Aspirates in Korean: Perspectives on Coalescence, CL, and Gemination

by

SOOMEE KIM
B.Sc., Ewha Women's University, 1997
B.A., Chonbuk National University, 2000

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of Linguistics)

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

September 2002

Department of Linguistics

The University of British Columbia
Vancouver, Canada

Date Sep 16, 2002

ABSTRACT

Korean non-continuant obstruents are typologically unusual in that they have a three-way contrast, but they are all voiceless. The three different categories are often called plain (lenis), tense (fortis), and aspirated. Although the fact that Korean non-continuant obstruents have three different types of phonation is well-established, the underlying representation, either structural or featural, of each type has not reached a consensus and still undergoes a lot of controversy. In this study, I focus on the aspirated consonants and argue that they are underlyingly geminates with a specified [s.g.] feature. This is supported by a phonological phenomenon called aspiration, which is analyzed as coalescence. Sumner argues for a view of Compensatory Lengthening in which Compensatory Lengthening results from the coalescence rather than deletion of a segment (Sumner 1999).

In the present thesis, I argue that aspirated consonants in Modern Seoul Korean are geminates (cf. Martin 1951 who proposes aspirates are clusters; Kim J. 1986, Kim S. 1990, Jun 1989, 1991, 1994 who also posit a geminate analysis). The geminate structure of aspirates, either underlying or derived, is underlyingly contrastive, and a surface result of morphophonemic alternation which I argue is the result of Compensatory Lengthening under a coalescence interpretation.

For the analysis, I use an Optimality Theory account (Prince & Smolensky 1993) within moraic theory (Hyman 1985, among others). I also show that the asymmetry between progressive and regressive aspiration that used to be treated by derivational theory can be solved within Benua's (1997) Transderivational Correspondence Theory. The goal of this research is to provide a complete account of aspiration in Korean within Optimality Theory (McCarthy & Prince 1993, 1995, Prince & Smolensky 1993) with its implications for the current theory of phonological representation.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

First and foremost, I am indebted to the people who have aided me most in the production of this thesis, my thesis committee members: Patricia A. Shaw, Douglas Pulleyblank, and Bryan Gick. If this thesis exists, it is because they never gave up on it or on me.

I am eternally in the debt of my supervisor, Patricia A. Shaw, for the very best education I could possibly receive. She supplied the needed guidance and direction whenever I felt lost in my research. I also cannot forget her constant encouragement, patience, and warm humor.

My other special thanks go to the other members of my committee. Douglas Pulleyblank would persistently challenge me whenever I took an existing theory for granted without clarifying or formalizing it. His insightful critiques helped my thesis to be far better. Thanks are due also to Bryan Gick who provided me with fresh ideas from a phonetic view.

Outside my committee, a number of other people have given me helpful advice and encouragement. I thank Dr. Rose-Marie Déchaine for continually checking on me to see if I am on the right track, Dr. Henry Davis for his intellectual encouragement, and Edna Dharmaratne for her warm help. I owe special thanks to my fellow graduate students in the department of linguistics at U.B.C.; in particular my classmates, Andrea Gormley and Rachel Susanne Wojdak, for their help in my research and English; Eun-sook Kim for her role as my mentor; Kayono Shiobara, Sugunya Ruangjaroon, and Masaru Kiyota for sharing laughter and tears with me; Gene Chu for lending me Rene Kager's *Optimality Theory* (1999); and Olga Steriopolo for her beautiful friendship. I would also like to thank my non-linguistic friends, especially my St. John's College friends, for making my life in Vancouver very enjoyable and precious.

And last but not least, I am very thankful to my family, especially my father for being proud of my academic aspirations; my mother for supporting and encouraging me with infinite love; Harold for being an inspiration; and Albert for being a cute impediment.

INTRODUCTION

One of the most controversial issues in Korean Phonology is how to represent the underlying phonation type contrasts for Korean consonants. In terms of structure, most current works (Kim-Renaud 1974, Ahn 1985, Sohn 1987, Cho & Inkelas 1992) claim that Korean has a three-way underlying phonation contrast- voiceless plain, tense, and aspirated and that these three different categories, plain, tense, and aspirated, of non-continuant obstruents are all singleton segments. The fact that they can show up in onset positions supports the singleton hypothesis, given a general syllable structure constraint in Korean that allows only single consonants in the onset as well as the coda (Kim 1965, 1967). On the other hand, some researchers argue that Korean tense and aspirated consonants are not unitary separate phonemes, but underlyingly consonant clusters or geminates. Martin (1954) and Yu (1989) argue that aspirates are consonant clusters of a plain consonant and /h/. Kim J. (1986), and Kim S. (1990) posit a geminate analysis within CV phonology, and Jun (1994) posits a geminate analysis within moraic phonology. Later, Choi & Jun (1998) support this geminate analysis with two phonetic durational facts. First, Korean aspirated and tense consonants have longer duration than their plain counterparts. Second, a vowel is shorter in length before aspirated and tense consonants than before plain consonants. With this geminate hypothesis, we can explain why tense and aspirated consonants behave differently from plain consonants in many ways. For example, unlike plain consonants, tense, and aspirated consonants never show up in coda positions. Further, plain consonants get voiced intervocalically whereas tense, and aspirated ones never do. This difference between plain consonants, and tense and aspirated consonants can be accounted for if we assume tense and aspirated consonants are geminates while plain consonants are singletons.

As we can see, the distinction between tense, aspirated, and plain phones is not discussed consistently in the literature in either structural or featural terms. Some researchers propose that a feature specification for [s.g.] is not necessary for aspirated consonants because length is an underlying contrast which distinguishes them from plain consonants (Martin 1954, 1982; Yu 1989; Kim 1990). However, Kim J. (1986) argues that aspirated consonants are underlyingly [s.g.]. According to her, tense and aspirated consonants have the same underlying geminate

structure but they are differentiated by the underlying feature [s.g.] of the aspirated consonant. She groups tense and aspirated consonants together for being geminates and distinguishes them from plain consonants that are singletons. Aspirated and tense consonants are further distinguished underlyingly because aspirated consonants are specified with the underlying feature [s.g.], while tense consonants have no specified feature underlyingly.

On the other hand, Han (1996) holds a different view from Kim J. (1986). She claims that plain and aspirated consonants are singletons and that tense consonants are geminates with phonetic support. Aspirated consonants are singletons with the underlying feature [s.g.]. So she agrees with Kim J. (1986) in that aspirated consonants have the underlying feature [s.g.], but differs her opinion in that aspirated consonants are singletons, not geminates.

In this thesis, I take the position of Kim J. (1986) among others and argue that aspirated consonants are geminates with the underlying feature [s.g.]. I show that [s.g.] surfaces only as morpheme-initial /h/, or as a specified feature on aspirated non-continuant obstruents that are geminates. However, unlike Kim J. (1986)'s derivational approach, on which most Korean phonology is based, I use Optimality Theory (henceforth OT) for my analysis. In the context of my proposal, this study also deals with the interesting pattern of asymmetry between progressive and regressive aspirations observed in Korean. As specifically argued in chapter 4, this is significant because it seems to challenge the Parallelist Hypothesis of OT. However, I show that this could be resolved using Benua's proposal of output-output constraints (1997).

The organization of this thesis is as follows. In chapter 1, I introduce the aspiration process, and review previous analyses of aspirated consonants including tense consonants. In the remainder of chapter 1, I present some theoretical background about Korean phonemes and syllable structure. In chapter 2, I describe and analyze the behavior of /h/. Chapter 3 provides evidence in Modern Farsi that supports the main idea of the thesis that the deletion of laryngeal consonants triggers Compensatory Lengthening (CL). In Chapter 4, I show how my proposal is accounted for within an OT model. Chapter 5 summarizes each chapter and suggests implications for future research.

CHAPTER 1

THEORETICAL ISSUES

In this chapter, I introduce the theoretical issues involved in the treatment of aspiration, and aspirated consonants. Some Korean background information about the phonemic inventory and syllable structure is also presented in section 1.3.

1.1 Aspiration

In Korean, plain non-continuant obstruents (e.g. /p/, /t/, /k/, /c/) are phonemically contrastive with aspirated non-continuant obstruents (e.g. /p^h/, /t^h/, /k^h/, /c^h/). In addition to underlying aspirated consonants, there are two sources of derived aspiration in Korean. In consonant clusters C_1C_2, if C_1 is /h/ and C_2 is a non-continuant obstruent, then /h/ coalesces with C_2 and C_2 becomes aspirated. This is called 'progressive aspiration'. When C_1 is an obstruent, and C_2 is /h/, then C_1 and C_2 coalesce and the obstruent, which is C_1 in this case, gets aspirated. This is 'regressive aspiration'. Examples of each are given in (1) and (2) below. Note that [-] indicates a morpheme boundary, and [.] marks a syllable boundary.

(1) Progressive aspiration: /h/ + non-continuant obstruent

a.	/nah-ko/	[nak.k^{h}o]	'bear and'	(-ko: connective suffix)
b.	/noh-tən/	[not.t^{h}ən]	'put-PAST'	(-tən: past progressive suffix)
c.	/nah[1]/	[nat]	'give birth to'	

(2) Regressive aspiration: obstruent + /h/

a.	/-he/	[he]	'do'	
b.	/mos-he/	[mot.t^{h}e]	'cannot do'	(-he: compounding verb)
c.	/kop-he/	[kop.p^{h}e]	'multiply'	

[1] Morpheme-final /h/ and /s/ surface as [t] here. See § 4.3 for the analysis.

In the previous literature, Korean aspiration is treated as coalescence of /h/ and the adjacent obstruent, which yields an aspirated counterpart of the obstruent. However, given the fact that /h/ rarely surfaces in Korean, one might question what motivates the postulation of /h/ in the input as in (1) and (2). In (2), the compounding verb, '*-he*', also can independently stand by itself, acting like a verb that means 'do it'. In this case, /h/ surfaces as in (2a), so we are motivated to say that /h/ is in the input, and it coalesces with the preceding consonant, making it an aspirated consonant in the output. In this case, the [s.g.] feature in the output, is inherited from the input /h/, which has the underlying feature, [s.g.]. However, in case of (1), where /h/ is postulated in morpheme-final position in the input, it is reasonable to question whether there is /h/ in the input because Korean does not allow any coda /h/, and therefore /h/ does not surface as in (1c).

The analysis is motivated by a comparison of data as in (3). Only the surface form is given without the underlying form for objective observation.

(3) a. [na.ta] 'grow-DEC' (-ta: declarative suffix)
b. [nat.t^ha] 'give birth to-DEC'

(3a) is the surface form when a Declarative suffix '*-ta*' follows a root morpheme, '*na*', which means 'grow'. However, in (3b), the same Declarative suffix '*-ta*' surfaces in a different form when it attaches to a verb, 'na', that has the same surface form with (3a), meaning 'give birth to'. The initial stop is aspirated in this case. The same pattern is shown in (4).

(4) a. [na.ko] 'grow-CON' (-ko: connective suffix)
b. [nak.k^ho] 'give birth to-CON'

In (4a), when a connective suffix '*-ko*' attaches to a verb root morheme, '*na*', which is the same root morpheme as in (4a), it appears faithfully on the surface. On the contrary, the same connective suffix '*-ko*' surfaces differently in (4b) when it is attached to a different root morpheme, which has the meaning of 'give birth to'.

The alternation pattern of the suffix in (3a,b) and (4a,b) can be explained by two possible hypotheses. First, we can say that Korean has two kinds of declarative suffixes and they alternate depending on the meaning of the verb roots to which they are attaching. However, in terms of acquisition, this is so unpredictable that the only way we can learn which suffix attaches to which verb is to learn it through rote memorization which is inefficient. Second, we can turn our attention to the verb instead of the suffix itself. We can assume that the aspirating feature, which is [s.g.], of the suffix-initial comes from the verb morpheme. The verb in (3b) and (4b) has the underlying feature [s.g.] within its domain and it triggers the aspiration of the suffix that starts with a non-continuant obstruent.

Evidence that supports the latter is found from the hiatus phenomenon. When a root verb that ends in a vowel is followed by a suffix that starts with a vowel, it results in a vowel adjacency, which is called 'hiatus'. Especially, when a vowel-initial suffix '-*ɨni*' 'since' attaches to a stem final vowel, the *ɨ* gets deleted to avoid hiatus as in (5). On the contrary, when a vowel-initial suffix '*ɨni*' attaches to a stem final consonant, the deletion of the *ɨ* does not occur as in (6).

(5) a.	/ka + ɨni/	[ka.ni]	'go-since'
b.	/ o + ɨni/	[o.ni]	'come-since'

(6) a.	/mək + ɨni/	[mə.kɨ.ni]	'eat-since'
b.	/ip + ɨni/	[i.pɨ.ni]	'wear-since'

If the suffix, '*ɨni*' survives on the surface, it indicates that the verb ends in a consonant. Consequently, this could be a good test to see if a verb ends in a consonant or not. If we apply this test to the verbs in (3) and (4), which are repeated as in (7), we can see a discrepancy in the surface form.

(7) a.	/na + ɨni/	[na.ni]	'grow-since'
b.	/nah + ɨni/	[na.ɨ.ni]	'give birth to-since'

Previously, we assumed that the verb in (3b) and (4b) might have the [s.g.] feature underlyingly because it aspirates the following suffix that starts with a non-continuant obstruent. When the suffix, '-*ɨni*' attaches to the verb in (7a), the '*ɨ*' gets deleted as expected. However, when the suffix, '-*ɨni*' attaches to the verb in (7b), the '*ɨ*' does not get deleted, implying that the verb ends in a consonant. If we put our assumptions together that there is a segment or a underlying feature that triggers aspiration of the suffix within the verb domain, and that there is a consonant at the final position of the verb, we reach the conclusion that this final consonant must be /h/ that has the underlying feature, [s.g.]. Otherwise, there is no source where the [s.g.] feature can come from. We can think of aspirated consonants as possible candidates for the final segment of the verb because they have the underlying feature [s.g.] as /h/, but these aspirated consonants do not trigger aspiration of the following obstruent[2] and do not behave like a ghost consonant /h/. Hence, the verb in (3b) or (4b) is in fact underlyingly an /h/-final verb, although Korean does not allow /h/ to surface in coda position.

To summarize this section, there are verb roots that end in /h/. This is supported by the two observed facts. First, when a non-continuant obstruent initial suffix attaches to these verbs, the following obstruent gets aspirated. Second, there is no deletion of '-*ɨ*' suffix when it attaches to these verbs. Once we establish the fact that there is underlying /h/ in the input, we can say that Korean aspiration involves /h/ and the adjacent obstruent.

In the next section, I will review the literature on aspirated consonants.

1.2 Previous literature on Aspirated consonants

There are two sources of the surface aspirated consonants. The first case is underlying aspirated consonants (see (8)) and the second case is derived aspirated consonants formed by a process of aspiration, as we have seen in section 1.1. The underlying aspirated consonants are the aspirated counterparts of the plain stops and an affricate. The three-way contrast of non-continuant obstruents is shown in tableau (8).

(8) Three-way contrast of Korean non-continuant obstruents

[2] In fact, aspirated consonants trigger tensification of the following obstruent. This phenomenon is called Post Obstruent Tensification (POT).

	bilabial	alveolar	palatal	velar
Plain	p	t	c	k
Tense	p'	t'	c'	k'
Aspirated	p^h	t^h	c^h	k^h

(9) Minimal triplets of the three phonation types

a. plain: pul 'fire'

b. tense: p'ul 'horn'

c. aspirated : p^hul 'grass'

The three-way contrast in phonation distinguishes the meaning of words, as shown in (9). Thus, plain, tense, and aspirated obstruents are underlyingly different phonemes. However, in terms of structure, there has not been a consensus on the underlying structural status of each phonation type, especially on tense and aspirated consonants. Han (1996) argues aspirated consonants are underlying singletons while Kim J. (1986), Kim S. (1990), Jun (1994), and Choi and Jun (1998) argue aspirates are underlying geminates.

Han (1996) proposes a two-way phonation type contrast in stops, namely, plain and aspirated. She argues that what are previously interpretated as a third contrast, viz. tense consonants, are underlyingly plain geminates on the basis of two sources of evidence: the surface realization of two homorganic plain obstruents and the language typology of geminates. In Korean, a tense non-continuant obstruent can be derived from two plain non-continuant obstruents on the surface, which implies that the property of tenseness comes from a geminate structure. The other piece of evidence comes from a typological observation. There is a strong cross-linguistic tendency for languages with geminates to show the contrast within both the obstruents and the sonorants, rather than only one or the other of them in the underlying phoneme inventory[3]. According to Han's survey of the UCLA Phonological Segment Inventory Database (UPSID) (Maddieson 1984), 30 languages have been identified to have geminate consonants, and of the 30 languages, 22 languages have both sonorant and obstruent geminates,

[3]A similar pattern is found in Taylor (1985)'s typological survey, based on the Stanford Phonology Archive (Crothers et al., 1979). Among 28 languages that have at least one geminate obstruent, four of them do not have sonorant geminates.

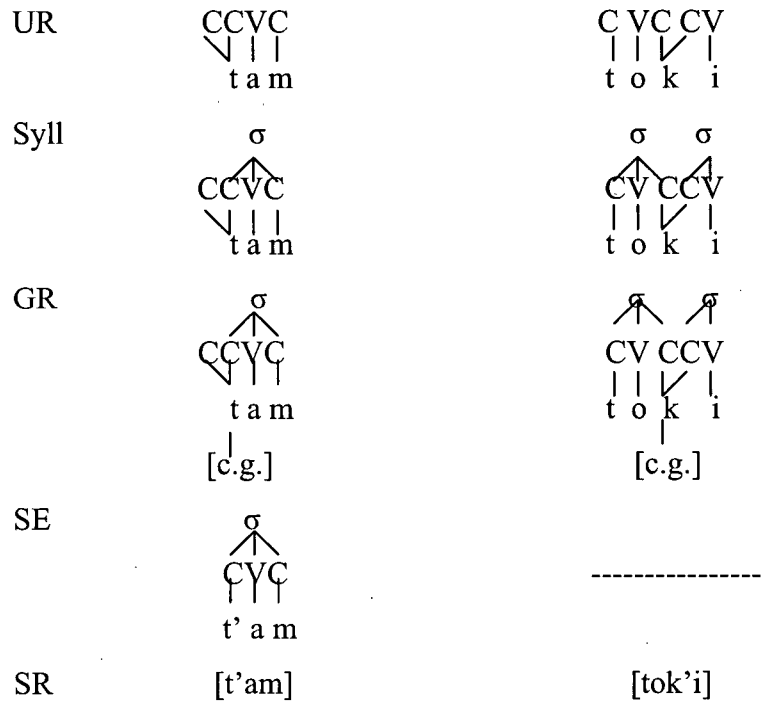
5 languages have only obstruent geminates, and 3 languages have only sonorant geminates. As Korean does have sonorant geminates such as /mm, nn, ll/, a much less marked system is observed if we have obstruent geminates as well.

Even though tense and plain consonants are distinguished in terms of timing relations, Han (1996) argues that on the surface they are also distinguished by featural specifications. The feature of tense consonants is inserted by a geminate reinforcement rule in her derivational hypothesis. She argues that Korean tense consonants are underlyingly plain geminates and the feature [c.g.] is redundantly specified later by a phonological rule of Geminate Reinforcement (GR). Thus in Han's analysis tense and plain consonants in Korean are distinguished by timing units in the underlying representation: tense consonants are assigned two timing units, while plain consonants have only one timing unit. In the surface representation, tense and plain consonants are further differentiated by the feature [c.g.] assigned to the tense consonants. Furthermore, Han (1996) solves an outstanding problem the previous geminate analyses have. She explains how tense consonants are allowed in the onset position against the strong syllable structure constraint in Korean, which allows only single consonants in the onset as well as the coda (Kim C. 1965, 1967). Most previous geminate analyses treat this problem with a stipulation that tense and aspirated consonants are exclusively allowed in the onset. According to her proposal, geminates in intervocalic position keep their own timing slots throughout the derivation, while those in initial or post-consonantal position lose one C-slot due to Stray Erasure (SE), since only one C-slot can be incorporated into the syllable structure[4] (Korean allows only one consonant in onset and coda on the surface.). The Korean syllable structure will be presented in more detail in the next section.

