CHAPTER 4

A representational account of vowel harmony in terms of variable elements and licensing

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This article develops a new theory of vowel harmony in which harmony is represented in terms of a licensing relationship between vowels that carry the harmonic element 'invariably' and vowels that carry this element 'variably'; the latter vowels are the alternating vowels. Of central concern is the occurrence of opaque and so-called transparent vowels, which cause asymmetries in the harmony systems. I also provide an account of a four-way typology in palatal harmony systems that has been proposed in Kiparsky and Pajusalu (2003). The licensing relation that accounts for vowel harmony is local at the nuclear projection. I will discuss several cases which violate nuclear locality, proposing an auxiliary hypothesis that allows skipping a nucleus under specific circumstances.

Keywords: vowel harmony, transparent vowel, opaque vowel, licensing, locality, Turkish, Tangale, Baiyinna Orochen, Maasai, Hungarian, Khalkha Mongolian, Kinande, Kibudu

1. Introduction

This article develops a new theory of vowel harmony that was first presented in van der Hulst (2012).[1] Vowel harmony is represented in terms of a licensing relationship between vowels that carry the harmonic element 'invariably' and vowels that carry this element 'variably'; the latter vowels are the alternating vowels. In Section 2 I outline the model. Section 3 first focuses on the occurrence of neutral vowels, i.e. opaque vowels and so-called transparent vowels (together called neutral

1. A fuller presentation of this theory is offered in van der Hulst (to appear) which contains many applications of this approach to all known types of vowel harmony. I'm grateful to Jeroen van de Weijer for his comments on this article.

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vowels) and then provides an account of the four-way typology of neutral vowels in palatal harmony systems that has been proposed in Kiparsky and Pajusalu (2003). In Section 4 I then provide a formal account of opaque and transparent vowels within the model proposed here. An important property of the model is that the licensing relation that accounts for vowel harmony is local at the nuclear projection. In Section 5, several cases are discussed which violate nuclear locality and an auxiliary hypothesis is suggested in the form of so-called *bridge locality*. Section 6 offers conclusions.

2. The framework

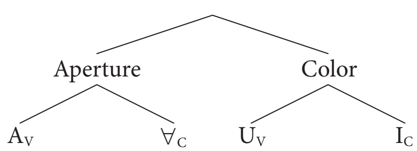
In this article I present a general theory of transparency and opacity in vowel harmony systems which contains an update of the proposals made in van der Hulst and Smith (1986). This account adopts the following principles:

(1) Fundamental principles of my proposal

a. Phonological primes are unary (they are called *elements*)
b. Element specification is *minimal*
c. Vowel harmony involves the *licensing* of *variable* elements in nuclei, with licensers typically being vowels in adjacent nuclei that contain a licensed instance of the relevant element
d. A variable element is phonetically interpreted only if it is licensed
e. Licensing is strictly *local* (i.e. no nucleus is 'skipped')

(1a) is characteristic of a model called *Radical CV Phonology* (RcvP for short, van der Hulst 2005, in prep.), which is a version of *Dependency Phonology* (DP; Anderson and Ewen 1987). In RcvP, there are four non-laryngeal elements, divided over two classes, 'aperture' and 'color':[2]

(2)



2. Strictly speaking, in RcvP these elements are all encoded in terms of two primitive elements, |C| and |V|. For the sake of clarity, I here use the traditional labels for the elements, but in (2) their C or V-status is indicated by way of a subscript.

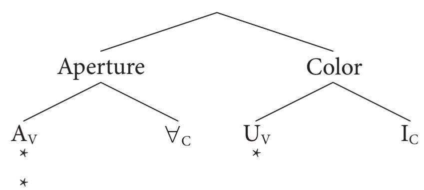
Within a class, elements can occur alone or in two kinds of combinations (differing in which element is the head). Additionally, the aperture elements can occur in a primary and secondary subclass, where only the former allows combinations. (The color elements only occur in a primary role.) While the primary subclass indicates aperture differences in the oral cavity, the secondary subclass allows activation of the other two cavities (i.e. pharyngeal or nasal):

(3) Aperture

Primary (Head)		Secondary (Dependent)
∀	high	NASAL (N)
∀A	high-mid	
A∀	low-mid	
A	low	PHARYNGEAL (*A*/*∀*)[3]

Minimal specification, (1b), is achieved by following an algorithm proposed in Dresher (2009), the *Successive Division Algorithm* (SDA; see van der Hulst, to appear, for details). This algorithm, illustrated for Finnish in (5) below, uses a specific ranking of the elements which I derive from (2), by assigning a grid mark to elements in each head position:[4]

(4) a.



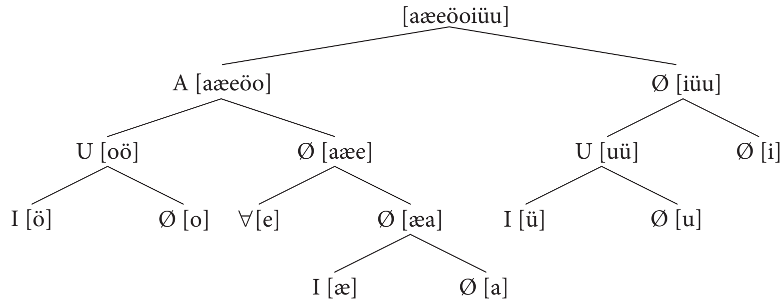
b. Ranking: A > U > I/∀

For Finnish the parsing structure, using the ranking in (4b), delivers (5), where (5a) illustrates the division of the vowel system and (5b) gives the resulting element representations:

3. The pharyngeal element is instantiate as either Advanced Tongue root (*∀*) or retracted tongue root (*A*); see van der Hulst (to appear) for discussion.

4. While elements within class nodes can enter in dependency relations with either one being a possible head, both the |A| element and the |U| elements are 'natural heads' in nuclear position. This is because the nuclear position is a V-position which thus favors V-type elements; see van der Hulst (in prep.) for details.

(5) a. Finnish: A > U > ∀ > I[5]



b.

[ö]	[o]	[e]	[æ]	[a]	[ü]	[u]	[i]
A	A	A	A	A			
U	U				U	U	
		∀					
I			I		I		

c.

[ö]	[o]	[e]	[æ]	[a]	[ü]	[u]	[i]
A	A	A	A	A			
U	U				U	U	
$\boxed{\forall}$	$\boxed{\forall}$	∀			$\boxed{\forall}$	$\boxed{\forall}$	$\boxed{\forall}$
I		$\boxed{\mathrm{I}}$	I		I		$\boxed{\mathrm{I}}$

Elements in boxes would be present in a full specification in (5c), but remain unspecified following the SDA are thus redundant. Such redundant elements are predictable, given the element ranking and the SDA, and *compatible* with the phonetic structure of the vowels in question. In all other cases, elements that are absent are incompatible with the phonetic structure of the vowel. The absence of incompatible elements can be contrastive (non-predictable) or predictable. When the absence is predictable, the relevant vowel is called a neutral vowel, because the relevant contrast is neutralized. An example of this case will be discussed in Section 3.1.

(1c) presents a crucial innovation of the RcvP model for vowel harmony. The motivation for using the variable notation is that it allows a distinction between invariant 'negative' vowels (i.e. vowels that lack the harmonic element) in *disharmonic roots* and *non-alternating affix vowels* on the one hand, and alternating vowels

5. For the vowel set [a, æ, e] |∀| takes precedence over |I|, so that [a] and [æ] end up as harmonic counterparts, which than parallels the other harmonic sets. Otherwise |I|, being more salient, will take precedence over |∀|; see(8) and fn. 9.

on the other. Thus, the model allows the following three-way distinction (where 'ε' stands for 'any element'):[6]

(6) a. ε b. (ε) c. –
X X X

a = invariant ε (*positive vowel*)
b = alternating vowel, element must be licensed to get interpreted
c = invariant non-ε (*negative vowel*)

While (6) allows a three-way distinction in how vowels in the lexicon are represented with respect to a given element, this proposal does not undermine the unary nature of the elements. Contrast in the vowel system is only expressed through presence or absence of an element. The variable notation encodes that certain vowels *as part of specific morphemes* have a dual character, most typically in displaying an alternation between presence and absence of the element. The notation '(ε)' simply means that for the relevant vowel it is undecided *in the lexicon* whether it will surface with or without the element in question.[7]

(1d) is derived from approaches to vowel harmony in *Government Phonology* (GP; Harris and Lindsey 1995; Ritter 1995; Charette and Göksel 1998, among others). In the present model (1d) implies that variable elements that are not licensed remain 'silent'. The notion of licensing has been widely referenced as playing a role in phonological generalizations. In my account of vowel harmony, the key type of licensing will be *lateral licensing*[8] along phonological 'tiers'. I will assume that the default setting for licensing directionality is 'bidirectional'. This is necessary for both root-control systems that have both harmonic prefixes and suffixes and for dominant-recessive systems (see Section 3.3).

(1e), locality, is a central theme in the discussion of vowel harmony (if not of all linguistic relations). The notion of locality has been used in different ways even within the study of vowel harmony. While virtually all accounts of vowel harmony appeal to some notion of locality, frameworks differ in important details of defining the relationship or in dealing with apparent violations of locality. I will defend a *strict* interpretation of locality, which avoids mechanisms such as 'discontinuous

6. This distinction parallels the distinction between [+F], [0F] and [−F] in a binary system, although as explained in the text, this does not mean that we have abandoned the unary character of phonological primes.

