Metrical Identity Effects of Phonological Variants: Vowel Lengthening in Korean*

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1. The Typology of Compensatory Lengthening

The process of compensatory lengthening (CL, hereafter) has been a compelling issue in the discussion of multi-tiered phonological theories. CL has been described as a process that preserves the structure of timing units despite segmental change.[1] The typological prevalence of CL in many languages has provided convincing evidence for the notion of *mora stability* or *moraic tier integrity* (Bickmore 1995). The fact that the deletion or gliding of a moraic segment may not affect mora count in the phonological output leads to the assumption that mora is a kind of autosegment and the moraic tier is a well-motivated, independent structure in the hierarchical system of phonological constituents.

The research on CL has generally focused on its universal nature mainly from the typological perspective. In other words, it has been generally argued that CL is an automatic result of universal conventions at least in languages with a syllable weight distinction (de Chene and Anderson 1979, Ingria 1980, Steriade 1982 among others). However, as indicated in Hayes (1989), it is an important, but somewhat neglected fact that CL is not a universal process. There are languages that do not exhibit CL, even when syllable weight distinctions and relevant desyllabifying processes are found.[2]

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[1] In the moraic theory of Hayes (1989), the relevant structure is moraic structure, which is adopted in the present study.

[2] Finnish is presented as a representative language in Hayes (1989).

In this respect, it would be more correct to posit that CL is partly language-specific, determined by a certain phonological parameter, with the presence of CL providing the unmarked case. To be more specific, there are at least two groups of languages in the typological perspective: *CL-languages* where deletion or gliding operates only on the segmental tier and *non-CL-languages* where deletion or gliding operates on both the segmental tier and the prosodic (or moraic) tier (Bickmore 1995). Such a typological division between CL-languages and non-CL-languages is significant in the sense that languages display different aspects of moraic structure adjustment for segmental change. In CL-languages, the status of moraic structure is independent of segmental structure, which is reflected by CL. In non-CL-languages, however, CL for moraic equity has no privilege, since deletion or gliding of a segment affects the entire segmental complex, that is, the phoneme and the associated element on the prosodic tier. As a result, segmental deletion or gliding is always accompanied by the deletion of mora, reflecting the lack of CL.

2. SK as a Non-CL-Language

(Standard) Seoul Korean (SK, hereafter) has been generally regarded as a typical language displaying CL, since the pioneering work of P-G Lee (1978) in Korean phonology.[3] As a consequence, the research on vowel lengthening through hiatus resolution in SK has mainly focused on the fundamental characteristics of the mechanism of vowel lengthening proposed for typical CL-languages. This study, however, approaches vowel lengthening in SK from a totally different view. The basic claim of the present study is that SK is not a genuine CL-language, even though it exhibits some similar patterns of vowel lengthening as in typical CL-languages. This somewhat contradictory assumption indicates that the analysis of vowel lengthening in SK needs a more careful investigation. Previous rule- or representation-based accounts have not been successful, especially in the sense that they have not provided a phonologically-convincing motivation of vowel lengthening in SK. In the present study, vowel lengthening in SK is

[3] The analysis of general characteristics of SK vowel lengthening in the present study is mainly based on P-G Lee (1978) who has provided every insight into the systematic understanding of aspects of SK vowel lengthening.

analyzed as a foot-based phonological process, mainly relying on the assumption that vowel lengthening can be metrical rather than moraic at least in certain languages (Minkova 1985, Prince 1990).

In this respect, the preservation of timing units or moraic structure, which has been generally proposed in most autosegmental studies on CL, cannot provide sufficient motivation for vowel lengthening at least in SK. Specifically, it will be proposed that SK vowel lengthening results from an *Output-Output Correspondence* (*OO-Correspondence*) constraint on metrical (foot) identity between phonological variants in hiatus resolution. Such an analysis captures the intriguing fact that compensatory vowel lengthening only occurs in cases where hiatus resolution is optional, but never in cases of obligatory hiatus resolution (Y-K Han 1988 and others).

3. Optional Hiatus-Resolving Processes and SK Vowel Lengthening

The solitary environment of vowel lengthening[4] in SK involves hiatus construction. In SK, there exists no visible cases of vowel lengthening triggered by the deletion or weakening of a coda consonant which involves the typical instance of CL.[5] Given that coda consonants in SK are moraic,[6] this means that when coda consonants delete in SK, the entire segmental complex, both the phoneme and the associated mora are removed.

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[4] There might be another case of vowel lengthening in SK where the vowel of a stressed syllable is lengthened in a systematic way. Such a case of *rhythmic lengthening* in a stressed syllable is typologically prevalent, whose property is apparently phonetic rather than phonological (Hayes 1995, Polgardi 1995). A detailed analysis of phonetic vowel lengthening in SK is provided in H-B Jung (1990). An interesting discussion on the nature of vowel lengthening is presented in Polgardi (1995), where the inherent nature of most processes of vowel lengthening is argued as phonetic rather than phonological.

[5] For the moraic compensation of the deletion or weakening of a coda consonant, either gemination of an adjacent consonant or lengthening of an adjacent vowel generally occurs.

[6] The moraic status of coda consonants is another significant issue in SK phonology. In the present analysis, it is assumed that coda consonants in SK have their own weight and thus, are moraic, without further discussion. For a detailed discussion on this issue, please refer to J-K Kim (2000).

3.1. Strategies of Hiatus Resolution

It is a well-attested cross-linguistic tendency that languages disfavor adjacent heterosyllabic vowel sequences such as V_1V_2. Such hiatus constructions are generally created through morphological or syntactic concatenation of vowel-ending morphemes/words with vowel-initial morphemes/words. Another common source of a hiatus context is (either synchronic or diachronic) intervocalic consonant deletion. Phonologically disfavored hiatus constructions are resolved by a variety of phonological strategies. The phonological motivation of hiatus resolution has been generally accounted for in terms of the undesirability of onsetless syllables (Casali 1996, Rosenthall 1994, 1997, among others),[7] compared with a canonical syllable such as CV. That is, through hiatus-resolving strategies, the second vowel of a VV construction can avoid being parsed into an onsetless syllable.

The most common and direct way of resolving hiatus is to delete one of the adjacent vowels. Both positional and featural properties of hiatic vowels are responsible for the decision of the target of vowel deletion. Hiatus constructions can be also resolved by epenthesizing either a glide or a consonant between adjacent vowels. The epenthesis of a glide generally requires the existence of a homorganic vowel, that is, an unround high front or round high back vowel in V_1 position. In the case of consonant epenthesis, the least marked consonant (a glottal stop in most cases) is generally selected. When the vowel in V_1 position is a glidable high vowel (either unround high front or round high back), hiatus can be resolved by making the first of two adjacent vowels a glide. The result is a syllable with a complex onset composed of consonant-glide sequence.[8] If the context is reversed, that is, when the second vowel is a glidable one, the two vowels can form a complex nucleus of a single syllable, resulting in an off-glide diphthong.[9] The most complex and radical way of hiatus resolution is coalescence of two adjacent vowels, of which the resulting vowel consists

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[7] Pulleyblank (1998) asserts that hiatus resolution is not always onset-driven. In his analysis of Yoruba vowel patterns, foot-based minimality conditions are responsible for vowel deletion as a hiatus-resolving strategy.

[8] Here I strictly differentiate the off-glide diphthongs from the so-called on-glide diphthongs, restricting the use of the term *diphthongs* to the former ones.

[9] Diphthongization (diphthong formation) occurs in a way that respects *Structural Preservation* and thus, usually is a more restricted process, compared with glide formation. That is, in a language which does not allow the existence of diphthongs, diphthong formation is not a possible option for hiatus resolution.

of the dominant features of both vowels. As usual in phonology, however, hiatus configurations are often tolerated in certain contexts. By syllabifying two adjacent vowels into two separate syllables, the V_1V_2 sequences remain unchanged and the hiatus context is tolerated. In this case, the onset requirement on syllable structure is violated, forced by other phonological pressures.

The overall picture of strategies of hiatus resolution can be schematized as in (1).

(1) Strategies of Hiatus Resolution

a. *Hiatus Resolution*

Vowel Deletion:	$(C)V_1V_2 \rightarrow .(C)V_1.$ or $.(C)V_2.$
Epenthesis:	$(C)V_1V_2 \rightarrow .(C)V_1.CV_2.$ or $.(C)V_1.GV_2.$
Glide Formation:	$(C)V_1V_2 \rightarrow .(C)GV_2.$
Diphthong Formation:	$(C)V_1V_2 \rightarrow .(C)V_1V_2.$
Coalescence:	$(C)V_1V_2 \rightarrow .(C)V_3.$

b. *Hiatus Retention*

Heterosyllabification:	$(C)V_1V_2 \rightarrow .(C)V_1.V_2$

SK displays the entire variety of hiatus-resolving strategies except diphthong formation, as the following (2) shows. SK is a typical example of a language lacking diphthongs and thus, diphthong formation is not a possible strategy.

