Neutral Vowels in Vowel Harmony*

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1. Introduction

In vowel harmony systems there is frequently a vowel that is usually neutral but nonetheless displays two different types of behavior in that it normally does not trigger harmony but sometimes it does. Traditionally, two types of behavior displayed by a neutral vowel, triggering the harmony on the one hand and not triggering the harmony on the other hand, are analyzed by positing an abstract vowel and absolute neutralization. However, this abstract solution with subsequent absolute neutralization has been criticized, as argued against by Kiparsky (1973), since abstract vowels do not actually occur in the inventories of analyzed languages.

The purpose of this paper is to account for the neutrality of certain vowels in the languages such as Middle Korean, Nez Perce, and Hungarian within the framework of Combinatorial Specification (Archangeli and Pulleyblank 1994) and alignment constraints (Kirchner 1993, Pulleyblank 1994, Cole and Kisseberth 1994), without adopting the abstract vowel analysis. The organization of the paper is as follows. In section 2 I present the data showing the dual behavior of the neutral vowels. In section 3 I introduce a brief background of alignment constraints in vowel harmony. In section 4 I propose the analysis of the neutral vowels adopting Combinatorial Specification in conjunction with alignment constraints. In section 5 I summarize the conclusions reached.

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2. Data

There are seven vowels in Middle Korean, as shown by the following vowel chart from Cheun (1974).

(1) Cheun (1974 : 7)

	Front		Central		Bank	
	UR	R	UR	R	UR	R
High	i			ɯ		u
Mid			ə		ʌ	
Low			3		a	

Traditionally, Middle Korean has analyzed as back/nonback harmony where roots containing the back vowels /u, ʌ, a/ occur with back vowel suffixes whereas roots containing the nonback vowels /ɯ, ə, 3/ occur with nonback vowel suffixes (K-M Lee 1961, W-J Kim 1963, Cheun 1974). The alternations of ə - ʌ and ɯ - u in suffixes are given in (2) and (3).

(2) Back vowel stems with back vowel suffixes

nalah - ʌl	'nation - Accusative'
mazʌm - ʌl	'mind - Accusative'
cuh - um - ʌl	'clean - Nominalizer - Accusative'

(3) Nonback vowel stems with nonback vowel sufixes

3lkul - əl	'face - Accusative'
pəl - əl	'fire - Accusative'
t3l - ɯm - əl	'deduct - Nominalizer - Accusative'

While the accusative suffix is -ʌl in (2) when the preceding stem vowels are back, it is -əl in (3) when the preceding stem vowels are nonback. Likewise, the nominalizer is -um in (2) after a back vowel stem whereas it is -ɯm in (3) after a nonback vowel stem.

The vowel /i/ is assumed to be neutral because it cooccurs freely with nonback

vowels or back vowels. The neutral behavior of /i/ is shown in (4).

(4) a. /i/ with nonback vowels

ui - lə	'position - Accusative'
əi - lə	'justice - Accusative'
c3i - lə	'brother - Accusative'

b. /i/ with back vowels

ch∧ik - ∧l	'book - Accusative'
mula - l∧l	'song - Accusative'
cui - l∧l	'sin - Accusative'

When back harmony occurs in (4b), it ignores the neutral vowel /i/ resulting in transparency.

While the neutral vowel /i/ shows transparency to back harmony, it sometimes triggers back harmony as in (5), which should be compared with the data in (6) where /i/ does not trigger back harmony.

(5) /i/ triggering back harmony

pi - l∧l	'rain'
li - l∧l	'village'
kilh - ∧l	'road'

(6) / i / not triggering back harmony

sim - əl	'mind'
sik - ə	'eating'
ip - əl	'mouth'

While the accusative suffix is - (l)∧l after /i/ in (5), it is -əl after /i/ in (6).[1]

Furthermore, some roots with /i/ show vacillation where both back and nonback suffixes alternate, as shown in (7).[2]

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[1] While the accusative suffix is -əl/∧l after a consonant, it is -lə/l∧l after a vowel.

[2] All data presented here are form Cheun(1974), which originally come from Yongpiechenka(1445).

(7) /i/ with both back and nonback suffixes

min - ʌl	min - əl	'people'
sin - ʌl	sin - əl	'subject'

In Nez Perce, an American Indian language which belongs to the Sahaptian language family, there are five vowels /i, æ, u, o, a/ and the vowels /æ, u/ and /o, a/ act as harmonic groups, as shown in (8). Even though the vowel /i/ belongs to the harmonic group /æ, u/, it can also cooccur with the harmonic group /o, a/. Thus, /i/ is considered as a neutral vowel.