7. This notation does not mean 'floating', as in autosegmental models, which is used for different purposes.

8. Lateral licensing can also be called *syntagmatic licensing*.

association' or 'feature/element insertion' to account for apparent violations. I emphasize that, for me, locality does *not* mean establishing a relation between two entities that are 'as close as possible' (as proposed in Nevins 2010), but rather (and more conventionally) between elements that are adjacent with reference to the nuclear tier (*nuclear locality*). To account for some cases of expected 'transparency' I will also invoke *bridge locality*, in which case the locality requirement for licensing is satisfied on an element tier that differs from the harmonic tier (such cases fall under the rubric of 'parasitic harmony', as first described in Steriade 1981, but form a special subclass of this rubric).

Languages that display vowel harmony for some element 'ε' are subject to a constraint of the general format in (7):

(7) All units X in domain D must be positive or negative for element |ε|

In the usual case X = nucleus, but X can also be another element (when we are dealing with bridge locality). The constraint in (7) is satisfied by specifying alternating vowels with the variable element, which automatically triggers the licensing relation. Vowel harmony is thus *not* the result of a (repair) rule that fills in or changes segmental structure.

A key aspect of my approach to vowel harmony is that vowels that refuse to alternate, and as such either block harmony or are (seemingly) 'ignored' by it, should not simply be designated as 'opaque' or 'transparent' on a language-specific basis. In fact, following an old proposal made by van der Hulst and Smith (1986), I will show that the behavior of non-alternating vowels is largely predictable from their element structure (which depends on the structure of the vowel system). So-called 'transparent' behavior (the term as such will turn out to be a misnomer) is possible when a vowel is *compatible* with the harmonic element. Thus, a vowel [i] can behave as 'transparent' in a palatal system because it is compatible with the presence of the palatal element |I|. However, we will see that such vowels can also act opaquely. In fact, we will see that there are four different ways in which a vowel such as [i] can behave in palatal harmony systems, following an important typological study of harmony on Balto-Finnic languages by Kiparsky and Pajusalu (2003). Importantly, none of the four types violate strict locality. On the other hand, vowels that are *incompatible* with the harmonic element, such as a non-advanced [a] in advanced tongue root (ATR) systems are predicted to be opaque, because the licensing relation cannot ignore or 'skip' an intervening vowel, as per strict locality. Apparent counterexamples to the expected opacity of incompatible vowels will be explained in terms of allowing locality to be defined with reference to another element tier (i.e. in terms of bridge locality).

As an illustration of the licensing approach to VH, consider the RcvP representation of the plural suffix in Turkish. The element analysis of the vowel inventory for Turkish 'that we need'[9] is given in (8):

(8)	i	ü	ɨ	u	e	ö	a	o
					A	A	A	A
		U		U		U		U
	I	I			I	I		

The plural suffix alternates between [ler] and [lar] (see (9)).[10] Given that the suffix never alternates for height, the element |A| is present invariably, as are, generally all other non-redundant elements that are not involved in a harmonic alternation. The |I| element, on the other hand, is subject to the harmony requirement in Turkish. Since suffixes alternate, they are provided with a variable copy of the element. Roots bear the |I| invariably (*positive roots*) or are devoid of it (*negative roots*). Lateral licensing applies when a variable element is preceded by an invariable element. The variable element in question becomes non-variable (cf. 9a), resulting in a palatal realization [ler]. When no licenser is present, it remains variable (cf. 9b), resulting in a non-palatal realization [lar]. The result is that both suffix vowels are harmonic with their root:[11]

(9)					
	a.	inek[12]	–	ler	'COW.PLUR'
		A		A	
		I I	»	$(\mathrm{I})_{\mathrm{L}}$	
	b.	kız	–	lar	'girl.PLUR'
				A	
				(I)	

9. |I| takes precedence over |∀| because it is more salient. Besides, the ∀-element does not discriminate within the sets that are distinguished by the element |A|.

10. See Kabak (2011) for a general overview of vowel harmony in Turkish.

11. The subscript 'L' is here provided purely for clarity; it has no formal status and will not be used most of the time. Notationally, we can think of licensing as the removal of the parentheses. In the following diagrams I do not actually remove the parentheses so that we can see the lexical status of the element specifications. A variable element preceded by '»' is licensed. Thus '»' stands for the licensing relation, not for 'spreading'.

12. All vowels in polysyllabic positive roots are specified with the invariant element. Licensing does not apply within morphemes, with the exception of roots that involve neutral vowels. This point will be discussed in Section 3.2.

Once a variable element is licensed, and thus no longer variable, it can itself function as a licenser for another variable element. In (10) we add the accusative suffix:

(10)	a.	inek	–	ler	–	i
		A		A		
		I I	»	$(I)_L$	»	$(I)_L$
	b.	kɪz	–	lar	–	ɪ
				A		
				(I)		(I)

Turkish also has labial harmony, in which low vowels do not participate. Here we could consider two approaches. Firstly, we could assume that low suffix vowels do not bear the |U| element. (In (11) the symbol '□' is a mnemonic for 'blocking'.):

(11)	k	u	r	t	–	l	a	r	-ɨ	'worm.PLUR.ACC'
							A			
		U			»		□		(U)	
							(I)			

Secondly, we could also say that low vowels *do* have a variable element but that a general constraint bars rounded low vowels from non-initial syllables, preventing a variable element for low vowels in suffixes to be licensed:

(12)	k	u	r	t	–	l	ar	-ɨ	'worm.PLUR.ACC'
							A		
		U			»		(*U)	(U)	
							(I)		

Either way, the fact that only non-round high vowels can appear after low vowels shows that licensing in Turkish is strictly local (as we expect). The |U| harmonic element in the stem cannot license the variable element of the accusative suffix vowel due to locality. Nor can the vowel of the plural suffix license the variable element in the next suffix. Low suffix vowels are said to be *opaque* to labial harmony. In Section 3.2 I will argue that the second approach should be favored.

There are also opacity effects in *disharmonic roots* in which a front vowel is followed by a back vowel. This will be illustrated with two disharmonic roots in Turkish, which has palatal harmony:

(13)	a.	m	e	z	a	t	'auction'
					A		
			I				

b.	t	a	t	i	l	‘vacation’
		A				
				I		

The second example (13b) illustrates an invariable and disharmonic occurrence of the element |I| in non-initial position. Both roots in (13) violate the harmony constraint, which is, of course, precisely what makes them exceptional.[13]

To illustrate how disharmonic roots behave under affixation, let us add the plural suffix to the examples in (14):

(14)	a.	m	e		z	a	t	–	l	a	r
						A				A	
			I	»		□				(I)	

b.	t	a	t	i	l	–	l	e	r
		A						A	
				I		»		(I)	

In (14a), the variable cannot be licensed by the invariable element |I| in the first syllable, because there is an intervening nucleus. Licensing in Turkish is local at the nuclear level. In (14b) the variable can be licensed by the element |I| in the final syllable of the root. Locality accounts for the opacity of the vowel [a] in (14a). An intervening vowel that does not possess the variable element will necessarily block the harmonic relation: it acts opaquely.

The account presented here crucially rests on a rejection of harmony as spreading or copying. In the disharmonic root [mezat], it is essential that the |I|-element of the first vowel does not influence the second root vowel. This follows from the fact that this vowel does not contain a variable element. In the model adopted here, only vowels which display ambiguous behavior can possess the variable element. This includes alternating vowels and, as I argue in Section 3.4, so-called neutral vowels. Since the negative vowels in disharmonic Turkish roots do not fall in either category, they do not possess variable elements.[14]

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13. For Turkish, whether or not disharmonic roots are considered exceptional depends on one’s evaluation of the study in Clements and Sezer (1982) which, according to these authors, reveals so many disharmonic roots that the reality of root-internal harmony is in doubt.

14. I will argue below in the discussion of Maasai vowel harmony that licensing of variable elements is blocked if neutralizing a lexical contrast. For that reason, it would be ‘harmless’ to postulate variable representations in disharmonic roots. But since in this model the diagnostic for variable elements is ambiguous behavior, there would be no variable elements in such roots to begin with, at least in so-called root-controlled systems, in which root vowels never alternate.

3. Asymmetries in VH

3.1 Opacity

Although it is interesting that languages would impose a vowel harmony requirement, one might argue that a fully regular and symmetrical VH system does not warrant the degree of attention that this phenomenon has received. In a fully symmetrical system there would be two sets of vowels, different in a certain phonological property, and each word would contain vowels from either one set or the other. Consider the language Anum (better known as Gua; Western Kwa spoken in Ghana; Painter 1971), which has ten vowels:

(15) Advanced: i, u, e, o, ɐ[15]
Non-advanced: ɪ, ʊ, ɛ, ɔ, a

All vowels in every word – here with a classifier prefix – either agree in being or not being advanced:

(16) ɐ-toshi 'she-goat'
a-dɪdɪ 'evening'
a-kʊnta 'brother-in-law'
ɐ-dudu 'charcoal'

Vowel harmony becomes more interesting when vowel harmony systems possess asymmetries, which involve the fact that certain vowels 'refuse' to agree. Such refusal can have several different causes, and different effects. We have already encountered some such cases in the previous section in the exposition of the RcvP approach to vowel harmony. In this and the following two sections, I will discuss these matters more systematically.