(2) Hiatus-Resolving Processes in SK

a. *Hiatus Resolution*

Vowel Deletion:	/s'ɨ-ə/	→	[s'ə]	'write, use, put on'
Glide Insertion:	/ki:-ə/	→	[ki.yə]	'crawl'
Glide Formation:	/po-a/	→	[pwa:]	'see'
Coalescence:	/sai/	→	[sɛ:]	'interval'

b. *Hiatus Retention*

Heterosyllabification:	/cu-ə/	→	[cu.ə]	'give'

3.2. General Characteristics of SK Vowel Lengthening

Related to the process of vowel lengthening, a crucial characteristic of hiatus resolution in SK can be pointed out. In SK, hiatus-resolving processes do not always trigger vowel lengthening which can be generally

expected in the sense of moraic compensation. This implies that along with glide insertion which has nothing to do with timing change in nature, the other three quantity-related processes such as vowel deletion, vowel coalescence and glide formation might not provide the necessary condition for vowel lengthening or CL in SK. The main purpose of this section is to provide the phonological motivation of vowel lengthening related to hiatus resolution, mainly focusing on the operational property of relevant desyllabifying processes.

The most frequently-attested process of hiatus resolution in SK is vowel deletion which deletes one of the two adjacent vowels. There exist three different types of obligatory vowel deletion in SK such as /ɨ/-deletion, identical vowel deletion, and /i/-deletion in morphemic concatenation. Such obligatory processes of vowel deletion do not trigger vowel lengthening.[10]

(3) Obligatory Vowel Deletion

a. Obligatory /ɨ/-Deletion

s'ɨ-ə	→	s'ə	'write'
k'ɨ-ə	→	k'ə	'turn off'
t'ɨ-ə	→	t'ə	'float'
k'ɛ-ɨni	→	k'ɛni	'break'
ci-ɨni	→	cini	'lose'
pe-ɨni	→	peni	'cut'

b. Obligatory Identical Vowel Deletion

s'ɨ-ɨni	→	s'ɨni	'write'
k'ɨ-ɨni	→	k'ɨni	'turn off'
t'ɨ-ɨni	→	t'ɨni	'float'
ka-a	→	ka	'go'
t'a-a	→	t'a	'pick'
sə-ə	→	sə	'stand'

c. Obligatory /i/-Deletion[11]

ci-ə	→	cə	'lose'

[10] In the analysis of vowel lengthening through hiatus resolution, only monosyllabic stems are meaningfully related, since SK allows the distinction of vowel length only in the initial syllable. Therefore, the lack of lengthening in the case of polysyllabic stems can be regarded as the result of a general restriction on the distribution of long vowels, regardless of the role of CL.

[11] Another instance of obligatory vowel deletion in SK /u/-deletion is as follows.

c'i-ə	→	c'ə	'steam'
cʰi-ə	→	cʰə	'hit'

The situation is totally different in stem-internal hiatus constructions. In this case, the attested processes of vowel deletion such as /ɨ/-deletion and identical vowel deletion are optional and accompanied by vowel lengthening as in (4).

(4) Stem-Internal Optional Vowel Deletion 1

a. Optional /ɨ/-Deletion

maim	→	maim/ma:m	'heart'
keilim	→	keilim/ke:lim	'laziness'
taim	→	taim/ta:m	'next'
cʰəim	→	cʰəim/cʰə:m	'first'
kail	→	kail/ka:l	'fall'
koil	→	koil ko:l	'county'
moi-	→	moi-/mo:-	'collect'

b. Optional Identical Vowel Deletion

muu	→	mu.u/mu:	'radish'
kiil-	→	ki.il-/ki:l-	'smoke'
kiikha-	→	ki.ik.ha-/ki:k.ha-	'secluded'

Unlike obligatory vowel deletion, optional vowel deletion can host a number of vowels as the target of deletion in the stem-internal position. Such stem-internal vowel deletion can also trigger vowel lengthening.

(5) Stem-Internal Optional Vowel Deletion 2

k'iu-	→	k'iu-/k'i:-	'insert'
piu-	→	piu-/pi:-	'empty'
keu-	→	keu-/ke:-	'vomit'
weu-	→	weu-/we:-	'memorize'

/pʰu-ə/	→	[pʰə]	'drain'

In J.-K. Kim (2000), the obligatory application of both /i/-deletion and /u/-deletion is accounted for in terms of the linked structure of [-back] or [round] in the stem, which is a synchronic residue of diachronic palatalization and labialization, respectively.

kyəul	→	kyəul/kyə:l	'winter'
əulli-	→	əulli-/ə:lli-	'match'
s'aum	→	s'aum/s'a:m	'fight'
toum	→	toum/to:m	'help'
pei-	→	pei-/pe:-	'be cut'
ei	→	ei-/e:-	'hurt'
kɛi-	→	kɛi-/kɛ:-	'be clear'
mɛi-	→	mɛi-/mɛ:-	'be tied'
heali-	→	heali-/he:li-	'count'
p'ɛas-	→	p'ɛas-/p'ɛ:s-	'rob'
pɛal	→	pɛal/pɛ:l	'gut'

Optional vowel deletion accompanying vowel lengthening can occur inter-morphemically in very restricted environments where the target of deletion is the suffix vowel of *Stative* /-ə/ following stem-final nonhigh front vowels, as in (6).[12]

(6) Optional Vowel Deletion in the Suffixation of Stative /-ə/

a.	se:-ə	→	seə/se:	'count'
	pe:-ə	→	peə/pe:	'cut'
	mɛ:-ə	→	mɛə/mɛ:	'tie'
	c'ɛ:-ə	→	c'ɛə/c'ɛ:	'cut open'
b.	t'e-ə	→	t'eə/t'e:	'take off'
	twe-ə	→	tweə/twe:	'become'
	k'ɛ-ə	→	k'ɛə/k'ɛ:	'wake up'
	p'ɛ-ə	→	p'ɛə/p'ɛ:	'pull out'

The data in (6a) clearly show that CL is triggered by optional vowel deletion, regardless of the lexical vowel length of the stem.[13]

Even if the unround high back vowel /ɨ/ is the vowel most susceptible to deletion in SK, it resists deletion in certain environments such as the

[12] In SK, this is the only case of deleting a vowel other than /ɨ/ and other than a vowel in an identical vowel sequence at the morpheme boundary, which is always optional.

[13] Underlyingly long vowels are shortened by the affixation of vowel-initial suffixes (P-G Lee 1975), which shows the instance of prevocalic shortening in SK (J-K Kim 2000).

inflection of so-called *h-/s-irregular verbs* as in (7). The point here is that such irregularity of the inflection of certain groups of verbs eventually causes the optionality of /ɨ/-deletion and thus, triggers vowel lengthening.

(7)	co:h-ɨni	→	coɨni / co:ni	'be good'
	nah-ɨni	→	naɨni / na:ni	'give birth to'
	pu:s-ɨni	→	puɨni / pu:ni	'pour'
	ci:s-ɨni	→	ciɨni / ci:ni	'construct'

To summarize the discussion on SK vowel deletion so far, the relation between vowel deletion for hiatus resolution and vowel lengthening is as follows: SK vowel deletion can be broadly divided into two different types in terms of the operational property of the process, namely obligatory or optional. Obligatory vowel deletion does not trigger vowel lengthening as in (3), while optional vowel deletion does as in (4)~(7).

The example of vowel coalescence, as another way of hiatus resolution, is relatively limited. The basic character of vowel coalescence is that it is only an optional process[14] and it is accompanied by vowel lengthening both intermorphemically and intramorphemically. The assumption that vowel lengthening in SK hiatus resolution is closely related to the specific operational character of the process (that is, *optionality*) can also be supported by the data in (8).

(8) Optional Coalescence

a. Stem-Internal Coalescence

ai	→	ai/ɛ:	'boy'
sai	→	sai/sɛ:	'space'
əiku	→	əiku/e:ku	'Ouch'
moi-	→	moi/mwe:-	'gather'
koi-	→	koi/kwe:-	'be stagnant'
oi	→	oi/we:	'cucumber'

[14] There exist some cases of obligatory vowel coalescence in SK. As in the following data, coalescence occurs in an obligatory fashion in certain cases of lexical causative/passive derivation.

sə-iu	→	seu	'stand'
ca-iu	→	cɛu	'sleep'
na-i	→	nɛ:	'come out'

b. Intermorphemic Coalescence [15]

po-i	→	poi/pwe:	'be seen'
k'o-i	→	k'oi-/k'we:	'twisted'
nu-i	→	nui/nwi:	'discharged'
c^ha-i	→	c^hai/c^hɛ:	'kicked'
p^ha-i	→	p^hai/p^hɛ:	'digged'
na-ɨy	→	naɨy/nɛ:	'my'
nə-ɨy	→	nəɨy/ne:	'your'
tu-ə	→	tuə/to:	'put'
cu-ə	→	cuə/co:	'give'
k'u-ə	→	k'uə/k'o:	'dream'

In hiatus constructions where the first vowel is high or round and has a corresponding glide, hiatus is resolved by glide formation. Glide formation is optional in general and thus, can trigger vowel lengthening as expected.