A

(8) Nez Perce vowels

neutral vowel	i	u
		o
	æ	a

The vowel /æ/ of a morpheme alternates with [a] if there is any other morpheme in the word containing /o/ or /a/, as shown by the data below. All data are from Aoki (1966).

(9) æ - a alternation

a. mǽq	'paternal luncle'
næ?ɪmǽq	'my paternal uncle'
mǽqaː?	'paternal uncle!'
b. tóːt	'father'
na?tóːtʻ	'my father'
tóːta?	'father!'

Yongpiechenka is the first document writtem with the new Korean alphabet and exhibits strict vowel harmony. After Yongpiechenka most documents show that vowel harmony becomes less strictly observed indicating the decline of vowel harmony. Thus, vowel harmony becomes productive only in ə-initial suffixes in verbal morphology and ideophones in Modern Korean.

c. cǽ·qæt	'raspberry'
cǽ·cæt	'raspberry'
caqǽ·t'ayn	'for a raspberry'

In (9b) the possessive prefix /næ?/ and the vocative suffix /æ?/ become [na?] and [a?] respectively when they occur with the stem containing the vowel /o/. In (9c), the postposition 'ayn 'for' triggers the harmony so that the stem vowel /æ/ becomes [a].

Also, the vowel /u/ in a morpheme alternates with [o] if there is any other morpheme in the word containing the vowels /o/ or /a/, as shown in (10).

(10) u ~ o alternations

a. wú·læ̀likæpæsæ	'(I) am riding into bushes'
b. wó·læ̀likapasaqa	'(I) rode into bushes recently'

In (10b) the recent past marker /qa/ triggers the harmony, thus the stem vowels /u/ and /æ/ become [o] and [a] respectively. Thus, the harmony is triggerd by any morpheme containing the vowel /o/ or /a/ regardless whether it is a stem vowel or an affix vowel.

The vowel /i/ is not affected by the harmony and thus is transparent, as seen by the data in (10). By contrast, /i/ can sometimes trigger the harmony. The following data illustrate the two types of behavior of /i/.

(11) /i/ not triggering harmony

a. ʔí·c	'mother'
næʔí·c	'my mother'
ʔí·cæʔ	'mother!'
b. qitti	'place firmly'
tulǽ·qittisæ	'(I) am putting my foot down firmly'

(12) /i/triggering harmony

a. cí·c	'paternal aunt'
naʔcí·c	'my paternal aunt'
cícaʔ	'paternal aunt!'

b. cik'il 'destroy'
tolá·ck'ilksa '(I) am destroying with my foot'

While the stems ?í·c and qitti which contain /i/ do not trigger the harmony, the stems cí·c and cik'il which contain /i/ trigger the harmony.

Hungarian, which belongs to the Uralic languages, has the following vowel system.[3]

(13) Hungarian vowels

neutral vowels	i	ü	u
	é	ö	o
	e		a á

Traditionally, Hungarian vowel harmony has been analyzed as front/back harmony whereby front vowels (ü, ö, e) occur with front vowels while back vowels (u, o, a, á) occur with back vowels (Clements 1977, van der Hulst 1985, Ringen 1988). Roots with front vowels (ü, ö, e) select front suffixes while roots with back vowels (u, o, a, á) select back suffixes, as shown in (14) and (15).[4]

(14) Front suffixes with front vowel roots

ür - nek	'gap (dative)'
öröm - nek	'joy (dative)'
elnök - né - nek	'president - wife of (dative)'
tömeg - nek	'crowd (dative)'
tömeg - töl	'crowd (ablative)'

(15) Back suffixes with back vowel roots

ház - nak	'house (dative)'

[3] The acute accent marks length. However, here, vowel length is not distinguished for other than /é/ and /á/ for simplicity.

[4] All data on Hungarian vowel harmony are from Ringen (1980, 1988), van der Hulst (1985), and Demirdache (1988).

ház - tɔl	'house (ablative)'
város - nak	'city (dative)'
város - tol	'city (ablative)'

Since the roots in (14) contain front vowels the dative suffix /nek/ remains. On the other hand, since the roots in (15) contain back vowels the dative suffix becomes [nak].

The front nonlow and unround vowels (i, é) have been assumed to be neutral to the front/back harmony since they can occur with either front vowels or back vowels. When the neutral vowels occur with back vowel roots, back harmony still occurs. As a result, the following suffixes are back as shown in (16).

