. The underspecification approach, however, can be thought of as just another way of tagging the lexicon. As Mohanan (1991) puts it "the use of underspecification to stipulate the distinction between alternating and non-alternating forms has no special advantage over the stipulation of lexical exceptionality." (pp. 322-323). This is because pre-specification of lexical exceptions cannot straightforwardly handle derived environment effects or structure-changing alternations (such as *obesity* in English as an exception to tri-syllabic shortening) (Mohanan 1991).

This speaks to the larger problem of using underspecification to mark whether a segment undergoes a phonological process. Underspecification analyses make the assumption that all specified segments are blockers and all underspecified segments are undergoers. However, there are cases in which this dichotomy cannot hold. For example, McCarthy and Taub (1992) note that in order to account for the wide range of processes involving coronals, both specification and underspecification is required for the feature [coronal]. Further, Steriade (1988) cites paradoxical cases in Hungarian vowel harmony in which specified vowels must still undergo vowel harmony.

The problems posed in previous literature highlight the inadequacy of underspecification as an explanation for lexical exceptions. Further, I will show that in the case of exceptions in vowel harmony and Optimality Theory, underspecification does not straightforwardly account for the harmonic-disharmonic dichotomy that exceptions pose, making implausible predictions about the nature of undergoers and non-undergoers in harmony systems.

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[7] Thank you to Charles Yu for emphasizing this possibility.

Still assuming ALIGN as the harmony-inducing constraint, underspecification only works if vowel harmony is created as an emergence of the unmarked effect (McCarthy & Prince 1995a). If ALIGN >> ID, then all inputs must harmonize, regardless of their underlying specification. This means that ID must outrank ALIGN, but harmony can still apply because an underspecified input does not violate ID constraints, as shown in (32).

(32) Harmony as Emergence of the Unmarked with Underspecification

/*pi* + mE/	ID[ATR]	ALIGN [+ATR]-R
a. [pimɛ]		*!
b. ☞ [pimɛ]		
c. [pɪmɛ]	*!	

This is different from previous accounts of vowel harmony using ALIGN and underspecification (Akinlabi 1994, 1997; Archangeli & Pulleyblank 2002; Kirchner 1993; Noske 2000; Orie 2003; Ringen & Vago 1998). These cases rank ALIGN >> ID, so that the input will harmonize regardless of the specification. However, once specification is used as a lexical marker for whether or not a vowel undergoes harmony, the M >> F ranking can no longer be used. This is especially problematic for any account in which an undergoer had a specified value in the input. For example, Noske's (2000) analysis of Turkana uses both full and underspecification for undergoers. In Turkana, a vowel in the suffix can spread [+ATR] to a stem vowel. Because stem vowels may surface as either [+ATR] or [–ATR] isolation, underspecification of the stem vowels that undergo harmony is not possible. For this reason, there is no way to account for potential lexical exceptions and the fact that some undergoers are specified.

Further, this approach cannot guarantee that an underspecified vowel will surface harmonically when following a specified vowel as demonstrated in (33) below. With the simple ID >> ALIGN ranking, the [+ATR] candidate and the [–ATR] candidate are equally likely to surface. This is because there are two vowels intervening between the leftmost [+ATR] and the right edge of the word, regardless of whether the final underspecified vowel is harmonic.

(33) Underspecification and Exceptions in Harmony

/pi + mɛ + mE /	ID[ATR]	ALIGN [+ATR]-R	*[–ATR]	*[+ATR]
a. ☞ [pimɛme]		**	*	**
b. [pimeme]	*!			***
c. [pɪmɛmɛ]	*!		***	
d. [pimɛmɛ]		**	**!	*

This 'tie' can be resolved by the relative ranking of *[+ATR] and *[–ATR], for example, but this makes the odd prediction that the behavior of an unspecified vowel in the presence of a non-undergoer is dependent on the non-undergoer's feature value, undermining the notion that unspecified vowels are harmony undergoers. This is best demonstrated by a case in which another specified vowel is added to the above example, shown below.