(9) Optional Glide Formation

ki-ə	→	kiə/kyə:	'crawl'
pi-ə	→	piə/pyə:	'be empty'
po-a	→	poa/pwa:	'see'
tu-ə	→	tuə/twə:	'put'

The data of obligatory glide formation, which can provide a convincing argument for the relation between CL and the optionality of the gliding process, is unfortunately rare in SK. We can find only one example as in (10a), since only onsetless monosyllabic stem can provide a relevant environment for quantity-sensitivity of obligatory glide formation. Here again, it should be noted that the lack of vowel lengthening in (10b) is the reflection of the general constraint prohibiting noninitial long vowel in SK. Therefore, they cannot provide any clue of the relation between vowel lengthening and the operational property of glide formation.

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[15] Here again, the coalescence occurring in the suffixation of polysyllabic stems does not accompany vowel lengthening, due to the dominant constraint which restricts long vowels only to the initial syllable in SK.

onui	→	onui / onwi	(*onwi:)	'siblings'
sinui	→	sinui / sinwi	(*sinwi:)	'sister-in-law'

(10) Obligatory Glide Formation

a. o-a	→	wa	'come'
b. moi-ə	→	moyə	'gather'
koi-ə	→	koyə	'be stagnant'
seu-ə	→	sewə	'raise'
s'au-ə	→	s'awə	'fight'

Based on the data analysis on the relation between hiatus-resolving process and vowel lengthening, it is obvious that vowel lengthening in SK can not be just triggered by *mora loss*. The crucial condition on vowel lengthening in SK is the *optionality* of the process of hiatus resolution. The specific type of hiatus-resolving processes, that is, glide formation, coalescence, or vowel deletion, is not a factor for vowel lengthening in SK. Whether or not vowel lengthening appears crucially depends on the *optionality* or *obligatoriness* of the relevant process.

Even if the discussion of this section seems to have focused on the optionality of the process, the real focus of this study is the questions of why obligatory processes do not require vowel lengthening and what is the decisive difference between optional and obligatory processes. The fact that optional processes trigger vowel lengthening in SK is not particularly special, since typologically many languages exhibit optional desyllabifying processes with CL (Hayes 1989). What is unique in vowel lengthening in SK is that obligatory processes do not accompany vowel lengthening. SK vowel lengthening is typologically marked in the sense that vowel lengthening does not necessarily occur for the compensation of the loss of underlying mora. Therefore, vowel lengthening in SK is an optional process triggered only by optional desyllabifying processes. The typologically unmarked character of CL is that it is an obligatory process triggered by any kind of desyllabifying process. That is, desyllabifying processes can be either obligatory or optional, but CL should occur, once an underlying mora is lost.

4. Rule/Representation-Based Approaches to SK Vowel Lengthening

The importance of the operational property of hiatus-resolving processes (optional or obligatory) in SK vowel lengthening has been the key-point of

the phonological analyses in previous studies, since it was pointed out firstly in Y-K Han (1988).[16] Almost as many phonological mechanisms as one can imagine in the framework of rule- or representation-based approaches have been proposed to capture the unique nature of SK vowel lengthening. One basic assumption shared by the previous studies is that vowel lengthening in SK occurs as the compensation for mora loss along with segmental deletion or shortening as in a typical CL-language. This is denied in the present study. Several representative analyses are briefly reviewed in this section, mainly focusing on their potential explanatory/ theoretical problems.

4.1. The Types of Hiatus-Resolving Processes

In the traditional research, vowel lengthening in SK, as a process of CL, has been described as being based on the difference between the types of phonological processes involved such as vowel deletion and glide formation (P-G Lee 1978). To be specific, P-G Lee (1978) proposes that glide formation can trigger CL, whereas vowel deletion cannot, leaving some exceptional cases aside. In this analysis, the crucial difference between glide formation and vowel deletion is whether it leaves any trace or not from the target of hiatus resolution. Glide formation is segment-changing and thus, leaves a trace in the output, while vowel deletion is segment-removing with no trace. Such a trace left by glide formation, but not by vowel deletion is assumed to have critical correlation with vowel lengthening.

The main criticism of P-G Lees analysis is that there are too many exceptional cases where glide formation does not trigger CL and too many cases where vowel deletion does trigger CL, as already discussed. Moreover, as indicated in many studies (Hyman 1985, Hayes 1989a etc.), it is a typologically universal fact that the glide in on-glide diphthongs is not related to the weight of a syllable and thus, nonmoraic. As a consequence, the claim that glide formation can trigger CL seems to imply such a misleading conclusion that the on-glide is related to the moraic tier in some way.

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[16] In Y-K Han (1988), the correlation between optional desyllabifying processes and vowel lengthening is accounted for in terms of different phonological levels. To be more specific, obligatory processes are lexical rules, while optional processes are post-lexical rules. Only post-lexical rules can trigger CL.

4.2. The Property of Specific Rules

In S-K Kang (1991), following S-C Ahn (1985), vowel lengthening with vowel deletion is explained by positing two different types of vowel deletion rules, an obligatory vowel deletion rule and an optional vowel deletion rule. The difference between them, in addition to their difference in obligatoriness, lies in whether the operation of a phonological rule includes mora deletion along with segment deletion. In the case of obligatory vowel deletion, the underlying mora is deleted together with the vowel, whereas in the case of optional vowel deletion, the underlying mora remains, regardless of vowel deletion. Therefore, CL can be triggered by optional vowel deletion, but not by obligatory vowel deletion in this analysis. However, this proposal is nothing but a description of the phenomenon, providing no phonologically-significant motivation of vowel lengthening in SK. It cannot be plausibly accounted for why vowel deletion should be divided into two different sub-rules, even though there is no difference in the phonological environment. Similar problems can also be raised when the other quantity-related processes of hiatus resolution such as coalescence and glide formation are considered. All this analysis can do is to posit different sub-rules and put the burden of phonological account on the rule-specific property.

4.3. Early and Late Syllabification

In her account of glide formation in SK, E-J Han (1990) argues that the difference between optional glide formation and obligatory glide formation is closely correlated with the difference between early syllabification and late syllabification (Y-S Lee 1993). Specifically, syllabification takes place early in the case of optional glide formation, while it is postponed until after obligatory glide formation occurs. This explains why optional glide formation triggers CL, but obligatory glide formation does not.

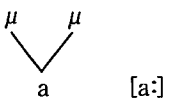
For a clear understanding of this analysis, one significant assumption on the moraic structure of vowels in underlying representation should be indicated first. Based on the claim that only unpredictable information is present in underlying representation, E-J Han assumes that in SK, only diphthongs, long monophthongs, and prevocalic /i, o, u/[17] are specified

[17] These prevocalic vowels can only be differentiated from glides such as /y, w/ by their moraic structure.

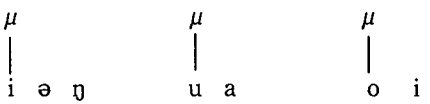
underlyingly as linked to one or more moras, while all the other short monophthongs have no moraic information in their underlying representation. Those underlyingly nonmoraic short vowels are assigned one mora each in the course of syllabification. Here, a general assumption of Hayes' (1989) moraic theory that all vowels and geminates are provided with moraic information underlyingly is not accepted. As a consequence, underlying representation of SK vowels can be depicted as follows, according to E-J Han.

(11) Underlying Representation of SK Vowels

a. *Long Vowels*



b. *Prevocalic Vowels (/i, u, o/)*



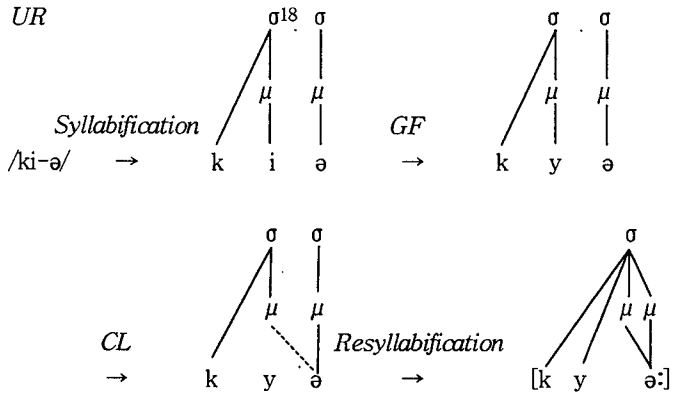
c. *On-glide Diphthongs*

d. *Short Vowels*

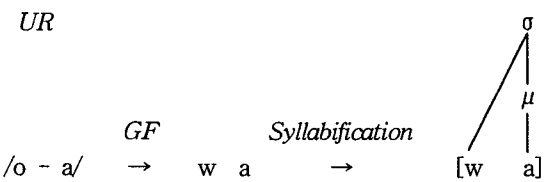
k u k a m

With these proposed underlying representations of SK vowels, the specific picture of glide formation in relation to the timing of syllabification is presented as follows.