(16) Neutral vowels with back vowel roots

radir - nak	'eraser (dative)'
kavics - nak	'pebble (dative)'
tanyér - nak	'plate (dative)'

While the neutral vowels show transparency to back harmony when they intervene between back vowels, there are some exceptional cases in which roots with neutral vowels seem to trigger back harmony. Compare the data in (17) and (18).

(17) Neutral vowels triggering harmony

hid - nak	'bridge (dative)'
hid - tɔl	'bridge (ablative)'
cél - nak	'goal (dative)'
cél - tol	'goal (ablative)'

(18) Neutral vowels not triggering harmony

viz - nek	'water (dative)'
viz - től	'water (ablative)'
vér - nek	'blood (dative)'
vér - től	'blood (ablative)'

The neutral vowels in (17) trigger back harmony so that the dative suffix /nek/ and the ablative suffix /töl/ become [nak] and [tol] respectively whereas the neutral vowels in (18) do not. Thus, the neutral vowels show two types of behavior. Until now we have seen the dual behavior of /i/ in Middle Korean, /i/ in Nez Perce, and /i é/ in Hungarian.

3. Alignment Constraints in Vowel Harmony

Traditionally, vowel harmony has been analyzed as the spreading rule of the harmonic feature. However, this view is replaced by a recent view where the harmonic feature appears through alignment constraints in the nonderivational constraint-based grammar developed by Prince and Smolensky (1993) and McCarthy and Prince (1993a). In the alignment approach the realization of the harmonic feature to the anchor vowels in a certain domain is expressed as constraints which align the harmonic feature with the anchors towards the right or/and left edges of the relevant domain (McCarthy and Prince 1993b, Kirchner 1993, Pulleyblank 1993, Cole and Kisseberth 1994).

The alignment may be blocked when the harmonic feature and the feature of the potential anchor are incompatible, namely ungrounded. If the harmonic feature cannot be aligned due to the feature cooccurrence constraint between the harmonic feature and the anchor feature, the harmony may be stopped at the anchor that causes the clash resulting in opacity or the harmony may continue after the anchor resulting in transparency. In treating opacity and transparency I adopt the following assumptions made in Cole and Kisseberth (1994).

(19) Cole and Kisseberth

a. Harmony is the requirement that a feature [F] be uniformly realized on anchors in an F-domain instead of autosegmental spreading.

b. Wide Scope Alignment (WSA) extends a harmony domain to the edge of a morphological or prosodic constituent.

c. While WSA constranints license harmony domains, Expression affiliates the harmonic feature to every anchor in a harmony domain.

Thus, transparency occurs when the WSA constraint is highly ranked to the extent not to be violated in a language. On the other hand, opacity occurs when the WSA constraint is lowly ranked so it is violated in a language.

Consider the case where the retracted tongue root harmony is triggered by the underlying [+RTR] feature of the leftmost vowel. The harmonic feature [+RTR] is realized to the adjacent vowels by the WSA-right and Expression constraints. However, the feature cooccurrence constraint which allows the realization of [+RTR] only if it combines with sympathetic features such as [+low], [+round], or [-high] may be active and ranked over the WSA-right and Expression constraints. If the WSA-right is ranked above Expression, the harmony domain extends beyond the anchor resulting in transparency. If the WSA-right is ranked below Expression, the harmony domain does not extend to the relevant right edge resulting in opacity. The following tableaus illustrate different constraint rankings deriving transparency and opacity in a CVCVCV sequence.

(20) Transparency ranking : RTR/Low, WSA-rt >> Express

UR : [+RTR]								
C [+low] C [ ] C [+low]						RTR/Low	WSA-rt	Express
	[+RTR]		[+RTR]		[+RTR]	*!		
C	[+low]	C	[ ]	C	[+low]			
	[+RTR]		[+RTR]			*!	*!	
C	[+low]	C	[ ]	C	[+low]			
☞	[+RTR]		[ ]		[+RTR]			*
C	[+low]	C		C	[+low]			
	[+RTR]		[ ]				*!	
C	[+low]	C		C	[+low]			

(21) Opacity ranking : RTR/Low, Express >> WSA-rt

UR : [+RTR]								
C [+low] C [ ] C [+low]						RTR/Low	Express	WSA-rt
	[+RTR]		[+RTR]		[+RTR]	*!		
C	[+low]	C	[ ]	C	[+low]			
	[+RTR]		[+RTR]			*!		*
C	[+low]	C	[ ]	C	[+low]			
	[+RTR]		[ ]		[+RTR]		*!	
C	[+low]	C		C	[+low]			
☞	[+RTR]		[ ]					*
C	[+low]	C		C	[+low]			

Notice that representations are composed only of combinations of features, and the view that harmony involves autosegmental spreading is not adopted. In the next section I analyze the dual behavior of certain vowels within the framework of Combinatorial Specification in conjunction with alignment constraints.

