An optimality-theoretic account of vowel harmony in Korean ideophones*

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This study provides an account of vowel harmony in Korean ideophones within the theoretical framework of Optimality Theory. We show that vowel harmony process is achieved by employing two high ranked alignment constraints. We address the issue of misalignment at the right edge of the harmonic domain arguing that it is the result of the interaction between the featural identity and Align-Right constraints. The harmonizing behavior of the high back round vowel /u/ and its variation in a same morpheme are analyzed by using a conjunctive constraint and reranking relevant constraints repectively. We also argue that we should make a distinction between two /u/s in nonintial syllable positions. (Hannam University)

Keywords: Vowel harmony, dark vowels, light vowels, Optimality Theory

1. Introduction

Vowel harmony in Korean occurs both in ideophones and in nonideophonic words. While vowel harmony is still productive in ideophones, it occurs only in vowel suffixation in nonideophonic words.[1]

The main purpose of this paper is to provide an analysis of vowel harmony in present Korean ideophones within the framework of Optimality Theory (Prince and Smolensky 1993), especially the advanced version as developed by McCarthy and Prince (1995). In this paper it is assumed that the active harmonic feature specification of vowel harmony in Korean ideophones is a floating [-ATR] feature specification (Kim 1984; Cho 1994)[2]. This floating harmonic feature is associated with the leftmost vowel of the stem and it distributes to the rightmost vowel of the stem. The domain of the vowel harmony is defined by the two optimality-theoretic alignment constraints (Akinlabi 1994a, 1997; Kirchner 1993; Pulleyblank 1993, 1994). The neutral behavior of the high unround vowels /i/ and /ɨ/ (*ɨ* is used for barred-i) is analyzed by invoking a feature cooccurrence constraint and faithfulness constraints. The high round vowel /u/ reflects several interesting aspects of the harmonic process. For some cases, /u/ behaves as a neutral vowel whereas in other cases it acts as a harmonizing vowel in noninitial syllable position. It is assumed in this

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[1] Lee (1993) claims that there is other sporadic harmony in different parts of the vocabulary.

[2] Kim(1984) uses the feature [-DVR] and [+DVR] for light vowels and dark vowels each. The [DVR] feature represents "deep voice resonance" which reflects a similar notion with tongue retraction or [-ATR].

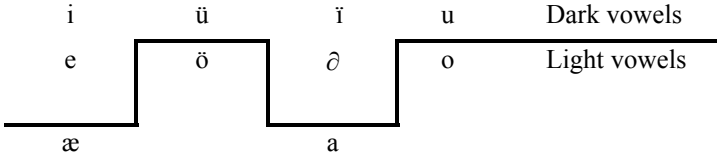
paper that the different underlying representation is responsible for the neutral behavior of /u/ in some morphemes. This can be accounted for by using the same constraint ranking employed for the neutral behavior of /i/ and /ï/. The harmonizing behavior of /u/ to the harmony in noninitial syllables can be analyzed by proposing a conjunctive constraint (Hewitt and Crowhurst 1996; Lubowicz 1997; Inkelas 1999) in order to avoid a constraint ranking paradox in Optimality Theory (henceforth OT). The variation of high round vowel /u/ as a neutral and as a harmonizing vowel to the harmonic process in noninitial syllable position will be accounted for by reranking the relevant constraints which are ranked very low in Korean vowel harmony.

The organization of this paper is as follows. In section 2, I present an overview of the vowel harmony in Korean ideophones with the data. In section 3, I introduce the theoretical background of this paper. In section 4, I provide an optimality-theoretic analysis. I summarize the analysis in section 5.

2. Vowel harmony in Korean ideophones

Korean has two types of ideophones. One type belongs to a dark form which consists of what are traditionally known as dark vowels (i, e, ü, ï, ∂, u). The other type belongs to a light form which consists of what are traditionally regarded as light vowels (æ, ö, a, o). Ideophones that contain dark vowels are normally conceived as having an augmentative connotation while those consisting of light vowels are considered reflecting a diminutive connotation.[3] The traditional differentiation of dark and light vowels in Korean ideophones is presented in (1).

(1) The traditional dark and light vowels in Korean



Ideophones containing dark vowels have their light counterparts as can be seen by the data given in (2)-(7). The data are mainly from Lee (1992), Lee (1993), Cho (1994), and Kim (1995).

[3]Citing Martin (1962:184), Lee (1993) presents some semantic distinction between light and dark ideophones.

Light forms:	small---pretty, paltry, insignificant, dinky fragile---unsubstantial, flimsy, frivolous, silly.
Dark forms:	heavy---weighty, ponderous, clumsy, unwieldy, bulky. dark---gloomy, inaccessible.

See also Huh (1985: 278-9) and Sohn (1994: 50) for this semantic distinction.