In Tangale (West Chadic, spoken in Nigeria; Jungraithmayr 1971; Kidda 1985) we find another ATR-harmony system, like Anum, but this time the vowel system is slightly different:

(17) a. i Advanced: i, u, e, o
ii Non-advanced: ɪ, ʊ, ɛ, ɔ, a

15. There is much variation in how to denote the advanced low vowel. In this article I have chosen to use the 'upside down 'a' symbol', 'ɐ'.

b. Minimal specification

i	u	e	o	ɪ	ʊ	ɛ	ɔ	a
		A	A			A	A	A
	U		U		U		U	
		∀				∀		
∀	∀	∀	∀					

While, in the minimal specification the ∀-element ('ATR') is missing from [ɪ, ʊ, ɛ, ɔ] because it is contrastively absent, the vowel [a] misses the element because its presence violates a phonotactic constraint, which accounts for the fact that the non-advanced low vowel [a] in Tangale is missing a harmonic counterpart. This is what we call a *neutral vowel* (i.e. the ATR contrast is *neutralized* for vowels that are low). We encountered neutral vowels also in the discussion of Finnish in the preceding section. In that case the vowels [i] and [e] were called neutral because they lack a 'back' counterpart in the vowel system. These vowels thus are predictably front which was accounted for, as per the SDA and element ranking, by leaving the I-element for these vowels unspecified. That said, it was observed that the unspecified I-element is *compatible* with the phonetic structure of [i] and [e]. The non-specification of the ATR element |∀| for [a] is different in nature because in this case the unspecified element is *incompatible* with the phonetic structure of this vowel.

This raises the empirical question whether neutral vowels that are compatible and incompatible for the harmonic element behave differently in vowel harmony? I will first discuss the behavior of [a] in Tangale and then, after discussion some related points, turn to Finnish in Section 3.3.

For the Tangale [a] we might expect that this vowel can only occur in non-advanced words so that all words will be fully harmonic, despite this gap in the vowel system? As it turns out, [a] can occur with vowels from *both* sets. Kidda (1985: 130) seems to suggest that in stems it only occurs with [ATR] vowels. However, on page 131 he provides the example [kulag-dɔ] 'her frying pan' to show that the suffix harmonizes with the [a], rather than the [u]. It would seem that the [a] somehow prevents the preceding [u] from imposing its ATR value on the suffix. [a] can occur in suffixes, e.g. [na]. When this suffix is positioned in between an advanced trigger in the root and a harmonic target vowel in a suffix, it will *block* the propagation of [+ATR] and seemingly starts propagation of its own invariant [−ATR] value:

(18) a. tɛna -nɔ 'my mortar'
b. kulag -dɔ 'her frying pan'
c. pɛd -na -n -gɔ 'untied me'
d. ɗib -na -g -gʊ 'cooked for us'

We can immediately understand the behavior of [a] if we make two assumptions:

(19) a. VH operates *locally*, i.e. from nucleus to nucleus

b. VH cannot affect vowels if this leads to an illformed combination of element specifications (such as ¬|A, ∀|[16])

The assumption of locality is quite generally adopted, implicitly or explicitly, but, as mentioned in Section 2.1, some authors regard this as an inviolable constraint while others do not. (19b) has been related to the assumption of *structure preservation* (Kiparsky 1982), which is characteristic of the class of so-called lexical phonological rules to which most vowel harmony rules seem to belong. In spreading models of VH the constraint in (19b) will prevent association of the harmonic element to the low vowel. In the present model, we assume that the phonotactic constraint in (19b) prevents an element from occurring *exclusively* with |A|. In other words, the phonotactic constraints accounts for the fact that the vowel [a] refuses to alternate harmonically.

In the case of Tangale, refusal to alternate results from a phonotactic constraint on the vowel system (a *paradigmatic constraint*). With reference to Turkish, we have seen that refusal to harmonize can also be caused by a positional restriction on the distribution of a vowel (a *syntagmatic constraint*). We can refer to this as *neutralization-by-position*. This case was illustrated for Turkish, where low vowels fail to labialize even though labial counterparts exist in the vowel system. In both cases, the opaque vowel has been represented as a negative vowel, i.e. a vowel lacking the variable element.

Turning now to the manner in which vowels are specified in actual morphemes, there are two ways to account for the fact that the vowel [a] acts opaquely.

Firstly, we could say that [a]'s simply lack the variable element. Then, without a variable element, [a] must act opaquely, given locality of licensing (as shown in 20b):[17]

(20) a. p{∀A}d -nA -n -g{UA} [pɛd -na -n -gɔ]
(∀)
b. ɗ{}b -nA -n -gU [ɗib -na -n -gʊ]
∀ » □ (∀)

16. Recall that cursive |∀| represents ATR; see (3). The notation '{|A, ∀|}' refers to the singleton set that contains the exclusive combination of these two elements. The notation '{A, ∀}' would refer to the set that contains the class of segments that contain these two elements.

17. Henceforth, for the sake of simplicity, non-harmonic elements will be represented together with consonants on one line. Also even though these representations refer to specific segments I have omitted the '|' symbols; see footnote 16.

The crucial point to observe here is that the variable element on the second suffix vowels cannot be licensed, given that licensing cannot ignore or skip the low vowel. Since the vowel [a] lacks a harmonic counterpart and is incompatible with the ATR-element it must act opaquely.

An alternative presents itself, however. For Tangale we could say that even low vowels in suffixes have the variable element and that the constraint in (19b) prevents licensing from being successful, since licensing of the variable element will produce an invalid element combination. Here I represent unsuccessful licensing with an asterisk inside the bracket:

(21)	a.	p{∀A}d		-nA	-n	-g{UA}	[pɛdnangɔ]
						(Ɐ)	
	b.	ɗ{}b		-nA	-n	-gU	[ɗibnangʊ]
		Ɐ	»	(*Ɐ)		(Ɐ)	

This approach was also considered for the Turkish case, where also a general constraint bars rounded low vowels from non-initial syllables, again preventing a variable element for low vowels in suffixes from being licensed:

(22)	k u r t		-l a r	- ɨ	'worm.ACC.PLUR'
			A		
	U	»	(*U)	(U)	
			(I)		

In this alternative, which will be adopted here, a general *default* statement can be made for the distribution of variable elements in a VH system:

(23) All suffix vowels have a variable harmonic element

If, as Clements and Sezer (1982) argue, the syntagmatic constraint can no longer be deemed viable for Turkish (because there are many exceptions within roots, usually loan words), we must instead adopt a constraint that bars the variable |U| element from *being licensed* in low suffix vowels, which would be a morphologized paradigmatic constraint. This, however, would still permit the variable element to be present in all suffixes.

3.2 On the form and function of phonotactic constraints

In Finnish and Tangale certain vowels refuse to alternative due to a paradigmatic phonotactic constraint. The absence of the ATR counterpart of [a] is accounted for by the constraint in (25ai) that bans the co-occurrence of the elements |A| and |Ɐ| (in the absence of other elements). Since constraints are propositional statements they can be stated in several logically equivalent ways. Instead of a ban on a conjunction of two elements, we can also state the constraints in terms of implicational statements. Thus, (25i–iii) are all logically equivalent. One might be inclined to give preference to (25aiii) because it directly expresses the predictable absence of |∀| in the minimal specification of Tangale (see 17b). However, it is important to stress that the constraints do not bear on the minimal specification. We can see this quite clearly when we examine the constraints that bar *[ɯ] and *[ɤ] for Finnish. The structures that these constraints bar (i.e. 25bi and 25ci) actually occur in the minimal specification of the Finnish vowel inventory (see 5b, here repeated as 24):

(24)	[ö]	[o]	[e]	[æ]	[a]	[ü]	[u]	[i]
	A	A	A	A	A			
	U	U				U	U	
			∀					
	I			I		I		

The rules that we would need to supply the I-element for [e] and [i], formulated in (25bii) and (25cii), are not logically equivalent to the constraints that bar *[ɯ] and *[ɤ] (i.e. 25bi and 25ci):

(25) a. Tangale: *[ɐ]
- i *[ɐ]: ¬{|A,∀|}
- ii *[ɐ]: {|∀|} → ¬{A}
- iii *[ɐ]: {|A|} → ¬{∀}

b. Finnish: *[ɯ]
- i *[ɯ]: ¬{}
- ii *[ɯ]: {} → {I}

c. Finnish: *[ɤ]
- i *[ɤ]: ¬{|A, ∀|}
- ii *[ɤ]: {|A, ∀|} → {I}

This means that constraints, even though they can be stated as implications, do not function to fill in redundant elements. The rules in (25bii) and (25cii), which express statements that would have to be formulated in addition to the constraints that bar *[ɯ] and *[ɤ] could be referred to a *default rules*. However, I assume that there is no 'filling in' of elements, thus no need for such default rules.[18] Rather, the structures that represent [i] and [e], while lacking the I-element, will simply be phonetically implemented as front. One might argue that because the phonetic vowels [i] and [e] are parsed in terms of elements 'as if' they were [ɯ] and [ɤ] raises

18. However, redundant elements may be 'activated' in the 'word plane'; see Section 3.3.

the suspicion of an 'abstract' analysis, but the implied rejection of such a representation is based on the misunderstanding that minimal representations of vowels are complete phonetic structures rather than cognitive units. Below, in Section 3.4 I return to the matter of phonetic implementation.