(34) Non-Undergoers and Non-Undergoers Mixed

/pi + mɛ + mE + gɛ/	ID[ATR]	ALIGN [+ATR]-R	*[–ATR]	*[+ATR]
a. [pimɛmegɛ]		*****!	**	**
b. [pimemege]	*!*			****
c. [pɪmɛmɛgɛ]	*!		****	
d. ☞ [pimɛmɛgɛ]		***	***	*

In the example in (34), default [+ATR] was chosen for the unspecified vowel. However, the output vowel cannot spread to the following non-undergoer, creating an extra alignment violation, causing the unspecified vowel to surface as [–ATR] to best agree with the non-undergoers. It is an odd prediction that the surface value of an unspecified vowel should be dependent on the presence or absence of a specified vowel.

While this argument may be specific to ALIGN, the AGREE constraint cannot handle the dominant-recessive vowel harmony of Nandi-Kipsigis Kalenjin[8]. The critical case is when the input contains an underspecified vowel in between a specified [–ATR] vowel and a specified [+ATR] vowel. The simple ranking ID >> AGREE does not distinguish between the candidate where the underspecified vowel harmonizes with the [+ATR] vowel and the candidate where the underspecified vowel harmonizes with the [–ATR] vowel.

(35) Harmony in Nandi-Kipsigis Kalenjin

/kA-ɣa:-ɣO-ɣe:r-A/ 'he had seen me'	ID[ATR]	AGREE [ATR]
a. [kæ-ɣæ:-ɣo-ɣe:r-æ]	*!	
b. ? [ka-ɣa:-ɣo-ɣe:r-æ]		*
c. [ka-ɣa:-ɣɔ-ɣɛ:r-a]	*!	
d. ? [ka-ɣa:-ɣɔ-ɣe:r-æ]		*

Both the [+ATR], and the [–ATR] candidates satisfy AGREE without violating ID. If *[–ATR] outranks *[+ATR], the [+ATR] vowel will surface as needed. The problem with this ranking is that it predicts that an underspecified vowel will surface as [+ATR] even if there is no [+ATR] vowel to harmonize with, an undesired result, as harmony undergoers should surface as [–ATR] in isolation[9].

[8] It may be possible to account for dominant recessive harmony with a less straightforward analysis, employing additional constraints such as NOSPREAD.

[9] This is essentially Bakovic's (2000) argument against approaches to vowel harmony that involve underspecification.

(36) Locality of harmony in Nandi-Kipsigis Kalenjin

/kA /	ID[ATR]	AGREE [ATR]	*[–ATR]
a. ✓ [ka]			*!
b. ☹ [kæ]			

Along with the arguments against underspecification made in previous literature, it is clear that exceptionality in vowel harmony is not straightforwardly handled with underspecification. I will now consider another alternative to lexically-indexed constraints: lexically-indexed rankings (partial rankings/orders) (Anttila 1995, 2002). As mentioned previously, these two methods for accounting for exceptions are often considered empirically equivalent, but they make distinct predictions about vowel harmony.

4.2 Lexically-Indexed/Partial Orders of Constraints

With lexically-indexed rankings, exceptions are accounted for by a partial order of constraints (Anttila 1995, 2002). Certain constraints are left unranked with respect to each other, and different morphemes will specify a specific ranking. Exceptions in vowel harmony can be accounted for by having undergoers select a harmony-inducing constraint ranking ALIGN[F] >> ID[F] while non-undergoers select the opposite ranking ID[F] >> ALIGN[F]. This is somewhat of a simplification for dominant-recessive harmony languages because there are three constraints involved: ALIGN, ID and MAX. However, for the purposes of this demonstration, the asymmetric faithfulness constraints are fixed at the top. The language will decide which ranking applies when both undergoers and non-undergoers appear in the same lexical item. The issue of how the language decides which ranking to use when has not been formally addressed, although Pycha (2006) proposes some process-specific diagnostics[10] for determining the correct partial order.

(37) Undergoers

/pɪ + me/ ALIGN >> ID	MAX[+ATR]	ALIGN [ATR]-L	ID[ATR]
a. [pɪme]		*!	
b. ☞ [pime]			*
c. [pɪmɛ]	*!		*

[10]Because these diagnostics are related to the specific phenomenon of partial blocking, these diagnostics do not appear to be applicable to vowel harmony.