(2) /i/ ~ /æ/ alternation

Dark		Light	Gloss
a. /cic∂l/	→	[cæcal]	‘chattering’
b. /pisil/	→	[pæsil]	‘faltering’
c. /cilk∂◴/	→	[cælka◴]	‘chewing’
d. /pit’ul/	→	[pæt’ul]	‘crookedly’

(3) /e/ ~ /æ/ alternation

Dark		Light	Gloss
a. /t’e◴k∂◴/	→	[t’æ◴ka◴]	‘cling’
b. /k’ecil∂k/	→	[k’æcilak]	‘listlessly’
c. /t’ekul/	→	[t’ækul]	‘rolling’
d. /hec∂k/	→	[hæcak]	‘scattering’

(4) /ü/ ~ /ö/ alternation

Dark		Light	Gloss
a. /tüluk/	→	[tölok]	‘swaying’
b. /hüt’uk/	→	[höt’ok]	‘wobbling’
c. /t’üt’u◴/	→	[t’öt’o◴]	‘staggering’
d. /hüc^{h}∂◴/	→	[höc^{h}a◴]	‘yielding’

(5) /ï/ ~ /a/ alternation

Dark		Light	Gloss
a. /k’ït∂k/	→	[k’atak]	‘nodding’
b. /hïlkïs/	→	[halkïs]	‘glance’
c. /hïntïl/	→	[hantïl]	‘waving’
d. /k’ïmp’∂k/	→	[k’amp’ak]	‘flickering’

(6) /∂/ ~ /a/ alternation

Dark		Light	Gloss
a. /∂lluk/	→	[allok]	‘mottled’
b. /t’∂lkïl∂k/	→	[t’alkïlak]	‘rattling’
c. /k’a◴c^{h}o◴/	→	[k’a◴c^{h}o◴]	‘hopping’
d. /p^{h}∂lt’∂k/	→	[p^{h}alt’ak]	‘jumping’

(7) /u/ ~ /o/ alternation

Dark		Light	Gloss
a. /c^{h}ull∂◴/	→	[c^{h}olla◴]	‘splash’
b. /pusïl∂k/	→	[posïlak]	‘rustling’
c. /hulihuli/	→	[holiholi]	‘slander’

d. /hull∂◴/ → [holla◴] ‘all naked’

As can be seen in (2)-(7), each alternation between dark and light vowel occurs in the syllable initial position. However, the high unround vowels /i/ and /ï/ have light counterparts only in initial syllables becoming [æ] and [a] but do not have light counterparts in noninitial syllables. Hence, the high unround vowels /i/ and /ï/ behave transparently to the harmonic process in Korean. Some of the data for the neutral behavior of the high round vowels to the harmony in noninitial syllables are regrouped in (8).

(8) The neutral behavior of /i/ and /ï/ in noninitial syllable position

Dark		Light	Gloss
a. /pisil/	→	[pæsil]	‘faltering’
b. /hulihuli/	→	[holiholi]	‘slander’
c. /pusïl∂k/	→	[posïlak]	‘rustling’
d. /hïntïl/	→	[hantïl]	‘waving’

The data given in (2)-(7) also reveal that the high round vowel /u/ also behaves as a neutral vowel since /u/, like /i/ and /ï/, can occur with both dark and light vowels only in initial syllables while it remains [u] in noninitial syllables. Thus, the high back vowel /u/ in such position is invisible to the harmonic process in Korean. Some of the data for the neutral behavior of /u/ in noninitial syllables are given in (9).

(9) The neutral behavior of /u/ in noninitial syllables

Dark		Light		Gloss
a. /t’ekul/	→	[t’ækul]	*[t’ækol]	‘rolling’
b. /hicuk/	→	[hæcuk]	*[hæcok]	‘grinning’
c. /n∂ul/	→	[naul]	*[naol]	‘flittering’
d. /pit’ul/	→	[pæt’ul]	*[pæt’ol]	‘crookedly’

However, the high round vowel /u/, unlike /i/ and /ï/ in noninitial syllables, behaves as a harmonizing vowel in some cases. When /u/ undergoes the harmony, it becomes [o] as seen in (10). Some of the data are reproduced from (2)-(7).

(10) /u/ as a harmonizing vowel in noninitial syllables

Dark		Light		Gloss
a. /∂lluk/	→	[allok]	*[alluk]	‘mottled’
b. /sukun/	→	[sokon]	*[sokun]	‘whispering’
c. /tu◴tu◴/	→	[to◴to◴]	*[to◴tu◴]	‘drumming’
d. /cumull∂k/	→	[comollak]	*[comullak]	‘fumbling’

In addition to the neutral and the harmonizing behavior of /u/ to the harmonic process exhibited in (9) and (10), /u/ shows one more interesting fact. That is, in some cases it behaves as a harmonizing and as a neutral vowel to the harmony in noninitial syllables within a same morpheme. The data are given in (11).