3.3 Context-free, context-sensitive and idiosyncratic neutralization

In addition to being due to a phonotactic paradigmatic or syntagmatic constraint, refusal to harmonize can also be *idiosyncratic*, namely when harmonic languages have morphemes containing vowels that do not submit to the harmony regulations even though participation is not in violation of any constraint on element combinations. This possibility occurs in two situations. We see this in disharmonic roots (examples from Turkish were discussed in Section 2), but also when vowels fail to harmonize in specific affixes. Such affixes (or the vowels in them) are also called disharmonic, although in this case the term does not refer to morpheme-internal disharmony (as in the case of disharmonic roots), but to disharmony across morpheme boundaries. For example, in Baiyinna Orochen (a Tungusic language), which has ATR harmony, some suffixes with [ɔ] refuse to alternate with [o] (Li 2006). As expected, these [ɔ]s block 'spreading' of the element |∀|. In the following two examples, the root contains ATR vowels ([ə] and [u]). The suffixes /w{AU}/ and /d{U}/ would normally alternate (between [wo-wɔ] and [du ~ dʊ]). After the invariant suffix [nɔr], however, they show up as [wɔ] and [dʊ], even though an ATR root precedes [nɔr]. Thus, since the non-alternating [nɔr] intervenes, the ATR feature of the last root vowel is unable to 'reach' the alternating suffixes, as locality would demand:

(26)	ətʃəxə	-nɔr	-wɔ -t	'paternal uncles.DEF.ACC'
	∀ ∀ ∀ »	□	(∀)	
	nəxu(n)	-nɔr	-dʊ -t	'younger brothers.DAT'
	∀ ∀ »	□	(∀)	

In this case the only possible account is to represent this suffix, which is exceptional to the default statement in (23), without a variable ATR-element which then predicts its opaque behavior.

If affixes can be exceptions to the statement in (23) by lacking the variable element, the question must be raised as to whether invariant affix vowels can have positive vowels, i.e. vowels specified with the harmonic element as invariant. Cases of this kind appear to be rare. Turkish, however, has some suffixes that are invariably front (Kabak 2011: 2836):

(27)	hasan	-gil	-de	'at Hasan and his people'
	A	A		
		I	» (I)	
	gel	-ijor	-sun	'you are coming'
	A	A		
		U »	(U)	
	I »	(I)		

As shown, alternating suffixes following this invariant suffix must be front, which means that their variable element is licensed by the invariant element of the invariant suffix. In the appropriate examples we can see that an invariant element in suffixes cannot license a variable element in a preceding suffix:[19]

(28) a. Barış-ın-ki-ler
Barış.GEN.Pronominalizer.PLUR
'those of Barış'

b. o-nun-ki-nden
(s)he-GEN.Pronominalizer-ABL
'from that of his or hers'

In (28a), the final stem vowel is high back unrounded. The genitive suffix is high and harmonic for rounding and backness. Hence it harmonizes with the final vowel of the stem 'Barış' with respect to these properties, resulting in [ɨn]. The following suffix [-ki] is invariably front. Its frontness clearly does not affect the preceding vowel. However, it does propagate its frontness to the following plural suffix. In (28b), in which the stem vowel [o] is back and round, the genitive is realized with a high round back vowel ([nun]). The invariant [-ki] again only causes frontness in the following suffix.

In conclusion, it would seem that affixes can be exceptional in two ways to the statement in (23), i.e. either by lacking the harmonic element or by having it invariantly, leading to opaque and harmonic behavior, respectively.[20]

But now we need an account of the inability of [-ki] to govern leftward. I will assume that this follows from the fact that licensing applies cyclically and the fact

19. These examples were kindly made available to me by Barış Kabak.

20. One reviewer makes the valid point that in cases of this kind there is an alternative approach which treats the disharmonic positive suffixes as 'compound-like' morphemes. Since there is no harmony across compound boundaries, this would then also explain why the disharmonic suffixes do not influence preceding vowels. Indeed, Polgárdi (1998) analyses the Turkish disharmonic suffixes in terms of domains. While this is a very plausible analysis of this case, I show in van der Hulst (to appear) that the presence of positive vowels in affixes cannot be universally excluded, i.e. including cases where a domain solution is not likely.

that variable elements are erased at the end of each cycle. This, effectively means that licensing, if cyclic, can only apply root-outward, which produces so-called *root-control* (RC) systems. There are also so-called *dominant/recessive* (DR) systems, which are said to have positively specified affixes that can cause roots to harmonize with them. Bakovic (2001) has suggested that such harmony (which permits root-inward licensing) can be accounted for by assuming that in these languages harmony is non-cyclic (or post-cyclic). What such dominant/recessive cases illustrate is that roots in these languages must contain variable elements, since otherwise it would be impossible for root vowels to harmonize with the invariant element of an affix. When licensing is post-cyclic, no variable elements would be erased so that root-inward licensing is possible.

However, this account leaves unexplained that the DR pattern has only been observed for tongue root systems. In terms of the RcvP model, this means that DR systems only involve the secondary pharyngeal element, namely |∀| ([ATR]) and |*A*| ([RTR]).

An alternative approach, which eliminates the need for a distinction between two levels (cyclic and post-cyclic), would be to interpret the difference between cyclic and non-cyclic licensing as involving two *planes*, instead of two derivational levels. In one plane, the morphological structure would be specified or visible. We could call this the 'cyclic plane', but I will here adopt the term 'morpheme plane'. The other plane could be called the non-cyclic plane, but I will simply refer to it as the 'word plane'. In this plane morphological structure is not visible. We could then correlate this plane distinction with the distinction between primary and secondary elements by stipulating that primary elements are active in the morpheme plane, whereas secondary elements are active in the word plane. This entails that all pharyngeal systems are, in principle dominant/recessive systems, showing the root-inward pattern only if the language happens to have affixes that are lexically specified with the harmonic element, as has previously been suggested in Ringen (1979) and Anderson (1980). A consequence is further that dominant/recessive system do not submit to (23) because the root/affix distinction is not in effect in the word plane. I refer to van der Hulst (to appear) for further details of this approach.

Maasai is a dominant/recessive system in which both roots and suffixes (but not prefixes) can contain the harmonic |∀| element. When preceding an ATR suffix, roots that otherwise are non-ATR show up with ATR. It is this crucial property which makes this system non-root controlled. Maasai can be analyzed as follows in the present system. All vowels that are invariantly ATR bear an invariable ∀-element, whereas all other vowels (unless they exceptionally fail to alternate) bear the variable specification (∀):[21]

21. The Maasai data are based on Levergood (1984) and Bakovic (2001).

(29) a. i/ɪ- ton/tɔn -<u>i e</u> → i-ton-ie ‘2 sit-APP’
A A
U
I
(∀) « (∀) « ∀ ∀

b. i/ɪ- ton/tɔn → ɪ-tɔn ‘2.sit’
A
U
(∀) (∀)

There is one specific circumstance involving disharmonic roots in Maasai that deserves attention. As the following example shows, non-ATR vowels in the disharmonic root /lukʊnkʊ/ ‘fowl’ change to ATR when followed by a positive (i.e. ATR) vowel in a ‘dominant’ suffix:

(30) i/ɪ- lu kʊn kʊ -ni → i- lukunku -ni ‘FEM.PLUR.fowl.PLUR’
(∀) « ∀ (∀) « (∀) « ∀

In accordance with the present approach, it must thus be the case that non-invariant ATR vowels in such disharmonic roots are specified with a variable element (∀), which is realized if it is licensed by an invariant element in a suffix. Given this, *lateral licensing of variable elements must not be allowed to apply in a non-derived environment*,[22] since otherwise, in this disharmonic root, variable vowels would always be licensed by the root-initial positive ∀-specified vowel, which effectively (and incorrectly) prevents roots from being disharmonic:

(31) e/ɛ- lu kʊn kʊ → *e- lukunku (correct: elukʊnkʊ ‘FEM.SING.fowl’)
(∀) » ∀ $\boxed{»}$ (∀) $\boxed{»}$ (∀)

The licensing relation in (31) between the first element in the root and the second cannot lead to the realization of the variable elements and consequently the second variable element cannot be realized either.

Returning to root control systems, we could now ask whether in these cases negative roots or negative vowels in disharmonic roots must then also be represented with variable elements. I illustrate this with the following disharmonic roots that occur in Hungarian (Törkenczy 2011):

22. Another way of saying this is that licensing cannot neutralize a potential lexical contrast (Ringen 1978; Kiparsky 1982).

(32)	a.	{AU} r {AU} m -n {A} k I I » (I)	[öröm -nek]	'joy.DAT'
	b.	v {A}: r {AU} s -n {A} k (I) (I) (I)	[va:ros -nak]	'city.DAT'
	c.	r {U} n {AU} -n {A} k I (I) (I)	[röno: -nak]	'Renault-DAT'
	d.	k {AU} szt {U} m -n {A} k (I) I » (I)	[kosztüm -nek]	'costume-DAT'

In (32b) there is no element that can start the licensing chain and, moreover, if licensing is not permitted morpheme-internally (as motivated above), no licensing can occur in (32c) and (32d) either. There is thus no gain from multiplying variable elements in this way,[23] so I will assume that variable elements occur in only two circumstances, both involving *dual behavior* of vowels:

(33) Variable elements occur only when:
  a. There is positive evidence for (systematic)[24] ambiguous behavior
  b. There is positive evidence for alternation

I have suggested that (paradigmatically or syntagmatically) neutral vowels (whether compatible or incompatible with the harmonic element) display ambiguous behavior in being able to co-occur with both types of harmonic vowels (forming so-called *mixed roots*). Returning to the case of Tangale, (33a) implies that the low vowel [a] is represented with the variable element, which due to a paradigmatic constraint can never be licensed. Likewise, the low vowel in Turkish suffixes has variable (U), given that the occurrence of rounding is prevented by a constraint (whether general phonotactic or morphologized). In this way we can maintain (23) as a general default statement for harmony systems.