[4] The template of a Korean syllable structure will be introduced in § 1.3. The status of CG (glide) onsets will be discussed in § 1.3 as well.

(10) /ttam/ 'perspiration' /tokki/ 'axe'

initial position intervocalic position



As for aspirated consonants, Han (1996) holds a different view from tense consonants. Aspirated consonants are assumed to be underlying singletons, except for the case where the aspirated consonants are derived from /h/ and a plain consonant across a morpheme boundary. The reason she does not apply the same mechanism as that for the word-initial tense consonants to word-initial aspirated consonants comes from the results of the phonetic experiments. Unlike tense consonants, aspirated consonants are quite constant in closure duration across the two prosodic positions. Thus there is no phonetic evidence to support the claim within Han's assumptions pertaining to derivational theory that initial aspirated consonants undergo Stray Erasure, which means that initial aspirated consonants have to be singletons to satisfy the syllable structure constraint.

On the contrary, Yu (1989), and Choi & Jun (1998) argue that aspirated consonants are geminates. Yu finds his evidence in the Korean accent pattern. Yu (1989) documents that Korean has an accent pattern as in (11). The accent in modern Korean falls on the leftmost heavy

syllable[5] as in (11a-g), otherwise falls on the rightmost light syllable as in (11h-l): (Note ['] marks accent on the immediately following σ.)

(11)	a. /'sa:ram/	'human being'
	b. /'nunpora/	'snowstorm'
	c. /'pa:po/	'fool'
	d. /'c^{h}eksang/	'desk'
	e. /'c^{h}wi:ciknan/	'job shortage'
	f. /pa'ram/	'wind'
	g. /pi'hengki/	'plane'
	h. /a'u/	'younger brother'
	i. /ə'mi/	'mommy'
	j. /i'ma/	'forehead'
	k. /wema'ti/	'single section'
	l. /k^{h}ita'li/	'tall person'

Accent falls on the leftmost heavy syllable that has a structure of CV: or CVC. In (11a, b, c, d, e), accent falls on the first syllable, because it is heavy. If the first syllable is an open syllable CV, and the next syllable is CVC like in (11f) or (11g), the accent falls on the second syllable. If the words do not have any heavy syllable as in (11h-l), accent falls on the rightmost light syllable. Note that initial aspirated consonants seem to play no role in accent patterns. An extrasyllabic mora does not affect the weight of the syllable, as in (11-l).

Keeping this Korean accent pattern in mind, look at the examples that include intervocalic aspirated or tense consonants in (12).

(12) (Yu, 1989)

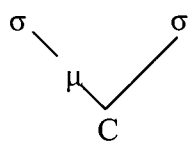
a. /'ik'i/	'moss'	a'. /'sat^{h}ang/	'candy'

[5] Heavy syllable is a syllable such as CVC or CVV that has two moras.

b. /'ək'e/	'shoulder'	b.' /'pak^{h}wi/	'wheel'
c. /'cok'i/	'vest'	c.' /'ap^{h}ɨm/	'pain'
d. /a'cəs'i/	'uncle'	d.' /'sic^{h}imi/	'pretense'
e. /a'cuk'ali/	'castor-oil plant'	e.' /ka'lik^{h}ita/	'point'

If aspirated and tense consonants are singletons, in an intervocalic position, they will be onsets[6] rather than codas in Korean. Thus, accent has to fall on the second syllable in (12) according to the accent pattern in (11). However, Yu (1989) documents that accent falls on the syllable preceding aspirated or tense consonants as in (12). This kind of accent pattern can be accounted for if we assume aspirated and tense consonants are ambisyllabic. I assume the ambisyllabic structure to be the same as geminate structure, the root node of the ambisyllabic segment linking to a mora of the preceding syllable and directly to the following syllable at the same time, as in (13).

(13)



If aspirated and tense consonants are ambisyllabic, as in (13), they can be simultaneously a coda of the preceding syllable and an onset of the following syllable. By being a coda of the preceding syllable, aspirated and tense consonants make the previous syllable heavy. This is why an open syllable preceding aspirated or tense consonants attracts the accent. Thus the ambisyllabicity of aspirated or tense consonants can account for the accent pattern in (12), which serves as evidence that aspirated consonants are geminates.

Huh (1965) finds evidence that supports the geminate hypothesis from the historical development of tense and aspirated consonants in Korean. According to Huh (1965), consonant clusters were allowed in Korean until the sixteenth century. In addition, each constituent in a cluster had its own phonetic value. As the language changed, the outer constituents assimilated to

[6] Korean has a high-ranking constraint, ONSET.

the inner most consonant, which was eventually changed into its tense counterpart as below (Jun, 1991).

(14) around the 16th century

(i) pt+s	→	tt+s	'meaning'
(ii) psi	→	ssi	'seed'
(iii) pste	→	tte	'time'

A similar pattern of historical development for some aspirated consonants in Modern Korean is shown below (Jun, 1991).

(15)	(i) amh.tak	→	am.t^{h}ak	'hen'
	(ii) salh.ko.ki	→	sal.k^{h}o.ki	'flesh'

This shows that some tense and aspirated consonants in Modern Korean were produced by the historical merger of plain consonants.

Another important argument concerns the semantic relation among plain, tense, and aspirated consonants in Korean onomatopoetic and mimetic words (Jun, 1991). Onomatopoetic and mimetic words with tense or aspirated onsets tend to have stronger connotations than ones with plain onsets. For example, /piŋ.piŋ/ is a mimetic word denoting the manner in which a top spins. In contrast, /p^{h}iŋ.p^{h}iŋ/ and /p'iŋ.p'iŋ/ denote faster, more intense, spinning. The interesting case is where the tense counterpart of a consonant does not exist. As I showed in the Korean consonantal phoneme inventory, /l/ in Korean does not have a tense/aspirated counterpart. Nevertheless, we can derive a stronger connotation by marking /l/ geminate as below (Jun, 1991):

(16) a.loŋ a.loŋ 'mottled' → alloŋ alloŋ 'densely mottled'

This suggests that tense and aspirated consonants have the same morphological and phonological status as geminates.

1.3 The Phonological Background of Korean

In this section, I provide some background information about the Korean phoneme inventory and syllable structure for those who are not familiar with Korean phonology.

1.3.1 Vowels and Consonants in Korean

There are seven vowel phonemes in Korean as follows:

(17) Vowel phoneme inventory[7]

	front	back	
	unround	unround	round
High	i	ɨ	u
Mid	e	ə	o
Low		a	

As for the consonants, Korean has the following phonemic consonants:

(18) Consonantal phoneme inventory (Kang, 1998)

	bilabial	alveolar	(alveo-) palatal	velar	glottal
Stop	p, p', p^h	t, t', t^h		k, k', k^h	
Affricate			c, c', c^h		
Fricative		s, s'			h
Nasal	m	n		ŋ	
Liquid		l			

Korean has 19 consonants in its consonantal inventory. Other than these 19 consonants, we have two more glides, /y/, and /w/. As it is still controversial whether they are consonants or vowels, and it is not significant for the present purpose, I do not include them in the phoneme inventory. Korean non-continuant obstruents are typologically unusual in that they have a three-way contrast, but they are all voiceless. The three different categories are often called plain (lenis),

[7] It is generally agreed that the low, front vowel /æ/ has been merged into /e/ over the last few decades. (Ko, 2001).

tense (fortis) and aspirated, and all these occur at three places of articulation: bilabial, denti-alveolar, and velar. The plain non-continuant obstruents have been described as lax, breathy, and slightly aspirated, the tense non-continuant obstruents as tense, laryngealized, and unaspirated, and the aspirated non-continuant obstruents as being strongly aspirated. Note that the fricative /s/ only has a two-way contrast: plain and tense. It does not have an aspirated counterpart as other stops and affricates. As fricatives are also obstruents, I refer to stops and affricates as non-continuant obstruents to distinguish them from fricatives that do not have a three-way contrast. Tableau (19) shows the three-way contrast of non-continuant obstruents that are stops and affricates.

(19) Korean non-continuant obstruents[8]: plain, tense, and aspirated distinctions (Hong 1997)

	bilabial	alveolar	palatal	velar
Plain	p	t	c	k
Tense	p'	t	c'	k'
Aspirated	p^h	t^h	c^h	k^h

1.3.2 Syllable Structure

In Korean, the maximal syllable structure is CGVC (Hong 1997) in which G stands for a glide (/y/ or /w/). Korean syllable structure is known to have only one consonant in onset and coda on the surface. It does not allow consonant clusters. However, I disagree with this claim on the basis of two facts. First, we have CG consonant clusters in onset position. Second, different consonant cluster effects are observed in coda position. I discuss this in more detail in section 4.5.

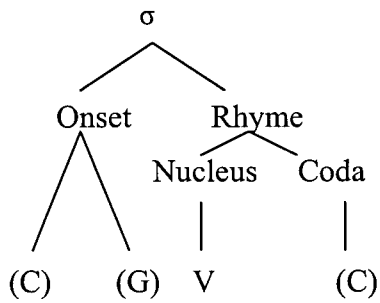
There is some debate about the treatment of the glide in Korean syllable structure. It has usually been regarded as part of a vowel (Kim C. & Kim H. 1991) owing to the orthography, but recently there is another claim that it may not be a part of a vowel but an onset element (Lee B. 1982). If such a claim is admitted, we may say Korean allows a consonant cluster only in the form of "C + G" in the syllable onset position. However, because this issue is beyond the scope of the present study, it will not be considered further here.

[8] In Hong (1997), /c/ is categorized as a palatal stop.

The plain consonants may occur in onsets or codas whereas laryngealized consonants like tense or aspirated consonants occur only in the onset position of the syllable, never in codas. Syllable coda position is restricted to only plain or lenis consonants /p, t, k/, nasals /m, n, ŋ/ and a lateral /l/.

The syllable template of Korean is represented as in the following (20) and the examples are given in (21).

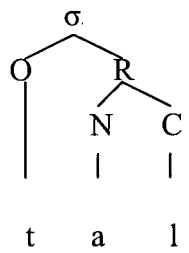
(20) Korean syllable structure



G: glide

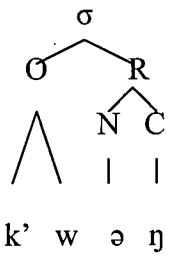
(21) Examples of Possible Syllables (O = Onset N = Nucleus C = Coda R = Rhyme)

a.



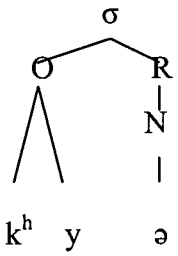
'moon'

b.



'pheasant'

c.



'turn on (the light)'

Note that tense or aspirated consonants can occupy the onset position of the syllable even when a glide is following as part of an onset. This means that these consonants are not a consonant cluster but a single consonant, otherwise they cannot be in onset position because it will violate the wellformedness of a Korean syllable structure. For example, if /k^h/ is considered to be a consonant cluster of /kh/, then (21c) would have 3 segments in onset position.

CHAPTER 2

THE BEHAVIOR OF /h/

As /h/ plays an important role, being a trigger of Korean aspiration, I describe and analyze the phonological behavior of /h/ in Korean in this chapter. In general, /h/ in Korean behaves like a consonant in the initial position of a word. However, in non-word-initial position, it rarely[9] appears on the surface, but only triggers different surface realizations.

2.1 Initial position

2.1.1 Word-initial position

/h/ can appear in word initial position. It can be word-initial in noun roots as in (22), or suffixes as in (23).

(22) a	he	[he]	'sun'
b.	hanɨl	[ha.nɨl]	'sky'
c.	hɨmɨs	[hɨ.mɨt]	'satisfaction'

(23) a.	hata	[ha.ta]	'do it'	(compounding verb 'do')
b.	–hi	[hi]	'Passive'	(passive suffix)
c.	–hako	[ha.ko]	'and'	(conjunctive suffix)

The words in (22) and (23) are all pure Korean words. The vocabulary of the Korean language is composed of indigenous words and loan-words, the latter being the result of contacts with other languages. The majority of the loan-words are of Chinese origin, often called Sino-Korean words. In modern Korean, native words are significantly outnumbered by Sino-Korean words. These Sino-Korean words constitute about 55% of Korean vocabulary. /h/ can appear in initial

[9] When /h/ is an onset intervocalically, it is produced in slow speech. See § 4.1 for more details (p.42).

position of Sino-Korean words, as in (24). Note that all morphemes are composed of a single syllable in Sino-Korean.

(24)	hak	[hak]	'school'
	he	[he]	'sea'
	ho	[ho]	'name'
	hə	[hə]	'false'
	hu	[hu]	'after'

2.1.2 Morpheme-initial position

When /h/-initial suffixes are bound to root morphemes, /h/ is realized differently on the surface depending on the preceding segment. Note that the aspirated consonants here are in fact geminates, as I will argue for later in chapter 4.

(25) Non-continuant obstruent + /h/-initial suffix

a.	kop-hata	[kop^{h}ata]	'to multiply-do'
b	yak-hata	[yak^{h}ata]	'to weak-do'
c.	ip-hi	[ip^{h}i]	'wear-Passive'
d.	mak-hi	[mak^{h}i]	'stop-Passive'
e.	tat[10]-hi	[tac^{h}i]	'shut-Passive'

If the preceding segment is a plain non-continuant obstruent as in (25), /h/ and the preceding segment merge to become the aspirated counterpart of the plain non-continuant obstruent. This is a case of regressive aspiration, as we have seen in the previous chapter.

(26) fricative[11] + /h/-initial suffix

a.	t'ɨs -hata	[t'ɨt^{h}ata]	'to mean-do'

[10] When a morpheme-final /t/ is followed by a high vowel, the coronal /t/ gets palatalized and surfaces as an affricate [c].
[11] Note that there is no /h/ + /h/ concatenation in Korean.

When /h/ is preceded by a fricative /s/, the result is not an /s^h/, but instead an aspirated /t^h/. The fricative /s/ is neutralized to /t/ in coda position and it is this /t/ that merges with /h/ to become aspirated. This seems like a rule-ordering process, but I show that this can be explained with an output-based approach in chapter 4.

(27) vowel/sonorant + /h/-initial suffix

a.	can#c^{h}i-hata	[canc^{h}ihata], [canc^{h}iata]	'to party-do'
b.	il-hata	[ilhata], [ilata]	'to work-do'

When /h/ is preceded by a vowel or a sonorant as in (27a,b), it deletes optionally depending on the rate of speech. If it is read carefully, /h/ is pronounced, otherwise it is deleted.

(28) aspirated/tense consonants + /h/-initial suffix

a.	ip^h-hako	[ip^{h}ako]	'leaf and'
b.	k'ɨt^h-hako	[k'ɨt^{h}ako]	'end and'
c.	pak'-hako	[pak^{h}ako]	'exterior and'

Note that in (28 a, b, c) the aspirated or tense segments in a morpheme-final position act like their plain counterparts in that they yield aspirated consonants when they coalesce with the following /h/.

(29) consonant cluster + /h/

a.	saks-hako	[sak^{h}ako]	'with a share'
b.	talk-hako	[tak^{h}ako]	'with a hen'

As mentioned before, Korean does not allow any complex onsets or codas. So when there is a consonant cluster morpheme-finally, it is reduced to a single consonant that satisfies coda restrictions. See more discussion of coda neutralization in chapter 4.

Other than the stem-suffix concatenation as in (25)-(29), root-root concatenation of Sino-Korean words is also common. While native Korean words are mostly constituted by one morpheme as in (22) and (23) unless it is a compound word, Sino-Korean words are constituted by more than one morpheme because most of them are compound words. In Sino-Korean morphemes where each constituent is a root morpheme, the morpheme-initial /h/ of the second constituent also surfaces differently depending on the preceding segment as in (30). Remember that the initial /h/ of the second morpheme surfaces when the second morpheme stands alone as in (24).

(30) Sino-Korean compound words

a.	ip#hak	[ip^{h}ak]	'entering school'
b.	pəp#ho	[pəp^{h}o]	'Buddhist name'
c.	nak#ha	[nak^{h}a]	'falling down'
d.	sək#hwe	[sək^{h}we]	'lime'
e.	no#hu	[nohu], [nou]	'old age'
f.	o#he	[ohe], [oe]	'misunderstanding'
g.	sil#hwa	[silhwa], [silwa]	'a true story'

When the preceding segments are non-continuant obstruents as in (30a-d), /h/ aspirates them and the preceding segment becomes its aspirated counterpart. In (30e-g), /h/ is preceded by a vowel or a sonorant. This is a case when free variation happens. Either /h/ is deleted or it is not, depending on the rate of speech. In fast speech, /h/ is deleted, while in slow speech, it is not.

2.1.3 Syllable-initial position

Within a word[12], /h/ can appear in syllable-initial position, as (31).

(31) a.	ahop	[ahop], [aop]	'nine'
b.	ilhɨn	[ilhɨn], [ilɨn]	'seventy'

[12] These are pure Korean words.

When /h/ appears word-internally, it can be either between two vowels, or between a sonorant /l/ and a vowel. In the medial position, it deletes optionally according to the speed of production or by the degree of formality.

2.2 Morpheme-final position

Although /h/ never surfaces in coda position, Korean is known to have stem final /h/ verbs and it is only in this case when /h/ can be in a morpheme-final position[13]. As the verbal roots are bound forms, morpheme-final /h/ is always followed by a suffix. In this section, I only give consonant-initial suffixes. I will talk about vowel-initial suffixes later in section 2.3.

When /h/ appears in morpheme-final position, it is preceded by a vowel as in (32)-(34), or by a sonorant which is a part of consonant cluster as in (35)-(37). While the morpheme-final /h/ can be preceded only by a vowel or a sonorant, it can be followed by various segments in terms of manner of articulation like non-continuant obstruents as in (32), and (35), nasals as in (33), and (36), fricatives as in (34), and (37).

(32) CVh + non-continuant obstruent initial-suffix

	/noh/	[not]	'put'
a.	noh-ko	[nok^{h}o]	'put-Connective'
b.	noh-ta	[not^{h}a]	'put-Declarative'
c.	noh-ca	[noc^{h}a]	'put-Persuasive'
	/nah/	[nat]	'give birth to'
d.	nah-ko	[nak^{h}o]	'give birth-Connective'
e.	nah-ta	[nat^{h}a]	'give birth-Declarative'
f.	nah-ca	[nac^{h}a]	'give birth-Persuasive'

[13] Besides /h/-final verbs, Korean is known to have /h/-final predicate adjectives that describe colors. When a non-continuant obstruent-initial suffix follows these predicate adjectives, the non-continuant obstruent gets aspirated. However /h/-final predicate adjectives do not pass the '-ɨni' test. In other words, when the suffix '-ɨni' is attached to /h/-final predicate adjectives, the initial vowel part 'ɨ' deletes. This implies that morpheme-final phone of the adjective is a vowel, not an /h/. Thus, I do not include these predicate adjectives in my current analysis as it is unknown whether they end in /h/ in the underlying form or not.

	/nəh/	[nət]	'insert'
g.	nəh-ko	[nək^{h}o]	'insert-Connective'
h.	nəh-ta	[nət^{h}a]	'insert-Declarative'
i.	nəh-ca	[nəc^{h}a]	'insert-Persuasive'

When /h/ is followed by a non-continuant obstruent, they merge together to become the aspirated counterpart of the non-continuant obstruent. This is progressive aspiration. Note that when an /h/-final verb morpheme stands alone, the /h/ surfaces as [t]. This is because Korean has a coda restriction that allows only non-continuant segments in coda position. See section 4.3 for more details.

(33) CVh + sonorant-initial suffix[14]

a.	noh-nɨn	[nonnɨn]	'put-Progressive'
b.	nah-nɨn	[nannɨn]	'give birth-Progressive'
c.	nəh-nɨn	[nənnɨn]	'insert-Progressive'

When /h/ is followed by a nasal, it is assimilated to the nasal sound, producing a geminate. This is very important for my geminate hypothesis because it shows that nasal segments geminate in the same environment when progressive aspiration occurs. This implies that aspirated consonants are geminates as well.