4. Combinatorial Specification Analysis

In Combinatorial Specification phonological representations consist only of a limited number of features, and phonemes are interpreted by the combinations of features. The features in the representations can be determined by examining the phonology of a particular language and seeing which features are phonologically active in the language. In Middle Korean the phonologically active features are [+round], [-high], [+low], and the harmonic feature [+RTR]. Previous studies analyze Middle Korean vowel harmony as back/nonback harmony adopting the harmonic feature [±back] in which the back vowels /u, ʌ, a/ are categorized as [+back] whereas the central vowels /ɯ, ə, ɜ/ are categorized as [-back]. However, the categorization of the harmonic group /ɯ, ə, ɜ/ as nonback is not adequate because /ɯ, ə, ɜ/ cannot be categorized as [-back] since they are considered [+back] in the standard distinctive feature system. Consequently, I posit that the feature which characterizes the harmonic group /u, ʌ, a/ is the feature [+RTR]. With respect to high vowels, the F-element [+round] differentiates the high vowels /i, ɯ, u/ in that /i/ is [-round] and /u/ is [+round]. The F-elements [-high] and [+low] are selected in order to distinguish /ə, ɜ/ and /ʌ, a/.

Four underlying F-elements result in sixteen combinatorial possibilities, as shown in (22).

(22) Middle Korean vowel representation

a. F-elements : +ROUND, -HIGH, +LOW, +RTR

b. Combinations

*	*	*	*	a_1	*	*	ɯ	$ɜ_1$	ʌ	a_2	ɤ	ə	$ɜ_2$	i_1	i_2
+RD	+RD	+RD	+RD		+RD	+RD	+RD				+RD				
-HI	-HI	V-HI		-HI	-HI			-HI	-HI			-HI			
+LO	+LO		+LO	+LO		+LO		+LO		+LO			+LO		
+RTR		+RTR	+RTR	+RTR			+RTR		+RTR	+RTR				+RTR	

Since round vowels are always high in Middle Korean, the feature combinations of [+round, -high] and [+round, +low] are excluded. Following the principle of Representational Simplicity, /$ɜ_2$/ and /a_2/ are chosen over /$ɜ_1$/ and /a_1/. Note that the F-element [+RTR] as well as the empty set is interpreted as /i/. The interpretation of [+RTR] as /i_1/ is not unexpected given the data in (5) which trigger the harmony.

The alternations of ə-ʌ and ɯ-u in suffixes occur because the harmonic feature [+RTR] of a stem is realized to the adjacent vowels by the WSA-rt and Expression constraints. As a result, suffix vowels also become [+RTR], as shown by the data in (2). On the other hand, when a stem does not contain the harmonic feature [+RTR], the harmony does not occur, as shown by the data in (3). When [+RTR] is realized to the nominalizer /ɯ/ whose representation is [+round] and accusative suffix /əl/ whose representation is [-high], they are interpreted as [u] and [ʌl] respectively.

When [+RTR] vowels cooccur with /i/ in a stem, the harmonic feature [+RTR] is realized beyond /i/, as shown by the data in (4b). Thus, WSA-rt outranks Expression in Middle Korean. The reason why [+RTR] is not realized on /i/ in forms like in (4b) is because [+RTR] is realized only with the sympathetic features [-high] or [+round]. This is not unnatural given that retracting of the tongue root enhances tongue body nonhighness (RTR/High condition) motivated by Archangeli and Pulleyblank (1994) as a grounded condition. Likewise the F-elements [+RTR] and [+round] are sympathetic to each other in that both tongue root retraction and lip rounding lower the second formant frequency (RTR/Round condition) motivated by Cho (1994). Since the grounded conditions RTR/High and RTR/Round prevent the harmonic feature [+RTR] from being realized without [-high] or [+round], they are ranked above Expression. Therefore, the constraint ranking in Middle Korean is as follows; RTR/High or RTR/Round, WSA-rt >> Express. The following tableau illustrates that the optimal output [chʌik-ʌl] results from the input /chʌik-əl/ 'book-Accusative' based on the

relevant constraint ranking.