While providing these suffix vowels with a variable element is not crucial to explain how they behave (since we have seen that their opaque behavior also follows if these vowels are negative for ATR or rounding, respectively), we will see that neutral vowels that are compatible with the harmonic element *must* be specified with the variable element to preserve strict locality, at least in those cases in which these vowels behave 'transparently' (as they do in Finnish). However, we will see

23. To license the variable element of neutral vowels in neutral vowels roots, I invoke a notion of positional licensing, i.e. licensing of the variable element in the first (stressed) syllable (see 41). This in itself would not cause a problem for specifying negative roots with variable elements, assuming that positional licensing, like lateral licensing, cannot have a neutralizing effect.

24. The use of 'systematic' is here meant to exclude the idiosyncratic mixing of vowels in disharmonic roots. Dual behavior is systematic if it follows from a phonotactic constraint.

that while incompatible neutral vowels (like [a] in Tangale) *must* behave opaquely, compatible neutral vowels can also display opaque or harmonic behavior.

To use variable specification for alternations *and* for neutral vowels covers precisely the two cases in which, in a binary model, underspecification would be invoked, namely contextual predictability and redundancy. Indeed, as noted earlier (see footnote 6), the variable notation is the formal parallel of underspecification in a binary feature system. In both cases, we are saying that the representation can go two ways, i.e. with or without the element in a unary system or with a plus or minus value in the binary system.

3.4 Transparency

We now turn to another case, Finnish, which has front-back (or palatal) harmony, and also asymmetries in the vowel system (see 5b) for a specification of the vowel system):

(34) Front: ü, ö, ä, i, e
Back: u, o, a

Again, we find that the vowels that lack a harmonic counterpart ([i] and [e]) can occur together with vowels of both classes (forming mixed roots). When such a vowel stands in between a front or back trigger and a target, in Finnish it does *not* seem to block the value of the trigger, and if the trigger is back, this value thus seemingly passes right through the [i] or [e] without affecting these vowels, which themselves are front:

(35) a. lyö -dä -kse -ni -kö 'for me to hit'
b. lyo -da -kse -ni -ko 'for me to create'

How can we account for the 'transparent' behavior of [e] and [i]? In formal terms, 'transparency' can be accounted for in several ways. We might assume that the vowels in question undergo harmony after which the non-surfacing back vowels are made front by a rule of *absolute neutralization*. This solution requires extrinsic rule ordering because the neutralization rule must apply after the VH rule.

A second approach to account for the transparency of [i] and [e] is to give up *locality* and allow [i] and [e] to be 'skipped'. Since [a] in Tangale is not skipped, skipping would have to be 'parametric' which leads to predicting vowel harmony systems that have been claimed to be impossible.[25]

25. In Section 5 I discuss the fact that systems that are unexpected given strict locality do occur, albeit rarely; to account for such systems I appeal to bridge locality.

Here I suggest an approach that builds on the three-way distinction in (6), repeated here for convenience as (36):

(36) a. ε b. (ε) c. –
X X X

a = invariant ε (positive vowel)
b = alternating vowel, element must be licensed to get interpreted
c = invariant non-ε (negative vowel)

The variable notation was initially introduced as a means to represent vowels that harmonically alternate. The variable accounts for the *duality* of harmonic vowels. Neutral vowels, while non-alternating, also display duality in the sense that these vowels can occur with vowels of both harmonic classes. I therefore proposed to extend the variable notation to represent neutral vowels (see 33a). This means that the front neutral vowels in Finnish can be represented as possessing a variable (I) in morphemes that contain these vowels. This is not at odds with the fact that these vowels in the minimal specification of the vowel system are specified as lacking the |I|-element. This minimal specification captures the system of contrasts in the language. Variable elements occur in morphemes representing vowels that display ambiguous behavior by being alternating or being neutral (i.e. compatible with both harmonic classes). In other words, variable vowels are not part of the contrastive set of vowels.

I will first demonstrate how this works when neutral vowels occur in suffixes and then address the occurrence of neutral vowels in root morphemes:

(37) Finnish

a. l{U} {UA} -dA -ks {A∀} -n{} -k{UA} [lyödäksenikö]
I » I » (I) » (I) » (I) » (I) 'for me to hit'

b. l{U}{UA} -dA -ks{A∀} -n{} -k{UA} [luodakseniko]
(I) (I) (I) (I) 'for me to create'

In (37a) all variable elements are licensed, including those that occur on the neutral vowels. After all, there is no phonotactic constraint that prevents the I-element from being licensed on them. As a result, these neutral vowels can license variable elements to their right. In (37b) none of the variable elements are licensed. Thus, following neutral vowels, non-neutral suffix vowels show up as back when the neutral vowels are preceded by a back vowel. This state of affairs gives rise to the illusion that the neutral vowels are 'transparent', but this is only so if 'backness' exists so that it can 'spread' across the neutral vowels. In the present model there is no backness. The backness of the rightmost suffix in (37b) simply results from the fact that its variable element is not licensed. Neutral vowels, in this analysis are not 'skipped', but instead fully participate in the harmony.

In this analysis, as can be seen in (37), the vowels [i] and [e] end up having two different representations, one with |I| (in 37a) and one without (in 37b). How do we account for the fact that the latter surfaces as front? As stated in the previous section, I do not postulate default rules that fill in elements. In the present model, the two representations simply receive the same phonetic interpretation:

(38)	a. {I}	{}	b. {A∀I}	{A∀}	Phonological level
	[i]		[e]		Phonetic implementation

(38) implies that phonetic interpretation can produce 'frontness' *in the absence* of an |I|-element. In this account the neutralization displayed in the Finnish system between non-low, non-round front and back vowels is merely phonetic. In van der Hulst (2012) I proposed that the same treatment of neutral vowels that are *in*compatible with the harmonic element is not permitted on the assumption that all licensed elements *must* be phonetically interpreted:

(39)	*{A∀}	{A}	Phonological level
	[a]		Phonetic implementation

What this means is that *context-free* phonetic interpretation is *monotonically increasing*: it can add, but not 'delete'.[26]

It could be argued that making an appeal to a mandatory increase of monotonicity of phonetic interpretation (though reasonable and perhaps independently required) is actually largely unnecessary. Turning back to Tangale, the reader will recall that I proposed that low vowels can be provided with a variable harmonic element which, as a result of a phonotactic restriction can never be licensed. This means that the representation on the left in (39a) does not arise in the first place. (39b), which captures a prohibition against undesirable 'abstractness' (Kiparsky 1968) would then only be needed to prevent unrecoverable 'deletion' of a 'ghost' element, i.e. an element that is purely diacritic. This means that we could not derive a language that differs from Tangale in having a vowel [a] that acts transparently

26. When neutralization is context-sensitive, as in the case of final devoicing in German or Dutch, phonetic interpretation can ignore elements (like, in this case the element 'voice') if final devoicing is attributed to phonetic interpretation rather than to a 'phonological operation'. It has been argued that neutralization is, in many cases, not complete. Following this idea, Gafos and Dye (2011) argue that the alleged neutralization between the [i] vowels in harmonic and anti-harmonic neutral vowel roots may not be complete. Similar claims have been made for contextual neutralization in languages that have final devoicing (see van der Hulst 2015b).

such that an ATR element preceding it could cause a vowel following it to be advanced. Such an analysis would require us to postulate a vowel structure |A∀| which would then have to be implemented as [a] which violates the prohibition on implementation in (39).

Let us now consider the occurrence of neutral vowels in root morphemes. Here we need to distinguish two cases. In one case, a root contains only neutral vowels (a 'neutral vowel root'), whereas in the other case the neutral vowel co-occurs with harmonic vowels (a 'mixed root'):

(40) Neutral vowel root

V	{A∀}	l j	{A∀}		- ll	{A}	[velje -llä]	'brother.ADESS'
	(I)		(I)	»		(I)		

In Finnish, so-called neutral vowel roots (NVRs) usually take front (inflectional) suffixes. If the neutral vowels are represented as variable, the question arises how the variable element in the suffix gets licensed. We need an additional licensing mechanism that licenses variable elements in neutral vowel roots. This mechanism will be called *positional licensing*. The idea is that, next to *lateral licensing* by a preceding licensed element, a variable element can also be licensed by occurring *in a certain position*. I will assume that the licensing position in Finnish is the initial syllable (which also happens to be the syllable with primary stress):[27]

(41) Neutral vowel root

V	{A∀}	l j	{A∀}		- ll	{A}	[velje -llä]	'brother.ADESS'
	$(I)_P$		» (I)	»		(I)		

When NVRs occur with derivational suffixes (see Anderson 1980) they (can) take back vowels in suffixes. This behavior is called *anti-harmonic*. I will return to anti-harmonicity in Section 3.4, although not with reference to Finnish where the conditions for this kind of behavior are not fully clear to me.