(12) Optional Glide Formation with Early Syllabification
(Vowel Lengthening) /*ki-ə*/ → [*ki.ə*] / [*ky:ə*] *'crawl'*



(13) Obligatory Glide Formation with Late Syllabification
(No Lengthening) /*o-a*/ → [*wa*] (*[*wa:*]) *'come'*



Since non-prevocalic short vowels are assumed as underlyingly non-moraic, the ordering between glide formation and syllabification is crucial in triggering CL. Only optional glide formation ordered after syllabification which assigns moraic structure to short vowels, can trigger CL. Obligatory glide formation, ordered before syllabification, however, cannot induce CL, since there is no mora deletion.

In addition to the assumption of different underlying representations regarding the moraic status of vowels, this analysis crucially relies on a somewhat stipulative ordering of syllabification which is generally assumed to be effective in an automatic way in every derivational stage. Such

[18] E-J Han actually follows the assumption that the onset is associated to the moraic node that is linked to the nucleus. In this analysis, however, the onset is directly linked to the syllable node which is generally considered as a simple theoretical preference with no significant difference in the analysis.

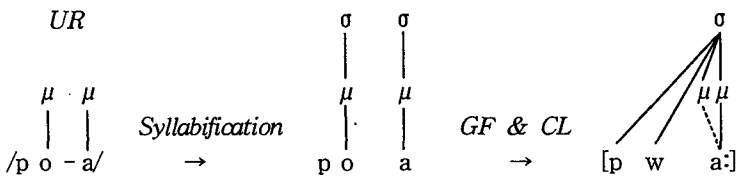
different information of ordering between glide formation and syllabification could be encoded into the underlying information of every specific lexical item. A phonological account based on a specific property of an individual lexical item, that is, its underlying information, is certainly a less desirable one.

4.4. Weightless Vowels

Another unique approach to vowel lengthening in SK comes from J-S Lee (1991) and Y-S Lee (1993), which is similar to E-J Han's (1990) approach in the sense that it is also based on the property of underlying representation. They both argue that there is a certain set of underlyingly weightless vowels and thus, deletion of these vowels does not trigger CL.[19] That is, the vowel of the stem which induces obligatory hiatus-resolving processes is nonmoraic in underlying representation, while the vowel of the stem which induces optional hiatus-resolving processes is underlyingly moraic. By such different underlying representation of moraic structure of vowels, the different aspect of CL is explained in this analysis.

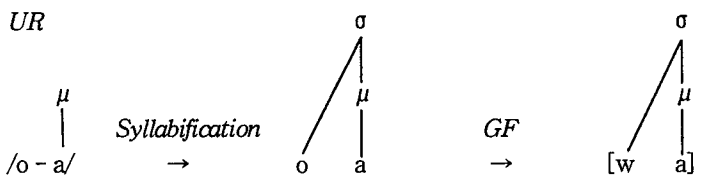
(14) Glide Formation of Moraic Vowels (CL)

/po-a/ → [*pwa:*] *'see'*



(15) Glide Formation of Nonmoraic Vowels (No CL)

/o-a/ → [*wa*] (*[*wa:*]) *'come'*



[19] All the other vowels certainly are underlyingly moraic following moraic theory of Hayes (1989), which is a clearly different assumption from the one adopted in E-J Han (1990).

If we follow this assumption, we should specifically posit that all the target vowels undergoing deletion for hiatus resolution are weightless (non-moraic) in both stem-final and suffix-initial positions. Even though this weightless-vowel-hypothesis seems to lead to a neat account of CL in SK, it is noticeable that such an analysis leaves potential problems about the property of typologically exceptional weightless vowels. Moreover, based on the assumption that the property of an individual segment plays a decisive role in the operation of CL, this analysis could be viewed as circular. That is, the reason why obligatory hiatus resolving processes do not trigger CL is that the target vowel is underlying moraless; conversely, the evidence for the existence of such exceptional nonmoraic vowels is their immunity to CL.

4.5. Summary

As briefly reviewed, there has been no convincing analysis which provides a phonologically-significant motivation for vowel lengthening in SK. By analyzing vowel lengthening in SK hiatus resolution as a process of CL in a typical CL-language, the focus of previous studies has thus been set on the lack of lengthening in obligatory hiatus-resolving processes, compared with optional processes displaying CL.

In this study, however, it is argued that SK is actually a non-CL-language, in that quantity-related processes such as deletion or gliding affects the entire segmental complex including associated elements on the prosodic tier, that is, mora. This is why obligatory hiatus-resolving processes do not trigger CL.

5. Output-Output Correspondence in SK Vowel Lengthening

As assumed in the present study, if SK is a non-CL language and thus, the lack of concomitant vowel lengthening in the case of mora loss is a natural result, as in obligatory hiatus-resolving processes, one remaining problem that should be convincingly answered is how optional desyllabifying processes can induce vowel lengthening in the same phonological environment. For the account of such an asymmetric aspect of vowel lengthening, it is argued in this study, that vowel lengthening occurring in optional hiatus resolution in SK is not a moraic but a metrical (that is, foot-based)

process. In other words, vowel lengthening in SK should not be regarded as genuine CL for moraic compensation. Vowel lengthening in SK can be regarded as a compensatory one, but not for moraic stability but for metrical stability, whose operation domain is a foot. In order to understand the metrical nature of vowel lengthening in SK, a potential derivational analysis of how vowel lengthening is correlated to the constitution of foot structure is in order, for the comparison with other previous derivational approaches.

5.1. A Foot-Based Derivational Analysis of SK Vowel Lengthening

As illustrated above, the somewhat complex aspects of vowel lengthening in SK can be simply characterized by the operational property (that is, optionality) of the relevant phonological processes, but not by the notion of moraic compensation. That is, the optionality of hiatus-resolving processes is a decisive condition on the occurrence of vowel lengthening. What this description implies is that there should be a certain phonological parameter which imposes the correlation between the property of quantity-related phonological processes and the operation of quantity adjustment, that is, vowel lengthening. If the mora is not the proper quantitative unit, the foot may be presented as another possible quantitative candidate which can capture such a correlation. In this study, the correlation between optionality of hiatus-resolving processes and the occurrence of concomitant vowel lengthening is accounted for in terms of the constitution of metrical foot structure, based on the assumption that the domain of vowel lengthening in SK is a foot. This claim implies that the constitution of foot structure is an indispensable prerequisite for the occurrence of vowel lengthening. To be more specific, vowel lengthening can be triggered, only when quantity-related processes of hiatus resolution occur after the assignment of foot structure.

At this point in the discussion, we have a theoretical issue that needs to be made clear. The issue concerns the process of foot building and its relation to other phonological processes. Foot structure may be assigned after the application of some phonological processes. And then, after foot structure has been constituted, some other phonological processes may also occur. This means that there may be a distinction between phonological processes, based on the point of occurrence in the phonological derivation. In other words, all the phonological processes can be divided into pre-

footing processes and post-footing processes. The footing process can be assumed to occur if and only if a well-formed (permissible) phonological sequence is derived.[20] Consequently, pre-footing processes which operate on ill-formed (impermissible) sequences are obligatory, while post-footing processes which operate for well-formed (permissible) ones are optional in nature. Another distinction between pre-footing processes and post-footing processes is that the former may change the quantity of a given input, whereas the latter should not. As long as it is noted that the basis of the constitution of a foot structure is phonological weight, that is, mora, this distinction may well be taken for granted.

(16) Foot-Based Distinction of Phonological Processes

UR →	*pre-footing processes*	→ *footing* →	*post-footing processes*	→ *SR*
	• obligatory • may induce a quantitative change		• optional • should preserve the quantity	

Narrowing down such distinction into the relevant processes of hiatus resolution, the correlation between optional processes and vowel lengthening is rather self-evident. All the optional hiatus-resolving processes are post-footing processes, while obligatory ones are pre-footing processes. Therefore, by this distinction, it can be argued that vowel lengthening in SK can be triggered by post-footing hiatus-resolving processes, but not by pre-footing processes. To put it differently, vowel lengthening in SK is a process of preserving the quantity of a given foot structure, by compensating a footmate for the loss of weight.

The following derivational example can be a clear summarization of the discussion so far.

[20] Apparently, the decision on the well-formedness of a phonological sequence is based on the language-specific parameter.