(34) CVh + fricative-initial suffix

a.	noh-sɨp	[nos'ɨp]	'put-Style'
b	nah-sɨp	[nas'ɨp]	'give birth-Style'
c.	nəh-sɨp	[nəs'ɨp]	'insert-Style'

[14] Korean does not have suffixes that start with other sonorants than /n/.

When a plain fricative follows /h/, the plain fricative becomes its tense counterpart because it does not have an aspirated counterpart. Though aspiration does not occur in (34) as in (32) when /h/ merges with non-continuant obstruents, the data in (34) still shows us that when there is a loss or coalescence of /h/, it affects the adjacent segment to get longer according to the analysis whereby tense consonants are geminates as well.

(35) CVR[15]h + non-continuant obstruent-initial suffix

	/k'ɨnh/	[k'ɨn]	'cut'
a.	k'ɨnh-ko	[k'ɨnk^{h}o]	'cut-Connective'
b.	k'ɨnh-ta	[k'ɨnt^{h}a]	'cut-Declarative'
c.	k'ɨnh-ca	[k'ɨnc^{h}a]	'cut-Persuasive'
	/ilh/	[il]	'lose'
d.	ilh-ko	[ilk^{h}o]	'lose-Connective'
e.	ilh-ta	[ilt^{h}a]	'lose-Declarative'
f	ilh-ca	[ilc^{h}a]	'lose-Persuasive'
	/t'ulh/	[t'ul]	'punch'
g.	t'ulh-ko	[t'ulk^{h}o]	'punch-Connective'
h.	t'ulh-ta	[t'ult^{h}a]	'punch-Declarative'
i.	t'ulh-ca	[t'ulc^{h}a]	'punch-Persuasive'

In (35), /h/ is a part of consonant cluster in morpheme-final position. When a non-continuant obstruent-initial suffix follows the /Rh/ cluster, it gets aspirated. This shows us that when /h/ is a part of consonant cluster in coda position, it gets deleted, but when a suffix follows it, it does not. For more discussion, see section 4.5.

(36) CVRh + sonorant-initial suffix

[15] R: Resonant

a.	k'ɨnh-nɨn	[k'ɨnnɨn]	'cut-Progressive'
b.	ilh-nɨn	[ilnɨn]	'lose-Progressive'
c.	t'ulh-nɨn	[t'ulnɨn]	'punch-Progressive'

(37) CVRh + fricative-initial suffix

a.	k'ɨnh-sɨp	[k'ɨns'ɨp]	'cut-Style'
b.	ilh-sɨp	[ils'ɨp]	'lose-Style'
c.	t'ulh-sɨp	[t'uls'ɨp]	'punch-Style'

The data in (36b) and (36c) show that the nasal segment does not get geminated when it follows /h/. This is interesting because in (33), the nasal sound geminates after /h/, supporting the geminate analysis. Detailed analysis of this matter is in section 4.5.

2.3 Intervocalic /h/

There are two cases where /h/ can be intervocalic. One is with a stem final /h/ followed by a vowel-initial suffix as in (38), and the other is when /h/ is in a morpheme-initial position preceded by a vowel as in (39). /h/ is deleted obligatorily in the former when it is morpheme-final, while /h/ is deleted optionally in the latter depending on the rate of the speech. In careful speech, /h/ is pronounced, while in casual speech, it is deleted.

(38) Vh]-V or VRh]-V

a.	coh-A	[coa]	'be good'	e. nəh-A	[nəə]	'put it'
b.	noh-A	[noa]	'let go'	d. k'ɨnh-A	[k'ɨnə]	'cut'
c.	s'ah-A	[s'aa]	'stack'	f. ilh-A	[ilə]	'lose'
d.	nah-A	[naa]	'give bear to'	h. t'ulh-A	[t'ulə]	'punch'

The infinitive suffix, /A/ has two allomorphs. It is realized as [a] or [ə] according to the vowel

quality of the verb stem (Kim S., 1989).[16] When the vowel in the stem is /o/ or /a/, the suffix is [a] and for the other vowels, the suffix is realized as [ə].

i.	coh-ɨmyən	[coɨmyən]	'if it is good'
j.	noh-ɨmyən	[noɨmyən]	'if one lets go'
k.	s'ah-ɨmyən	[s'aɨmyən]	'if one stacks'
l.	nah-ɨmyən	[naɨmyən]	'if one gives bear to'
m.	k'ɨnh-ɨmyən	[k'ɨnɨmyən]	'if one cuts'
n.	nəh-ɨmyən	[nəɨmyən]	'if one puts in'
o.	ilh-ɨmyən	[ilɨmyən]	'if one loses'
p.	t'ulh-ɨmyən	[t'ulɨmyən]	'if one punches'

However, the conditional suffix '–ɨmyən' surfaces as the same form regardless of the vowel quality of the stem. In this case, only the coda *h* of the stem deletes, when the conditional suffix follows it.

Now consider the behavior of intervocalic /h/ where /h/ is suffix-initial as in (39A) or morpheme-initial as in (39B):

(39) V]-hV

A. Stem + h-initial suffix

a.	p^hi-ha	[p^hiha], [p^hia]	'avoid'
b.	ko-ha	[koha], [koa]	'speak'

B. Sino-Korean

a.	o#hu	[ohu], [ou]	'afternoon'

[16] Vowel Harmony (ATR (advanced tongue root) assimilation:/ɨ, ə/ is marked for [ATR], while /o,a/ is not (Lee J-S 1992).

b.	yə#heŋ	[yəheŋ], [yəeŋ]	'travel'
c.	yə#han	[yəhan], [yəan]	'grudge'
d.	ku#ho	[kuho], [kuo]	'relief'
e.	si#həm	[sihəm], [siəm]	'exam'
f.	so#hwa	[sohwa], [sowa]	'digestion'

C. Within a morpheme

a.	mahɨn	[mahɨn], [maɨn]	'forty'
b.	ahɨn	[ahɨn], [aɨn]	'ninety'

As mentioned previously, when the intervocalic /h/ is in morpheme-initial position, it optionally deletes depending on the rate of speech, while intervocalic /h/ in morpheme-final positions obligatorily deletes. This implies that morpheme-initial positions are more significant than morpheme-final positions in Korean.

There seems to be no restriction on the surrounding vowels of /h/. The data from (22)-(24) show that all the 7 vowels can follow /h/. The data from (32) to (39) show that all the vowels except for /e/ can precede /h/. This is rather accidental than systematic given the fact that Korean does not have an h-final verb stem that has /e/ for its nuclear vowel.

2.4 Historical Residue

2.4.1 *h* final substantives[17]

In Korean, /h/ is only allowed morpheme[18]- finally nowadays when it is a part of the verb or predicate adjective stem. However, in Middle Korean used in the 15th century, there were some exceptional cases where /h/ could be morpheme-final in other parts of speech. These were known as h-final substantives. Well- known cases were *hanɨlh* 'sky', *patah* 'sea', *narah* 'country', and *anh* 'inside', etc.

[17] Substantives include nouns, pronouns, and numerals.
[18] Although /h/ may be root-final, but it never surfaces as syllable-final.

(40) 15th Century

a.	hanɨlh-i	[hanɨlhi]	'sky-NOM'	(-i: Nominative suffix)
b.	patah-i	[patahi]	'sea-NOM'	
c.	narah-i	[narahi]	'country-NOM'	
d.	anh-i	[anhi]	'in-NOM'	

When a Nominative subject suffix '*i*' attaches to these h-final nouns, the morpheme-final /h/ syllabifies as an onset of the following syllable. However, the morpheme-final /h/ of these nouns has been deleted with the lapse of time. The influence of /h/ of these h-final substantives has mostly disappeared these days except for some words. Nowadays, we can see the synchronic residue of /h/ in some words (e.g. *an* 'inside', *am* 'female', *su* 'male', *məli* 'head', and *sal* 'flesh') only when they combine with certain root morphemes (i.g. *pak* 'out', *talk* 'hen', *pyungali* 'chick', *koki* 'meat', respectively) that start with non-continuant obstruents. The data in (41) imply the presence of morpheme-final /h/, but in the data in (42), there is no surface manifestation of an /h/. The input indicates (h) which may reflect a floating [s.g.] feature to account for its realization only on stops or to fill Onset.

(41) a.	an(h)#pak'	[anp^{h}ak']	'in and out'
b.	am(h)#talk	[amt^{h}ak]	'hen'
c.	su(h)#pyungali	[sup^{h}uŋar[19]i]	'male chick'
d	məli(h)#kalak	[mərik^{h}arak]	'hair'
e.	sal(h)#koki	[salk^{h}oki]	'red meat'
f.	su(h)#oli	[sutori], *[suhori]	'male duck'

(42) a.	an-i	[ani], *[anhi]	'in-NOM'
b.	am#oli	[omori], *[amhori]	'female duck'
c.	məli-ka	[mərika], *[mərik^{h}a]	'hair-NOM'

[19] Voicing assimilation: /l/ surfaces as [r] intervocalically.

As shown in (41), the initial morphemes here do not surface with a final [h]. However when these morphemes combine with other root morphemes that start with non-continuant obstruents, the non-continuant obstruent surfaces as aspirated as if it has been affected by /h/. This implies that the lexical representation of the input must include /h/. Interestingly, when a vowel-initial root morpheme follows h-final substantives, /h/ surfaces as [t] if there is no consonant preceding /h/ as in (41f). This is to avoid hiatus. When the same vowel-initial root morpheme follows /h/ that is preceded by another consonant as in (42b), /h/ does not surface and simply deletes. There is no reason for /h/ to surface because the preceding consonant of /h/ avoids hiatus in this case. Note that when a suffix rather than a root, no matter it is vowel-initial or consonant-initial, follows h-final substantives, there is no influence of /h/ on the surface as in (42a) or (42d).

The historical fact that Korean had h-final substantives supports the motivation of h-final verbs, though Korean does not allow /h/ to surface in coda.

CHAPTER 3

LARYNGEAL CONSONANTS AND CL

Compensatory Lengthening (CL) is defined as the lengthening of a segment upon the deletion or shortening of a nearby segment. Hayes (1989) has argued that while deletion of segments from a syllable rhyme often triggers lengthening of a neighboring segment, deletion of an onset segment rarely does, suggesting that the relevant unit for compensatory lengthening is the mora, rather than the skeletal slot. Within a moraic account, deletion of a vowel or consonant leaves an empty mora node, whose association with another melodic unit results in quantity. In other words, deletion causes compensatory lengthening because it results in a stranded mora, creating an empty prosodic unit to which one of the residual segments spread.

There are several cases described in the literature (e.g. Kavitskaya 2001) when the deletion of glottal or laryngeal stops causes historical or synchronic CL of surrounding vowels, as for example, in Tehrani Farsi (Indo-European), Ket (isolate language of Siberia), Leti (Austronesian), Wanka Quechua (Quechuan), Mohawk (Iroquoian), Klamath (Penutian), Bella Coola (Salish), Choktaw (Muskogean), etc. In this chapter, I provide cross-linguistic evidence in Modern Farsi cited from Sumner (1999) that corroborates the main idea of the thesis that the deletion of laryngeal consonants may trigger CL. In both Farsi and Korean, a laryngeal consonant triggers CL when it coalesces with the adjacent consonant. The principal difference between the Farsi data and Korean data is in the realization of CL. In Farsi, the deletion of glottal consonants triggers lengthening of a surrounding vowel, whereas in Korean, the deletion or coalescence of /h/ triggers gemination of the adjacent consonant. A further difference derives from the differences in phonetic inventory: because /h/ is the only laryngeal consonant in Korean, it alone functions to trigger CL, whereas both /h/ and /ʔ/ do so in Farsi.

3.1 CL data in Farsi

Modern Colloquial Tehrani Farsi exhibits CL triggered by only a subset of consonants which are lost in the relevant environment (Darzi 1991). The subset of consonants that triggers CL in Farsi is restricted to the two laryngeal consonants, /ʔ/ and /h/.

(43) Modern Colloquial Tehrani Farsi:

a.	/robʔ/	ro:b	'quarter'	b.	/qæhr/	qæ:r	'wrath'
c.	/suʔ/	su:	'bad'	d.	/pæhna/	pæ:na	'width'
e.	/fekr/	fek	'thought'	f.	/qænd/	qæn	'sugar'
g.	/bist/	bis	'twenty'	h.	/dozd/	doz	'thief'

CL only occurs with the loss of glottal consonants. In (43a-d), when a laryngeal consonant such as /ʔ/ or /h/ deletes, the surrounding vowel lengthens. In (43g-h), a consonant coda deletes, but its deletion does not result in CL. At first glance, one may assume that this is because only glottal consonants are moraic while other consonants are not. While the moraic status of glottal consonants is still controversial, I will not address this further because it is outside the scope of my current study.

One might question how we know that there are glottal consonants in the underlying form in data (43). Darzi (1991) gives one type of evidence that supports the hypothesis that glottal consonants are present underlyingly. In Farsi, there is a language game in which the last syllable of a word is transposed to its beginning.

Darzi played this language game with his consultant and got the following result, which I provide in (44). The first column shows the formal conservative forms of words and the second column shows their colloquial forms which Darzi produced incorporating the effect of CL, and the third column shows the response on the part of the consultant.

(44)	conservative	colloquial	consultant's response
	taʔmir	tæ:mir	mir-tæʔ
	jæʔfær	jæ:far	fær-jæʔ
	zæhra	zæ:ra	ra-zæh
	pæhna	pæ:na	na-pæh[20]
	meʔmar	me:mar	mar-meʔ
	ʔeʔdam	ʔe:dam	dam-ʔeʔ

[20] In Darzi (1991), the form of the consultant's response is [næ-pæh]. However, I consulted one Farsi speaker and I got [na-pæh]. As the vowel change in [næ-pæh] seems to be irrevelant to my current discussion, I use [na-pæh] instead.

tehran	te:ran	ran-teh
behtær	be:tær	tær-beh
to?me	to:me	me-to?
zohre	zo:re	re-zoh
ʃahrud	ʃa:rud	rud-ʃah

Now, if there were no underlying glottal consonants in the colloquial form that contains a long vowel, how would one explain a glottal consonant showing up at the end when the consultant switched the order of two syllables? In fact, the glottal consonant that shows up in column 3 is identical to the glottal consonant that lies in the conservative forms. These facts can only be accounted for under a hypothesis that posits glottal consonants in the underlying representation of the colloquial forms.

To sum up, when a segment (a consonant or a vowel) gets deleted, it tends to leave a trace of its position. There are two ways to leave a trace when a segment gets deleted. It can lengthen the adjacent segment, which is called CL, or it can leave a feature on the neighboring segment by spreading or reassociation. In Korean, the laryngeal consonant /h/ seems to leave its mark by in both ways when it is deleted: geminating and aspirating the adjacent segment. I will discuss this within an Optimality Theory framework in the next chapter.

CHAPTER 4

OT ACCOUNT

In this chapter, I account for the facts of Korean aspiration as documented in chapter 2 within an Optimality Theory (OT) framework.

4.1 Coalescence

In this section, I present an Optimality Theoretic account of Korean aspiration. Before analyzing the phenomenon, I will briefly recapitulate the relevant generalizations. As mentioned in chapter 1, when plain non-continuant obstruents /p,t,c,k/ are followed or preceded by /h/, the result is a corresponding aspirated consonant on the surface. This is called aspiration. This aspiration phenomenon is of two types: a progressive aspiration when /h/ precedes a non-continuant obstruent, and a regressive aspiration when /h/ follows a non-continuant obstruent. Hong (1997) postulates that the maximal syllable is CGVC[21] in which G stands for a glide (/y/ or /w/). This delimits a maximal Onset to one consonant and one glide. In the analysis to be developed here (Shaw 2002), I argue that complex codas of declining sonority, specifically, $RO]_\sigma$, are well-formed, and must be recognized in order to account for the asymmetric patterning of aspirates or certain morphophonemic changes. The maximal syllable must, therefore, be revised to allow $..VRO]_\sigma$. Complex codas of any other type, e.g. $OO]_\sigma$ or $*RR]_\sigma$, are strictly prohibited, however, with the consequence that any OO sequence must be heterosyllabic. Further, /h/ never clusters in an [hC] or [Ch] sequence tautosyllabically. Therefore, progressive aspiration occurs when a morpheme-final /h/ is followed by a morpheme-initial non-continuant obstruent (e.g. /t/, /k/, /c/,/p/) and regressive aspiration occurs when the reverse holds, when a morpheme-final non-continuant obstruent is followed by a morpheme-initial /h/.

As the two segments, /h/ and a non-continuant obstruent, do not lose their own segmental features during aspiration, this is coalescence. The process of coalescence is the fusion of two underlying segments into one surface segment (McCarthy, 1998). The surface segment typically combines the properties of its underlying parents.

---

[21] See § 1.3.

Pre-OT work on coalescence has mostly focused on the question of how the properties of the two input segments are united in the single output segment.

(45) The representation of coalescence

Since there is retention of features of two input segments in a single output segment, the correspondence of the retained segment must be considered. In OT, the focus is on the competition between candidates with deletion vs. candidates with coalescence. Deletion involves a MAX violation, while coalescence is posited by McCarthy & Prince (1995) to involve a violation of another constraint on correspondence, namely UNIFORMITY. And it is the ranking between the two faithfulness constraints that decides the outcome. These two constraints are given in (46) and (47) respectively.

(46) MAX-IO (McCarthy & Prince 1995)
Every segment of the input S_1 has a correspondent in the output S_2.

(47) UNIFORMITY --- "No Coalescence" (McCarthy & Prince 1995: 123)
No element of S_2 has multiple correspondents in S_1.
For $x, y \in S_1$ and $z = S_2$, if $x = z$ and $y = z$, then $x = y$.

If MAX is ranked higher than UNIFORMITY, then we expect to get coalescence because the higher-ranking constraint, MAX does not allow any deletion. On the other hand, if UNIFORMITY is ranked higher than MAX, this ranking results in deletion instead of coalescence because the higher-ranked constraint, UNIFORMITY does not allow any one-to-multiple correspondence relation between input and output elements. Thus, the basic idea of coalescence is composed of two constraints: forcing all segments to be acknowledged in the output by violating UNIFORMITY and avoiding deletion of segments by observing MAX-IO.

Other than the faithfulness constraints, we also need markedness constraints that can account for the unique behavior of /h/, which helps us to understand Korean aspiration. Consider the following cases in (48) and (49).

(48) In syllable-final position, /h/ never surfaces.

a.	/nah/	[nat[22]]	'give birth to'
b.	/noh/	[not]	'put'

Remember that although /h/ does not surface when it is in coda position, we have motivated stem-final /h/ underlyingly in the input because of two major types of synchronic morphophonemic evidence. First, a following non-continuant obstruent becomes aspirated and this must be triggered by the preceding /h/ that is underlyingly in the input. Second, when a suffix, -ɨni 'since', attaches to these roots, 'ɨ' of the suffix does not get deleted, which means the root ends in a consonant. Further, evidence from historical sources was also cited.

On the other hand, there is no problem with /h/ surfacing in word-initial positions.

(49) a.	he	[he]	'sun'
b.	hanɨl	[ha.nɨl]	'sky'
c.	hosu	[ho.su]	'lake'

As in (48) and (49), /h/ surfaces in syllable-initial position, but not in coda position. Before introducing the constraints for our OT account, I give the feature geometry[23] of /h/ in (50). Adopting Clements & Hume (1995), (50) is its simplified version showing only features relevant to the present discussion, assuming a monovalent feature system.

(50) /h/

Root
|
Laryngeal
|
[s.g.]

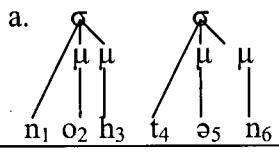
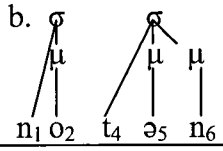
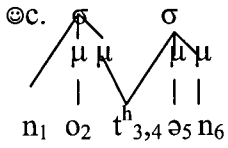
[22] Coda neutralization. See more details in § 4.3.1.
[23] See more details in § 4.3.1.