In (37), the exceptional morpheme selects high-ranked ALIGN, allowing for harmony. In (38), the morpheme selects high-ranked ID, preventing spreading.

(38) Non-Undergoers

/pɪ + me/ ID >> ALIGN	MAX[+ATR]	ID[ATR]	ALIGN [ATR]-L
a. ☞ [pɪme]			*
b. [pime]		*!	
c. [pɪmɛ]	*!	*	

The indexed rankings approach is quite straightforward, allowing for a dichotomy between lexical items; some lexical items undergo harmony, while others do not. Because the selected ranking applies to the entire lexical item, this approach predicts that exceptions will affect the entire lexical item. This will be discussed in more depth below.

4.3 Morpheme-Bound Exceptions and Lexically-Indexed Rankings

Accounting for exceptions in Nandi-Kipsigis Kalenjin using lexically-indexed rankings would mean that the opaque, exceptional morphemes would select the disharmonic ranking ID[ATR] >> ALIGN[+ATR]-R, ALIGN[+ATR]-L. The lexically-indexed ranking approach makes the incorrect prediction that an exceptional non-undergoer will cause complete lack of harmony throughout the lexical item, thereby violating the morpheme-bound principle presented above. This occurs when a single exceptional morpheme selects a single ranking to apply to the entire lexical item. Morphemes which otherwise would undergo harmony are essentially 'dragged into' being opaque along with the exceptional non-undergoer.

(39) Morpheme-Bound Nature of Exceptions in Nandi-Kipsigis Kalenjin

/ka-<u>ka:</u>-kɔ-√ke:r-a/ ID >> ALIGN 'he had seen me'	MAX [+ATR]	ID [ATR]	ALIGN [+ATR]-R	ALIGN [+ATR]-L	*[–ATR]
a. [kæ<u>ɣæ:</u>ɣoɣe:ræ]		*!***			
b. ✓ [ka<u>ɣa:</u>ɣoɣe:ræ]		*!*		**	**
c. ☹ [ka<u>ɣa:</u>ɣɔɣe:ra]			*	***	****
d. [ka<u>ɣa:</u>ɣɔɣɛ:ra]	*!	*			*****

Here, there is no way for the undergoers to have a say in whether or not they participate in harmony; the opaque morpheme has selected high-ranked faithfulness, and all other morphemes are subject to it as well.

One possible way to avoid the prediction that the presence of an opaque morpheme will block harmony entirely is to split up the computation, so that the opaque morpheme is in one optimization with one ranking, and the non-opaque morphemes apply in a different optimization with different rankings. Presumably, this can be done with Stratal OT. Stratal OT (Bermudez-Ortero forthcoming; Kiparsky 2000) is a way of accounting for effects of morphology on phonological processes. Using Stratal OT, it is possible to assign different rankings at different optimizations of the grammar. Everything in the root and all following affixes may be marked as Level 1. Level 1 is given the ranking ALIGN[ATR] >> ID[ATR]. The problem with a Stratal OT approach is that it predicts that exceptionality should always correspond with categories such as root, Level 1, etc., and that undergoers are always affixed at an earlier level than non-undergoers, (in order for low-ranked faithfulness only to undergoers and high-ranked faithfulness to apply only to non-undergoers).

(40) Morpheme-Bound Nature of Exceptions of harmony in Nandi-Kipsigis Kalenjin

/kɔ-√ke:r-a/ Root + Level 1	MAX [+ATR]	ALIGN [+ATR]-L	ALIGN [+ATR]-R	ID[ATR]	*[–ATR]
a. ☞ [ɣoɣe:ræ]				**	
b. [ɣɔɣe:ra]		*!	*!		**
c. [ɣɔɣɛ:ra]	*!			*	***

The opaque prefix is attached at Level 2, with the ranking ID[ATR] >> ALIGN[ATR].