(17) Foot-Based Derivational Analysis of Vowel Lengthening in SK

UR	→	*pre-footing processes* (obligatory hiatus resolution)	→	*footing*	→	*post-footing processes* (optional hiatus resolution)	→	*SR*	*Gloss*
/ka-a/	→	ka	→	$(ka)_F$ [21]	→	DNA	→	[ka]	'go'
/sə-ə/	→	sə	→	$(sə)_F$	→	DNA	→	[sə]	'stand'
/ci-ə/	→	cə	→	$(cə)_F$	→	DNA	→	[cə]	'lose'
/o-a/	→	wa	→	$(wa)_F$	→	DNA	→	[wa]	'come'
/se-ə/	→	DNA	→	$(seə)_F$ [22]	→	$(se:)_F$	→	[se:]	'count'
/maim/	→	DNA	→	$(maim)_F$	→	$(ma:m)_F$	→	[ma:m]	'heart'
/ki-ə/	→	DNA	→	$(kiə)_F$	→	$(kyə:)_F$	→	[kyə:]	'crawl'
/po-a/	→	DNA	→	$(poa)_F$	→	$(pwa:)_F$	→	[pwa:]	'see'
/ai/	→	DNA	→	$(ai)_F$	→	$(ɛ:)_F$	→	[ɛ:]	'child'

In the case of obligatory hiatus-resolving processes, since desyllabification occurs before the footing process with moraic deletion, vowel lengthening cannot occur. In the case of optional hiatus-resolving processes, however, as a post-footing process, desyllabification cannot be accompanied by moraic deletion. This keeps the weight of the foot structure of a given input. It clearly shows why the mechanism of vowel lengthening in SK is crucially based on foot structure, instead of moraic structure.

In this study, it is argued that vowel lengthening in SK should be accounted for in terms of the constitution of foot structure. The domain of

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[21] Even though *Foot Binarity* is a widely-attested prosodic notion which requires a foot must be bimoraic in quantity-sensitive systems and disyllabic in quantity-insensitive systems, it cannot be understood as a universal property. There exist many languages that permit subminimal monomoraic words, which invokes the need for the existence of degenerate feet language-specifically (Hayes 1995). In Hayes (1995), such cross-linguistic variation is accounted for in terms of strong versus weak prohibition on degenerate feet. To be more specific, in some languages with strong prohibition, degenerate feet are completely banned, while in others with weak prohibition, they are allowed especially in the metrically strong position. In languages with monomoraic prosodic words, therefore, degenerate feet are subject to conform to the *Prosodic Hierarchy* which requires a prosodic word to have at least one foot. SK can be regarded as a typical example of such a language with weak prohibition on degenerate feet.

[22] Whether foot structure is trochaic or iambic is another significant issue, even though it is not crucial to the present discussion. For a comprehensive analysis of the headness of foot structure in SK is provided in J-K Kim (2000).

vowel lengthening in SK is a foot. Consequently, vowel lengthening can be triggered by optional, post-footing hiatus-resolving processes, but not by obligatory, pre-footing processes. The proposed tentative derivational analysis, therefore, is also crucially relying on the strict ordering relation among phonological processes. The main focus of the remainder of the present analysis, therefore, is shifted onto the issue of how a foot-based process like SK vowel lengthening can be incorporated into the constraint-based framework of OT without requiring serial ordering.

5.2. Output-Output Correspondence in Morphologically-Related Words

5.2.1. Transderivational Correspondence Theory

As proposed in *Correspondence Theory* by McCarthy and Prince (1995), correspondence relations can hold between independent words as well as between input-output and base-reduplicant pairs. Based on such a claim of the potential corresponding relation between pairs of individual surface forms, Benua (1997) provides a theory of *Transderivational Correspondence (Output-Output Correspondence)* where morphologically-related words are required to be identical in some phonological parameter by ranked and violable constraints.[23]

By such a transderivational mechanism, that is, *Output-Output Correspondence* (*OO-Correspondence*, hereafter) relation, morphologically-related words are phonologically correlated in some way across their individual input-output mapping, which is depicted as follows in Benua (1997).

(18) Transderivational (Output-Output) Correspondence

		OO-Correspondence		
	[rooti]	↔	[rooti + affix]	
IO-Correspondence	↑↓		↑↓	*IO-Correspondence*
	/root/		/root + affix/	

[23] The theoretical precursor of *Output-Output Correspondence*, which played a significant role in rule-based generative phonology is *paradigm uniformity* where identity effects between morphologically-related words are closely related to the phonological cycle. Such notion of *Output-Output Correspondence* has been explored in many OT approaches (Benua 1995, Burzio 1996, Flemming 1995, Kenstowicz 1996, McCarthy 1995 and others) under various terms such as *OO-correspondence*, *paradigm uniformity*, *base identity*, and *uniform exponence* (Kager 1999).

What is most important in this theory is that there exist two different types of faithfulness requirement which are separately ranked and thus, interact with each other. *OO-Identity* constraints,[24] as a phonological reflex of a morphological relation between two related words,[25] coexist and interact with *IO-Faithfulness* constraints as well as markedness constraints. When *OO-Correspondence* emerges and thus, takes precedence over *IO-faithfulness* or markedness requirements, canonical phonological processes misapply, increasing phonological identity of morphologically-related words. In other words, *OO-Identity* forces phonology either to take place where it is not conditioned or to fail to occur where it is conditioned. When *OO-Correspondence* is dominated and thus, does not play a visible role, a general pattern of phonology appears with no identity-driven phonological anomalies.

5.2.2. Transderivational Identity Effects in English

English displays a number of transderivational identity effects triggering phonological misapplication in morphological derivation. A well-known division[26] of English affixes such as *Class 1* and *Class 2* is distinguished by different phonological patterns of the words that contain them. These classes of affixes exhibit different identity effects where a phonological process may either overapply in the improper condition or underapply in the proper condition.

A first example of identity-driven misapplication in English comes from overapplication of cluster simplification in a certain set of suffixed words such as *damn, condemn, signer*.

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[24] The base of an *OO-Correspondence* relation is assumed as a licit output word which is both morphologically and phonologically well-formed.

[25] The identity relation between randomly-selected words is prevented by the affixs subcategorization frame which specifies the *OO-Correspondence* relation that links the affixed output in a paradigmatic identity relation. Therefore, the *OO-Correspondence* relation can hold only between a morphologically-derived word and its base.

[26] Class 1 Affixes: *-al, -ate, -ic, -ity, -ous, in-* etc.
Class 2 Affixes: *-able, -er, -ful, -ist, -ness, un-* etc. (Siegel 1974)

Words with *Class 2* affixes are highly faithful to their base, copying main stress and various derived segmental properties, while words with *Class 1* affixes are less faithful, copying only the placement of nonprimary stress.

(19) Identity-Driven Overapplication of Cluster Simplification in English

Base	*Class 1*	*Class 2*
/damn/	/damn-ation/	/damn-ing/
[dæm]	[dæmn+eyšʌn]	[dæm+ɪŋ]

The cluster of /mn/ is not permissible in the tautosyllabic position as in *damn* and thus /n/ is not realized in the surface output forms. In the affixation of a vowel-initial *Class 1* suffix as in *damnation*, the second member of consonant cluster can be affiliated to the position of onset in the second syllable. Consequently, cluster simplification is not conditioned and thus, cannot occur. However, in the affixation of a *Class 2* suffix as in *damning*, cluster simplification is actually unexpectedly effective, resulting in the case of overapplication of a phonological process. Such an occurrence of the overapplication of cluster simplification enhances the identity of the pair of morphologically-related words such as *damn/damning*. In the case of cluster simplification, therefore, *OO_2-IDENTITY* between the base and the words with *Class 2* affixes (*damn/damning*) takes precedence, forcing an irregular phonological pattern, whereas *OO_1-IDENTITY* between the base and the words with *Class 1* affixes (*damn/damnation*) is neglected.[27]

Another example where English phonology displays identity effects is in stress placement in the *Class 1* affix paradigm. Secondary stress in English iterates from the left edge, creating *initial dactyls* where three light syllables precede the main stress.[28]

(20) General Pattern of Secondary Stress in English
Lòllapalóoza
Tàtamagóuchi
àbracadábra

In the words with *Class 1* affixes, however, such a canonical pattern of secondary stress is disobeyed,[29] where secondary stress is placed on the

[27] In terms of constraint interaction, this can be interpreted as follows: the *OO_2-IDENTITY* constraint is highly-ranked above the *IO-MAX* constraint, while the *OO_1-IDENTITY* constraint is lower-ranked, providing no visible activity in this specific environment. A detailed analysis based on the constraint ranking system of English is not presented in this study. Please refer to Benua (1997).

[28] As is well-known, main stress in English nouns is normally placed on a heavy penult, else on the antepenultimate syllable.

second, not the first, of three light syllables preceding main stress.

(21) Secondary Stress in the Words with *Class 1* Affixation

orìginálity	(*òriginálity)
arìstocrátic	(*àristocrátic)
munìcipálity	(*mùnicipálity)

Such an irregular appearance of secondary stress in the second syllable of those words with *Class 1* affixation actually increases the metrical identity with the relevant base words in which the second syllable hosts main stress.