Since /h/ has a laryngeal node as in (50), I apply Lombardi's alignment constraint which is given in (51).

(51) ALIGN-L ([lar], σ): Every laryngeal node stands at the left edge of a syllable.
(This constraint is also referred to as a laryngeal neutralization constraint by Lombardi (1994).)

The alignment constraint in (51) requires that 'h', or more specifically [s.g.], stands at the onset of a syllable. The effect of this constraint is that /h/ is licensed only in onset position. In turn, this constraint does not allow any laryngeal feature, including [s.g.], in coda position, thus ruling out /h/ codas. Returning to the progressive aspiration case, we see in (52) a tableau with the three constraints introduced so far: UNIFORMITY, MAX, and ALIGN-L ([lar], σ). As mentioned earlier, it is the ranking among the faithfulness constraints – MAX-IO>> UNIFORMITY- that gives coalescence rather than deletion according to McCarthy (1995). I indicate correspondence through the use of indices in tableau (52).

(52) Tableau for 'not^{h}ən'

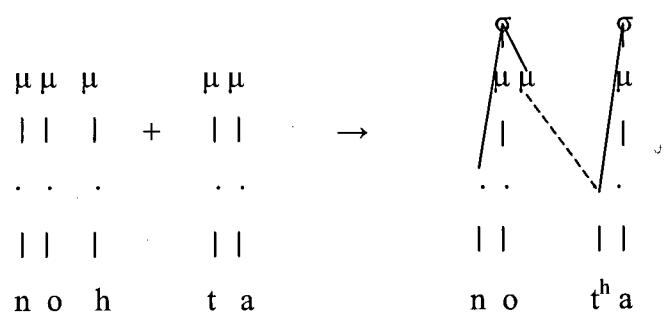
$\mu\ \mu\ \mu\ \mu\ \mu\ \mu$ $n_1\ o_2\ h_3\ t_4\ ə_5\ n_6$	ALIGN-L ([lar], σ)	MAX-IO (segment)	UNIFORMITY
a. 	*!		
b. 		*!	
☺c. 			*

Candidate (a), where neither deletion nor coalescence happens, violates ALIGN-L ([lar], σ), because it has /h/ in coda position. Candidate (b) is ruled out because it violates MAX-IO by deleting /h/. The winning candidate is (c)[24] in which coalescence occurs. The ALIGN-L ([lar], σ) constraint works as the motivating constraint for coalescence in this case. Also there is no deletion of a segment in (c), which satisfies the constraint MAX-IO. Although violating UNIFORMITY, candidate (c) surfaces as the optimal output, because it satisfies both the higher–ranking constraints. Two issues need to be addressed about tableau (52). First, following Hyman (1985) it is crucially assumed that every segment is underlyingly moraic in the input. Second, note that candidate (c) does not violate ALIGN-L ([lar], σ). Though [s.g.] is specified on an ambisyllabic segment that is aligned to both edges of a syllable, it is still aligned to the left edge of a following syllable. More discussions on these two issues follow in section 4.2.

Let us take a deeper look at the constraint, MAX-IO (segment). To disambiguate the meaning of the constraint, I redefine the MAX-IO (segment) constraint as MAX-IO (root node).

(53) MAX-IO (root node): Every root node in the input must be in the output.

(54) /noh-ta/ [not^{h}a] 'put-Dec'



(· root node)

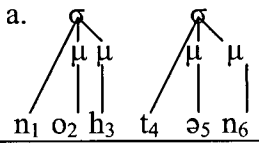
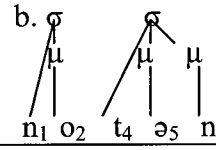
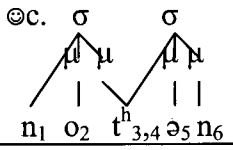
As shown in (54), when there is coalescence of the /h/ segment and the adjacent obstruent, the root node of /h/, in fact, deletes during the process of aspiration. The feature [s.g.] of /h/ disassociates from its root node and attaches to the following root node of the obstruent. While the root node that [s.g.] has left deletes, thus leaving an unassociated mora, the following root node that gained the [s.g.] feature compensatorily lengthens to fill in the empty mora. In (54),

[24]Candidate (c) wins because it does not violate MAX-μ as well. The constraint MAX-μ is introduced in the next section.

you can see there are five root nodes in the input, while in the output, there are only four root nodes. Thus coalescence actually leads to a violation of MAX-IO (segment), or MAX-IO (root node), unless the two-root theory is assumed for a geminate structure (see Selkirk 1991). So the interaction of two constraints, MAX-IO (root node) and UNIFORMITY, is not enough to account for coalescence in Korean aspiration because coalescence violates both of them. Instead, it is the MAX-IO [s.g.] constraint that selects the coalescence candidate from the deletion candidate as the [s.g.] feature remains throughout the process of coalescence.

(55) MAX-IO [s.g.]: The feature [spread glottis] in the input has a correspondent in the output.

(56) Tableau for 'not^{h}ən'

μ μ μ μ μ μ | | | | | | $n_1 o_2 h_3 t_4 ə_5 n_6$	ALIGN-L ([lar], σ)	MAX-IO [s.g.]	MAX-IO (root node)	UNIFORMITY
a. 	*!			
b. 		*!	*	
☺c. 			*	*

Candidate (a) is excluded because it violates ALIGN-L ([lar], σ). The MAX-IO [s.g.] constraint plays a role in selecting the optimal output from the remaining two candidates. As seen above in tableau (61), both candidates (b) and (c) violate MAX-IO (root node). But, MAX-IO [s.g.] ranks higher than MAX-IO (root node) and the winning candidate is the one that satisfies this higher-ranking constraint, which is (c). Thus as we see in tableau (56), coalescence in Korean aspiration is the result of the high-ranked well-formedness constraint ALIGN-L competing with the two faithfulness constraints, MAX-IO (s.g.) and MAX-IO (root node). This implies that

UNIFORMITY does not play crucial role in selecting the optimal output. As UNIFORMITY seems to be very low- ranking, I will leave it out from the tableaux from now on.

To determine the ranking between ALIGN-L ([lar], σ) and MAX-IO [s.g.], see the tableau in (57).

(57) /noh-a/ [no.a] 'put-Infinitive'

/noh-a/	ALIGN-L ([lar], σ)	MAX-IO [s.g.]
a. noh.a	*!	
☺ b. no.a		*

We know that ALIGN-L ([lar], σ) ranks higher than MAX-IO [s.g.] from the above tableau in (57). When a vowel suffix follows a morpheme-final /h/, the /h/ gets deleted and never surfaces. This means that Korean phonology deletes morpheme-final /h/ at the expense of violating MAX-IO.

So far, the following ranking of three constraints can account for the alternations in (56) and (57), where a non-continuant obstruent suffix and a vowel suffix follows /h/ respectively.

(58) ALIGN-L ([lar], σ) >> MAX-IO [s.g.] >> MAX-IO (root node)

Another case of progressive aspiration is shown in tableau (59). (RT: root node)

(59) /nah-ko/ [nak^{h}o] 'bear-and'

μ μ μ μ μ $n_1 a_2$ h_3 k_4 o_5	ALIGN-L ([lar], σ)	MAX-IO [s.g.]	MAX- IO (RT)
a. σ σ μ μ μ n_1 a_2 h_3 k_4 o_5	*!		
b. σ σ μ μ n_1 a_2 k_4 o_5		*!	*
☺c. σ σ μμ μ n_1 a_2 $k^h_{3,4}$ o_5			*

Candidate (a) is ruled out because it has /h/ in a coda, which violates ALIGN-L ([lar], σ). Candidate (b) violates MAX-IO [s.g.], because there is no correspondent of /h/ including the feature [s.g.] in the output. Therefore, candidate (c) wins though it violates MAX-IO (root node).

Let us go back to tableau (57), in which a vowel suffix follows a morpheme-final /h/. We know that coda /h/ is not allowed, so it has to coalesce or delete to satisfy the high-ranked alignment constraint. But what if a morpheme-final /h/ is syllabified as an onset?

(60) /noh-a/ [no.a] 'put-Infinitive'

/noh-a/	ALIGN-L ([lar], σ)	MAX-IO [s.g.]	MAX-IO (RT)
a. noh.a	*!		
☺ b. no.a		*!	*
☹ c. no.ha			

The tableau above wrongly predicts candidate (c) as the optimal output. In candidate (c), morpheme-final /h/ surfaces as an onset of the following syllable. In this way, candidate (c) avoids having a coda /h/ and deleting /h/ at the same time, satisfying both ALIGN-L ([lar], σ), and MAX-IO constraints. Then what keeps [no.ha] from surfacing as the optimal output? It seems that /h/ is not welcomed as an onset. We need a markedness constraint that marks /h/ as not being an optimal onset. Prince and Smolensky (1993) propose a universal hierarchy of markedness constraints for onsets (61).

(61) *a/Ons >> .....*h/Ons >> ..... *T/Ons

The hierarchy above in (61) means that the more sonorous a segment is, the more marked it is for an onset. Adapting from Prince and Smolensky, I will use the following constraint given in (62).

(62) *h/Ons : no /h/ onset.

The constraint in (62) forbids /h/ from being an onset. This dominates the faithfulness constraint, MAX-IO [s.g.]. However, as ALIGN-L ([lar], σ) constraint is never violated, I assume that *h/Ons constraint ranks lower than it.

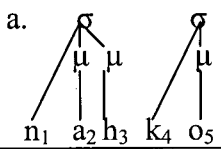
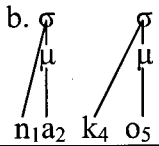
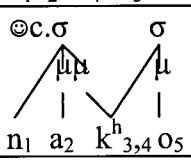
(63) /noh-a/ [no.a] 'put-Infinitive'

/noh-a/	ALIGN-L ([lar], σ)	*h/Ons	MAX-IO [s.g.]	MAX-IO (RT)
a. noh.a	*!			
☺b. no.a			*	*
c. no.ha		*!		

With the *h/Ons constraint, we can get the correct surface form. Candidate (c) is excluded because it has /h/ in onset position, violating *h/Ons. The nonrealization of onset /h/ by the markedness constraint *h/Ons is penalized by the faithfulness constraint MAX-IO [s.g.] which prohibits the deletion of the feature [s.g.].

The constraint, ALIGN-L ([lar], σ) and the constraint, *h/Ons may look contradictory. While ALIGN-L ([lar], σ) allows a laryngeal feature only in onset position, *h/Ons bans /h/ from being an onset. However, there is a way not to violate both constraints ALIGN-L ([lar], σ) and *h/Ons when there is a neighboring non-continuant obstruent. Namely, both constraints may not be violated by merging /h/ with a neighboring obstruent. At the same time, MAX-IO [s.g.] is also not violated since the feature, [s.g.] survives in the form of aspiration, even though this leads to a violation of the lower-ranked constraint UNIFORMITY not shown in the tableau.

(64) /nah-ko/ [nak^{h}o] 'bear-and'

μ μ μ μ μ n$_1$ a$_2$ h$_3$ k$_4$ o$_5$	ALIGN-L ([lar], σ)	*h/Ons	MAX-IO [s.g.]	MAX-IO (RT)
a. 	*!			
b. 			*!	*
☺c. 				*

Candidate (a) violates the ALIGN-L ([lar], σ) constraint by having a /h/ coda. Candidate (b) satisfies ALIGN-L ([lar], σ) and *h/Ons vacuously, but it violates MAX-IO (s.g.) instead. It also violates MAX-IO (RT) because it deletes the segment /h/. Candidate (c) satisfies the ALIGN-L ([lar], σ) constraint, because the /h/ is coalesced with the onset of the following syllable. In this way, /h/ avoids being in coda position. It does not violate *h/Ons because the onset is not the /h/ segment. It also satisfies MAX-IO [s.g.], as it keeps the [s.g.] feature by the form of coalescence with the adjacent obstruent. The only constraint candidate (c) violates is MAX-IO (RT).

The constraint, *h/Ons seems to explain why morpheme-final /h/ does not syllabify as an onset. However, if we have the *h/Ons constraint to keep intervocalic /h/ from being in syllable initial position, how do we get word-initial /h/s as in (49)? Word initial position /h/ violates the *h/Ons constraint because syllable initial positions subsume word initial positions. The examples in (49) are repeated in (65).

(65) a.	he	[he]	'sun'
b.	hanɨl	[ha.nɨl]	'sky'
c.	hosu	[ho.su]	'lake'

(66) /hanɨl/ [ha.nɨl] 'sky'

/hanɨl/	ALIGN-L ([lar], σ)	*h/Ons	MAX-IO [s.g.]	MAX-IO (RT)
☺a. ha.nɨl		*!		
☹b. a.nɨl			*	*

The tableau in (66) incorrectly predicts that candidate (b) is the optimal output. With the high-ranking constraint *h/Ons, we cannot get the correct output that we want. We need another constraint that allows /h/ to be in word-initial positions.

Beckman (1998) develops a theory of positional faithfulness which both generates and explains the range of positional asymmetries attested in natural language phonology. First, positional faithfulness is supported by functional considerations (Kager, 1999). It is well known that contrasts are best realized in perceptually salient positions (Noote-boom 1981, Hawkins and Cutler 1988, Ohala 1990, Ohala and Kawasaki 1984). Salient positions include word-initial

consonants, prevocalic (or released) consonants, stressed vowels, and vowels in initial syllables. Phonologically, word-initial syllables exhibit all of the asymmetrical behaviors typical of "strong licensers": they permit a wide range of marked segments, trigger directional phonological processes, and resist the application of otherwise regular alternations. On the basis of this observation, Beckman (1998) argues that the phonologically privileged status of root-initial syllables arises from high-ranking initial-syllable faithfulness constraints.

I will apply Beckman's positional faithfulness to explain that /h/ surfaces in word-initial position.

(67) MAX [s.g.]/ [WORD_: The word-initial feature [spread glottis] in the input has a correspondent in the output.

This constraint must rank higher than *h/Ons to get the effect of word-initial /h/s. With this ranking, we are able to account for the survival of word-initial /h/s in the output.

(68) /hanɨl/ [ha.nɨl] 'sky'

/hanɨl/	MAX [s.g.]/ [WORD_	*h/Ons	MAX-IO [s.g.]
☺ a. ha.nɨl		*	
b. a.nɨl	*!		*

The positional faithfulness constraint, MAX [s.g.]/ [WORD_ , keeps the word-initial /h/ segment from deleting. Candidate (a) wins because the other candidate violates the higher-ranking constraint, MAX [s.g.]/ [WORD_ . Note that MAX [s.g.]/ [WORD_ ranks higher than MAX-IO [s.g.] and the markedness constraint, *h/Ons, is sandwiched in between them in tableau (68). This ranking is consistent with the ranking schema for positional faithfulness. A faithfulness constraint for a feature [F] referring to a prominent position dominates the general faithfulness constraint for [F]. This allows a sandwiching of the markedness constraint in between positional and general faithfulness constraints, producing positional faithfulness:

(69) Ranking schema for positional faithfulness

IO-Faithfulness (prominent positions) >> Markedness >> IO-Faithfulness (general)

With the MAX [s.g.]/ [$_{WORD}$_ constraint, word-initial /h/s are allowed in spite of the constraint, *h/Ons, that does not allow onset /h/s. But what about word-medial /h/s that are in onset position? Earlier in section 2.3, we saw that when intervocalic [h] corresponds with root-final position in the input, it obligatorily deletes. However, when intervocalic [h] corresponds to morpheme-initial position in the input, then it is variably realized, depending on rate of speech. That is, initial [h] deletes intervocalically depending on rate of speech. In careful speech, the onset /h/ is pronounced clearly, whereas it is not pronounced in casual speech.

Consider the effects of the constraint ranking motivated thus far:

(70) /o#he/ [o.e] 'misunderstanding'

/o#he/	MAX[s.g.]/$_{WORD}$_	*h/Ons	MAX-IO [s.g.]	MAX-IO (RT)
☺ a. o.e			*	*
b. o.he		*!		

The tableau in (70) shows the form of casual speech as candidate (a). The optimal output is the candidate that deletes the intervocalic /h/. Candidate (b) is excluded because it has an /h/ onset, violating *h/Ons.

However, there is one issue to think about at this point. Remember that in slow speech, the unchosen candidate (b) in tableau (70) is the optimal form. In order to get candidate (b) as an optimal output, we need another constraint that protects stem-initial /h/s from deletion.

(71) MAX [s.g.]/ [$_{Mstem}$_: Stem-initial [s.g.] in the input has a correspondent in the output.

In careful speech, this constraint ranks higher than *h/Ons.

(72) /o#he/ [o.he] 'misunderstanding'

/o#he/	MAX [s.g.]/WORD_	MAX [s.g.]/ [Mstem_	*h/Ons	MAX-IO [s.g.]
a. o.e		*!		*
☺ b. o.he			*	

This is called 'free variation' when a single input is mapped onto two outputs, each of which is grammatical. The fact that free variation is 'free' does not imply that it is totally unpredictable. It means that no grammatical principles govern the distribution of variants. Instead, a wide range of extragrammatical factors such as sociolinguistic variables (e.g. gender, age, and class), and performance variables (such as speech style and tempo) may affect the choice of one variant over the other (Kager 1999).

This 'free variation', or 'optionality' is achieved through crucially unranked constraints. This idea might sound incompatible with OT because we usually assume that OT constraints are strictly ranked. However, 'free ranking' was observed as a purely theoretical option by Prince and Smolensky (1993) and has since been argued to be the OT counterpart of optional rule application. When two constraints C_1 and C_2 are freely ranked, the evaluation procedure branches at that point. In one branch, C_1 is ranked above C_2, while in the other branch the ranking is reversed.

(73) Interpretation of free ranking of constraints C_1, C_2

Evaluation of the candidate set is split into two subhierachies, each of which selects an optimal output. One subhierarchy has $C_1 >> C_2$, and the other $C_2 >> C_1$.

Note that in tableau (72), it is the competition of MAX [s.g.]/ [Mstem_ and *h/Ons that selects the optimal output from the two possible candidates. Thus if we rerank these two constraints, we will get the other optional output in casual speech.

(74) /o#he/ [o.e] 'misunderstanding'

/o#he/	MAX[s.g.]/WORD	*h/Ons	MAX [s.g.]/ [Mstem_	MAX-IO [s.g.]
☺ a. o.e			*	*
b. o.he		*!		

In this case, candidate (b) is ruled out because it violates the higher-ranking constraint, *h/Ons by having h in onset position. Candidate (a) where onset /h/ is deleted surfaces as optimal nonetheless violating the MAX [s.g.]/ $[_{Mstem}$_ constraint as we reranked it lower than *h/Ons. Optionality is achieved by reranking the adjacent constraints. To get the casual and fast speech form, the markedness constraint, *h/Ons ranks higher than the positional faithfulness constraint, MAX [s.g.]/ $[_{Mstem}$_. To get the careful and slow speech form, the faithfulness constraint, MAX [s.g.]/ $[_{Mstem}$_ ranks higher than the markedness constraint, *h/Ons.

I summarize the ranking of the constraints that have been motivated thus far, in (75). This ranking applies to the casual speech form. For the alternative careful speech form, MAX [s.g.]/ $[_{Mstem}$_ is reranked higher than *h/Ons which is given in (76).

(75) MAX [s.g.]/$_{WORD}$_ >> *h/Ons >> MAX [s.g.]/ $[_{Mstem}$_ >> MAX-IO [s.g.]: *casual speech*
(76) MAX [s.g.]/$_{WORD}$_ >> MAX [s.g.]/ $[_{Mstem}$_ >> *h/Ons >> MAX-IO [s.g.]: *careful speech*

What is particularly interesting in the variable speech analysis is that it is in casual speech that the positional markedness constraint *h/Ons intervenes in between the bifurcated [s.g.]-faithfulness, thus providing a very direct window on the process of language change entailed, here: namely, the movement of a markedness constraint up the ranking hierarchy of faithfulness constraints, creating a wedge to divide what was perhaps historically a single MAX-IO [s.g.] constraint[25]. Note that besides the faithfulness constraint MAX-IO [s.g.], we need two more positional faithfulness constraints, MAX [s.g.]/$_{WORD}$_ and MAX [s.g.]/ $[_{Mstem}$_. MAX [s.g.]/ $_{WORD}$_ is never violated so it is on top of the hierarchy, while MAX [s.g.]/ $[_{Mstem}$_ is violable so it ranks lower than MAX [s.g.]/$_{WORD}$_.