(23)

UR : [+RTR] ch [-high]		[ ]	k	-	[-high]	RTR/High or RTR/Rnd	WSA-rt	Express
ch	[+RTR] [-high]	[+RTR] [ ]	k	-	[+RTR] [-high]	*!		
ch	[+RTR] [-high]	[+RTR] [ ]	k	-	[-high]	*!	*!	
☞ ch	[+RTR] [-high]	[ ]	k	-	[+RTR] [-high]			*
ch	[+RTR] [-high]	[ ]	k	-	[-high]		*!	

The grounded conditions rule out the realization of [+RTR] without the enhancing features, as in the first and second candidates. Since WSA-rt is highly ranked in Middle Korean, the fourth candidate whose harmony domain is not extended is ruled out. Therefore, the third candidate which only violates lowly ranked Expression wins because it satisfies other highly ranked constraints. The harmonic feature [+RTR] to /ə/ which is [-high] underlyingly is interpreted as [ʌ].

The unexpected behavior of /i/ triggering the harmony, as shown by the data in (5), has been traditionally analyzed by positing an abstract vowel /ɨ/. Thus, /i/ which triggers the harmony in (5) is replaced by /ɨ/ whereas /i/ which does not trigger the harmony in (6) remains. Then, the vowels /ɨ/ and /i/ are neutralized as /i/. However, this abstract solution with subsequent absolute neutralization has been criticized, as seen in Kiparsky (1973). In contrast, the two types of behavior displayed by /i/, triggering harmony on the one hand and not triggering harmony on the other hand, can be accounted for by the combinatorial specification analysis in (19). While $/i_2/$ with no feature specification does not trigger the harmony, $/i_1/$ with [+RTR] triggers the harmony. Therefore, /i/ in (5) is actually $/i_1/$ whereas /i/ in (6) is actually $/i_2/$, as shown in the underlying representations for [pi-lʌl] 'rain' and [sim-əl] 'mind' in (24).

(24) [+RTR]

a. p [ ] - 1 [-high] 1 b. s [ ] m - [-high] 1

Consequently, only (24a) which has the harmonic feature [+RTR] underlyingly undergoes the harmony following the constraint ranking. However, [+RTR] cannot be realized in (24b) because of general constraints which prevent epentheis and deletion of the feature differently from underlying represention (Prince and Smolensky 1993, McCarthy and Prince 1993a). As a result, only the accusative suffix of /pi$_1$/ becomes [l∧l] where as the accusative suffix of /si$_2$m/ surfaces as [əl].[5]

For the words in (7) which occur with both [+RTR] and [+ATR] suffixes there is an ambiguity on whether the words contain /i$_1$/ or /i$_2$/. When the word is considered as containing /i$_1$/, harmony occurs and thus, the suffix becomes [+RTR]. On the other hand, when the word is considered as containing /i$_2$/, harmony does not occur and thus, the suffix is realized without [+RTR]. The two different different inputs for [min-∧l/min-əl] 'people' are provided in (25).

(25) [+RTR]

a. m [ ] n - [-high] 1 b. m [ ] n - [-high] 1

When the word /min/ is considered as containing /i$_1$/ as in (25a), harmony occurs and the suffix becomes [∧l]. When the word is considerd as containging /i$_2$/ as in (25b), harmony does not occur and the suffix remains as [əl]. Thus, the combinatorial specification analysis is able to account for the unexpected behavior of /i/ triggering the harmony, which has been traditionally analyzed by positing an abstract vowel and absolute neutralization, on one hand and not triggering the harmony on the other hand. Additionally, this case shows that the determination of the input, namely underlying representation is important to produce the optimal output as well as constraints and some degree of underspecification is necessary.

In Nez Perce the phonologically active F-elements are [+RTR], [+round], and [+low]. Since there are three phonologically active F-elements for the underlying representations

[5] This analysis is similar to Archangeli and Pulleyblank's (1994) analysis of Barrow Inupiaq where /i1/ which has [-back] triggers palatalization but /i2/ which has no feature specification does not trigger palatalization.

of phonemes, there are eight combinatorial possibilities for three underlying F-elements, as shown in (26).