Turning now to roots in which neutral vowels occur with harmonic vowels we can distinguish between cases in which neutral vowels follow harmonic vowels and cases in which they precede them:

27. Positional licensing, like lateral licensing, cannot neutralize a lexical contrast, which means that it can only apply to neutral vowels. Positional licensing does not necessarily require the presence of stress. Other designated positions, such as initial or final, can also support positional licensing.

(42) Mixed roots

a.	k {AU} t {} - n {A} (I)	[koti -na]	‘house.ESS’
b.	k {A} d {A∀} - ll {A} I » (I) » (I)	[käde -llä]	‘hand.ADESS’
c.	v {A∀} r {AU} - ll {A} $(I)_P$ » □ (I)	[vero -lla]	‘tax.ADESS’
d.	k {A∀} s {U} - ll {A} $(I)_P$ I » (I)	[kesy -llä]	‘tame.ADESS’

We must note here that the variable treatment of neutral vowels in Finnish assumes that lateral licensing can take place root internally. This, as it turns out, is not true unconditionally. In Section 3.3 I motivated that root-internal licensing is blocked *if it has a neutralizing effect*. This implies that harmonic polysyllabic positive roots are specified with licensed elements throughout:

(43)	P {UA} {U} t {A} – n {A} I I I » (I)	[pöytä -nä]	‘table.ESS’

Licensing (whether lateral or positional) of a variable element of harmonic vowels would neutralize the potential contrast between a front and back vowel. This is not the case for neutral vowels, for which neutralization is lexicalized, so to speak. Hence licensing of the variable element of neutral vowels is, as such, not neutralizing. Given that this is so, we can maintain that lateral licensing, when neutralizing, is confined to morphologically derived environments. In Section 3.2 I have shown that this assumption is also crucial for the account of disharmonic roots in Maasai.

3.4 A four-way typology

3.4.1 *The RcvP account*

Contrary to what we observed for Finnish, there are other Uralic languages such as Khanty (formerly referred to as Ostyak) and Mulgi (both discussed in Kiparsky and Pajusalu 2003) in which neutral vowels either always impose their frontness property on subsequent suffix vowels or are always anti-harmonic, respectively.

The first case is illustrated by Khanty, where neutral front vowels impose their frontness on following vowels. In this case, then, neutral vowels must be specified *with* invariant |I|, *contrary to minimal specification*:

(44) Khanty[28]

a. l{U} {UA} -dA -ks {A∀} -n {} -k {UA} [lyö -dä -kse -ni -kö]
I » I » (I) I » I » (I)

b. l{U}{UA} -dA -ks {A∀} -n {} -k {UA} [luo -da -kse -ni -kö]
(I) I » I » (I)

c. v {A∀} l j {A∀} -ll {A} [velje -llä]
I I » (I)

d. k {AU} t {} -n {A} [koti -nä]
I » (I)

e. k {A} d {A∀} -ll {A} [käde -llä]
I I » (I)

f. v {A∀} r {AU} -ll {A} [vero -lla]
I (I)

g. k {A∀} s {U} -ll {A} [kesy -llä]
I I » (I)

The frontness of [kö] can be derived by allowing the frontness of the preceding neutral vowel [i] to license the variable element, which means that this vowel must possess the licensed element |I|. While this is unexpected because the frontness of the neutral vowel [i] is redundant, it does not invalidate the notion of strict locality. The important point here is that positive evidence from the behavior of a neutral vowel can supplement minimal specification by requiring the presence of an element that is not minimally required in the representations of morphemes.

In Mulgi, a Uralic language belonging to the Finnic subgroup, all vowels following [i] and [e] are required to be back, even when these vowels are preceded by harmonic front vowels. In other words, in Mulgi, all neutral vowels are *anti-harmonic*. While perhaps unexpected, this situation again does not entail a violation of locality, since the backness of vowels that follow neutral front vowels is not related to the quality of vowels that precede the neutral vowels. I will assume that in Mulgi neutral front vowels in morphemes are not specified with the variable (I)-element because they do not display dual behavior, but rather without the |I|-element; yet in phonetic interpretation these |I|-less vowels are phonetically front:

28. For ease of comparison, I am using the Finnish examples to demonstrate how these forms *would* sound in Khanty and in Mulgi, assuming, based on the information in Kiparsky and Pajusalu (2003), that for each case an appropriate example can be found in these languages.

(45) Mulgi

a.	l {U} {UA} -dA -ks{A∀} -n{} -k {UA} I » I » (I) (I)	[lyö -dä -kse -ni -ko]
b.	l{U}{UA} -dA -ks{A∀} -nI -k {UA} (I) (I)	[luo -da -kse -ni -ko]
c.	v {A∀} l j {A∀} -ll {A} (I)	[velje -lla]
d.	k {AU} t {} -n {A} (I) (I)	[koti -na]
e.	k {A} d {A∀} -ll {A} I (I)	[käde -lla]
f.	v {A∀} r {AU} -ll {A} (I)	[vero -lla]
g.	k {A∀} s {U} -ll {A} I » (I)	[kesy-llä]

In this account both Khanty and Mulgi differ from Finnish in that the neutral vowels are *un*ambiguous in the former (front in Khanty and back in Mulgi). While, for all three languages, the SDA and element ranking produces the same minimal specification, it is based on how vowels behave that this minimal representation is augmented in morphemes. In Finnish type languages, given the evidence for ambiguous behavior neutral vowels are provided with a variable element, whereas in Khanty such vowels are represented with the element |I| because they always induce fronting on following harmonic vowels. Apparently, neutral vowels in Mulgi behave as one would expect given minimal specification.

To the above typology of systems, we need to add a fourth type, as displayed in Uygur, which operates like Finnish, except for the fact that neutral vowel roots take back suffixes.[29] We can account for the difference between Finnish and Uygur by regarding positional licensing as a parameter, which is switched 'on' for Finnish and 'off' for Uygur. (For Khanty and Mulgi this parameter is irrelevant.)

Concluding, as shown in Kiparsky and Pajusalu (2003), there is a four-way typology regarding the behavior of front neutral vowels in palatal harmony systems. Here I have proposed an account that assumes the model of vowel harmony proposed in Section 1:

29. Within the Balto-Finnic group, Western Estonian is said to have the same pattern.

(46) A typology of the behavior of neutral front vowels in palatal harmony (taking [i] as representative):

a. Khanty: [i] = specified with |I|
b. Finnish: [i] = specified with variable (I); positional licensing (on)
c. Uygur: [i] = specified with variable (I); positional licensing (off)
d. Mulgi: [i] = unspecified for |I|

The three ways in which [i] is specified instantiate the three logical possibilities for specification in the RcvP model (see 36). The distinction between (46b) and (46c) lies in the role of positional licensing. Uygur is, in fact, similar to Hungarian which also has positional licensing, while admitting a class of 60 exceptional neutral vowel roots (see Törkenczy 2011). Kiparsky and Pajusalu (2003, fn. 12) note that "In Uyghur, a closed class of roots exceptionally triggers front harmony: /bir-lAr/ > *birlär* 'ones'." The difference would be that whereas Hungarian NVRs regularly take front suffixes and back suffixes exceptionally, this is the other way around in Uygur. I have remarked earlier that Finnish NVRs can also take back vowels, specifically in derivational suffixation. This suggests that all three languages require a lexical and morphological governance of positional licensing, rather than a blunt on/off setting of this licensing mechanism, but I will leave a further exploration of that aspect for future research.

Having shown how the four cases are represented within the RcvP model, *as the only possible types* from a formal point of view, we could now ask *why* languages would take one route or another.[30] Considering the four cases, it would seem that the two extreme types (Khanty and Mulgi) result from giving in to certain 'preferences' and not to others, or giving in more to one than to another. As mentioned, in Mulgi, neutral vowels behave as we would expect if the *inertness* of redundant elements is fully acknowledged. As a result, neutral vowels are unspecified for |I| in all morphemes and thus display anti-harmonic behavior. In Khanty, on the other hand, it would seem that the *phonetic quality* of neutral vowels determines their behavior which means that they act as if they possess the |I| element even though it is redundant, thus causing frontness on following variable suffix vowels. Clearly these two tendencies are in conflict. A formal recognition of these tendencies treats them as values of a parametric ('binary') constraint[31] or as separate (non-parametric or 'unary') constraints. A binary parameter would only allow the two cases represented by Khanty and Mulgi. However, it would seem that the two other cases (Finnish and Uygur) can be treated as being intermediate. While I do not embrace

30. This question and the proposed solution can also be raised for the approaches in Rebrus and Törkenzcy (2015ab), van der Hulst (2015a) and Polgárdi (2015).

31. A parameter, once set, is of course a constraint.

the model of constraint interaction that is advocated in Optimality Theory (Prince and Smolensky 1993), we could invoke the general notions of *combination* and *dependency* and allow two unary constraints to be combined with one being dominant over the other. Adopting the labels *Inertness* and *Quality* for the constraints identified here, we can represent the two intermediate systems as follows:[32]

(47)

Quality	Quality	Inertness	Inertness
	|	|	
	Inertness	Quality	
Khanty	Finnish	Uygur	Mulgi

I assume that the intermediate cases reveal themselves when the behavior of the neutral vowel in roots is not clear from co-occurring non-neutral vowels, thus only in neutral vowel roots. In Finnish, it is the dominance of Quality which causes neutral vowel roots to take front suffix vowels, which formally turns positional licensing on. In Uygur, on the other hand, Inertness causes positional licensing to be turned off.