Turning back to the Korean aspiration, let us see if this constraint hierarchy can explain both the progressive and regressive aspirations.

(77) Tableau for [not^{h}ən] 'put-PAST progressive'

[25] Shaw p.c. 2002

/noh-tən/	ALIGN-L([lar], σ)	MAX [s.g.]/[$_{WORD\_}$	MAX[s.g.]/[$_{Mstem}$	*h/Ons	MAX[s.g.]
a. noh.tən	*!				
☺ b. not.t^{h}ən					
c. no.tən					*!

Tableau (77) shows a case of progressive aspiration, where a morpheme final /h/ coalesces with the following obstruent. Candidate (a) has an /h/ coda, violating ALIGN-L ([lar], σ). In candidate (c), the morpheme-final /h/ deletes to not violate ALIGN-L ([lar], σ), but at the expense of violating MAX-IO [s.g.]. Candidate (b) surfaces as the optimal output.

(78) Tableau for [ip^{h}ak] 'admission to school'

/ip#hak/	ALIGN-L ([lar],σ)	MAX[s.g.]/[$_{WORD\_}$	MAX[s.g.]/[$_{Mstem\_}$	*h/Ons	MAX[s.g]
a. ip.hak				*!	
☺ b. ip.p^{h}ak					
c. i.pak			*!		*

In tableau (78), we have a case of regressive aspiration in which /h/ coalesces with the previous stop. Candidate (a) is ruled out because it violates *h/Ons by having /h/ in onset position. Candidate (c) deletes the stem-initial /h/, violating MAX[s.g.]/ [$_{Mstem\_}$ and MAX-IO [s.g.]. Candidate (b) is the winning candidate. Coalescence occurs to satisfy the *h/Ons constraint and MAX[s.g.]/ [$_{Mstem\_}$ at the same time. Note that in progressive aspiration, the ALIGN-L ([lar], σ) constraint triggers coalescence, whereas it is the *h/Ons constraint that motivates coalescence to occur in regressive aspiration.

If you compare the input in (77) with the input in (78), you may notice that the morphological concatenation is different. The input in (77) is composed of one root, while the input in (78) is a two-root compound. Progressive aspiration always occurs within one word because the verbal root-final /h/ coalesces with the following non-continuant obstruent that is part of a suffix. On the other hand, regressive aspiration which involves morpheme-initial /h/s[26] that can be part of a suffix or a noun, can occur within one prosodic word as progressive

[26] See section 2.2.

aspiration does or across two morphemes as in (78). I give another example of regressive aspiration within a single prosodic word in (79).

(79) Tableau for [yak^{h}e] 'weak- infinitive'

/yak-he/	ALIGN-L ([lar],σ)	MAX[s.g.]/[$_{WORD}$_	MAX[s.g.]/[$_{Mstem}$_	*h/Ons	MAX[s.g.]
a. yak.he				*!	
☺ b. yak.k^{h}e					
c. ya.ke			*!		*

The ranking of the constraints above works well for regressive aspiration that occurs word-internally as well. Candidate (a) violates *h/Ons, so it is ruled out from the competition. Candidate (c) is excluded because it violates MAX [s.g.]/ [$_{Mstem}$_, not having the correspondent of stem-initial [s.g.] in the output. Candidate (b) surfaces as optimal.

4.2 Geminate Analysis

Since de Chene & Anderson (1979), compensatory lengthening (CL) has been a persistent topic in the phonological literature. For example, it is one of the phenomena used in support of moraic theory, which treats all cases of CL as instances of mora preservation. In this section, I seek other evidence of CL that occurs to preserve moraicity in Korean Aspiration. The geminate analysis of aspirated consonants has been proposed several times in the literature but all of them use derivational theory (Kim J. (1986), Yu (1989), Kim S. (1989, 1990), Jun (1989, 1991, 1994), Choi & Jun (1998)). In this section, I will show that aspirated stops are geminates using moraic phonology (Hyman 1985, Hock 1986, among others) within an OT framework.

Kim S. (1989) presents evidence for the aspirated consonants having two timing units (geminates), using the diverse realization of /h/ as given in (80).

(80) a. /nah-tən/ → [nat^{h}ən] 'give birth to- Past Progressive'

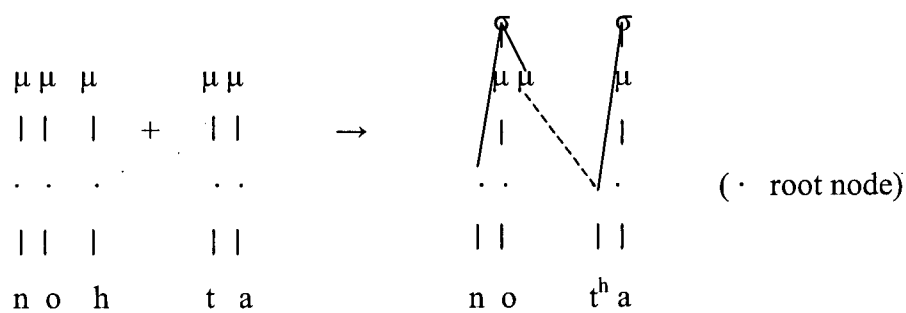
b. /noh-nɨn/ → [nonnɨn] 'give birth to-Present Progessive'

c. /noh-sɨp/ → [nos'ɨp] 'give birth to-Style'

d. /noh-a/ → [noa] 'give birth to-Infinitive'

The examples (a) through (d) in (80) show that a plain consonant becomes aspirated or tensified in the same environment where a nasal geminates or a vowel lengthens. In (80c), a fricative /s/ follows /h/, and it becomes the tense counterpart after coalescing with /h/. As there is no /s^h/ in the Korean phoneme inventory, it is realized as /s'/ which has the same property of tenseness[27] as aspirated sounds. Note that in (80b), the alveolar nasal /n/ becomes a geminate after coalescing with /h/. When /s/ or /n/ is preceded by /h/, they become geminates (tense consonants are geminates (Han, 1996)). When plain non-continuant obstruents /p, t, c, k/ are preceded by /h/, the result is a corresponding aspirated consonant on the surface. At the first glance, /h/ seems to surface very differently depending on what segment comes next. However, the seemingly different realization of /h/ becomes explainable if we assume that aspirated consonants are geminates.

(81) /noh-ta/ [not^{h}a] 'put-Dec'

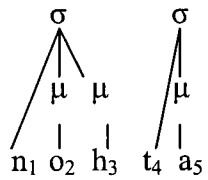
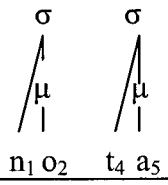
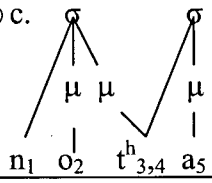
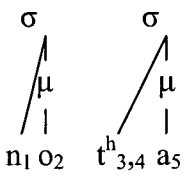


As mentioned previously, when /h/ coalesces with the following non-continuant obstruent, the laryngeal feature of /h/ disassociates from its root node. Once the feature, [s.g.] is spread to the adjacent segment, its root node gets deleted, leaving a stranded mora. It is this empty mora that triggers CL of the coalesced segment and gemination occurs to preserve the moraic weight of a syllable. Sumner (1999) argues that CL results from coalescence and it is the coalesced segment that gets longer. In line with her argument, I assume that it is the coalesced segment that takes the stranded mora. This explains why the preceding vowel does not get compensatorily

[27] Both tense and aspirated consonants are characterized by a stronger air pressure (Han, 1996).

lengthened instead in (81). While this can be explained by a language-specific constraint that bans the coalescence of /h/ with a vowel, I will not include this constraint in the following tableau in (82) because it is not my focus of this thesis.

(82) /noh-ta/ [not^{h}a] 'put-Dec'

$\mu_1\ \mu_2\ \mu_3\ \mu_4\ \mu_5$ $n_1\ o_2\ h_3\ t_4\ a_5$	ALIGN-L ([lar], σ)	*h/Ons	MAX- IO [s.g.]	MAX-IO (RT)
a. 	*!			
b. 			*!	*
☺ c. 				*
☹ d. 				*

This tableau cannot select the optimal output because it predicts two candidates to win. Candidate (a) violates ALIGN-L ([lar], σ) by having /h/ in coda position. Candidate (b) satisfies ALIGN-L ([lar], σ) at the expense of violating MAX-IO [s.g.], which is fatal. Both candidate (c) and (d) in which coalescence occurs satisfy the motivation constraint, ALIGN-L ([lar], σ) and the faithfulness constraint, MAX-IO [s.g.] at the same time, surfacing as optimal. The difference between candidate (c) and (d) is that candidate (c) preserves moraic weight while candidate (d) does not. Thus a faithfulness constraint that keeps moraicity is needed.

(83) MAX-μ : Every μ in the input has a correspondent in the output.

This constraint must rank higher than MAX-IO (RT) because the violation of MAX-μ is more serious than the violation of MAX-IO (RT). Consider tableau (84).

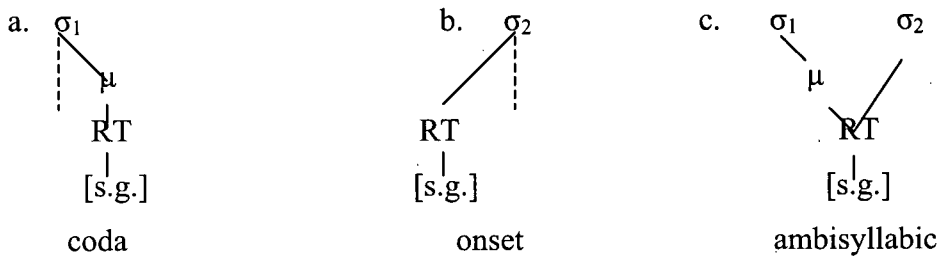
(84) /yak-he/ [yak^{h}e] 'weak- Infinitive'

μ μ μ μ μ y_1 a_2 k_3 h_4 e_5	ALIGN-L ([lar],σ)	*h/Ons	MAX-IO [s.g.]	MAX-μ
a. σ σ μ μ μ y_1 a_2 k_3 h_4 e_5		*!		
b. σ σ μ μ y_1 a_2 k_4 e_5			*!	*
☺ c. σ σ μ μ μ y_1 a_2 $k^h_{3,4}$ e_5				
d. σ σ μ μ y_1 a_2 $k^h_{3,4}$ e_5				*!

This is a case of regressive aspiration. Candidate (a) is excluded because it violates *h/Ons by having an /h/ onset. Candidate (b) is ruled out, violating MAX [s.g.]. Candidate (d) violates MAX-μ, because the second μ in the input does not have a correspondent in the output. Therefore, candidate (c) surfaces as optimal where the aspirated consonant geminates. Note that the ambisyllabicity of the aspirated segment does not violate the ALIGN-L ([s.g.], σ)

constraint[28]. Though the aspirated non-continuant obstruent is part of a coda of the preceding syllable and at the same time part of an onset of the following syllable, it is still aligned to the left edge of the following syllable. In the same way, if one had a constraint, ALIGN-R ([s.g.], σ), then the ambisyllabic aspirated consonant in candidate (c) would not violate it either because it is still aligned to the right edge of the preceding syllable. Note that ALIGN-L ([s.g.], σ) is different from $*[s.g.]]_{\sigma}$ in that it allows ambisyllabicity while the negative coda constraint does not. Visual reference is given in (85). (RT: root node)

(85)



(85a) satisfies ALIGN-R ([lar], σ), and does not violate $*_{\sigma}[[s.g.]$. (85b) satisfies ALIGN-L ([lar], σ) and does not violate $*[s.g.]]_{\sigma}$. However, (85c) satisfes ALIGN-R ([lar], σ), but violates $*_{\sigma}[[s.g.]$. At the same time, (85c) satisfies ALIGN-L ([lar], σ), but violates $*[s.g.]]_{\sigma}$.

Another issue to be addressed here is the assumption that all segments are underlyingly moraic, and that segments which are parsed in surface structure into onsets are subject to a really highly ranked constraint that onsets are not moraic (Hyman, 1985).

Going back to (80), when /h/ is followed by a nasal, it is assimilated to the nasal sound producing a geminate as in (80b). When a plain fricative follows /h/, the plain fricative becomes a tense counterpart as in (80c). Hence one can question why sonorants and fricatives do not show the same behavior as non-continuant obstruents when they meet /h/. Kim S. (1989) explains this by *Structure Preservation*[29]. Phonemic inventory and the syllable structure is preserved during the phonological derivation. In other words, as Korean does not have aspirated sonorants or aspirated fricatives in the phoneme inventory as in (18), they cannot be derived and surface in the output as optimal.

[28] The alignment constraint is defined as crisp alignment throughout my thesis (McCarthy & Prince 1993).

[29] Structure Preservation (Kiparsky 1985): No lexical rule application will generate structures prohibited underlyingly.

As apiration targets only non-continuant obstruents like /p/, /t/, /k/, and /c/, but not sonorants or continuant fricatives such as /s/, I capture this targeting effect by the following constraint which renders certain combinations of features possible in a particular context.

(86) [s.g.]/[-cont] : If [s.g.], then [-cont].

However, as nasals are also [-cont], a negative constraint that forbids nasal segments to aspirate is needed.

(87) *[s.g.]/[nasal]: If [s.g.], then not [nasal]. (Avoid feature combinations of [s.g.] and [nasal].)

With this constraint, we can account for (80b) and (80c) now. Only the relevant constraints are shown in the following tableaux (88) and (89).

(88) /noh + nɨn/ → [nonnɨn] 'put + Present Progessive'

μ μ μ μ μ μ /n o h n ɨ n/	*[s.g.]/[nasal]	MAX- IO [s.g.]	MAX-μ	MAX-IO (RT)
a. no.nɨn		*	*!	*
b. non.n^{h}ɨn	*!			*
☺ c. non.nɨn		*		*

Note that the *[s.g.]/[nasal] constraint must rank higher than MAX-IO [s.g.] to rule out the wrong candidate (b) that keeps the feature [s.g.] and satisfies MAX-IO [s.g.]. Both candidate (a) and (c) satisfy the *[s.g.]/[nasal] constraint and violate MAX-IO [s.g.] and MAX (RT). However, candidate (a) fatally violates MAX-μ. So candidate (c) is chosen.

(89) /noh + sɨp/ → [nos.s'ɨp] 'put + Style'

/noh-sɨp/	[s.g.]/[-cont]	MAX-IO [s.g.]	MAX-μ	MAX-IO (RT)
a. no.sɨp		*	*!	*
b. nos.s^{h}ɨp	*!			*
☺ c. nos.s'ɨp		*		*

Candidate (b) violates the high-ranking constraint, [s.g.]/[-cont], so it is ruled out. The competition between candidate (a) and (c) is a good example that shows when /h/ deletes or coalesces with the adjacent segment, CL of the adjacent segment occurs to keep the moraic weight. Candidate (a) loses because it violates MAX-μ by losing the underlying mora of /h/ in the input. Finally, candidate (c) surfaces as optimal.

So far, we have seen in this section that derived aspirated consonants are geminates because gemination occurs to preserve the moraic weight during aspiration. The constraint ranking for Korean aspiration is summarized below in (90).

(90) ALIGN-L ([lar], σ), MAX [s.g.]/ $[_{WORD}$_ >> MAX [s.g.]/ $[_{Mstem}$_, *h/Ons, [s.g.]/[-cont], *[s.g.]/[nasal] >> MAX-IO [s.g.] >> MAX-μ >> MAX-IO (RT)

4.3 Asymmetry in Progressive Aspiration and Regressive Aspiration

In the previous section, we have seen how Korean aspiration is handled within a constraint-based OT account. In this section, I will deal with some asymmetric mismatches between progressive and regressive aspirations. Progressive and regressive aspirations differ in the order of the sequence of /h/ and the non-continuant obstruent with which it coalesces. /h/ comes first, followed by a non-continuant obstruent in progressive aspiration, while in regressive aspiration it is the reverse: the non-continuant obstruent comes first, and the /h/ segment follows. As it is only the order in which /h/ and the consonant occur that differs, and OT is a surface-based approach that does not allow any rule-ordering or intermediate stage, we expect progressive aspiration and regressive aspiration to be symmetric in their phonological behavior.

(91) a.	/coh-ko/	[cok^{h}o]	'like-Connective'
b.	/cok-he/	[cok^{h}e]	'satisfy-do'
c.	/nah-ta/	[nat^{h}a]	'give birth to-Declarative'

d. /nat[30]-hako/ [nat^{h}ako] 'with a sickle'

As seen above in (91), progressive aspiration and regressive aspiration seem to behave quite symmetrically and yield the same aspirated obstruents. In (91a), /h/ comes first, and /k/ follows, while in (91b), /k/ is followed by /h/. However, both (91a) and (91b) yield the same output, [k^h]. The same situation is found in (91c) and (91d). Unfortunately, Korean does not have suffixes that start with /p/, so it is hard to compare the coalescence between /p/ and /h/, and /h/ and /p/.

On the contrary, consider the following data in (92):

(92)	a. /noh-sɨp/	[nos'ɨp]	'put-Style'	(-sɨp: style suffix)
	b. /mos-he/	[mot^{h}e]	'cannot do'	(-he: do)
	c. /noh-ca/	[noc^{h}a]	'put-Persuasive'	(-ca: persuasive suffix)
	d. /koc-hako/	[kot^{h}ako]	'with a cape'	(hako: conjunctive suffix)

We can see that progressive and regressive aspirations do not match in their outputs, yielding different aspirated non-continuant obstruents or a tense counterpart after coalescence. Interestingly, regressive aspiration in (92b) and (92d) ends up forming the same aspirated obstruent in the output even when different inputs are involved. More examples are illustrated in (93).

(98)	a. /os + hako/	[ot^{h}ako]	*[os^{h}ako]	'with clothes'
	b. /nac + hako/	[nat^{h}ako]	*[nac^{h}ako]	'with a day'
	c. /sot^h + hako/	[sot^{h}ako]		'with a pot'
	d. /suc^h + hako/	[sut^{h}ako]		'with charcoal'

[30] Korean does not have a root morpheme that ends in /t/. Only some prefixes end in /t/. 'nat' is a prefix that usually attaches to other roots such as *kali* 'rick', or *al* 'a grain'. However, it is known that a prefix in a prefix plus stem combination forms a separate prosodic word in Korean (Kang, 1992).

Note that all the morpheme-final obstruents in (93) act like /t/ in that it forms an aspirated /t/ when they coalesce with the following /h/. This phenomenon is called Coda Neutralization, and I will discuss it in the next section in greater detail.

4.3.1 Coda Neutralization

In this section, I will show that Korean Coda Neutralization can be explained by using Lombardi's Place markedness constraints (2001) in an OT account. Coda Neutralization is important to understand Korean Apiration because it plays a part in yielding the asymmetry between progressive and regressive aspirations.

In Korean, there is a Coda Neutralization phenomenon in which all labial and velar stops change to homorganic plain stops (p, p', p^h → [p] and k, k', k^h → [k]) and all coronal obstruents to [t] (/t, t', t^h, s, s', c, c', c^h/ → [t]), in word-final syllable-coda position (Hong, 1997).