(11) Variation of /u/ within a same morpheme

Dark		Light		Gloss
a. /silc'uk/	→	[sælc'uk]	[sælc'ok]	'grudging'
b. /p∂tu◴/	→	[patu◴]	[pato◴]	'struggling'
c. /ump^{h}uk/	→	[omp^{h}uk]	[omp^{h}ok]	'dented'
d. /m∂lt'u◴/	→	[malt'u◴]	[malt'o◴]	'vacantly'

The data given in (8)-(11) show on the one hand the similar behavior of /i/, /ɨ/ and /u/ with respect to the neutral behavior to the harmony process. On the other hand, the data also reveal their different behavior: only /u/ can undergo vowel harmony becoming [o] in noninitial syllables and only /u/ can act both as harmonizing and as neutral vowels within a same morpheme. So far I have presented some interesting aspects of vowel harmony in Korean ideophones. In the next section I will introduce the theoretical background which I will mostly make use of in this paper.

3. Theoretical Background

The theoretical background of this paper is Optimality Theory (Prince and Smolensky 1993), particularly the more advanced version called Correspondence Theory (McCarthy and Prince (hereafter M&P) 1995). OT is primarily based on constraints and constraint interaction.

OT assumes that Universal Grammar consists of a set of conflicting constraints on representational wellformedness, and that an individual grammar consists of the ranking of these constraints. Thus, in the OT perspective any conflict between constraints is resolved in favor of the higher ranked constraint at the expense of violating a lower-ranking constraint because all constraints in OT are violable.

In OT a given input is associated with a set of candidate output forms. These outputs are evaluated with respect to a set of constraints which are ordered by ranking to select the most harmonic form. Since all constraints are violable in OT, the optimal output form is the one that satisfies the most highly ranking constraints among the conflicting constraints. The important principles of OT are presented in (12).

(12) Principles of Optimality Theory (M&P 1994)
   a. **UNIVERSALITY**: Universal grammar provides a set *Con* constraints that are universal and universally present in all grammar.
   b. **VIOLABILITY**: Constraints are violable, but violation is

minimal.

c. **RANKING**: The constraints of *Con* are ranked on a language-particular basis; the notion of minimal violation is defined in terms of this ranking. A grammar is a ranking of the constraint set.

d. **INCLUSIVENESS**: The constraint hierarchy evaluates a set of candidates that are admitted by very general considerations of structural wellformedness.

e. **PARALLELISM**: Best-satisfaction of the constraint hierarchy is computed over the whole candidate set. There is no serial derivation.

M&P (1995) develop the theory, further incorporating the notion of a one-to-one corresponding relation between input and output, base and reduplicant, and input and reduplicant. But Correspondence Theory itself is set within OT; thus, the fundamental ideas of OT presented in (12) play a crucial role in Correspondence Theory. The idea of a one-to-one corresponding relation is defined by M&P as given in (13).

(13) Correspondence (M&P 1995:262)
Given two strings S_1 and S_2, **Correspondence** is a relation $\Re$ from the elements of S_1 to those of S_2. Segments $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **Correspondents** of one another when $\alpha \Re \beta$.

In Correspondence Theory the faithfulness constraints are further divided and governed by two different types of constraints. The faithfulness relation between segments is regulated by MAX and DEP while the featural faithfulness relation between corresponding segments is governed by featural identity constraints.

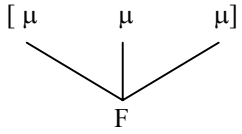
In an optimality-theoretic perspective, the domain of vowel harmony could be delimited by employing alignment constraints (M&P 1993a, b; Prince and Smolensky 1993). Particularly I will make use of a constraint called Featural Alignment (Akinlabi 1994a, 1997; Kirchner 1993; Pulleyblank 1993, 1994) in which a harmonic feature is aligned with an edge of a grammatical category. This is defined in (14) in which the grammatical category may be either morphological or phonological (Kirchner 1993; Pulleyblank 1994).

(14) Featural Alignment
Align (Pfeat, Gcat): Any occurrence of a prosodic feature is aligned with some grammatical category.

Thus, the domain of vowel harmony is defined by the two alignment constraints. When a harmonic feature F is aligned with edges of morphological

or phonological domains of the harmony, the harmony is achieved as illustrated in (15). This represents a simple harmony process in which all vowels within the domain agree in their harmonic feature specification F.

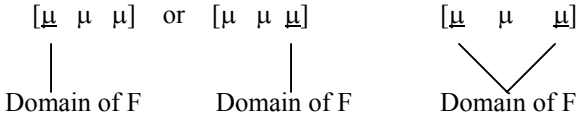
(15) Domain alignment (Pulleyblank 1994)



But in some cases, a featural alignment constraint may be violated under pressure from feature cooccurrence constraints which leads to a misalignment as discussed in Akinlabi (1994a). That is, the vowel harmony process is interrupted by the attendance of neutral vowels. Those neutral vowels can be either *opaque vowels* that do not undergo harmony and block the harmony process as illustrated in (16a), or *transparent vowels* that do not undergo harmony but are invisible (or transparent) to the feature distribution as seen in (16b).