(41) Morpheme-Bound Nature of Exceptions of harmony in Nandi-Kipsigis Kalenjin

!/ka/+ /<u>ka:</u> /+ [ɣoɣe:ræ] Level 2	MAX [+ATR]	ID [ATR]	ALIGN [+ATR]-L	ALIGN [+ATR]-R	*[–ATR]
a. [kæ<u>ɣæ:</u>ɣoɣe:ræ]		*!*			
b. ☞ [ka<u>ɣa:</u>ɣoɣe:ræ]			**		**
c. [ka<u>ɣa:</u>ɣɔɣɛ:ra]	*!**	***			*****

This gives the appropriate output here, with the unfortunate consequence that the prefix [ka-] was forced to be affixed at Level II. The problem is that [ka-] is not an opaque morpheme, as evidenced by the form [kæɣu:te] 'I was blowing'. In the present analysis, [ka-] will act as opaque, which is clearly incorrect. If one were to affix [ka-] after the opaque morpheme with the ranking ALIGN[ATR] >> ID[ATR], it would undo the opacity of the opaque morpheme, as shown in (42) below.

(42) Morpheme-Bound Nature of Exceptions of harmony in Nandi-Kipsigis Kalenjin

/ka/+ [<u>ɣa:</u>ɣoɣe:ræ] Level 2	MAX [+ATR]	ALIGN [+ATR]-L	ALIGN [+ATR]-R	ID[ATR]	*[–ATR]
a. ☹ [kæ<u>ɣæ:</u>ɣoɣe:ræ]				**	
b. ✓ [ka<u>ɣa:</u>ɣoɣe:ræ]		*!*			**
c. [ka<u>ɣa:</u>ɣɔɣɛ:ra]	*!**			***	*****

Infixing the opaque morpheme after the first cycle also fails because harmony spreads to the prefix [ka-], and this spreading is not undone by the opaque ranking. Rather than blocking harmony, the non-undergoer is simply transparent to it.

(43) Morpheme-Bound Nature of Exceptions of harmony in Nandi-Kipsigis Kalenjin: Level 2

[kæ+-ɣa:-+ɣo-ɣe:r-æ] Level 2	MAX [+ATR]	ID [ATR]	ALIGN [+ATR]-L	ALIGN [+ATR]-R	*[–ATR]
a. ☹ [kæɣa:ɣoɣe:ræ]			**	****	*
b. ✓ [kaɣa:ɣoɣe:ræ]	*!	*	**		**
c. [kæɣæ:ɣoɣe:ræ]		*!			

One problem with Stratal OT is that it does not allow for a mixed order of affixation. However, the ordering of undergoers and non-undergoers in Nandi-Kipsigis Kalenjin shows that this cannot be the case. This problem becomes fatal because Stratal OT does not provide a way to preserve what happens at each level. If one pass has high-ranked faithfulness, and the next pass has low-ranked faithfulness, the high-ranked faithfulness is essentially undone. The only way for Stratal OT to allow for morpheme-bound behavior in exceptions in vowel harmony is to have a very strong requirement that previous cycles remain untouched, presumably implemented through faithfulness constraints. However, such faithfulness would have to be universally undominated in order to avoid the prediction that non-morpheme-bound harmony exceptions are possible. A constraint referring to cycles in the grammar would defeat Stratal OT's avoidance of direct reference to morphological structure. Further, Bermudez-Ortero (2006) argues against such an approach in his treatment of opacity in Canadian raising because the context for dipthongization (e.g., 'writer') is in the stem level (e.g, 'write'). Finally, even if such faithfulness constraints were possible, a lexically-indexed ranking approach is clearly a more complex, problematic approach.

The next section explores further predictions of the use of lexically-indexed constraints.

5. Further Predictions

Under the current proposal, exceptions in vowel harmony are accounted for with lexically-indexed faithfulness constraints. However, it is possible for indexed markedness constraints to have an effect as an exceptional trigger. If the generalization for undergoers and non-undergoers holds for triggers, than markedness-induced exceptional triggers should only have a direct effect on the vowels immediately adjacent to it. In regressive ATR harmony in Assamese (Mahanta 2007), a class of morphemes trigger harmony in normally opaque /a/, which alternates with [o]. However, this effect is only found if opaque /a/ is local to the triggering morpheme. The examples in (44) below show harmony in Assamese. Examples (a) and (b) are regular suffixes, in which [+ATR] spreads to the root vowel (a), except when the final root vowel is an /a/ (b). (c) and (d) show the exceptional morpheme in which [+ATR] spreads to /a/ if it is the final vowel of the root.