(26) Combinatorial Specification of Nez Perce vowels

a. F-elements : +RTR, +ROUND, +LOW

b. Conditions : if + round then not + low, if + low then not + round

c. Combinations

*	o	a	*	i_1	u	æ	i_2
+RTR	+RTR	+RTR		+RTR			
+RD	+RD		+RD		+RD		
+LO		+LO	+LO			+LO	

Since there is no low round vowel in the inventory of Nez Perce, the combinations of [+round] and [+low] are ruled out. The remaining combinations of F-elements are interpreted as five phonemes of the Nez Perce vowel system. I interpret the F-element [+RTR] and the empty set as /i_1/ and /i_2/ respectively. The interpretation of [+RTR] as /i/ seems justifiable given the data where some instances of /i/ trigger the harmony, as seen in (12).

The alternations of æ - a and u - o result from the alignment of the harmonic feature [+RTR] from the dominant vowels /o/ and /a/. When there is a dominant vowel, the [+RTR] feature of the doninant vowel is realized in the whole word by the WSA and Expression constraints. Since the harmony occurs bidirectionally, both WSA-right and WSA-left occur in this language. For example, [+RTR] from the stem /tó·t-æ?/ and from the affix /cæqǽ·t-'ayn/ is realized to the adjacent vowel, thus becoming [tó · ta?] 'father!' and [caqá·t'ayn] 'for a raspberry', respectively. The realization of [+RTR] to [+low] is interpreted as [a].

While the realization of the harmonic feature [+RTR] to [+low] of the vowel /æ/ and [+round] of the vowel /u/ is interpreted as [a] and [o] respectively as evidenced by the alternations of æ - a and u - o, that to the neutral vowel /i/ does not affect /i/. Since the harmonic feature is realized after the transparent vowel extending the harmonic domain to the word, WSA-right and WSA-left are ranked over Expression. The reason that [+RTR] is not realized to /i/ is because /i/ does not have the feature

[+low] nor [+round]. This is not unnatural given the sympathetic correlation between the harmonic feature [+RTR] and the features [+low] and [+round] expressed by the RTR/Low and RTR/Round grounded conditions. As a result, [+RTR] alone is not salient enough to be realized. Thus, the RTR/Low or RTR/Round are ranked above Expression which affiliates [+RTR] because they block the affiliation. The following tableau illustrates that the candidate [wó·lalikapasaqa] from the input /wú·lælikæpæsːæqa/ '(I) rode into bushes recently' best satisfies the constraint hierarchy RTR/Low or RTR/Round, WSA-rt and WSA-lf >> Expression.

(27) UR :

w [+rnd] l [+low] l [ ] k [+low] p [+low] - s [+low] - q [+low]	[+RTR]	RTR/High or RTR/Rnd	WSA-rt & WSA-lf	Express
[+RTR] [+RTR] [+RTR] [+RTR] [+RTR] [+RTR] [+RTR] w [+rnd] l [+low] l [ ] k [+low] p [+low]-s [+low]-q[+low]		*!		
w [+rnd] l [+low] l [ ] k [+low] p [+low]-s [+low]-q[+low]	[+RTR] [+RTR] [+RTR] [+RTR]		*!	
☞ [+RTR] [+RTR] [+RTR] [+RTR] [+RTR] [+RTR] w [+rnd] l [+low] l [ ] k [+low] p [+low]-s [+low]-q[+low]				*

If the harmony occurs throught the whole word like the first candidate, it violates the highly ranked grounded condition. If the harmony is blocked before the transparent vowel /i/ like the second candidate, it violates WSA that is ranked higher than Expression. If the harmony resumes after /i/ like the third candidate, it only violates Expression. Since the third one least violates in the constraint hierarchy, it is the optimal output. The combination of the features [+RTR] and [+round] is interpreted as [o] while the combination of [+RTR] and [+low] is interpreted as [a].

The phoneme /i/ is neutral because it can belong to the dominant vowel series /o/ and /a/ as well as to the recessive vowel series /æ/ and /u/, as illustrated by the data in (11) and (12). The two types of behavior displayed by /i/, that as a dominant vowel triggering the harmony on one hand and as a recessive vowel not triggering the harmony on the other hand is because there are two different /i/'s underlyingly, as shown by the Combinatorial Specification of Nez Perce vowels in (26). While /i$_1$/

which has [+RTR] triggers the harmony, /i₂/ which has no feature specification does not trigger the harmony.[6] Importantly, these two different types of behavior are expected within the combinatorial specification analysis. The interpretation of [+RTR] as /i/ is based on the behavior of /i/ triggering the harmony phonologically, even though it is not [+RTR] phonetically.[7] The input representations for the words [tulǽ·qittisæ] '(I) am putting my foot down firmly' and [tolá·ck'ilksa] '(I) am destroying with my foot' are provided in (28) and (29), respectively.