3.4.2 *Alternative accounts*

3.4.2.1 *Van der Hulst (2015a) and a reply to Rebrus and Törkenczy (2015b).* In van der Hulst (2015a, 2016) I have suggested an account of the four-way typology which appealed to a 'function' that assigns underlying representations to neutral vowels based on how they behave in each type of system. That account offered an alternative to the function that is advanced in Rebrus and Törkenczy (2015a):

(48) A typology of the behavior of neutral front vowels in palatal harmony (taking [i] as representative):

a. Khanty: [i] is always /i/	(i.e. specified with |I|)
b. Finnish [i] is /ɨ/ after a back vowel, else /i/	(i.e. without or with |I|)
c. Uygur: [i] is /i/ after a front vowel, else /ɨ/	(i.e. with |I| or without)
d. Mulgi: [i] is always /ɨ/	(i.e. unspecified for |I|)

In this account Hungarian would follow the pattern of Finnish, albeit that some 60 roots (the so-called anti-harmonic roots) are exceptions to the elsewhere clause. I offered this alternative, which nicely captured the four-way typology in a very simple manner, in the spirit of discussion. For lack of space I could not adopt the 'translation' of this approach into the RcvP model which I presented in (46). That said, it seems to me that (46) and (48) are very similar, as is apparent from the parentheticals in (48).

32. The approach used here, which uses dependency relations between constraints (as an alternative to unlimited ranking) was suggested in van der Hulst (2011: 565), but remains to be developed.

Rebrus and Törkenczy (2015a) introduce a 'front/back scale' as a primitive of their model and they note that given this scale, the harmonic behavior of stems that is empirically attested in languages follows a certain pattern: there can be only one switch from B to F. To derive this, they formulate a function that assigns the values B or F to the stem types in the scale (see their page 16). A central claim is that the assignment of B and F values is monotonic (see p. 18), which makes it impossible to derive a pattern such as BFBFF, which has two points where the value assignment switches. The monotonic function is curtailed by the stipulation of "proper prototypical values" (p. 24).

(49) ([B] = back, [F] = front, [N] = neutral; *B* and *F* = back and front "behavior")

Stem contexts (front/back scale)		[B]_	[BN]_	[N]_	[FN]_	[F]_
Attested types (values)	a. Khanty	*B*	*F*	*F*	*F*	*F*
	b. Finnish	*B*	*B*	*F*	*F*	*F*
	c. Uyghur	*B*	*B*	*B*	*F*	*F*
	d. Mulgi	*B*	*B*	*B*	*B*	*F*

While (48) produces the exact same pattern, Rebrus and Törkenczy (2015b) point out that this account overgenerates with reference to the occurrence of lexical variation and vacillation which occur only at the switching point between the back and the front value:

(50)

Stem contexts (front/back scale)		[B]_	[BN]_	[N]_	[FN]_	[F]_
Attested types	a. Khanty	*B*	*F*	*F*	*F*	*F*
	b. Finnish	*B*	*B*	*F*	*F*	*F*
	Hungarian	*B*	*B*	*B*|*F*	*F*	*F*
	c. Uyghur	*B*	*B*	*B*	*F*	*F*
	d. Mulgi	*B*	*B*	*B*	*B*	*F*

I suggested to treat Hungarian as allowing exceptions to the elsewhere clause of (48b), but, as Rebrus and Törkenczy correctly point out, if all four systems are allowed to have exceptions, this would also allow, for example, anti-harmonic neutral vowel roots in Khanty or harmonic neutral vowel roots in Mulgi. Such cases are excluded in their model, which appeals to the above-mentioned monotonic function.

(51)

Stem contexts (front/back scale)		[B]_	[BN]_	[N]_	[FN]_	[F]_
Attested types	a. Khanty	*B*	*F*	*F*	*F*	*F*
	*unattested	*B*	*F*	*B*|*F*	*F*	*F*
	b. Finnish	*B*	*B*	*F*	*F*	*F*
	Hungarian	*B*	*B*	*B*|*F*	*F*	*F*
	c. Uyghur	*B*	*B*	*B*	*F*	*F*
	d. Mulgi	*B*	*B*	*B*	*B*	*F*
	*unattested	*B*	*B*	*B*|*F*	*B*	*F*

However, such unattested cases are no longer possible within the RcvP account provided in the previous section, because it places the burden of exceptional behavior on positional licensing, which only comes into play in languages that represent neutral vowels as variable. In languages in which neutral vowels behave consistently in the same manner (as either front or back), positional licensing is not relevant.

Rebrus and Törkenczy also criticize the account in van der Hulst (2015a) for using 'abstract' representations, i.e. segments that are not attested in the phonetic surface. The RcvP approach presented here, using variable elements, is not so 'abstract'. Firstly, it disallows diacritic abstractness (as per 39). It does, however admit two different representations for neutral vowels that are compatible with the harmonic element, namely, for Finnish and Hungarian [i], one with |I| (when the variable element is licensed) and one without (when the variable element is not licensed). The specification of [i] as having a variable element effectively also assigns two sources for this vowel. In van der Hulst (2015a) it had to be stipulated that these two sources are in complementary distribution. The account in the previous section does not need this restriction, because the two outcomes of variable (I) are derived from licensing. I submit that the kind of abstractness that is permitted here is the best answer to the dual behavior of neutral vowels that display 'transparency'.

Finally, we must note that the values F and B that are assigned to stem types by the monotonic function proposed by Törkenczy and Rebrus are very much like 'underlying representations' in that, like such representations, these values account for how vowels behave which can include behavior that is at odds with their phonetic properties.

3.4.2.2 *Polgárdi (2015)*

Polgárdi (2015) (in a response to the Rebrus and Törkenczy 2015a paper), following proposals in Demirdache (1988), Polgárdi (1998) and Dienes (1997, 2000), offers an elegant account of the four-way typology, which makes use of the head or dependent status of the element |I|. Taking Finnish as an example, the element theory that Polgárdi assumes would specify the vowel system as follows:

(52)	/i/	/ü/	/u/	/e/	/ö/	/o/	/æ/	/a/
				A	A	A	$\underline{\text{A}}$	$\underline{\text{A}}$
	$\underline{\text{I}}$	I		$\underline{\text{I}}$	I		I	
		$\underline{\text{U}}$	$\underline{\text{U}}$		$\underline{\text{U}}$	$\underline{\text{U}}$		

In this account |I| in neutral vowels ([i] and [e]) is a head element, while in other cases it is a dependent. To account for transparency, a head |I| is laterally licensed to spread when preceded by a dependent occurrence of |I|. Likewise, head |I| is licensed to spread when occurring in a neutral vowel root; she calls this *external licensing* (which is comparable to my positional licensing). In this approach the four-way typology can be derived from different conditions under which head elements can spread. Polgárdi follows Dienes (1997, 2000) who makes the following predictions:

(53) The behavior of neutral vowels headed by the harmonic element X̲
  i. Such a vowel can be harmonic if the element X̲ does not require extra licensing to be able to spread,
  ii. It can be transparent if X̲ may only spread if licensed to do so
  iii. It can be opaque (a non-undergoer and blocker) if X̲ is not allowed to spread under any circumstances.

(53i) accounts for Khanty, in which all front vowels, including the neutral ones, spread. (53iii) delivers Mulgi, in which neutral vowels fail to spread completely. The intermediate cases appeal to (53ii), which allows for various special licensing circumstances. While in both Finnish and Uygur a dependent |I| can license a following head |I| to spread, only Finnish, in addition, licenses the head |I| to spread in neutral vowel roots. As Polgárdi points out, this allows one, as of yet unattested case, namely a language that lacks 'lateral' licensing and only has external licensing in which neutral vowels would spread in neutral vowel roots, but not when preceded by a harmonic front vowel.[33] In my account such a language would be impossible since lateral licensing is considered to be 'automatic' in the sense that a variable element will always be licensed if a licenser is locally available.

Since I adopt a quite similar dependency model, what prevents me from following this elegant approach? The reason is that my element syntax works differently. Given that the elements |A| and |I| belong to different classes (see 2 above), they cannot enter into a dependency relation, which results in the fact that the I-element is the sole color element (and thus a head) in both [e] and [æ] (granted that this element would be specified for both vowels, which, as per minimal specification, is not the case). To represent [æ] with a non-head |I| would lead us to a distinction between headed and non-headed elements ('diacritic headedness') which RcvP rejects.

In conclusion, Polgárdi and I use a slightly different syntax for element combinations and, in addition, I use the variable notation. Aside from these differences, both models offer very similar alternatives to the account proposed in Törkenczy and Rebrus (2015a) of the four-way typology that was discussed above.

33. Polgárdi keeps her options open and suggests that this may be an accidental gap or, in other words, a possible system.

4. Transparency and opacity revisited

Van der Hulst and Smith (1986) proposed that non-participating vowels display predictable behavior with respect to 'transparency' and opacity:

(54) 'Transparency' and opacity
  a. A vowel that is *compatible* with the harmonic element is *transparent*
  b. A vowel that is *incompatible* with the harmonic element is *opaque*

In the light of the preceding discussion we need to revise (54). What remains is statement (54b), which is still valid. Any vowel that intervenes in between a licenser and potential licensee will act opaquely if it is incompatible with the harmonic element. In the RcvP approach incompatible vowels are negative vowels, i.e. they lack the harmonic element or they contain it as a variable which cannot be licensed due to a constraint. Thus, in Votic, which lacks non-initial [ö], the vowel [o] acts opaquely with respect to the harmonic element |I| (see Harms 1968; Blumenfeld and Toivonen 2009), just as non-advanced [a] in Tangale must be opaque when |∀| is the harmonic element.