(44) Local Exceptional Triggering in Assamese (Mahanta 2007)

	Root	Suffix	Derived Form	Gloss
a.	mɛr	-oti	meroti	‘wind’ (causative)
b.	kɔpah	-i	kɔpahi	‘made of cotton’
c.	sal	-ija	solija	‘roof-ed’
d.	patɔl	-ija	patolija	‘lightly’

In (b), /a/ is opaque to harmony, but the suffix [-ija] (c) triggers harmony in /a/ in (c), when the vowel is local to the suffix vowel, but not in (d), when /a/ is non-adjacent to the exceptional suffix. Mahanta shows that these suffixes can be accounted for using a high-ranked indexed markedness constraint, but could not be accounted for with lexically-indexed rankings.

One may expect that indexed ALIGN would produce a non-local effect. However, the effect of indexation depends on how the locus of violation for the constraint is defined. For ALIGN([αF], R, PrWd, R), the right edge of the autosegment must be aligned with the right edge of the prosodic word. For indexed ALIGN, the constraint is only violated when the right edge of the autosegment bears indexation. Once the rightmost vowel of the index morpheme spreads one segment to the right, the indexed constraint is satisfied; it need not spread further. This is because once the rightmost vowel of the indexed morpheme has spread to one segment, the rightmost vowel of the autosegment is no longer indexed, and therefore, no longer part of the locus of violation for the indexed constraint. This is demonstrated in (45), which violates indexed ALIGN and (46), which satisfies indexed ALIGN without complete spreading.

(45) Violation of ALIGN[ATR]$_I$-R

```
o          a    a
|          |    |
[+ATR]   [–ATR]
```

(46) Satisfaction of ALIGN[ATR]$_I$-R

```
o_I    o      a
|      |      |
[+ATR]   [–ATR]
```

While I have shown that exceptional triggers exist, any case of long-distance exceptional harmony triggers must be a case of featural affixation (Akinlabi, 1994, Finley 2009), or morpheme realization (Kurisu 2001). A featural affix (Akinlabi 1994) (any morpheme which bears no segmental material but featural material only) could induce harmony-like effects if faithfulness to the particular feature value is high-ranked. If the feature value associated with the morpheme requires correspondence with all vowels in the lexical item, then it is possible to create long-distance harmony effects with a single morpheme. Finley (2009) refers to these cases as morphemic vowel harmony, because a particular morpheme induces agreement of a specific feature value on its base form; realization of this particular morpheme depends on both realization of a feature value, and long-distance spreading of that feature value. Elevated lexically-indexed markedness constraints cannot handle the feature-specific nature of this type of vowel harmony. For example, AGREE requires that the vowels share the same feature value, but morphemic harmony demands a particular feature value[11].

Even allowing for lexically-indexed markedness constraints, inducing an exceptional non-trigger for harmony using the lexically-indexed approach to exceptions is problematic, predicting that there should be few, if any, cases of exceptional non-triggers. This is true for a constraint like AGREE that has a locus of violation that includes both disagreeing segments. For example, if an indexed non-trigger is followed by a disharmonic trigger, high-ranked AGREE will be violated because the locus of violation contains the trigger.

(47) Prevention of Potential Non-Trigger

/<u>ma</u>-pi/ <u>WEAK</u>	AGREE[ATR] STRONG	ID[ATR]	AGREE[ATR] <u>WEAK</u>
a. [mæpi]		*	
b. ☹ [mapi]	*		*
c. [mapɪ]		*	

The locus of violation for the harmony-inducing constraint, along with other factors, such as directionality and dominance, will determine the presence or absence of a potential exceptional non-trigger in a language. Without clear empirical data on exceptional non-triggers, it is impossible to know which harmony-inducing constraint makes the correct predictions. Below are two potential cases of exceptional non-trigger. However, each of these cases admits a potential alternative analysis. The fact that there are few potential cases supports the prediction that exceptional non-triggers, if they exist, should be rare.