(16) Schematic representation of neutral vowels

a. Opacity: b. Transparency:



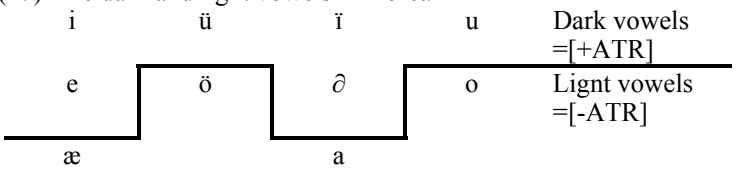
In (16a) it is inevitable that the left or right edge alignment constraint is violated because it is more important to observe some feature cooccurrence constraints, which prohibit the realization of two independent feature specifications on a single segment, than to satisfy the alignments. Thus, a set of alignment constraints, feature cooccurrence constraints, and other optimality-theoretic constraints can account for the vowel harmony process.

In the next section I will provide an optimality-theoretic analysis of vowel harmony in Korean ideophones.

4. Analysis

In this section, I first begin with simple harmony in which all vowels within a harmonic domain share the identical feature specification [-ATR] or [RTR]. The active harmonic feature [-ATR] is based on the featureal distinction between the light and the dark forms of ideophones. The light form of ideophones is assumed to be represented by the featural specification [-ATR] while the dark form of ideophones is considered to be represented by [+ATR] as shown by the featural distinction between the light and the dark ideophones in Korean.

(17) The dark and light vowels in Korean



Next, I will discuss the neutral behavior of the high unround vowels /i/ and /ï/, and then the neutral behavior of the high round vowel /u/ and its harmonizing behavior in noninitial syllable position. Finally I will analyze the variation of /u/ to the harmony within a same morpheme.

4.1 Simple harmony

In vowel harmony with a complete harmony pattern, each vowel in the harmonic domain should share the same feature specification. Korean ideophones show a complete vowel harmony pattern in some of the data given in section 2. In such cases, the active harmonic feature [-ATR], which is assumed to be a floating feature underlyingly, is realized on all vowels within the domain of the harmony as illustrated in (18).

(18) A complete pattern of harmony

It is assumed in (18) that all vowels carrying the feature specification of [-ATR] are interpreted as phonetically retracted while all vowels that are not associated to the feature specification [-ATR] are construed as phonetically advanced.

To account for the simple harmony in Korean ideophones, the following constraints given in (19) are employed.

(19) Constraints for simple vowel harmony in Korean

a. Align (-ATR, L, Stem, L): Align-L
The featural specification [-ATR] is aligned with the left edge of the stem.

a. Align (-ATR, R, Stem, R): Align-R
The right edge of any [-ATR] feature specification

coincides with the right edge of the ATR domain.

b. Parse-[-ATR]
Associate a floating [-ATR] feature specification with an appropriate vowel.

c. Identity-Input Output (hi): Ident-Hi
The high feature of the input vowels is identical in their correspondents in the output.

For the complete pattern of vowel harmony, two alignment constraints, Align-L and Align-R, must be satisfied to properly transmit the active harmonic feature through the domain. This pattern of vowel harmony is displayed by the data presented in section 2. Some of them are reproduced in (20).

(20) A complete pattern of harmony

Dark		Light	Gloss
a. /cic∂l/	→	[cæcal]	'chattering'
b. /∂lluk/	→	[allok]	'mottled'
c. /cilk∂◴/	→	[cælka◴]	'chewing'
d. /c^{h}ull∂◴/	→	[c^{h}olla◴]	'splash'

The constraint table (21) exhibits the two alignment constraints in Korean vowel harmony.

(21) /cic∂l/ → [cæcal] 'chattering'

-A Input: /cic∂l/	Align-L	Align-R
-A | a. c i c a l	*!	
-A | b. c æ c ∂ l		*!
-A ☞ ⌒ c. c æ c a l		

As seen in (21), Align-L and Align-R must be satisfied for the complete pattern of vowel harmony. If one of the constraints is violated as in (a) and (b), such vowel harmony cannot be achieved.

For the active floating harmonic feature specification [-ATR] to be realized on the domain of the harmony, Parse-[-ATR] must be undominated in Korean vowel harmony. This undominated constraint should be ranked higher than Ident-Hi because any leftmost vowel of the stem must be associated with the harmonic feature even at the cost of

violating Ident-Hi. Thus, when an initial vowel is high, Ident-Hi is violated vitably since Parse-[-ATR] always takes precedence over Ident-Hi. The constraint ranking between them is illustrated in (22).[4]

(22) /k'ïtɔk/ → [k'atak] 'nodding'

-A Input: /k'ïtɔk/	Parse-[-ATR]	Ident-Hi
☞ -A a. k' a t a k		*
b. k' ï t ɔ k	*!	