We have seen that (54a) is adequate with reference to Finnish [i] which is 'transparent' because it is compatible with the harmonic element |I|. I have argued that transparent vowels are specified with variable (I).

However, as a general statement (54a) cannot be maintained if compatibility is understood as referring to the phonetic quality of the neutral vowel, since both in Khanty and in Mulgi neutral front vowels are *not* transparent. Rather, they are harmonic and opaque, respectively. I thus replace the statements in (54) by the following statements, taking into account that in my approach harmony involves licensing of a variable element:

(55) 'Transparency' and opacity
  a. A vowel *with a variable element* is '*transparent*'
  b. A vowel that *lacks* the harmonic element is *opaque*

This statement is not just true for non-participating vowels, it governs the behavior of *all* vowels in harmonic systems. In a sense, both harmonic and neutral vowels are 'transparent' when their ability to license a following variable element is dependent on them being preceded by a licensed element. The term 'transparency', given the model adopted here, is a misnomer if it is meant to suggest that a transparent vowel is ignored or skipped. This is not the case in the model proposed here.

5. Bridge locality

In van der Hulst (2016, to appear) I discuss various cases of unexpected transparency, i.e. cases in which vowels that lack the harmonic element appear to be transparent. It is shown that some such cases require recognition of locality for harmony being defined in terms of another element tier (*bridge locality*), which is taken to be a 'marked' option.

5.1 Unexpected transparency and opacity: The case of Khalkha (Mongolian)

In Khalkha (Mongolian) two harmonies are operative, ATR and labial harmony. Labial harmony raises some interesting issues. The most interesting challenge to the theory proposed in the previous section comes from Mongolian labial harmony, in which [u, ʊ] do not trigger this harmony, while [i], on the other hand, is skipped. The vowel system of Khalkha is as in (56a); (56b) shows the harmonic pairs for labial harmony (Svantesson 1985):

(56) a. Vowel system

i	u
	ʊ
e	o
a	ɔ

b. Harmonic pairs for labial harmony

e – o
a – ɔ

c. Unpaired: i, u, ʊ

d.

/o/	/ɔ/	/e/	/a/	/u/	/ʊ/	/i/
A	A	A	A			
U	U			U	U	
∀		∀		∀		

(57) Transparent [i] (with respect to labial harmony)

piir -ig -e	'brush.ACC.RFL'	pirr -e	'brush.RFL'
suuʒ -ig -e	'tail.ACC.RFL'	suuʒ -e	'tail.RFL'
teeʒ -ig -e	'gown.ACC.RFL'	teeʒ -e	'gown.RFL'
poor -ig -o	'tail.ACC.RFL'	poor -o	'tail.RFL'
mʊʊr -ig -a	'cat.ACC.RFL'	mʊʊr -a	'cat.RFL'
c^haas -ig -a	'paper.ACC.RFL'	c^haas -a	'paper.RFL

As shown, labial harmony does not affect high vowels, but given that they do not, these vowels behave unexpectedly in that [u] and [ʊ], which obviously bear the rounding property, are opaque for the propagation of roundness. This is unexpected because, given minimal specification, these vowels must be specified with the |U|-element. Nor do they cause roundness on the vowels following. Even worse, the vowel [i], which is incompatible with the spreading value acts transparently. Here strict locality seems to be clearly violated. However, if labial harmony is triggered only by [o, ɔ], and only targets low vowel suffixes, then we may conclude that harmony is dependent on both licenser and licensee having the element |A|, thus forming a 'bridge'. This is also the reason why [i] can be 'skipped', and [u,ʊ] are opaque. This is illustrated in (58):

(58)	a.	mɔ	ri	-tɔi	'horse-COMP'
		A	------------------	A	(bridge)
		U	»	(U)	
	b.	ɔr	ʊ:l	a:d	'enter-CAUS-PERF'
		A	------------------	A	(bridge)
		U	U	(U)	

Thus, the only solution that seems possible here is to take Steriade's (1981) notion of 'parasitic harmony' as point of departure, and to assume that the licensing relation for labial harmony in (58) is *relative* to the |A|-tier. This would mean that the relation in (58a) is local, in that it holds between two adjacent |A| elements; the intervening [i] is simply invisible for licensing. In (58b), on the other hand, the licensing relation between the initial |U| and the |U| in the suffix is blocked on account of an intervening |U| specification. Notice also that there is no licensing relation between this intervening |U| and the variable |U| in the suffix since these do not share a |A| element.[34]

It is important to distinguish between two types of parasitic harmony. When licensing is conditioned such that licenser and licensee must share a certain property this itself does not give rise to a licensing bridge. A bridge arises when the tier on which the other property resides become the reference for locality. In Khalkha the latter situation obtains. In many Turkic languages labial harmony only obtains in words that are also subject to palatal harmony which means that labial harmony is parasitic on licenser and licensee sharing the palatal element. In this case, however, the I-tier is not the reference for locality which means that non-round back vowels cannot display unexpected 'transparency'. Because these languages have palatal harmony we would of course not expect to find back vowels in words that contain

34. Other cases of this sort are reported in Li (1996).

front vowels, but such combinations can occur in disharmonic roots; there is no evidence that in these cases non-round back vowels can be 'skipped'; see van der Hulst and Moskal (2013).

The present analysis allows a variation on what we find in Khalkha Mongolian, which arises if the parasitic bridge condition was absent. In that case we predict that rounding takes place following all round vowels (including [u, ʊ]) and we would expect [i] to be opaque. This strikes me as a perfectly natural labial harmony system.

5.2 Unexpected transparency of [a] in tongue root systems

We have seen that in a language with ATR harmony the low vowel [a], when missing an advanced harmonic counterpart, acts opaquely. For a while it seemed as if the harmony system of Kinande presented a counterexample to this claim (Schlindwein, 1987). The crucial issue in this case is that while vowel harmony in most cases is considered a *lexical rule*, subject to *structure preservation*, vowel harmony in Kinande must be analyzed as a *post-lexical rule*, which I take to be part of phonetic implementation. This is evidenced, among other things, by the fact that it produces allophonic vowel qualities, namely raised mid vowels, which are therefore not lexically contrastive. In addition, it turns out that the low vowels are not transparent in the intended sense of being unaffected and 'skipped'. Rather, the long low [a:] is clearly affected by ATR-spreading and this effect is less noticeable on short [a] due to its shortness (Gick, Pulleyblank, Campbell and Mutaka 2006).

However, there are other cases with reported transparent [a] in systems in which this vowel also misses an advanced counterpart. Kutsch Lojenga (1994) reports on a tongue root harmony system in Kibudu (a Bantu language spoken in Zaire). She states that [a] is transparent to [+ATR] spreading which is illustrated by the following examples:

(59)	a.	mʊ-kanɪ mɪ-kanɪ	'stone, pip of a fruit' noun classes 3/4
	b.	mu-tanji mi-tanji	'type of wild animal' noun classes 3/4

As shown, the noun class prefix vowels harmonize with the vowel that is to the right of the vowel /a/; see Kutsch Lojenga (2008) for another case of this kind.[35] This situation is precisely the one that the theory presented here predicts not to exist if licensing refers to the nuclear level for locality.

35. Archangeli and Pulleyblank (1994) handle cases of this kind by a rule that inserts [+ATR] 'on the other side' of the neutral vowel, thus avoiding spreading across it.

To analyze such data, while preserving strict locality as understood here, perhaps in this case too it is possible to appeal to bridge locality, which is possible if we allow the color elements *together* to form a bridge for (∀)-licensing:[36]

(60)	/o/	/ɔ/	/e/	/ɛ/	/a/	/u/	/ʊ/	/i/	/ɪ/
	A	A	A	A	A				
	U	U				U	U		
			I	I					
	∀		∀			∀		∀	

In conclusion, problematic cases can be handled in terms of the marked option of invoking bridge locality.

6. Concluding remarks

In this article I have proposed a theory of vowel harmony (fully developed in van der Hulst, to appear) that uses licensing of variable elements, which I have illustrated with various examples involving asymmetries that are due to vowels that 'do not play ball'. I have also provided an account of a four-way typology that has been attested for palatal harmony systems in Kiparsky and Pajusalu (2003), and compared this account to various alternatives that have been offered in different theoretical frameworks. My account built on a somewhat different proposal in van der Hulst (2015a) which was written as a response to Rebrus and Törkenczy (2015a). A pivotal aspect of my approach is an appeal to variable copies of elements. I revised the theory of how neutral vowels behave that was proposed in van der Hulst and Smith (1986), taking into account the diverse behavior of neutral vowels that are compatible with the harmonic element. Apparently problematic cases in which incompatible neutral vowels fail to act opaquely have been explained in terms of bridge locality. Needless to say that bridge licensing presents a weakening of the theory that we started out with. However, more would be lost if we simply said that incompatible neutral vowels can be skipped, which would allow non-locality to creep into the theory.

36. Here we could appeal to *tier conflation* for systems that do not allow combinations of color elements; see Kaye, Lowenstamm and Vergnaud (1985) or simply assume that the bridge is formed by the color node. As an alternative, it could be explored whether the primary |∀| could form the bridge, despite the fact that the element is not necessary in the minimal specification. I refer to van der Hulst (to appear) for discussion of these options.

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