(22) Metrical Identity with Noncanonical Secondary Stress

Base Word	*OO_I-Identity*	*Class 1 Affixation*
	↔	
orígin		orìginálity
arístocrat		arìstrocrátic
munícipal		munìcipálity

By underapplying the leftward alignment of secondary stress in Class 1 affixation, the metrical identity between morphologically-related words is increased, exhibiting another example of an OO-Correspondence relation in English phonology.

5.2.3. Summary

It might be a fairly straightforward claim that morphologically-related words somehow tend to be phonologically similar, due to their morphological similarity. Yet in certain cases, the morphological correlation with a shared underlying form does not always entail or guarantee phonological similarity, since affixation can create a totally different phonological environment. Even in such cases, words in the same morphological paradigm try to enhance their phonological identity, sacrificing otherwise general patterns of phonology. Such an active role for the output-output correspondence relation in the interaction of input-output correspondence relation is what Benua's (1997) Transderivational Correspondence Theory mainly claims for. A multiple set of correspondence relations such as input-output, base-

[29] The affixation of *Class 2* suffixes is stress-neutral with no visible role in the placement of the stress.

reduplicant, and output-output coexist in the grammar, interacting with one another.

5.3. Output-Output Correspondence between Phonological Variants

5.3.1. Metrical-Identity Effects in SK Vowel Lengthening

As discussed, the identity effect in a morphological paradigm indicates prominent activity of correspondence among morphologically-related output forms in phonological processes. Returning to the issue of vowel lengthening in SK phonology, what is noticeable is that there is another potential instance of an active *OO-Correspondence* relation between certain surface-true output forms. Phonological variants created by optional phonological processes provide another case of a pair of output forms which are closely related both phonologically and morphologically. Considering the active role of *OO-Correspondence* relation in phonology, it is a rather well-expected next step of reasoning to posit that there would also exist a correspondence relation among phonologically-related variants as the result of *optionality* of a phonological process.

Narrowing this claim down into the present analysis, the motivation of vowel lengthening occurring in optional hiatus-resolving processes can be accounted for in terms of such an *OO-Correspondence* relation between phonological variants. That is, vowel lengthening in SK is the result of a metrical identity requirement between phonological variants. To be more specific, through vowel lengthening, an output form of optional hiatus resolution can keep metrical identity with its phonological variant containing the unresolved hiatic output form, by having the same quantity of bimoraic foot structure. This notion of *metrical identity effect* can also explain why there is no lengthening effect in the case of obligatory hiatus-resolving processes. Since obligatory processes cannot produce phonological variants, no environment of the *OO-Correspondence* relation is provided. In obligatory processes, only the *IO-Faithfulness* relation is valid and thus, metrically-driven vowel lengthening cannot occur.

(23) OO-Identity Effect in Hiatus-Resolving Processes

a. Obligatory Processes (No Effect)

[s'ə]

↑↓ *IO-Correspondence*

/s'ɨ-ə/

b. Optional Processes (Metrical Identity Effect)

OO-Correspondence

(maim)$_F$	↔	(ma:m)$_F$	
↑↓		↑↓	IO-Correspondence
/maim/		/maim/	

5.3.2. Optionality, Variation, and the Domain of Hiatus Resolution

5.3.2.1. Optional Rules and Obligatory Rules

One of the most difficult aspects in the analysis of SK hiatus resolution, especially in rule-based approaches, might be the fact that the occurrence of various strategies are not complementary; their applications are often optional. In other words, the selection of a proper strategy for a certain hiatus context is not limited to a single designated one. In a hiatus context, glide formation, glide insertion, and coalescence can all be the possible options for resolving hiatus. This state of affairs virtually produces a complex set of variable output forms corresponding to a single input. Another source of the phonological variants out of hiatus resolution comes from the optionality of the processes themselves. In most cases of hiatus resolution in SK, the particular phonological process is not obligatory. As the data in (24) show, the phonological activity of a hiatus-resolving process such as glide formation is quite complex. Hiatus resolution is variable in one sense, since it may be resolved by different processes. In another sense, it is an optional process, since the output which retains the hiatus construction is also allowed.

(24)	tu-ə 'put'	→	tu.ə	(hiatus retention)
			tu.wə	(glide insertion)
			twə:	(glide formation)
			to:	(coalescence)

There is, however, a case of hiatus where only glide formation is the right process and its application is obligatory, not optional, as follows.

(25) pɛu-ə 'learn' → pɛ.wə (*pɛ.u.ə, *pɛ.u.wə, *pɛ.o)

In previous studies on SK hiatus resolution, the main analyses have been crucially based on the property of individual rules and their ordering, which could be easily expected in rule-based approaches. By the operational property of a rule (optional or obligatory), the aspect of the application of a

rule is decided. Hence, the variation between a hiatus-preserving output and various hiatus-resolving forms is a simple reflection of the optionality of rules of hiatus resolution. The variation among hiatus-resolving forms can be accounted for in terms of rule ordering which is not fixed. That is, by variable ordering among hiatus-resolving processes, phonological variation occurs in certain environments. Consequently, the analysis of hiatus resolution in rule-based approaches is reliant on a number of rules such as optional vowel deletion, obligatory vowel deletion, optional glide formation, obligatory glide formation, optional glide insertion, and optional coalescence etc., and variable rule-ordering among them. In a sense, most of the major questions on hiatus resolution have been answered, but only in a descriptive way without convincing explanation.

5.3.2.2. Optionality and Speech Style

The fact that phonological variation is an inherent character of continuous speech (Neu 1980) has been a problematic, but significant issue of phonology (Labov 1969, Cedergren 1973, Morris 1998 among others).[30] In standard generative approaches, phonological variation has generally been analyzed by devices like variable or optional rules.[31] In a generative model like *Lexical Phonology*, such optional rules, which usually are not domain-sensitive, are often assumed to operate late in the phonology, that is, in the post-lexical stratum (Kaisse 1985).[32] It has been a general idea that phonological variation is closely related to non-phonological factors such as speech style, rate of speech, and social consideration, etc. (Cedergren 1973, Guy 1980, Morris 1998 among others). By the change of speech style (from careful speech to casual speech) or rate of speech (from normal (slow) speech to fast speech), phonological variation can occur. Many optional operations of phonological processes, including hiatus resolution in the present analysis, can be understood in this way. To be more specific, a phonological rule is applicable in casual speech, but not in careful speech, resulting in the optional operation of a process by speech style.

With this background at hand, the issue that the present analysis most

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[30] Morris (1998) provides a comprehensive review on this issue.

[31] The notion of a variable rule has been widely used in the field of sociolinguistics, where it often has a slightly different meaning from an optional rule. In the present analysis, however, these two terms will be used interchangeably.

[32] In Kaisse (1985), they are termed as (*optional*) *fast speech rules*.

concerns is how such optionality of the process of hiatus resolution in SK can be formalized in the constraint-based phonological approach. From a functionalist perspective, to which the fundamental rationale behind constraint-based approaches are closely connected, phonology can be described as the tension between perceptual maximality and articulatory minimality. For the maximally distinctive perception, on the one hand, speakers ideally seek to pronounce everything as is in the input (Hammond 1997) to make easy the perception for listeners. For the economical articulation, on the other hand, speakers strive for an ease of the articulation, thus sacrificing the unambiguous perception. The decision between these two incompatible axes of speech is often closely related with speech style. Ideally speaking, in careful speech, speakers generally provide the maximal output of speech which is as faithful to the input as possible, whereas in casual speech, they produce a more minimal output of speech, removing any surplus part of the input for the economy of articulation. It is in the mode of articulatory priority when the optional (variable) processes emerge in phonology. As many generative phonologists have claimed (Stampe 1969, Hooper 1976, Harris 1989 among others),[33] optional rules, by way of stylistic change, reflect universal phonetic tendencies which are determined by the fundamental physiological and acoustic limitations of the articulating organs (Morris 1998). Thus, by the change of speech style from careful speech to casual speech, optional rules can apply in order to minimize the articulatory effort.

In OT, such a functional opposition of perception and articulation in speech can be represented by two broadly-defined constraint families: *FAITHFULNESS* constraints and *MARKEDNESS* constraints. Faithfulness constraints which require the input to be parsed faithfully concerns the perceptual function of speech, while markedness constraints which require the output to have unmarked structure generally, but not always, concern the articulatory function of speech. Therefore, when faithfulness constraints outrank markedness constraints, generally in careful speech, the perception is enhanced, producing maximally distinctive output forms. Conversely, when markedness constraints outrank faithfulness constraints, generally in casual speech, the articulation is optimized, resulting in maximally economical output forms.[34]

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[33] Hoopers (1976) theory has been generally referred to as *Natural Generative Phonology*, stemming from Stampes (1969) *Natural Phonology*.

[34] The two situations are rather ideal or extreme, mostly effective in a logical

(26) a. FAITHFULNESS >> MARKEDNESS (perceptual maximality) (careful speech)
b. MARKEDNESS >> FAITHFULNESS (articulatory minimality) (casual speech)

Such a functional approach of a constraint-based system to speech, in relation to speech style, can provide the theoretical basis in the analysis of SK hiatus resolution, especially in the understanding of the optional operation of hiatus-resolving processes.