Parse-[-ATR] should dominate Ident-Hi. If the ranking between them is reversed, the optimal output will be (b) which is not correct. The candidate that does not undergo the harmony loses to (a) by virtue of the high ranked Parse-[-ATR].

Ident-Hi is ranked higher than Align-R whose ranking relation will play an important role for the neutral behavior of high vowels in noninitial syllable position. This is illustrated in the constraint table (23). In this table, the high ranked constraints such as Align-L and Parse-[-ATR] do not show any particular ranking between them.

(23) /cicɔl/ → [cæcal] 'chattering'

-A Input: /cicɔl/	Parse- [-ATR]	Align-L	Ident-Hi	Align-R
a. c i c ɔ l	*!			
-A b. c æ c ɔ l			*	*!
-A c. c i c a l		*!		
☞ -A d. c æ c a l			*	

[4]I follow standard OT traditions with respect to the constraint table format. The optimal candidate is indicated by '☞', violations by '*', and fatal violations by '!'. Shading in constraint tables indicates the irrelevance of a constraint to the state of the candidate. Dotted lines between constraints are normally indicative of a lack of established ranking between constraints.

In (23), (a) is not the optimal form since it violates Parse-[-ATR] which is a crucial violation. However, it satisfies the other constraints only trivially. Candidates (b) and (c) are not the optimal outputs either because they violate Align-R and Align-L respectively. On the contrary, (d) satisfies both alignment constraints. Accordingly, (d) emerges as the optimal output in which each vowel in the harmonic domain undergoes the harmony becoming [æ] and [a]. The constraint table also shows that Align-L should be ranked higher than Align-R because the floating feature specification [-ATR] always anchors at the left edge of the stem; consequently, in the syllable initial position every vowel behaves as a harmonizing vowel.

The constraint ranking established for the simple pattern of Korean vowel harmony can account for such types of vowel harmony data as given in (20). The constraint ranking is given in (24).

(24) Ranking for simple Korean vowel harmony
Parse-[-ATR], Align-L » Ident-Hi » Align-R

In the next subsection, I will discuss the neutral behavior of high unround vowels in noninitial syllables.

4.2 Neutral behavior of high unround vowels to harmony

In this section I begin with the behavior of the high unround vowels in the syllable initial position. Then I discuss their behavior in noninitial syllables. The high unround vowels /i/ and /ɨ/ act transparently to harmony, remaining [i] and [ɨ] in noninitial syllables as shown by the data given in (8). Thus, those two high unround vowels are invisible to the transmission of the feature [-ATR] over the harmonic domain. But notice that they act that way only in noninitial syllables. This means that they behave as a harmonizing vowel in initial syllable position as we have already seen in section 2. In an optimality-theoretic perspective, the harmonizing behavior of those vowels can be accounted for by the interaction of Align-L and Ident-Hi constraints as illustrated in (18), and the feature cooccurrence constraint given in (25).

(25) *RTR/HI condition
*RTR/HI condition: If [-ATR] then [-high]
(If [-ATR] then not [+high])

This *RTR/HI feature cooccurrence constraint requires that an RTR (or -ATR) and a feature high of a vowel should not be permitted in a single segment together. Accordingly, *RTR/HI is undominated in Korean vowel harmony. Ranking Align-L and *RTR/HI, which do not show any specific ranking between them, over Ident-Hi ensures that the leftmost vowel must

undergo harmony even at the cost of violating Ident-Hi. This is illustrated in the constraint table (26).

(26) /cilk∂◴/ → [cælka◴] 'chewing'

Input: /cilk∂◴/	*RTR/HI	Align-L	Ident-Hi
a. c ɪ l k a ◴ (-A)	*!		
☞ b. c æ l k a ◴ (-A)			*

The feature cooccurrence constraint *RTR/HI plays a crucial role in the analysis of the transparent behavior of high unround vowels in noninitial syllables. The combination of ranking *RTR/HI and Align-L over Ident-Hi and Align-R will account for this as illustrated in the constraint table (27).

(27) /pisil/ → [pæsil] 'faltering'

Input: /pisil/	*RTR/HI	Align-L	Ident-Hi	Align-R
☞ a. p æ s i l (-A)			*	*
b. p i s æ l (-A)		*!	*	
c. p ɪ s i l (-A)	*!			*
d. p æ s æ l (-A)			**!	