(28) /i₂/not triggering the harmony

t [+rnd] l [+low] - q [ ] tt [ ] - [+low]

(29) /i₁/triggering the harmony

[+RTR]

t [+rnd] l [+low] - c k' [ ] l k - s [+low]

Since there is no harmonic feature [+RTR] underlyingly in (28), the harmony does not occur. On the other hand, since /i₁/ has [+RTR] underlyingly in (29), it triggers the harmony. Both WSA-right and WSA-left extend the harmony domain into the whole word and Expression affiliates [+RTR] to all vowels. Thus, the best candicate is [tolá·ck'ilksa] in which [+RTR] is realized to the all adjacent vowels bidirectionally. When [+RTR] combines with the F-elements [+low] and [+round], it sufaces as the [+RTR] counterpart [o] or [a] respectively. Note that phonologically active [+RTR] alone cannot be phonetically realized due to the RTR/Low and RTR/Round conditions. Thus, the two types of behavior displayed by /i/, not triggering the harmony on one

[6] In previous analyses, the participation of /i/ in both harmonic sets is explained by assuming an extra underlying vowel /ɨ/. Then, /i/ and /ɨ/ would be neutralized surfacing as /i/. Similarly, Hall and Hall (1980) posit two different /i/'s, namely /i/ which is [+ART] and /I/ which is [-ATR], in underlying representation. However, the postulation of abstract vowels /ɨ/ or /I/ which do not surface and the use of context-free neutralization could be criticized.

[7] See Anderson (1981) for more cases where phonological phenomena are incongruous with phonetic facts. My view about this issue is that phonology may be accounted for by phonetics like the case of grounded conditions, but it is not necessarily as in the framework of Combinatoria Specification.

hand and triggering the harmony on the other hand, are due to two different /i/'s in underlying representation.

While Hungarian vowel harmony is traditionally analyzed as front/back harmony, I adopt the F-element [+RTR] as the harmonic feature because the vowels /ü/ and /ö/ are not characterized by [front] but actually characterized by [back] according to Rialland and Djamouri (1984) based on formant charts of Khalka Mongolian, which has a similar vowel inventory to Hungarian. Thus, only [+RTR] is the common F-element that can group together the back vowels /u, o, a, á/ contrasting with the front vowels. In order to distinguish the front round vowels from the front unround vowels the F-element [+round] is adopted. The height of vowels would be differentiated by having the F-element [+high] and [+low]. Given this, phonologically active F-elements are [+round], [+high], [+low], and [+RTR].

There are sixteen combinatorial possibilities for the four underlying F-elements, as shown in (30).

(30) Combinatorial Specification of Hungarian vowels

a. F-elements : +ROUND, +HIGH, +LOW, +RTR

b. Conditions : if + high then not + low, if + low then not + high
if + round then not + low, if + low then not + round

c. Combinations

*	*	u	*	*	ü	*	o	*	i_1	a	ö	i_2	e	$é_1$	$é_2$
+RD	+RD	+RD	+RD		+RD	+RD	+RD				+RD				
+HI	+HI	+HI		+HI	+HI			+HI	+HI			+HI			
+LO	+LO		+LO	+LO		+LO		+LO		+LO			+LO		
+RTR		+RTR	+RTR	+RTR			+RTR		+RTR	+RTR				+RTR	

Since the F-elements [+high] and [+low] are incompatible, the condition in (30b) rules out the combinations containing both [+high] and [+low]. Also, the combination of [+round, +low] is ruled out by the Round/Low (or Low/Round) condition in (30b). I interpret the combinations of [+high, +RTR] and [+RTR] as $/i_1/$ and $/é_1/$ respectively in addition to [+high] as $/i_2/$ and the empty set as $/é_2/$. The interpretation of [+high, +RTR] as /i/ and [+RTR] as /é/ is evidenced by the data in (17) where harmony is triggered. From the fact that some instances of /i/ and /é/ trigger harmony we may

deduce that these instances of /i/ and /é/ contain the harmonic feature [+RTR].

I analyze the alternations between e - a and between ö - o in suffixes as the result of the rightwards alignment of the harmonic feature [+RTR] of the root vowels. Thus, only the suffixes with [+RTR] root vowels undergo the harmony, as shown in the data in (15), compared with the suffixes in (14) which do not undergo the harmony because the roots do not contain the harmonic feature [+RTR]. For example, [+RTR] of a stem is realized to the suffix /nek/ which is [+low] or /töl/ which is [+round] by the WSA-right and Expression constraints. While the combination of [+RTR] and [+low] is interpreted as [a], that of [+RTR] and [+round] is interpreted as [o].