5.3.2. Constraint-Based Analysis of SK Vowel Lengthening

5.3.2.1. Relevant Constraints

For the analysis of vowel lengthening in the framework of the constraint interaction system of OT, focusing on the metrically-driven *OO-Identity Effects*, the relevant constraints are presented as follows.

(27) Relevant Constraints of Vowel Lengthening in SK

- ONSET $_{SUFF}$[σ
  Syllables must have onset in the suffixation (in the derived environment).
- ONSET†[35]
  Syllables must have onset.
- MAX-(F)
  Every feature of the input has a correspondent in the output. (MAX-[+high], MAX-[-high], MAX-[+back], MAX-[-back], MAX-[low], MAX-[round])
- *CG
  The complex cluster consonant-glide is prohibited in onset position.
- SEGMENT-INTEGRITY (Seg-Int)[36]
  If one feature of a segment is preserved, all its features are preserved.

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sense. In general cases, faithfulness constraints and markedness constraints are interleaved and thus, often represent somewhat compromised output forms.

[35] The floating constraint is indicated by the symbol†.

[36] The role of most *IDENT-(F)* constraints, which concerns the featural modification in a segment-based theory of correspondence, can also be carried out by *Seg-Int* (especially in the case of feature loss) (Casali 1996).

- WEIGHT-IDENTITY (WT-IDENT)
  The corresponding segments must have the same weight.
- MAX-μ
  Every mora of the input has a correspondent in the output.
- OO-IDENTITY (FOOT) (OO-IDENT(FT))
  Output correspondents are identical in the size of foot structure.

The constraint *ONSET* captures the phonological motivation of hiatus resolution. As discussed above, the phonological variation in a constraint-based system is the result of the variable dominance relation among ranked universal constraints. Narrowing this down into vowel deletion, the variation by optional operation of vowel deletion in SK (hiatus resolution, in general) is the result of a variable ranking relation between a markedness constraint like *ONSET* and faithfulness constraints like the *MAX-(F)* constraint family. When *ONSET* and the individual constraints of the *MAX-(F)* family are interleaved, *ONSET* can force the deletion of only a certain set of vowels (/ɨ/ in SK, more precisely). However, when *ONSET* dominates all the members of the *MAX-(F)* constraint family, any vowel can be a licit target of vowel deletion, which reflects the stylistic variation of speech from careful speech to casual speech. In this way, phonological variation can be generally accounted for in the constraint ranking system. By the domination of *ONSET* and the specific ranking relation among *MAX-(F)* constraints, optional vowel deletion in SK is analyzed in a neat way. However, the situation around optional hiatus-resolving processes is rather subtle and complex. As pointed out previously, the optional operation of hiatus-resolving processes, in casual speech, are also accompanied by the change of its domain. Specifically, in careful speech, hiatus resolution only occurs in the derived environment, that is, in suffixation, but not in the stem-internal position. However, in casual speech, the process of hiatus resolution can occur, regardless of morphemic structure. This means that with the reranking (or emergence) of *ONSET*, the evaluative domain of the constraint is also expanded into a prosodic word, ruling out all the hiatic constructions in a prosodic word. Such a treatment of so-called *Derived Environment Effect* in the constraint system, however, is simple and neat, on the one hand, but too powerful, on the other hand. The expansion of the domain of certain constraints, along with reranking, is a too powerful or too opportunistic way of handling one of the most significant aspects of phonological processes. Therefore, this study proposes a different mechanism

of capturing the *Derived Environment Effect* in the constraint-based system, by incorporating the morphemic information directly to the constraint. The basic assumption is that the constraint *ONSET*, and likewise with all the other domain-sensitive constraints, can be divided into two constraints: a general constraint *ONSET* which is not domain-sensitive[37] and a more specific constraint *ONSET* which is domain-sensitive ($ONSET_{SUFF}$, in this analysis). In careful speech, the general *ONSET* constraint is ranked low enough to be inactive in hiatus resolution. Only the activity of a specific $ONSET_{SUFF}$ constraint is visible in all the hiatus-resolving processes. This is why obligatory vowel deletion which targets /ɨ/ (and a vowel in a sequence of identical vowels) occurs only in the derived environment.

In a featural correspondence approach adopted in the present study, the faithfulness relation between input and output is evaluated at the level of feature, not segment. Therefore, the deletion of a vowel can be understood as a cumulative effect of featural deletion: deletion of [+high] and [+back] in the case of /ɨ/-deletion. The relevant constraint for the deletion of features is *MAX-(F)*. Generally, vowel deletion in hiatus occurs when the relevant *MAX-(F)* constraints are ranked lower than *ONSET*, the constraint that forces hiatus resolution. The fact that only the vowel /ɨ/ is susceptible to deletion in SK indicates that only the constraints *MAX-[+high]* and *MAX-[+back]* of the *MAX-(F)* constraint family are ranked lower than *ONSET*, the constraint forcing hiatus resolution.[38] The rest of *MAX-(F)* family dominates *ONSET*. The general *ONSET* constraint should include some specific condition in order to rule out the possibility of obligatory /ɨ/-deletion in a non-derived environment, that is, in a stem-internal context. Within the stem, a hiatus context with /ɨ/ is retained.

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[37] In careful speech, the role of the general *ONSET* constraint is almost invisible in SK hiatus resolution. In casual speech, in contrast, it is reranked as a dominant constraint, forcing a variety of hiatus-resolving processes which are not allowed in careful speech. Such a unique nature of the constraint *ONSET* as a floating constraint is indicated as $ONSET^{\dagger}$ in the tableau. For a more detail discussion on the notion of the floating constraint in relation to speech style, please refer to Reynolds (1994), Morris (1998), and J-K Kim (2000).

[38] This is the way how the least marked segment in a language is captured in the OT framework. Since the vowel /ɨ/ is the most susceptible vowel to both deletion and epenthesis in SK as proposed in many previous studies, the constraints such as *MAX-[+high]*, *MAX-[+back]*, *DEP-[+high]*, and *DEP-[+back]* are relatively low-ranked constraints among the members of the *MAX-(F)* and *DEP-(F)* constraint families.

In order to capture the optionality of glide formation in SK, there must be a certain phonological constraint which is ranked above the constraint $ONSET_{SUFF}$, blocking the application of glide formation in suffixation. If there is no other phonological restriction on the output form with glide formation, glide formation must be an obligatory process of hiatus resolution, since glide formation does not incur any kind of unfaithful corresponding relation of features. What is responsible for the optionality of glide formation is *CG, a markedness constraint on syllable structure which disfavors complex structure in the onset position of a syllable.

In understanding vowel coalescence, the existence of a constraint which disfavors the coalesced form is critical. For a clear understanding, let us compare a case of vowel deletion with that of vowel coalescence.

(28)	a. s'ɨ-ə	→	s'ə	'use'	V_1	V_2	→	V_2
					[+high]	[-high]		[-high]
					[+back]	[+back]		[+back]
	b. sai	→	sɛ:	'space'	V_1	V_2	→	V_3
					[low]	[+high]		[low]
					[+back]	[-back]		[-back]

The example in (28a) displays a typical case of vowel deletion which is obligatory with /ɨ/ in SK, while (28b) shows a case of optional vowel coalescence. In terms of faithfulness of featural correspondence, these two cases are identical. That is, in both vowel deletion and vowel coalescence, the features [+high] and [+back] are unparsed in the output. Since the relevant faithfulness constraints *MAX*-[+*high*] and *MAX*-[+*back*] are ranked low enough to guarantee nonfatal violations, /ɨ/-deletion is always preferable to hiatus retention in SK and thus, is an obligatory process. However, the case of height coalescence in (28b) is not an obligatory process, even though it has exactly the same amount of featural violations as /ɨ/-deletion. What this asymmetry between vowel deletion and vowel coalescence implies is that vowel coalescence causes a fatal violation of certain (markedness) constraint in addition to constraints of featural faithfulness. In McCarthy and Prince (1995), the constraint *UNIFORMITY* is presented as a relevant constraint which disfavors coalescence.

(29) UNIFORMITY (No Coalescence) [39]

No element of the output has multiple correspondents in the input.

What the constraint *UNIFORMITY* militates against is a multiple corresponding relation[40] between an output segment and input segments which coalescence produces. As the term 'multiple correspondents' indicates, the constraint *UNIFORMITY* is crucially based on the segment-based theory of correspondence. Therefore, in a feature-mediated correspondence approach adopted in this study, *UNIFORMITY* should be replaced by a different constraint. There is no case of multiple correspondence among features. All the features of the input and the output always stand in a one-to-one correspondence relationship. Following Casali (1996), the constraint *SEGMENT-INTEGRITY* (*Seg-Int*)is presented as a constraint which is responsible for penalizing a form of coalescence. As stated, *Seg-Int* requires a cohesive relation among the features of a segment in the input. Therefore, coalescence which forces to break such featural integrity of an input segment by parsing only a selected feature (or features) is a typical instance.