In (27), (b) and (c) are not the optimal outputs because they each violate Align-L and *RTR/HI. (d) loses to (a) because of its one more violation of Ident-Hi. (d) violates Ident-Hi twice since the harmonic feature [-ATR] is properly associated with the left and right edges of the harmonic domain. Accordingly, the two high vowels each become [æ]. Ident-Hi crucially dominates Align-R in (27). This ranking is important to account for the neutral behavior of high unround vowels in noninitial syllables. If the ranking between them is reversed, the output in which all vowels undergo harmony, will be selected as the best form. Thus, (a) emerges as the

optimal output in (27) in which high unround vowels act transparently to harmony. The constraint ranking revealed in (27) is very similar to the one shown in (24) in that we just have added *RTR/HI in (27). But if we apply this constraint to the simple type of harmony data given in (20), it will not affect the result of the optimization. Thus, we can combine the two rankings to one as given in (28).

(28) Parse-[-ATR], *RTR/HI, Align-L » Ident-Hi » Align-R

However, if we apply the ranking given in (28) to a trisyllabic input in which high unround vowels occur in second syllables and the first and the last vowels undergo the harmony process, the ranking cannot select a correct output as the optimal form. For example, the correct outputs of the input forms /k'ecil∂k/ 'listlessly' and /t'∂lkïl∂k/ 'rattling' are [k'æcilak] and [t'alkïlak] respectively. The constraint ranking given in (28) will pick an output which has a gapped configuration.[5] To eliminate the gapped configuration, I employ the constraint given in (29).

(29) *GAPPED (Akinlabi 1997; Pulleyblank 1994)
Autosegmental association may not be gapped.

This constraint is undominated in Korean vowel harmony. Thus, this will eliminate an output with gapped configuration as illustrated in the table (30).

(30) /k'ecil∂k/ → [k'æcilak] 'listlessly'

-A Input: /k'ecil∂k/	*GAP	*RTR/ HI	Align -L	Parse [-ATR]	Ident- Hi	Align -R
-A | a. k' æ c i l∂ k						**!
-A ◠ b. k'æ c æ l ∂k					*!	*
-A ◠ c. k' æ c i l a k	*!					
-A ◠ d. k'æ cæ l a k					*!	

[5]According to Pulleyblank (1994), a gapped configuration is universally ruled out. He argues that a form with the gapped configuration is not an appropriate candidate because gapped candidates are excluded by UG.

e. ☞ k' æ c i l a k (-A, -A)				*

(a) is not the optimal output because it has one more violation of Align-R than (e). (b) and (d) are not the optimal forms either since they violate Ident-Hi which (e) does not violate. They violate Ident-Hi because the feature [-ATR] is associated with high unround vowel /i/ in the second syllable position. (c) is edged out by (e) since (c) violates the undominated *GAPPED constraint. Now (e) emerges as the best output in (30) which has only one violation of Align-R.[6]

The constraint ranking revealed in (30) can account for both the simple vowel harmony and the neutral behavior of high unround vowels in noninitial syllables. The combined constraint ranking is given in (31).

(31) Parse-[-ATR], *RTR/HI, *GAPPED, Align-L » Ident-Hi » Align-R

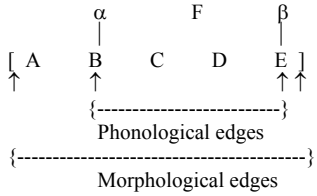
In the next subsection, I will discuss the neutral behavior of the high round vowel /u/ in some cases and its harmonizing behavior in other cases along with its variation in noninitial syllables.

4.3 The behavior of /u/ in noninitial syllables

The high round vowel /u/ is very similar to high unround vowels in that /u/, like /i/ and /ï/, behaves as a neutral vowel in the harmony process remaining [u] in noninitial syllables. The data for the neutral behavior of /u/ which were given in (9) are reproduced in (32).

(32) The neutral behavior of /u/ in noninitial syllables

[6]Candidate (e) violates Align-R even though the final vowel is associated with the inserted feature [-ATR]. The evaluation of the Align-R in (e) is based on the *phonological edges* in the sense of Pulleyblank (1994) and Archangeli and Pulleyblank (1994). According to Pulleyblnak (1994), there are some differences between morphological and phonological edges. Phonological edges can be construed as the domain whose scope can be delimited by feature associations while morphological edges are acting as default delimiters.



In this configuration, the accessible domain of a feature F is confined by the left edge α/B and the right edge β/E; this is phonological edges.

	Dark		Light		Gloss
a.	/t'ekul/	→	[t'ækul]	*[t'ækol]	'rolling'
b.	/hicuk/	→	[hæcuk]	*[hæcok]	'grinning'
c.	/n∂ul/	→	[naul]	*[naol]	'flittering'
d.	/pit'ul/	→	[pæt'ul]	*[pæt'ol]	'crookedly'

Since /u/ and high unround vowels display a similar behavior in the harmonic process, I will employ the same constraint ranking that was used for the analysis of the neutral behavior of high unround vowels in the previous subsection. In addition to the ranking given in (30), I propose an additional constraint which will play an important role for various behaviors of /u/ in noninitial syllables. The constraint is given in (33).