(94) a.	/sup^h/	[sup]	'forest'
	/sup^h-e/	[sup^{h}e]	'forest-LOC'
b.	/puək^h/	[puək]	'kitchen'
	/puək^h-e/	[puək^{h}e]	'kitchen-LOC'
c.	/pat^h/	[pat]	'field'
	/pat^h-e/	[pat^{h}e]	'field-LOC'
d.	/nac/	[nat]	'day'
	/nac-i/	[naci]	'day-Nom'
e.	/nas/	[nat]	'scythe'
	/nas-ɨl/	[nasɨl]	'scythe-Acc'
f.	/k'oc^h/	[k'ot]	'flower'
	/k'oc^h-ɨl/	[k'oc^{h}ɨl]	'flower-Acc'

g. /pak'/	[pak]	'outside'
/pak'-e/	[pak'e]	'outside-LOC'

Fricatives, stops, and affricates in coda position, regardless of whether they are aspirated, tensed, or plain, surface as unreleased plain counterpart. On the other hand, when these fricatives, and non-continuant obstruents, are in onset position, they surface as the way they are in the input, keeping their features to the output. Coda neutralization also applies to coda /h/. Remember that morpheme-final /h/s surface as [t].

(95) a. /nah/	[nat]	'give birth to'
b. /noh/	[not]	'put'

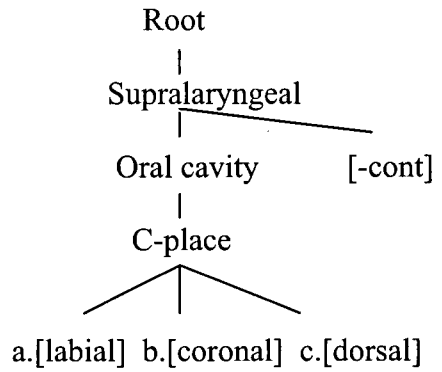
To know what featural restrictions apply to coda position in Korean, we need to take a look at the feature geometry of each segment that coda neutralization applies to. As coda neutralization applies only to obstruents, I will focus on obstruents. Before representing the featural structure of each segment, a definition of natural classes such as stops, fricatives, and affricates is necessary in order to prevent any confusion.

Oral stops, fricatives, and affricates are known as obstruents because they are all non-sonorant. The stops produced with a constriction blocking airflow are [-continuant], while the fricatives which permit turbulent airflow are [+continuant]. While it is easy to distinguish between stops and fricatives in terms of the feature [continuant], the interpretation of affricates is controversial. The affricate is produced with an initial closure, but unlike the closure of a stop, the closure of an affricate is released gradually, sounding very much like a fricative. This is why it sometimes behaves like a stop and sometimes like a fricative. Korean has only one affricate, /c/. It behaves like a stop in the sense that it has a three-way contrastive phonation. As other plain stops such as /p/, /t/, /k/ have their aspirated and tense counterparts, /c/ has its aspirated and tense counterparts as well. On the other hand, /c/ acts like an /s/ because it is neutralized to /t/ in coda position. In coda position, while all the aspirated or tense stops are neutralized to their plain counterparts, the aspirated or tense affricate is not neutralized to its plain counterpart /c/. Instead,

it is neutralized to /t/ as other fricatives such as /s/ and /h/ are neutralized to /t/ in coda position. In this sense, /c/ behaves like a fricative. In feature geometry, this seesaw behavior of the affricate can be seen as having both [+continuant] and [-continuant] features at the same time. However, as my thesis assumes a monovalent feature system, this cannot be possible.

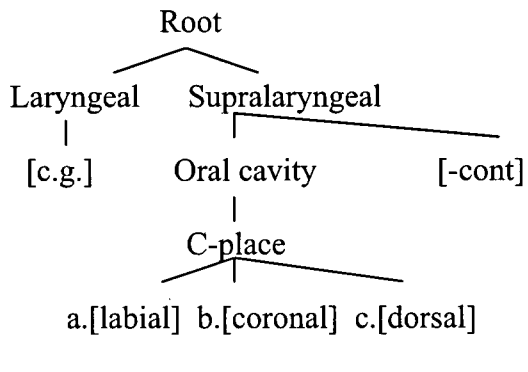
Traditionally, [strident] has been used to distinguish the "noisy" fricatives and affricates (labiodentals, sibilants, uvulars) from the "mellow" ones (bilabials, dentals, palatals, velars) (Chomsky and Halle (1968), Clements and Hume, (1995)). Since stridency is a property of fricatives and affricates, I will use [strident] to group affricates and fricatives together. At the same time, I assume that only fricatives are continuant. Thus, stops and affricates are reduced to a class that is [-continuant]. In this way, stops and affricates can be referred to as noncontinuant obstruents, and fricatives as continuant obstruents. Adapting the model from Clements and Hume (1995), the following diagram outlines the feature geometry of stops, affricates, and fricatives from (96) to (103). Note that I use [-continuant] as a marked feature in my analysis.

(96) plain stop:
(/p/, /t/, /k/)



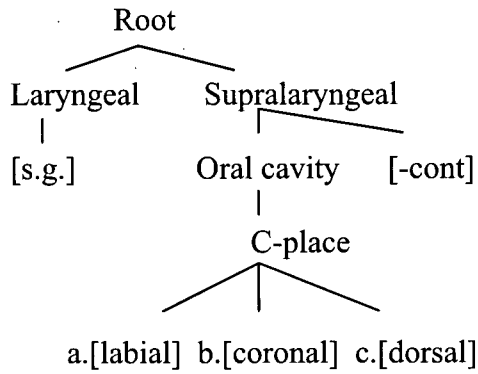
/p/ : if place feature is a.
/t/ : if place feature is b.
/k/ : if place feature is c.

(97) tense stop :
(/p'/, /t'/, /k'/)



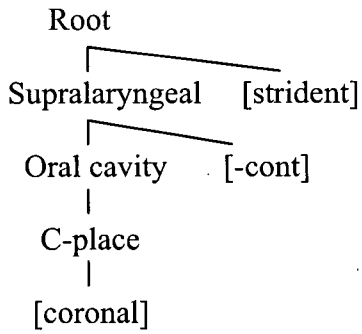
/p'/ : if place feature is a.
/t'/ : if place feature is b.
/k'/ : if place feature is c.

(98) aspirated stop:
(/p^h/, /t^h/, /k^h/)



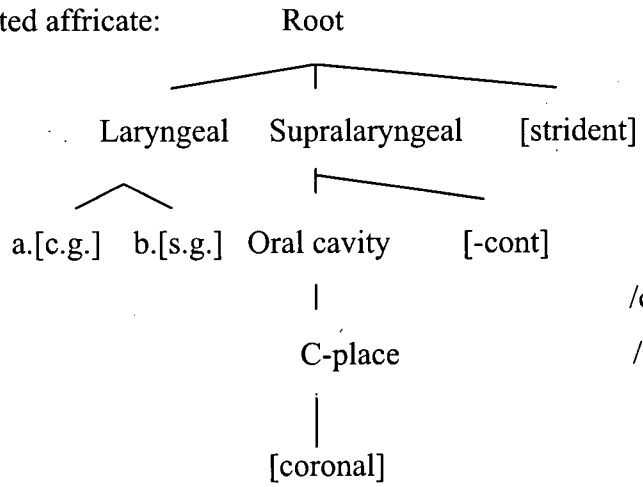
/p^h/ : if place feature is a.
/t^h/ : if place feature is b.
/k^h/ : if place feature is c.

(99) plain affricate :
(/c/)



The affiliation of the feature [strident] is still unclear[31] (Elizabeth & Hume, 1995). In this thesis, I maintain the conservative position that [strident] links under the root node.

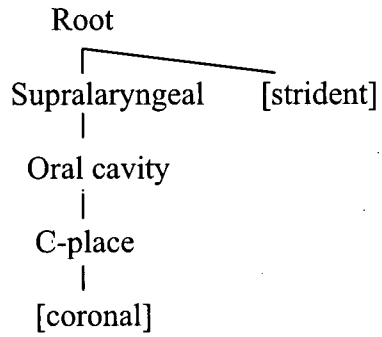
(100) tense, aspirated affricate:
(/c'/, /c^h/)



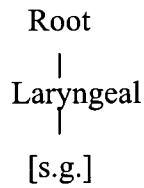
/c'/: if laryngeal feature is a.
/c^h/: if laryngeal feature is b.

[31] However, more recently some linguists have suggested that this feature should be restricted to coronal sounds.

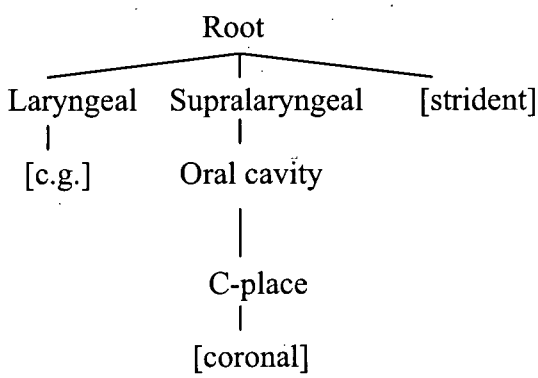
(101) fricative:
(/s/)



(102) fricative:
(/h/)



(103) tense fricative:
(/s'/)



As seen above, fricatives and affricates share the feature [strident], and the aspirated stops and the tense stops share the laryngeal feature, which is [s.g.], and [c.g.] respectively. Therefore, I propose the following alignment constraints for Korean coda neutralization.

(104) ALIGN-L ([lar], σ) : Every laryngeal node stands at the left edge of a syllable

(105) ALIGN-L ([strid], σ): Every [strident] feature stands at the left edge of a syllable

In fact, the constraint, ALIGN-L ([lar], σ) was introduced earlier in (51) as a motivation constraint for coalescence in progressive aspiration. And coda neutralization gives another independent motivation for the constraint, ALIGN-L ([lar], σ). These alignment constraints in (104) and (105) have the effect of not allowing [s.g.], [c.g.], and [strident] in coda position. This is Coda

Neutralization in which aspirated and tense consonants in coda position change into their plain counterparts.

As for the ranking, I assume that ALIGN-L ([strid], σ) has the same ranking as ALIGN-L ([lar], σ). As ALIGN-L ([lar], σ) ranks higher than MAX-IO [s.g.] (see (57)), ALIGN-L ([strid], σ) ranks higher than MAX-IO [strid]. The ranking of ALIGN-L ([strid], σ) must be higher than MAX-IO [strid] because morpheme-final fricatives or affricates change to a stop at the expense of violating MAX-IO [strid]. The constraint MAX-IO [strid] and the interaction between ALIGN-L ([strid], σ), and MAX-IO [strid] are shown in (106), and (107) respectively.

(106) MAX-IO [strid]: The feature [strid] in the input must have a correspondent in the output.

(107) Tableau for [myəc^h] 'several'

/myəc^h/	ALIGN-L ([lar], σ)	ALIGN-L ([strid], σ)	MAX-IO [strid]
a. myəc^h	*!	*	
☺b. myət			*
c. myəc		*!	

Candidate (a) violates both ALIGN-L ([lar], σ) and ALIGN-L ([strid], σ) because the /c^h/, which has both features, [s.g.], and [strident], is in coda position. Candidate (c) violates ALIGN-L ([strid], σ) having an affricate in a coda. Candidate (b) is optimal because the violation it incurred is less serious than the violation other candidates incurred. So the markedness constraints that trigger a phonological phenomenon such as aspiration or coda neutralization rank higher than the faithfulness constraints.

(108) ALIGN-L ([lar], σ), ALIGN-L ([strid], σ) >> MAX-IO [s.g.], MAX-IO [strid]

The interaction between alignment constraints and faithfulness constraint above in tableau (107) shows that both laryngeal and strident features are restricted in coda position. However, place features seem not to be restricted in coda position. Remember that all labial and velar stops change to homorganic plain stops (p, p', p^h → [p] and k. k', k^h → [k]) and all coronal obstruents

to [t] (/t, t', t^h, s, s', c, c', c^h/ → [t]), in syllable-coda position (Hong, 1997). The only segment that is not coronal but change to a coronal stop, [t], after coda neutralization is /h/. But this is not a change in place feature because /h/ does not have a place node at all in the underlying form.

The fact that /h/ surfaces as [t] in coda position is not surprising because coronal is the least marked place. Following Prince and Smolensky (1993) and Lombardi (2001), I assume that Place markedness is not due to underspecification, but rather to a universally ranked family of markedness constraints.

(109) *Dor, *Lab >> *Cor

Coronals are more unmarked than dorsals and labials due to the universally ranked constraints above in (109). This ranking is fixed by UG, since all languages show the same Place markedness relations (Lombardi, 2001). These Place markedness constraints are penalized by the faithfulness constraint, MAX_{PLACE}. MAX_{PLACE} outranks Place markedness constraints because the most marked places do surface in coda positions. I assume that the faithfulness constraint, MAX_{PLACE}, is very high-ranking because it is never violated. This constraint is outlined in (110).

(110) MAX_{PLACE}: Every place node in the input has a correspondent in the output. (PLACE: LAB, DOR, COR)

The place node in (110) can be Labial, or Dorsal, or Coronal.

(111) Tableau for /noh/ [not] 'put'

/noh/	MAX_{PLACE}	ALIGN-L ([lar], σ)	MAX [s.g.]	*Dor/*Lab	*Cor
a. noh		*!			
☺ b. not			*		*
c. nok			*	*!	

This tableau shows us why /h/ neutralizes to [t] in coda position. Candidate (a) is ruled out because it has /h/ in coda position, violating the high-ranking constraint, ALIGN-L ([lar], σ).

Both candidates (b) and (c) violate MAX [s.g.], however, candidate (c) is ruled out because it violates *Dor. Candidate (b) violates *Cor, but its violation is less serious than the violation of *Dor in candidate (c), so it surfaces as optimal.

(112) Tableau for [pu.ək] 'kitchen'

/puək^h/	MAX_{DOR}	ALIGN-L ([lar], σ)	*Dor	*Cor
a. pu.ək^h		*!	*	
☺ b. pu.ək			*	
c. pu.ət	*!			*

As I mentioned earlier, MAX_{PLACE} penalizes any change of place from the input. This is how we get a dorsal segment in the output, even though it is the most marked. Candidate (a) violates ALIGN-L ([lar], σ) because it has [s.g.] in coda. Both candidates (a) and (b) violate *Dor, having a dorsal segment in the output. Candidate (c) violates MAX_{DOR} because the place of the coda segment has changed. Candidate (b) wins out, although it violates *Dor.

To place the ranking of the place markedness constraints, one must remember that /h/ surfaces as [t] in word-final coda position.

(113) a. /nah/	[nat]	*[na]	'give birth to'
/na/	[na]		'I'
b. /noh/	[not]	*[no]	'put'
/no/	[no]		'oar'

As we know /h/ is not allowed in coda position, there are two options. Firstly, it can be deleted. This does not violate any Place markedness constraint because /h/ does not have a place node. Secondly, we can change /h/ to a segment that is allowed in coda position even though it violates a place markedness constraint. From the data in (113), we know that the latter option is taken. This shows that it is better to keep a segment than to delete it even though the segment is marked.

(114) /nah/ [nat] 'give birth to'

/nah/	ALIGN-L ([lar], σ)	MAX-μ	MAX (RT)	*Cor
a. na		*!	*	
☺ b.nat				*
c.nah	*!			

The ranking hierarchy that I used to account for Korean aspiration in (90) is repeated in (115).

(115) ALIGN-L ([lar], σ), MAX [s.g.]/ $[_{WORD\_}$ >> *h/Ons, MAX [s.g.]/ $[_{Mstem\_}$ >> MAX-IO [s.g.] >> MAX-μ >> MAX-IO (RT)

Now if we merge the new constraints for coda neutralization outlined in this section, we arrive at the following constraint hierarchy in (116).

(116) ALIGN-L ([lar], σ), ALIGN-L ([strid], σ), MAX [s.g.]/ $[_{WORD\_}$, MAX_{PLACE} >> *h/Ons, MAX [s.g.]/ $[_{Mstem\_}$ >> MAX-IO [s.g.] >> MAX-μ >> MAX-IO (RT) >> *Dor, *Lab >> *Cor

(117) Tableau for [not] 'put'

/noh/	ALIGN-L ([lar], σ)	MAX_{PLACE}	MAX [s.g.]	MAX-μ	*Dor/*Lab	*Cor
a. noh	*!					
b. no			*	*!		
☺ c. not			*			*
d.nop			*		*!	

Candidate (a) violates ALIGN-L ([lar], σ), having /h/ in coda position. As the alignment constraint is high-ranking, candidate (a) is ruled out. The rest of the candidates all violate MAX-IO [s.g.]. But candidate (b) is ruled out because it violates the next highest-ranking constraint,

MAX-μ, by deleting /h/. Note that both candidate (c) and (d) satisfy MAX_{PLACE}. As /h/ does not have a place node, it does not require a correspondent in the output to satisfy MAX_{PLACE}. However, candidate (d) is ruled out because it violates *Lab which ranks higher than *Cor that candidate (c) violates. Thus, candidate (c) surfaces as the optimal output.

4.3.2 Overapplication of Coda Neutralization

In Korean, a root-final obstruent is neutralized when the root appears as an independent word and also before a consonant-initial suffix. However, the root-final obstruent is not neutralized before a vowel-initial suffix. Note that /t, t^h, s/ palatalize to [c, c^h, sJ], respectively before suffix with initial high front vocoid /i/ or /y/. The following are noun derivatives adapted from Hong (1997).

(118) /os/	'clothes'	
a. /os/	[ot]	citation form
b. /os-to/	[ot.t'[32]o]	'clothes-also'
c. /os-kwa/	[ot.k'wa]	'clothes-and'
d. /os-i/	[o.sJi]	'clothes-Nom'
e. /os-ɨl/	[o.sɨl]	'clothes-Acc'

(119) /kət^h/	'surface'	
a. /kət^h/	[kət]	citation form
b. /kət^h-to/	[kət.t'o]	'surface-also'
c. /kət^h-kwa/	[kət.k'wa]	'surface-and'
d. /kət^h-i/	[kəc.cJ^{h}i]	'surface-Nom'
e. /kət^h-ɨl/	[kət.t^{h}ɨl]	'surface-Acc'

The bare noun roots [ot] and [kət] in (118a) and (119a) show that root-final /s/ and /t^h/ coda-neutralize when these roots appear alone. However, root-final /s/ and /t^h/ do not coda-neutralize before a vowel as in (123d,e) and (124d, e).

[32] Post-obstruent tensification

Because Korean verbs cannot appear as independent words, they must always be morphologically accompanied by inflections. Unlike nouns, verb roots are bound and cannot surface independently, without inflectional affixation.

(120) /əp^h/ 'turn upside down'

a. əp^h-ko	[əp.k'o]	'turn upside down-Cont'
b. əp^h-A	[ə.p^{h}ə[33]]	'turn upside down- Infinitive'

(121) /pəs/ 'take off'

a. pəs-ko	[pət.k'o]	'take off-Cont'
b. pəs-A	[pə.sə]	'take off-Infinitive'

(122) /kat^h/ 'be same'

a. kat^h-ko	[kat.k'o]	'be same-Cont'
b. kat^h-A	[kat.t^{h}a]	'be same-Infinitive'

(123) /is'/ 'exist'

a. is'-ko	[it.k'o]	'exist-Cont'
b. is'-A	[is.s'ə]	'exist-Infinitive'

(124) /ic/ 'forget'

a. is'-ko	[it.k'o]	'forget-Cont'
b. ic-A	[i.cə]	'forget-Infinitive'

The verbal Root-final /p^h/, /s/, /t^h/, /s'/ and /c/ are realized on the surface when they appear before a vowel. In other words, when a vowel-initial suffix is attached to a Root, [s.g.]/[c.g.]/[strid] feature of the Root-final obstruent are retained.

[33] Vowel assimilation.

The survival of the underlying features [s.g.]/[c.g.]/[strid] of the Root-final obstruent before a vowel-initial suffix can be explained by the following input-to-output correspondence constraints in (125).

(125) a. MAX-IO [strid]: Every [strident] feature in the input has a correspondent in the output.
b. MAX-IO [s.g.] : Every [s.g.] feature in the input has a correspondent in the output.
c. MAX-IO [c.g.] : Every [c.g.] feature in the input has a correspondent in the output.

As mentioned before, the alignment constraint family is ranked above the faithfulness constraint family to explain the loss of underlying [s.g.]/[c.g.]/[strid] in coda position. The following tableau shows only the interaction between the alignment constraint and MAX-IO constraint.