While the combination of [+RTR] and the sympathetic features [+low] or [+round] surfaces as [+RTR] counterparts, that to /i/ or /é/ does not. Since /i/ and /é/ consistently lack the sympathetic F-elements [+low] or [+round], we may reason that [+RTR] can only be realized on an element that contains one of the sympathetic features, [+low] or [+round]. Since /i/ and /é/ do not have [+low] nor [+round], they are not affected by the harmony due to the RTR/Low and RTR/Round conditions. However, the harmony resumes after /i/ or /é/ due to highly ranked WSA-right extending the harmony domain. The candidates for /kavics-nek/ 'pebble (dative)' are evaluated in (31).

(31)

UR : [+RTR] k [+low] [-high] c s - n [+low] k	RTR/Low or RTR/Rnd	WSA-rt	Express
[+RTR] k [+low] [+RTR] [-high] c s - n [+low] k	*!		
[+RTR] k [+low] [+RTR] [-high] c s - n [+low] k	*!	*!	
☞ [+RTR] k [+low] [+RTR] [-high] c s - n [+low] k			*
[+RTR] k [+low] [-high] c s - n [+low] k		*!	

The first and second candidates are ruled out because they violate the highly ranked grounded conditions and WSA. The third candidate is more optimal than the fourth one because it only violates lowly ranked Expression. The combination of [+RTR, +low] is interpreted as [a] thus becoming [kavics-nak].

While the vowels /i/ and /é/ show transparency to the harmony, there are some instances of /i/ and /é/ which unexpectedly trigger the harmony, as exemplified in the data of (17). Thus, the vowels /i/ and /é/ triggering the harmony are actually $/i_1/$ and $/é_1/$ of (30) because $/i_1/$ and $/é_1/$ contain the harmonic feature [+RTR]. Given this, it is not unexpected that /i/ and /é/ show two diffferent types of behavior; one triggering the harmony as in the data of (17) and the other not triggering the harmony as in the data of (18). The input representations for the words [hid-nak] 'bridge (dative)' and [viz-töl] 'water (ablative)' showing the different types of /i/ are given in (32).

(32)

a. $/hi_1d$-nek/ [+RTR]

h [+high] d - n [+low] k

b. $/vi_2z$-töl/

v [+high] z - t [+rnd] l

Since (32a) has the harmonic feature [+RTR] underlyingly, the harmony occurs. By contrast, harmony does not occur in (32b) because there is no harmonic feature which triggers the harmony. Thus, the two different types of behavior displayed by /i/ and /é/ are accounted for by positing two different /i/'s and /é/'s which result from the range of possible F-element combinations in the combinatorial specification analysis of Hungarian vowels.

5. Conclusion

It is shown that the two types of behavior by a neutral vowel are due to two different feature combinations interpreted as one phoneme in Combinatorial Specification. In Middle Korean the behavior of the neutral vowel /i/ is naturally derived by the combinatorial specification analysis of Middle Korean vowels.

Specifically, /i/ which triggers the harmony has [+RTR] in the underlying representation whereas /i/ which does not trigger the harmony has no feature specification in the underlying representation. Similarly, in Nez Perce the neutral vowel /i/ has two different underlying representations and this results in two different types of behavior. In Hungarian the neutrality of the vowels /i/ and /é/ is accounted for by positing underlyingly two different feature combinations for the neutral vowels /i/ and /é/ respectively. Note that the harmonic feature [+RTR] is realized only if it is combined with its sympathetic features such as [-high], [+low], or [+round]. Therefore, [+RTR] on the neutral vowels without its sympathetic features does not surface phonetically, even though it is phonologically active. Importantly, Combinatorial Specification derives these phonologically necessary but phonetically incongruous distinctions.

Given the combinatorial specification analyses of Middle Korean, Nez Perce, and Hungarian where a neutral vowel has two different underlying representations resulted from the range of feature combinations, it is not unexpected that the neutral vowels in the languages show two different types of behavior; one triggering the harmony and the other not triggering the harmony. To conclude, the behavior of neutral vowels is accounted for in a unified way within the framework of Combinatorial Specification. Consequently, the postulation of abstract vowels and subsequent absolute neutralization in traditional analyses can be avoided. This is particularly beneficial to the analysis of Hungarian since two abstract vowels are necessary otherwise.

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