(33) *U: The high round vowel is not permitted.

This markedness constraint is ranked very low in Korean vowel harmony. Hence, it does not show any specific ranking with the low ranking constraint such as Align-R as illustrated in the constraint table (34). In the table, the undominated *GAPPED constraint is not included.

(34) /t'ekul/ → [t'ækul] 'rolling'

Input: /t'ekul/	-A	*RTR/ HI	Align -L	Parse [-ATR]	Ident -Hi	Align- R	*U
☞ a. t' æ k u l	-A |					*	*
b. t' e k o l	-A |		*!		*		
c. t' æ k o l	-A ∧				*!		

Candidate (b) is not the optimal form because it violates Align-L by not associating the harmonic feature with the left edge of the harmonic domain. (c) is not the optimal form either since it violates Ident-Hi. It violates the constraint because the high unround vowel in the noninitial syllable does undergo harmony becoming [o]. In fact, it fares better on Align-R and *U than (a) but it gives way to (a) because Ident-Hi is ranked higher than Align-R and *U. Thus, candidate (a) emerges as the optimal form in (34). The constraint ranking used in the table (34) also can account for the data with three syllables if we include the undominated *GAPPED constraint.

Another interesting behavior of /u/, which can distinguish it from high unround vowels, is that in some cases /u/ acts as a harmonizing vowel becoming [o] in noninitial syllables as shown by the data given in (10) which are reproduced in (35).

(35) /u/ as a harmonizing vowel in noninitial syllables

Dark		Light		Gloss
a. /∂lluk/	→	[allok]	*[alluk]	'mottled'
b. /sukun/	→	[sokon]	*[sokun]	'whispering'
c. /tu◴tu◴/	→	[to◴to◴]	*[to◴tu◴]	'drumming'

If we apply the constraint ranking shown in the constraint table (34) to the data given in (35), this ranking will incorrectly select the output in which the noninitial vowel /u/ acts neutrally to harmony, as the optimal output. Thus, the ranking employed in (34) cannot account for the harmonizing behavior of /u/ in noninitial syllables. The data given in (35) do not have any particular structural differences in comparison with the data given in (32). Thus, it is assumed in this paper that the data given in (32) are lexically marked and should be represented differently in underlying forms than the data given in (35). Historically the noninitial /u/ in (32) is different than that in (35), in that the /u/ in (32) is associated with a feature during its change from a bilabial sonorant in fifteenth century Korean.[7] On the other hand /u/ in (35) is a normal high back round vowel. For this reason, the /u/ in (32) behaves the same as the high unround vowels in noninitial syllables behaving transparently to harmony.

To account for the harmonizing behavior of /u/, I conjoin the low ranked constraints such as Ident-Hi and *U into a single conjunctive constraint [Ident-Hi & *U]$_{segment}$. According to Hewitt and Crowhurst (1996) and Lubowicz (1997), only constraints that share a fulcrum (an argument) can be conjoined (cf. Inkelas 1999). This can be construed that the domain of the application of the constraints should be the same. This

[7]In this paper, I assume that the neutral behavior of high back round vowels in noninitial syllables is due to the difference in underlying represention between the data given in (32) and (35). The evidence comes from historical change of /p̲/ to /u/. Even though current Korean does not distinguish the two possible different /u/s, we could argue that there were two different /u/s in 15th century Korean. One is the canonical high back round vowel /u/ and the other is 'pseudo' /u/ which has been changed from /p̲/. The underline here is to indicate a symbol 'o' in Korean character; /p/ and /o/ are actually written together vertically and phonetically realized as [β]. In 15th century it was considered a sonorant. Huh (1985) argues that the difference between bilabial stop /p/ and /p̲/=[β] is that the former has '0' and the latter has '1' in terms of sonority scale value. Some examples for this changes are given below;

∂.tï.p̲ïn	>	∂.tï.u̲n	'dark'
sy∂.p̲ïl	>	sy∂.u̲l	'Seoul'
i.p̲ïl	>	i.u̲l	'withering'

As can be seen by the data, the round feature of [u] is related to the lip rounding feature of [β]. Thus, we should make some distinction between the canonical high back vowel /u/ and the other /u/ which is changed from /p̲/. Accordingly, I assume that the noninitial /u/ of the data presented in (32) is associated with the feature front, making it difficult to associate with other feature specifications while the nonintial /u/ of the data given in (35) is not specified for any feature so that it could freely be associated with the transmission of the feature [-ATR].

condition is satisfied in the conjunctive constraint of the Korean vowel harmony case because the fulcrum of each conjoined constraint is a segment. Both Ident-Hi and *U target a segment. The conjoined constraint ranks higher than each independent constraint and it will only be violated if each constraint is violated together, in which case it receives only one violation mark, "*". The harmonizing behavior of /u/ in noninital syllables is illustrated in the constraint table (36).