(126) /os/ [ot] 'clothes'

/os/	ALIGN-L ([strid], σ)	MAX-IO [strid]
a. os	*!	
☺ b. ot		*

Candidate (a) violates higher ranked ALIGN-L ([strid], σ) while Candidate (b) violates a lower ranked MAX- IO [strid]. So candidate (b) wins. The ranking above in the tableau (126), will also predict the case when coda neutralization does not apply.

(127) /os-ɨl/ [o.sɨl] 'clothes-Acc'

/os-ɨl/	ALIGN-L ([strid], σ)	MAX-IO [strid]
a. o.tɨl		*!
☺b o.sɨl		

Candidate (a) loses [strid] feature in the output, violating MAX-IO [strid]. So candidate (b) surfaces as the optimal output.

However, in compounds, the overapplication of Coda Neutralization is observed in the final obstruent of a prefix in a prefixed word and of the left member of a compound. The final obstruent of the left member of a compound always neutralizes, regardless of whether it is followed by a consonant or a vowel or whether it appears in onset or coda position, as shown in the (b) examples below.

(128) a. /kət^h-ɨl/	[kət.t^{h}ɨl]	'outside-Acc'
b. /kət^h#os/	[kə.tot]	'outer garment'
(129) a. /os-ɨl/	[o.sɨl]	'clothes-Acc'
b. /os#an/	[o.tan]	'inside the clothes'
(130) a. /nac-i/	[na.cɟi]	'day-Nom'
b. /nac#os/	[na.tot]	'day clothes'
(131) a. /k'oc^h-i/	[k'oc.cɟ^{h}i]	'flower-Nom'
b. /k'oc^h#ilɨm/	[k'o.tɟi.lɨm]	'flower's name'

All the cases in (b) are overapplication of Coda Neutralization. As is apparent in the (a) examples, Coda Neutralization does not occur in the case of a root-final obstruent when it is followed by a vowel suffix, whereas it does occur when followed by another vowel-initial root morpheme as in the (b) examples.

The overapplication of Coda Neutralization is also observed in the prefix-final consonant.

(132) Prefixed Roots

a. /təs#os/	[tə.tot]	'outer garment'
b. /tes#os-ɨl/	[tə.to.sɨl]	'outer garment-Acc'
c. /hot^h#ipul/	[ho.tɟi.pul]	'single-layer quilt'

As shown in the data, the prefix-final consonant is neutralized before a root-initial vowel. The prefix-final consonant before a vowel-initial root patterns together with the final consonant of the first member of a compound before a vowel-initial second member. This finding suggests that a prefix forms a separate prosodic domain from the following in a fashion similar to the way in which the first member of a compound forms a separate domain from the following second member of the compound.

Kang (1992) argues that in Korean a prefix in a prefix plus stem combination as well as each member of a compound forms a separate prosodic word (ω) in addition to lexical categories (i.e., N, V, A, Adv). In other words, those prefixes before a root are not prefixes but roots. Thus, in (132 (a)) the prefix, /təs/ 'outer', and the stem, /os/ 'clothes', form a separate prosodic word $((\text{təs})_{\omega}(\text{os})_{\omega})$ whereas in (132 (b)) the noun root, /os/ 'clothes', and the suffix, /i/ 'Nominative', form a single prosodic word $((\text{osi})_{\omega})$. The former forms two prosodic words $((\text{təs})_{\omega}(\text{os})_{\omega})$ and thus, the first constituent is subject to Coda Neutralization. In contrast, the latter forms a single prosodic word $((\text{osi})_{\omega})$ and thus the environment for Coda Neutralization may not be met.

Following her arguments, now we can see why there is a prefix-suffix asymmetry with respect to Coda Neutralization. As Coda Neutralization is a prosodically bounded phenomenon, it shows a different pattern depending on the prosodic domain. The overapplication of Coda Neutralization takes place when there are more than two prosodic domains within a prosodic structure. In fact, the asymmetry between progressive and regressive aspiration is one kind of prefix-suffix asymmetry as Coda Neutralization. Remember that suffix is involved in progressive aspiration, while prefix or root is involved in regressive aspiration.

In the next section, I provide an OT account of the overapplication of Coda Neutralization, and furthermore, the asymmetry between progressive and regressive aspiration, using Benua's Transderivational Correspondence Theory (1997).

4.4 Transderivational Correspondence Theory (TCT, Benua 1995, 1997)

The most basic correspondence relation in the classical model of OT (Prince & Smolensky 1993, McCarthy & Prince 1995) is between inputs and outputs. However, other correspondence relations are possible. Benua (1997) introduces Output-Output Faithfulness to the Correspondence Theory, claiming that there is a family of Output-Output (O-O) constraints

which demand identity in much the same way as I-O or B-R constraints. This faithfulness constraint represents the relation between two paradigmatically related surface forms: an output base is evaluated with respect to the output form from which it has been derived. The core idea is that word formation rules -- e.g., affixation of 'cat' to yield 'cats' -- are mirrored by a correspondence relation between the derived word and its base word.

A major advantage of this approach is that it provides an Optimality-Theoretic solution to certain cyclic effects in phonology. In Transderivational Correspondence Theory (henceforth, TCT), a morphologically complex word's output may depend crucially on properties of the output of a subword contained within the complex word. In classical OT, outputs can only refer to inputs because the correspondence relation is between inputs and outputs. Thus, it is hard to capture "identity-driven" misapplication effects which may derive from other related outputs instead of inputs. However, TCT is motivated by the class of cases in which identity of related words surpasses what is expected from shared underlying form. In these cases, a derived word violates a phonotactic pattern to better resemble its base word. As TCT compares a derived output with its base output, it can account for how morphologically-related words are phonologically more alike than what would be anticipated by normal application of phonological processes.

As we can see, TCT is an attempt to capture over- and underapplication phenomena, so I use this approach to account for the overapplication of Coda Neutralization in Korean.

As in SPE, Kiparsky (1982, 1983), Allen (1978), and others, Benua classifies affixes in English into two groups, class 1 and class 2 according to their surface phonological patterns. Class 1 affixes trigger an OO_1-correspondence relation, and class 2 affixes are subcategorized by an OO_2- correspondence relation. Each relation is governed by a set of identity constraints: OO_1-Identity constraints evaluate class 1 paradigms and OO_2–Identity constraints evaluate class 2 paradigms. Both sets of OO-Identity constraints are ranked in the English hierarchy of markedness and IO Faith constraints. The differences between class 1 and class 2 words follow from the rank of identity constraints on two distinct OO-correspondence relations. It is the higher- ranking OO constraint that forces any kind of misapplication such as over and underapplication.

Although Benua's case study deals with affixation only, I extend her analysis to Korean compounding. Remember that in Korean prefixed words, "prefixes" pattern with roots and they form their own prosodic domain (Kang, 1992). Also overapplication of Coda Neutralization occurs in final obstruents of root compounds. So I classify prefixes and roots as class 2, whose OO-Identity constraint outranks IO-Identity constraint, resulting in overapplication. Further, I classify suffixes as class 1 whose OO-Identity constraint ranks lower than IO-Identity constraint. See below for a visual explication of these relations.

(133) Two OO-correspondence Relations

a. Class 1	*kət^h*	*kət^h-e*		b. Class 2	*kət^h*	*kət^h#os*
	'out'	'out-Loc'			'out'	'outer#clothe'

	OO_1-Identity			**OO_2-Identity**	
[kət]	→	[kət.t^{h}e]	[kət]	→	[kə.tot]
↑		↑	↑		↑
/kət^h/		/kət^h-e/	/kət^h/		/kət^h#os/

In Korean, aspirated consonants are neutralized to their plain counterparts in syllable-final position. As seen above in (133), the root-final /t^h/ does not surface in *kət^h* [kət] 'out'. The /t^h/ must be present in the underlying form of this root, because it surfaces in *kət^h-e* [kət.t^{h}e] 'out-Loc', where it is syllabified as an onset to a vowel-initial class 1 suffix in (133a). However, when the same root precedes a vowel-initial root, the aspirated consonant fails to surface, even though it could be syllabified as an onset to a vowel-initial root in (133b). This is an overapplication identity effect. Coda neutralization applies to the class 2 word, where it would seem to be not properly conditioned, because coda neutralization is properly conditioned in the base.

Coda Neutralization demonstrates a direct conflict between IO-Faith and OO-Identity constraints. In class 1 suffixation, IO-Faith takes precedence over OO_1-Identity. The suffixed word in the class 1 paradigm realizes all input features, in satisfaction of IO-MAX, even though one of these inputs is not realized in the base, and OO_1-DEP is violated. In (133a), the root final [t^h] in the suffixed word has no base correspondent. Thus, the ranking is IO-MAX >> OO_1-DEP.

In class 2 compounding, on the other hand, IO-MAX is violated under domination by OO_2-Identity. In (133b), the input root's [t^h] is not realized in the derived word so that an OO_2-DEP violation is avoided. Class 2 prefixed or compound words as in (133b) are more faithful to their output bases than class 1suffixed words are to their output base. Class 2 prefixed or compound words can only realize root segments or features that are also realized in the base. In this case, the relevant ranking is OO_2-DEP >> IO-MAX. One case of class 2 prefixation or compounding is shown in tableau (134). I use only the relevant constraints for Coda Neutralization in tableau (134) due to limited space.

(134) /os/ → [ot] 'clothes'

/os/	ALIGN-L ([strid], σ)	MAX-IO [strid]	MAX-μ	*Dor, *Lab	*Cor
a. os	*!				*
b. o		*	*!		
☺ c. ot		*			*

The ranking for Coda Neutralization is shown above in tableau (134). Note that the MAX-IO [strid] constraint is an IO-faithfulness constraint. If a prefix attaches to this noun in (134), the OO_2 constraints will apply because prefixes belong to class 2. I assume that the OO_2 constraints rank higher than IO constraints because they force the misbehavior that violates IO- faithfulness.

(135) /təs#os/ → [tə.tot] 'outer clothes'

Recursion (A)

/təs/	ALIGN-L ([strid], σ)	OO_2-DEP[strid]	IO-MAX[strid]	*Dor,*Lab	*Cor	>>
a. təs	*!				**	
b. təs	*!				**	
☺ c. tət			*		**	
d. tət			*		**	

Recursion (B)

>>	/təs + os/	ALIGN-L ([strid],σ)	OO_2-DEP[strid]	IO-MAX[strid]	*Dor,*Lab	*Cor
	a.' tə.sot			*		***
	b.' tə.tot		*	**		***
	☺ c'.tə.tot			**		***
	d.' tə.sot		*!	*		***

Recursion (A) is a tableau for selecting the optimal output base and Recursion (B) is a tableau for selecting the optimal derived word. Recursion (A) is a dominant recursion and the candidates that fail Recursion (A) are ruled out from the competition in Recursion (B) in the first place. The evaluation of both tableaux occurs at the same time. This is why we can have so many base candidates that are the same in recursion (a) because each of them are evaluated with its derived word candidate that are different in recursion (b) as a pair. The reason I'm giving the same candidates twice in tableau (135) is to compare the pair that has the same base but a different derived word. Paradigm (135a) and paradigm (135b) are eliminated by high-ranking ALIGN-L ([strid], σ). The competition between (135c) and (135d) is decided by OO_2 –DEP [strid], which selects paradigm (135c) because the neutralized segment in the derived word corresponds to the neutralized segment in the base. The normal application of Coda Neutralization, in which only codas get neutralized, in paradigm (d) overrides OO_2 –DEP [strid] and fails. Note that the OO_2-DEP constraint is a constraint that corresponds between the output candidate in recursion (a) and the output candidate in recursion (b) in a paradigm.

Another example is given in (136).

(136) /puək^h#an/ → [pu.ə.kan] 'inside the kitchen'

Recursion (A)

/puək^h/	ALIGN-L([lar], σ)	OO_2–DEP[s.g.]	IO-MAX[s.g.]	*Dor, *Lab	*Cor	>>
a. puək^h	*!			*		
b. puək^h	*!			*		
c. puək			*	*		
☺ d. puək			*	*		

Recursion (B)

>>	/puək^h + an/	ALIGN-L([lar], σ)	OO_2–DEP [s.g.]	IO-MAX[s.g.]	*Dor, *Lab	*Cor
	a'. puə.k^{h}an				*	
	b'. puə.kan			*	*	
	c'. puə.k^{h}an		*!		*	
	☺ d'. puə.kan			*	*	

Candidate paradigm (136a) and (136b) are ruled out because they fatally violate high-ranking markedness in the dominant recursion. Candidate (136c) is the normal application candidate, in which Coda Neutralization applies always and only where it is properly conditioned, so the aspirated obstruent retains its [s.g.] feature in the derived word because it is in onset position, and not in coda position. However, this candidate fatally violates OO_2 –DEP [s.g.], since the spread glottis feature in the derived word does not match with the spread glottis feature in the base word. The optimal overapplication paradigm (136d) satisfies OO_2-DEP [s.g.] by failing to realize the [s.g.] feature of the obstruent in the derived word and violating lower-ranked IO-MAX [s.g.].

Remember that unlike prefixes, suffixes belong to Class 1 in Korean. While class 2 prefixed or compound words are highly faithful to their bases, words with class 1 suffixes are less faithful, which implies the low rank of OO_1- faithfulness constraints. I assume that OO_1-DEP [s.g.]/[c.g.]/[strid] ranks lower than IO-MAX [s.g.]/[c.g.]/[strid]. The case of normal application of Coda Neutralization when vowel-initial suffixes follow obstruent-final roots is illustrated in tableau (141) below. I take an example, /os-e/ 'clothes-at', in which a Locative suffix '-e' follows a noun root 'os'.

(137) Class 1: Normal Application

ALIGN-L ([strid], σ) >> IO-MAX [strid] >> OO_1-DEP [strid]

	a.	[os]	[o.se]	*underapplication*
☺	b.	[ot]	[o.se]	*normal application*
	c.	[ot]	[o.te]	*overapplication*

Recursion (A)

/os/	ALIGN-L ([strid], σ)	IO-MAX [strid]	OO_1-DEP [strid]	>>
a. os	*!			
☺ b. ot		*		
c. ot		*		

Recursion (B)

>>	/os–e/	ALIGN-L ([strid], σ)	IO-MAX [strid]	OO_1-DEP [strid]
	a. o.se			
	☺ b. o.se			*
	c. o.te		*!	

The underapplication paradigm (137a) is not optimal because it violates ALIGN-L ([strid], σ). The competition between normal application in (b) and overapplication in (c) demonstrates the IO-faithfulness >> OO_1-faithfulness ranking. Candidate (137c) satisfies OO_1-DEP [strid], but incurs a greater violation of IO-MAX [strid] than optimal (137b), since the obstruent in the derived word does not retain the same [strid] feature of the fricative in the input root. The optimal paradigm shows normal application of Coda Neutralization because OO_1-faithfulness ranks lower than IO-MAX [strid].

For words with class 1 suffixation, it is more important to realize all the underlying features than to be faithful to the features of a base correspondent: IO-MAX >> OO_1-DEP. On the other hand, for words with class 2 prefixation, or compounding, faithfulness with the base is paramount, and input feature is not realized in the prefixed or compound word if it is not realized in the base: OO_2-DEP >> IO-MAX. The Coda Neutralization hierarchy is summarized in (138).

(138) Coda Neutralization

ALIGN-L ([lar], σ), ALIGN-L ([strid], σ), OO_2-DEP [s.g.]/[c.g.]/[strid] >>
IO-MAX [s.g.]/[c.g.]/[strid] >> OO_1-DEP [s.g.]/[c.g.]/[strid]

4.4.1 Asymmetry in Progressive and Regressive Aspiration

Now we go back to the matter that I addressed earlier in section 4.3. As I mentioned previously, one of the asymmetries between progressive and regressive aspiration comes from the effect of Coda Neutralization. Coda Neutralization applies to both cases, progressive and regressive aspiration. However, as the type of affixes that are involved in progressive and regressive aspirations are different, the application of Coda neutralization differs and affects progressive and regressive aspiration in a different way. The /h/ in progressive aspiration is root-morpheme final and is always followed by a suffix, which belongs to Class 1 suffixation. On the other hand, regressive aspiration involves [prefix#root] or [root#root], so it belongs to Class 2 prefixation or compounding. The examples for each aspiration are given in (139), and (140) respectively.

(139) Progressive aspiration /noh-ca/ 'put-Persuasive'

Class 1: Normal Application ALIGN-L ([lar], σ) >> IO-MAX [s.g.] >> OO_1-DEP [s.g.]

a. [noh] [noh.ca] *underapplication*

☺ b. [not] [noc.c^{h}a] *normal application*

c. [not] [not.c'a] *overapplication*

Recursion (A)

/noh/	ALIGN-L ([lar], σ)	IO-MAX [s.g.]	OO_1-DEP[s.g.]	*Dor, *Lab	*Cor	>>
a. noh	*!					
☺ b. not		*			*	
c. not		*			*	

Recursion (B)

>>	/noh-ca/	ALIGN-L ([lar],σ)	IO-MAX [s.g.]	OO_1-DEP[s.g.]	*Dor,*Lab	*Cor
	a'. noh.ca	*				*
	☺b'. noc.c^{h}a					*
	c'. not.c'a		*!			*

Paradigm (a) is excluded because it violates ALIGN-L ([lar], σ) in the dominant recursion of constraints by having /h/ in coda position. The competition between normal application (139b) and overapplication (139c) is decided by IO-MAX [s.g.] ranked above OO_1-DEP [s.g.]: normal

application is optimal because it satisfies the dominant faithfulness constraint. The optimal paradigm's violation of OO_1-DEP [s.g.] is low-ranking and irrelevant.

(140) Regressive aspiration /nɨc#he/ 'late year'

Class 2 : Overapplication ALIGN-L ([strid], σ), OO_2-DEP [strid] >> IO-MAX [strid]

a. [nɨc] [nɨc.he] *underapplication*

b. [nɨt] [nɨc.c^{h}e] *normal application*

☺c. [nɨt] [nɨt.t^{h}e] *overapplication*

Recursion (A)

/nɨc/	ALIGN-L([strid], σ)	OO_2-DEP[strid]	IO-MAX [strid]	*Cor	>>
a. nɨc	*!			*	
b. nɨt			*	*	
☺c. nɨt			*	*	

Recursion (B)

>>	/nɨc + he/	ALIGN-L ([strid], σ)	OO_2-DEP [strid]	IO-MAX[strid]	*Cor
	a'. nɨc.he	*			*
	b'. nɨc.c^{h}e		*!		*
	☺c'. nɨt.t^{h}e			*	*

Candidate paradigm (a), which underapplies coda neutralization in the prefix, is eliminated by its violation of ALIGN-L ([strid], σ) in the dominant recursion. The normal and overapplication paradigms in (140b-c) have the same optimal prefix. Remember that prefix forms a prosodic domain as a root does, so in this case prefix is the base. The normal application candidate in (140b) violates OO_2-DEP [strid] by failing to identify with its base prefix in terms of [strid] feature, and this violation is fatal. Overapplication in (140c) is optimal, in spite of its IO-MAX violation.

More examples of progressive and regressive aspirations are given in (141) and (142) respectively.

(141) Progressive aspiration /noh-ta/ 'put-Dec'

Class 1: Normal Application ALIGN-L ([lar], σ) >> IO-MAX [s.g.] >> OO_1-DEP [s.g.]

a. [noh] [noh.ta] *underapplication*

☺ b. [not] [not.t^ha] *normal application*

c. [not] [not.t'a] *overapplication*

Recursion (A)

/noh/	ALIGN-L ([lar],σ)	*h/Ons	IO-MAX[s.g.]	MAX-μ	OO_1-DEP[s.g.]	>>
a. noh	*!					
☺b. not			*			
c. not			*			
d. not			*			

Recursion (B)

>>	/noh + ta/	ALIGN-L([lar], σ)	*h/Ons	IO-MAX[s.g.]	MAX-μ	OO_1-DEP[s.g.]
	a. noh.ta	*!				
	☺b. not.t^ha					*
	c. no.t^ha				*!	*
	d. not.t'a			*!		