The constraint *WT-IDENT* requires correspondents to have the same quantity. Accordingly, it militates against all the quantity-changing processes such as lengthening or shortening of vowels and gemination or degemination of consonants.[41] As a member of the basic faithfulness constraint family, the constraint *MAX-μ* demands the faithful parsing of the moraic structure in the input.

The requirement of *WT-IDENT* is often in a conflicting relation with that of *MAX-μ*, which can be explicitly displayed in quantity-sensitive processes. The focus of *WT-IDENT* is on the stability of the moraic structure of an individual input segment, while the focus of *MAX-μ* is on the stability of the moraic structure of the whole input. CL displays an exemplary case of the conflict between these two constraints. The occur-

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[39] Lamontagne and Rice (1995) presents a similar constraint in a more direct fashion in their analysis of coalescence in Athapaskan languages.

* Multiple Correspondence (*MC)

Elements of the input and the output must stand in a one-to-one correspondence relationship with each other.

[40] McCarthy and Prince (1995) provides another case of multiple correspondence which is the exact reverse of coalescence. That is, a segment of the input may have multiple correspondents in the output. Diphthongization and phonological copying are typical examples. For such a case, they present the constraint *INTEGRITY*.

INTEGRITY (No Breaking)

No elements of the input has multiple correspondents in the output.

[41] Apparently, the violation of *WT-IDENT* by geminated or degeminated consonants is relevant only in a language with moraic coda consonants.

rence of CL is crucially induced by the dominance of the constraint *MAX-μ*. In order to satisfy the requirement of *MAX-μ*, the overall weight of the input must be intact, regardless of the associated segmental change. In contrast, *WT-IDENT* is inevitably violated by CL that forces the moraic shift from a desyllabified segment to a neighboring segment. As the result of CL, the compensatorily-lengthened vowel always has a correspondent with different weight.

5.3.2.2. Constraint Interaction and SK Vowel Lengthening

In typical CL-languages, CL can be regulated by the ranking relation *MAX-μ* >> *WT-IDENT*, as in the tableau (30). In CL-languages, vowel deletion induced by hiatus resolution should always be accompanied by compensatory vowel lengthening.

(30) Hiatus Resolution with Vowel Lengthening in CL-Languages

/(C)V_1V_2/	ONSET	MAX-μ	WT-IDENT
a. (C)V_1.V_2	*!		
b. (C)V		*!	
☞ c. (C)V:			*

In non-CL-languages, in contrast, vowel lengthening through hiatus resolution is prevented in order to keep the identity of moraic quantity of an individual segment as in the tableau (31).

(31) Hiatus Resolution without Vowel Lengthening in Non-CL-Languages

/(C)V_1V_2/	ONSET	WT-IDENT	MAX-μ
a. (C)V_1.V_2	*!		
☞ b. (C)V			*
c. (C)V:		*!	

As discussed, SK is not a legitimate CL-language and thus, the lack of concomitant vowel lengthening in obligatory hiatus-resolving processes is the natural result of the constraint ranking relation like *WT-IDENT* *MAX-μ*. As the following two tableaux in (32) and (33) show, the optimal output does not exhibit vowel lengthening in the compensation of vowel deletion and glide formation.

(32) Obligatory Vowel Deletion (No Lengthening)

/s'ɨ-ə/ → [s'ə] (*[s'ə:]) 'use, put on, write'

/s'ɨ-ə/	ONSET$_{SUFF}$	WT-IDENT	MAX-μ	MAX-[+high]	MAX-[+back]
a. s'ɨ.ə	*!				
☞ b. s'ə			*	*	*
c. s'ə:		*!		*	*

(33) Obligatory Glide Formation (No Lengthening)

/o-a/ → [wa] (*[wa:]) 'come'

/o-a/	ONSET$_{SUFF}$	WT-IDENT[42]	MAX-μ
a. o.a	*!		
☞ b. wa		*	*
c. wa:		**!	

Considering the proposed ranking relation such as *WT-IDENT* >> *MAX-μ*, the occurrence of vowel lengthening in optional hiatus-resolving processes in SK is a totally unexpected one. This is where the activity of the *OO-Correspondence* constraint plays a pivotal role. With the dominant ranking relation of *OO-IDENT (Ft)* over *WT-IDENT*, the weight identity of an individual segment can be sacrificed for the enhancement of *OO-Identity*, as the following tableaux show.

(34) Optional Vowel Deletion (Vowel Lengthening)

/k'ɛ-ə/ → [k'ɛə] / [k'ɛ:] (*[k'ɛ]) 'wake up'

/k'ɛ-ə/	ONSET†	MAX-[-high]	ONSET$_{SUFF}$	OO-IDENT(FT)	WT-IDENT	MAX-μ	MAX-[+back]
† a. k'ɛ.ə	(*!)[43]		*				
b. k'ɛ		*		*!		*	*
† c. k'ɛ:		*			*		*

[42] The gliding of /o/ into [w] also violates the constraint *WT-IDENT*, by losing its underlying weight.

[43] The violation of the constraint *ONSET* in casual speech is indicated in parenthesis.

(35) Optional Glide Formation (Vowel Lengthening)
/ki-ə/ → [kiə] / [kyəː] (*[kyə]) 'crawl'

/ki-/	ONSET†	*CG	ONSET SUFF	OO-IDENT(FT)	WT-IDENT	MAX-μ
☞ a. ki.ə	(*!)		*			
b. kyə		*		*!	*	*
☞ c. kyəː		*			**	

(36) Optional Coalescence (Vowel Lengthening)
/sai/ → [sai] / [sɛː] (*[sɛ]) 'interval'

/sai/	ONSET†	Seg-Int	ONSET SUFF	OO-IDENT(FT)	WT-IDENT	MAX-μ
☞ a. sa.i	(*!)					
b. sɛ		*		*!		*
☞ c. sɛː		*			*	

In optional hiatus-resolving processes, there exist surface multiple phonological variants. As discussed, such optionality of hiatus resolution is crucially based on the emergence of the floating constraint *ONSET*†. The retention of hiatus constructions in optional hiatus resolution is forced by the highly-ranked *MAX-F* constraints in vowel deletion as in (34), **CG* in glide formation as in (35), and *Sg-Int* in coalescence as in (36). With the emergence of *ONSET*†, the retained hiatus constructions can be resolved, producing phonological variants. What is crucial is that there exists a metrically-induced identity relation between such phonological variants of hiatus resolution. In tableaux (34)~(36), candidate (c) is in an OO-identity relation with candidate (a), but not candidate (b). The *OO-Correspondence* constraint *OO-IDENT(Ft)* specifically requires that phonological variants should have the identical size of feet, that is, bimoraic feet. It is the active role of such an *OO-Correspondence* constraint that endows optional hiatus-resolving processes with the power of quantity adjustment in a non-CL-language like SK. Through vowel lengthening as in candidate (c), the metrical identity between phonological outputs (variants, that is, candidates (a) and (c)) can be apparently enhanced. As a consequence, vowel lengthening occurring in optional hiatus-resolving processes in SK is another instance of an active *OO-Correspondence* relation between certain surface-true output forms which are phonologically and morphologically-related.

With the emergence of the *OO-Correspondence* relation and its dominance over the *IO-Faithfulness* relation of weight identity, the canonical phonological pattern (hiatus resolution without moraic compensation) misapplies, resulting in vowel lengthening in SK.

6. Summary and Concluding Remarks

Vowel lengthening that occurs in SK hiatus-resolving processes is unique in the sense that it can be induced only by optional processes. Based on the assumption that SK is not a genuine CL-language, vowel lengthening in SK has been analyzed as a foot-based, metrical process. The critical relation between vowel lengthening and the operational property, that is, *optionality* of hiatus-resolving processes, has been captured by the notion of *Output-Output Correspondence* relation between surface output forms. Like the *OO-Identity Effect* attested between morphologically-related words, vowel lengthening in SK is an intriguing instance of *OO-Identity Effect* between phonological variants. Through vowel lengthening, the metrical identity between phonological variants can be clearly enhanced.

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ABSTRACT

Metrical Identity Effects of Phonological Variants: Vowel Lengthening in Korean

Jong-Kyoo Kim

Vowel lengthening occurring in (Standard) Seoul Korean (SK) hiatus-resolving processes is unique in the sense that it can be induced only by optional processes. Based on the assumption that SK is not a genuine

language displaying compensatory lengthening, vowel lengthening in SK has been analyzed as a foot-based, metrical process. The critical relation between vowel lengthening and the operational property, that is, *optionality* of hiatus-resolving processes has been captured by the notion of *Output-Output Correspondence* relation between surface output forms. Like the *OO-Identity Effect* attested between morphologically-related words, vowel lengthening in SK is an intriguing instance of *OO-Identity Effect* between phonological variants. Through vowel lengthening, the metrical identity between phonological variants can be clearly enhanced.

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