(36) /sukuk/ → [sokon] 'chattering'

-A /sukun/	Align -L	Parse- [-ATR]	[Ident-Hi & *U]$_s$	Ident- Hi	*U	Align- R
-A | a. s o k u n			*!	*	*	*
-A | b. s u k o n	*!		*	*	*	
-A ☞ ∧ c. s o k o n				**		

In (36), candidate (b) is not the optimal output because it violates the undominated Align-L. Candidate (a) is edged out by (c) because (a) violates the conjunctive constraint while (c) satisfies the constraint. Candidate (a) violates the conjunctive constraint as a result of violating Ident-Hi and *U once each. On the contrary, (c) does not violate the conjunctive constraint since it only violates Ident-Hi twice while satisfying *U. Thus, candidate (c) emerges as the best form in (36). The harmonizing behavior of /u/ in noninitial syllables is accounted for by proposing a conjunctive constraint.

Finally, the most interesting behavior of /u/ in noninitial syllable position is that within a same morpheme it behaves both as a harmonizing vowel becoming [o] and as a neutral vowel remaining [u]. Thus, it reflects a variation in noninitial syllables with respect to the harmony as shown by the data given in (11) which are reproduced in (37).

(37) Variation of /u/ within a same morpheme

Dark		Light		Gloss
a. /silc'uk/	→	[sælc'uk]	[sælc'ok]	'grudging'
b. /pɔ̂tu◴/	→	[patu◴]	[pato◴]	'struggling'
c. /umpʰuk/	→	[ompʰuk]	[ompʰok]	'dented'
d. /mɔ̂lt'u◴/	→	[malt'u◴]	[malt'o◴]	'vacantly'

In an optimality-theoretic perspective, a variation within a same morpheme is analyzed by reranking relevant constraints. This is possible in OT

because a variation within a same morpheme is usually handled by low ranked constraints. This may be understood as high ranking constraints having a crucial impact on the selection of the optimal form. On the other hand, low ranking constraints may not have such an effect on the optimal form; accordingly the ranking between the low ranking constraints is not so clearly divided.

To account for the variation of /u/ within a same morpheme, I rerank the relevant constraints established in the constraint table (34). The ranking in (34) will account for the neutral behavior of /u/ while the reranked constraint will account for the harmonizing behavior of /u/. This is illustrated in the constraint tables (38) and (39) respectively. In those tables, the undominated constraints such as *GAPPED and *RTR/HI are not included.

(38) The neutral behavior of /u/

-A /pɔ̃tu◴/	Align-L	Parse-[-ATR]	Ident-Hi	Align-R	*U
☞ a. -A | p a t u ◴				*	*
b. -A ◠ p a t o ◴			*!		

(39) The harmonizing behavior of /u/

-A /pɔ̃tu◴/	Align-L	Parse-[-ATR]	Align-R	*U	Ident-Hi
a. -A | p a t u ◴			*!	*	*
☞ b. -A ◠ p a t o ◴					**

The constraint ranking in (38) selects the output in which /u/ behaves as a neutral to the harmony while the ranking in (39) chooses the output form in which /u/ acts as a harmonizing vowel. Thus, ranking Align-R and *U over Ident-Hi accounts for the harmonizing behavior of /u/ in non-initial syllables. The constraint ranking for the variation of /u/ is given in (40).

(40) a. The neutral behavior of /u/

Parse-[-ATR], *RTR/HI, *GAPPED, Align-L » Ident-Hi » Align-R, *U

b. The harmonizing behavior of /u/
Parse-[-ATR], *RTR/HI, *GAPPED, Align-L » Align-R, *U » Ident-Hi

As shown in this section, OT provides tools to account for the various behaviors of /u/ in noninitial syllables. In the next section, I will summarize the analysis.

5. Conclusion

In this paper I have provided an analysis of present Korean vowel harmony within OT. The domain of the harmony is delimited by two alignment constraints. The neutral behavior of high vowels is accounted for by ranking the undominated feature cooccurrence constraint and Align-L over Ident-Hi and *U. Regarding a misalignment at the right edge of the harmonic domain, it is explained that it is not a feature cooccurrence constraint that takes precedence over the Align-R constraint, but it is a result of the interaction between the featural identity and Align-R constraints. The harmonizing behavior of /u/ is analyzed by proposing a conjunctive constraint which conjoins two low ranked constraints. The harmonizing behavior of /u/ within a same morpheme is accounted for by reranking relevant constraints. With respect to the different groupings of /u/ in some cases, it is argued that we need to make a distinction in the underlying featural chracteristics of /u/ in Korean.

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