One potential case of an exceptional non-trigger occurs in Lango. Lango, a Nilotic language of Northern Uganda (Benua & Smolensky 2001; Okello 1975; Poser 1982; Woock & Nooonan 1979), has a complicated ATR vowel harmony system, in which harmony triggers and undergoers are affected by feature co-occurrence constraints (Archangeli & Pulleyblank 1994; Smolensky 2006). This harmony system contains morphemes that do not participate in vowel harmony. All these cases are exceptional non-undergoers except for the demonstrative suffix /o/. Here, [+ATR] vowels should spread to the stem, as in the plural, [nam]/[næme] 'lake'. In the case of the demonstrative suffix, the mid vowel does not spread [+ATR], nor does the root spread [–ATR].

(48) Exceptional Non-Trigger in Lango (Okello 1975)

a.	[jat]	'tree'	[jatto]	*[jætto]	'that tree'
b.	[rɔmɔ]	'sheep'	[rɔmɔno]	*[romono]	'that sheep'
c.	[mɛja]	'table'	[mɛjano]	*[mejæno]	'that table'

This looks like a case of an exceptional non-trigger. However, this particular case is difficult because Lango has many phonological restrictions for triggers of vowel harmony, and it is possible that the apparently exceptional case falls under these restrictions. For example, Archangeli and Pulleyblank (1995) cite a restriction against

[11] Further, more arguments against a markedness-based account of morphemic harmony are presented in Finley (2009).

[–HIGH] and [+BACK] vowels spreading. In addition, there are no other potential harmony triggers with underlying /o/ in Lango, making it unclear whether the non-participation of /o/ is restricted to the morpheme or to the vowel. Okello (1975) also gives evidence that the demonstrative suffix is part of a morphological domain outside the domain of harmony. Another demonstrative suffix (which is [–ATR]) also doesn't undergo harmony, and demonstrative suffixes are more mobile than other suffixes, suggesting that the morpheme boundary between the stem and demonstrative is somehow more impervious than other boundaries. Because the Lango case can be analyzed using general phonological principles, it should not be treated as a lexical exception.

Another potential case of an exceptional non-trigger can be found in Finnish (Kiparsky 1981), (e.g., [martty:r-ko], where [y] is opaque and disharmonic)[12]. In these cases, neutral vowels (front, rounded vowels) in loanwords, are optionally opaque. While these vowels are disharmonic, they can either spread their [–BACK] feature to following suffixes, behaving as opaque vowels or not spread at all, behaving as transparent vowels. Assuming that transparency and opacity are regulated by the ranking of a particular constraint or constraint set (Kiparsky & Pajusalu 2003; O'Keefe 2007), this can be accounted for by indexing the different morphemes to differently ranked transparency-inducing constraints.

In this section, I have shown that while there are cases of exceptional triggers, there are no clear cases of exceptional non-triggers in vowel harmony, and that exceptional triggers are quite rare. One possibility for this may due to the fact that exceptionality among triggers produces an interaction between the undergoer and the trigger. While exceptional undergoers and non-undergoers appear to be independent of the trigger, the effect of the exceptional non-trigger is found on the segments fail to undergo harmony. This interaction may make it difficult for the learner to associate the source of the exception (trigger or target), because the learner must take the behavior of one morpheme and associate it with properties from another. Further research is needed to establish the reasons for this dichotomy in the typology of exceptions in vowel harmony.

6. Conclusions and Implications

This paper has shown that exceptions in vowel harmony are morpheme-bound. This morpheme-bound nature of vowel harmony exceptions can be accounted for using lexically-indexed constraints. The locus of violation for lexically-indexed constraints makes the unusual prediction that long distance phenomena like vowel harmony should localize in the face of exceptions through morpheme-bound behavior. Lexically-indexed rankings make the opposite prediction; an exceptional morpheme should affect the entire lexical item. Stratal OT only offers a solution if each cycle is subject to high-ranked faithfulness constraints to preserve the exceptionality effects, but the prediction that long distance vowel harmony exceptions should occur cannot be escaped. One question is whether such unbounded cases exist, either in languages not yet analyzed, or in other long distance phenomena.

Exceptions in phonology are not idiosyncratic, but highly principled. Optimality Theory not only provides a clear way for accounting for exceptions, but a way to create theories that make testable predictions about the nature of exceptions. This paper has shown that vowel

[12] Thank you to an anonymous reviewer for directing me to this potential example of a non-trigger.

harmony provides a window on the principled nature of exceptions in phonology, and how these principles can help differentiate between theories of exceptions.

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