Paradigm (a) violates ALIGN-L ([lar], σ) in the dominant recursion by keeping /h/ in coda position. In Recursion (B), paradigm (d) violates IO-MAX [s.g.] by losing the [s.g.] feature in the output. Paradigm (b) and (c) are normal application candidates. The only difference between paradigm (b) and (c) is that the aspirated stop in paradigm (b) is a geminate, while the one in paradigm (c) is a non-geminate, violating MAX-μ. Hence, paradigm (b) surfaces as optimal.

(142) Regressive aspiration /mos-he/ 'cannot do'

Class 2 : Overapplication ALIGN-L ([strid], σ), OO_2-DEP [strid] >> IO-MAX [strid]

a. [mos] [mos.he] 'underapplication'

b. [mot] [mos.s'e] 'normal application'

☺c. [mot] [mot.t^he] 'overapplication'

Recursion (A)

/mos/	ALIGN-L([strid],σ)	OO_2-DEP[strid]	*h/Ons	IO-MAX[strid]	MAX-μ	>>
a. mos	*!					
b. mot				*		
☺ c.mot				*		

Recursion (B)

>>	/mos + he/	ALIGN-L([strid],σ)	OO_2-DEP[strid]	*h/Ons	IO-MAX[strid]	MAX -μ
	a. mos.he	*!		*		
	b. mos.s'e		*!			
	☺ c. mot.t^he				*	

Here a prefix, 'mos' attaches to a root verb, 'he', so this prefixation belongs to Class 2, in which the overapplication candidate is optimal. Paradigm (a) underapplies Coda neutralization by retaining the [strid] feature in coda position, so it fatally violates A-L ([strid], σ) in the dominant recursion. The competition between paradigm (142b) and paradigm (142c) is decided by the OO_2 faithfulness constraint in the following recursion. Paradigm (c) violates IO-MAX [strid], but it is a low ranking constraint so it wins out.

To summarize, paradigmatic identity forces overapplication of coda neutralization in class 2 prefixed or compound words of Korean, while coda neutralization disturbs paradigmatic identity in class 1 suffixation paradigms. The constraint hierarchy that explains Coda Neutralization and Aspiration as well is repeated in (143).

(143) Summary ranking

ALIGN-L ([lar], σ), ALIGN-L ([strid], σ), MAX_{PLACE}, MAX [s.g.]/ $[_{WORD\_}$,
OO_2-DEP [s.g.]/[c.g.]/[strid]>>*h/Ons, MAX[s.g.]/ $[_{Mstem\_}$ >> IO-MAX [s.g.]/[c.g.]/[strid] >>
MAX-μ >> MAX-IO (RT) >> OO_1-DEP[s.g.]/[c.g.]/[strid] >> *Lab, *Dor >> *Cor

Class 2 words are faithful to their bases and class 1 words are not, because two distinct OO-Identity constraints rank differently in the coda neutralization hierarchy. The constraint on the OO_2-correspondence relation is higher-ranked than its OO_1-Identity counterpart. And this

different ranking in coda neutralization hierarchy results in asymmetry in progressive and regressive aspirations.

4.5 Consonant Cluster Effect

Turning back to data in (36), remember that when /h/ is a part of a consonant cluster, and a nasal segment follows it, the nasal segment does not get geminated. Some of the data is given in (144).

(144) a.	ilh-nɨn	[il.nɨn]	'lose-Progressive'
b.	t'ulh-nɨn	[t'ul.nɨn]	'punch-Progressive'

However, I assume that when non-continuant obstruent initial suffix follows /h/ when it is a part of a consonant cluster in coda position, it gets geminated.

(145) a.	ilh-ko	[ilk.k^{h}o]	'lose-Connective'
b.	ilh-ta	[ilt.t^{h}a]	'lose-Declarative'
c.	ilh-ca	[ilc.c^{h}a]	'lose-Persuasive'

This can be explained by positional markedness constraints that reflect the Sonority Hierarchy. In Nuxalk (Bella Coola), the maximal onset is $_\sigma$[OR , where O stands for an obstruent and R, a resonant, based on the reduplicative behavior (Bagemihl, 1991). The fact that OR onsets are possible generally in Nuxalk, whereas OO onsets are not, follows familiar constraints on sonority sequencing in tautosylabic clusters (Shaw, 2002).

Shaw (2002) introduces a fixed universal markedness hierarchy of subconstraints within a family of COMPLEXONSET (*CMPXONS) constraints to explain clusters that are syllabified as the onset to a nuclear syllable.

(146) Fixed UG Markedness Hierarchy of *CMPXONS constraints

$*_\sigma$[RO >> $*_\sigma$[OO >> $*_\sigma$[OR

This is based on Sonority Sequencing Constraints (Clements 1990, among others) that integrate the effect of sonority peak. Sonority must rise from the beginning of a σ to the σ peak which is a nucleus. When an onset side of a syllable reflects sonority rising in consonant clusters, the other side of a syllable, the coda, reflects the mirror image. In other words, consonant clusters in coda observe sonority decline. Consequently the ranking hierarchy in (146) is reversed for COMPLEXCODA as in (147).

(147) $*OR]_{\sigma}$ >> $*OO]_{\sigma}$ >> $*RO]_{\sigma}$

So a cluster that is made of segments with identical sonority such as RR will be more marked than a sequence that declines in sonority: $*RR]_{\sigma}$ >> $*RO]_{\sigma}$. With this markedness constraint hierarchy, the asymmetric behavior of a sonorant-initial suffix and an obstruent-initial suffix when it follows /h/ that is part of a consonant cluster in coda position can now be explained.

(148) /ilh-nɨn/ [il.nɨn] 'lose-Progressive'

/ilh-nɨn/	ALIGN-L ([s.g.], σ)	$*RR]_{\sigma}$	MAX-IO [s.g.]	MAX-μ	$*RO]_{\sigma}$
a. ilh.nɨn	*!				*
b. iln.nɨn		*!	*		
☺ c. il.nɨn			*	*	

In candidate (a), /h/ in the coda leads to a violation of ALIGN-L ([s.g.], σ). Candidate (b) has two resonants, a lateral and a nasal in coda position, thus violating $*RR]_{\sigma}$. So candidate (c) surfaces as optimal, where /h/ simply deletes. Note that the gemination of /n/ in candidate (b) satisfies MAX-μ, but violates $*RR]_{\sigma}$ as a part of the geminate /n/ plays a coda of the preceding syllable resulting in a resonant cluster. This is why /n/ does not get geminated.

(149) /ilh-sɨp/ [ils.s'ɨp] 'lose-Style'

/ilh-sɨp/	ALIGN-L ([s.g.], σ)	*RR]$_\sigma$	MAX-IO [s.g.]	MAX-μ	*RO]$_\sigma$
a. ilh.sɨp	*!				*
☺ b. ils.s'ɨp			*		*
c. il.sɨp			*	*!	

This is a case when a fricative initial suffix follows a consonant cluster. Candidate (a) is ruled out because it violates the high-ranking constraint, ALIGN-L ([s.g.], σ). Candidate (a) also violates *RO]$_\sigma$ because it has /lh/ cluster which is a sequence of a resonant and an obstruent in coda position. Both candidate (b) and (c) violate MAX-IO [s.g.] by losing /h/, however, candidate (c) violates MAX-μ which ranks higher than *RO]$_\sigma$ that candidate (b) violates. Thus candidate (b) surfaces as optimal.

(150) /ilh-ta/ [ilt.t^{h}a] 'lose-Declarative'

/ilh-ta/	ALIGN-L ([s.g.], σ)	*RR]$_\sigma$	MAX-IO [s.g.]	MAX-μ	*RO]$_\sigma$
a. ilh.ta	*!				*
☺ b. ilt.t^{h}a					*
c. il.ta			*!	*	

Candidate (a) has a /lh/ cluster in coda, so it violates ALIGN-L ([s.g.], σ) and non-crucially *RO]$_\sigma$. Candidate (b) violates RO]$_\sigma$ because it has a lateral which is R and a geminate aspirated stop which is O in coda. However, candidate (c) fatally violates a higher-ranking constraint, MAX-IO [s.g.]. So candidate (b) wins.

CHAPTER 5

IMPLICATIONS

5.1 Summary

In this section, I will summarize each chapter so far. In chapter 1, I introduced the aspiration process, and reviewed previous analyses of aspirated consonants including tense consonants. Korean has a three-way contrast of non-continuant obstruents; plain, tense, and aspirated. Plain consonants behave differently from tense and aspirated consonants in many ways; it is hypothesized that this difference results from the different underlying structure of tense and aspirated consonants. As for the structural representation, many linguists hold different views. Han (1996) distinguishes tense consonants as having an underlying feature [c.g.], whereas plain consonants and aspirated consonants do not. Plain and aspirated consonants are further distinguished by the timing structure. Kim J. (1986), Yu (1989), Jun (1994), Choi & Jun (1998) argue that plain consonants are singleton segments, while aspirated and tense consonants are geminates. Furthermore, aspirated and tense consonants are distinguished by their distinctive features. Aspirated consonants are marked for [s.g.], while tense consonants are marked for [c.g.]. In the remainder of chapter 1, I presented some theoretical background about Korean phonemes and syllable structure.

In chapter 2, I described and analyzed the behavior of /h/. /h/ is important because it triggers aspiration. Chapter 3 provided cross-linguistic evidence in Modern Farsi that corroborates the main idea of the thesis that the deletion of laryngeal consonants may trigger Compensatory Lengthening (CL).

In Chapter 4, I showed how my proposal is accounted for within an OT account. In 4.1, I argued that derived aspirated consonants come from the coalescence of /h/ and a non-continuant obstruent. The [s.g.] feature of /h/ is not deleted when /h/ coalesceses with a non-continuant obstruent. Instead, the [s.g.] feature is inherited to a non-continuant obstruent that /h/ coalesceses with. Thus, derived aspirated consonants end up with the same featural specification of [s.g.] as underlying aspirated consonants. In section 4.2, following Kim J. (1986) among others, I argued that aspirated consonants are geminates within moraic phonology. The formal analysis here is

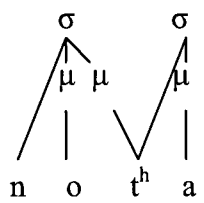
predicated on the assumption that all segments in Korean are moraic (Hyman, 1985), with the universal proviso that if a segment is parsed into onset, it does not keep its moraic status. CL of the aspirated consonant occurs to preserve the moraic weight of the morpheme-final segment. In section 4.3, I addressed the asymmetry between progressive and regressive aspirations. This asymmetry comes from Coda neutralization, which is prevalent in Korean phonology. In order to explain Coda neutralization, I adopt Benua's Transderivational Correspondence Theory (1997). Progressive aspiration belongs to class 1 suffixation in which the normal application candidate surfaces as the optimal candidate, while regressive aspiration belongs to class 2 prefixation or compounding in which the overapplication candidate surfaces as optimal. Section 4.5 talks about the effects when a consonant-initial suffix follows cosonant clusters in coda position.

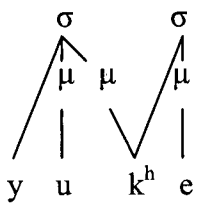
A residual issue relates to non-derived initial aspirated consonants. In the immediately following section, I argue that initial aspirated consonants have the same geminate structure as derived aspirated consonants have. The only difference is that the mora of initial aspirated consonants is extrasyllabic.

5.2 Implications for Initial aspirated consonants

In this thesis, I argue that aspirated consonants that are morphophonemically derived from aspiration are geminate consonants because CL occurs to preserve the moraicity of the morpheme-final segment that goes under coalescence with the following segment. This implies that word-medial aspirated consonants are always geminates.

(151) a. /noh-ta/ [not.t^{h}a] 'put-DEC' b. /yuk#he/ [yuk.k^{h}e] 'land and sea'





Then what about the initial aspirated consonants that are not derived from aspiration? I assume their structure is the same as the derived aspirated consonants. This means that initial aspirated consonants are geminates as well, and that they have an initial mora for their weight. This entailed claim is independently corroborated by two other prosodically sensitive phenomena in Korean: accent amd mimetic reduplication.

5.2.1 Accent system

Let us consider, first, the implications of this claim for the analysis of the accent system. We have seen previously in section 1.2 that initial aspirated consonants do not play any role in deciding the accent of a syllable, unlike word-medial aspirated consonants.

Remember that Korean accent falls on the leftmost heavy syllable, otherwise falls on the rightmost light syllable.

(152)	a. /'sa:ram/	'human being'	b. /'nunpora/	'snowstorm'
	c. /i'ma/	'forehead'	d. /wema'ti/	'single section'
	e. /k^{h}ita'li/	'tall person'	f. /'sat^{h}ang/	'candy'

In (152a) and (152b), the accent falls on the first syllable because the first syllable is heavy, having CVV and CVC structure respectively. In (152c) and (152d), the accent falls on the last syllable because there is no heavy syllable in the word. What is important here is (152e) and (152f) that has an aspirated consonant word-initially, and word-medially respectively. In (152f), the accent falls on the first syllable, meaning that it is heavy. So we can see that the medial aspirated consonant is moraic and plays a role in deciding the accent, its postulated geminate structure making the preceding syllable heavy. On the other hand, in (152e), the accent falls on the rightmost syllable. This means that the first syllable that starts with an aspirated consonant is light, meaning that the aspirated consonant does not play any role in the syllable weight. What accounts for this is that the mora of the initial aspirated consonant is extrasyllabic. The two diagrams in (153) illustrate that the prosodic structure independently motivated in the previous chapters provides a straightforward account of the attested accent patterns here.

(153) /k^{h}ita'li/ 'tall person' /sat^{h}ang/ 'candy'

5.2.2 Mimetic Reduplication

The second prosodically relevant domain which provides strong empirical support for the proposed analysis of initial aspirates is reduplication. Specifically, the present claim is consistent with Jun (1989, 1991,1994)'s metrical weight constraint that he proposes to account for partial reduplication of Korean mimetics.

(154) Metrical Weight Consistency (MWC)

The number of feet in the output of partial extension must be identical to that in the input.

Korean possesses a rich onomatopoeic and mimetic vocabulary that may be augmented by partial reduplication or suffixation. Semantically, partial reduplication lengthens or temporally extends the meaning of the base form. Jun argues that Korean partial reduplication falls out from a more general morphological process which is subject to a prosodic condition on the metrical weight of surface forms. I provide data cited from Jun (1994).

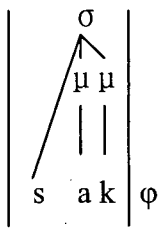
(155)	Base[34]	Partial Reduplication (PR)	
	a. /sak/	/sa-sak/	'crisp'
	b. /tuŋ/	/tu-tuŋ/	'sound of booming drum'
	c. /t^{h}aŋ/	/t^{h}a-taŋ/	'bang'
	d. /p'aŋ/	/p'a-paŋ/	'sound of rain dropping'

As seen in (155a, b), when the base has a plain non-continuant obstruent onset, the base is reduplicated without coda. Interestingly, when the base has an aspirated or a tense onset as in

[34] I only show the monosyllabic bases, given space limitations. Polysyllabic forms behave the same.

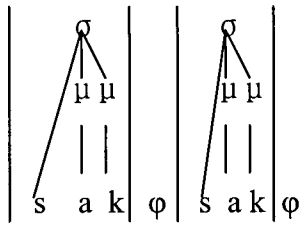
(155c) or (155d), the reduplicant surfaces not only without the coda but also the base loses its tenseness or aspiration. According to Jun, this is because of the constraint in (154) that assures that the number of feet in the input equals the number of feet in the output. All the inputs contain a single foot[35] and all the output words contain only a single foot since they have but a single heavy syllable on their right edge.

(156) a. base



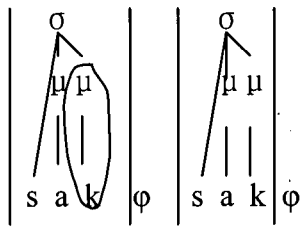
1 foot

b. reduplication

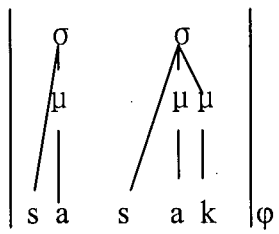


2 feet

c. MWC



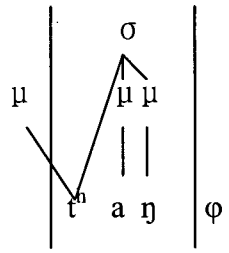
d. output



1 foot

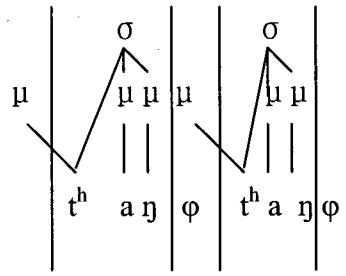
[35] Korean metrical feet are (i) right-headed, (ii) unbounded, and (iii) quantity-sensitive (Lee (1974)).

(157) a. base



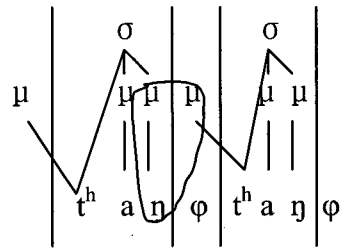
1 foot

b. reduplication

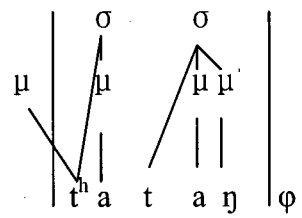


2 feet

c. MWC



d. output



1 foot

In (157), note that if only the coda of the first syllable is deleted, a stray mora of the second syllable will be associated to the first syllable, making its output two feet, thus violating the MWC. If we assume that the initial aspirated consonant has no mora associated to it, then there is no reason why only the plain counterpart is reduplicated as the onset of the base. Aspiration of the onset of the base is deleted whenever a stray mora is deleted during the process of the partial reduplication. This implies that the initial aspirated consonant is affiliated with a mora.

While Jun does not provide an OT account for his interpretation, I predict that my analysis of aspirated geminate structure can account for this same fact under "the Emergence of the Unmarked (TEFU)" analysis (McCarthy & Prince 1995) within OT. I leave this for future research due to constraints of time.

(158) FAITH_{IO}(FT) >> No-Coda >> MAX_{BR} (FT: feet)

REFERENCES

Ahn, Sang-Cheol. 1985. "*The interplay of phonology and Morphology in Korean*", Ph.D. dissertation, University of Illinois, Urbana.

Ahn, Sang-Cheol. 1998. *An Introduction to Korean Phonology*. Hanshin Publishing Co. 90-97.

Allen, Margaret. 1978 *"Morphological Investigations"*, Ph.D. dissertation, University of Connecticut.

Bagemihl, Bruce. 1991 "Syllable structure in Bella Coola", *Linguistic Inquiry* 22: 589-646.

Beckman, Jill N. 1998 "*Positional Faithfulness*", UMass dissertation, [ROA 234].

Causley, Trisha. 1998 "Faithfulness and Contrast: The Problem of Coalescence", *The Proceedings of the seventeenth West Coast Conference on Formal Linguistics* 17.

Cain, Bruce D. 2000 "An account of coalescence and compensatory lengthening in Dhivehi Maldivian)", *Working papers of the Cornell Phonetics Laboratory 13.*

Chang, Woohyeok. 2000 "Geminate vs. Non-geminate Consonants in Italian: Evidence from a Phonetic Analysis, *U. Penn Working Papers in Linguistics*, Volume 7.1.

Cho, Mi-Hui & Lee, Shinsook. 1989 "The Role of the Prosodic Word in an Ordering Paradox of Korean", *Japanese/Korean Linguistics* 9.

Cho, Youngmee Yu. 1989 "Parameters of Consonantal Assimilation in Japanese and Korean", *Japanese/Korean Linguistics* 1.

Cho, Youngmee Yu & S. Inkelas. 1992 "*Post-obstruent tensification in Korean and geminate inalterability*", Paper presented at the ICKL, George Washington University, Washington, D.C.

Chomsky, Naom & Morris, Halle. 1968. *The sound pattern of English. New York*: Harper and Row.

Choi, Seongwon & Jun, Jongho. 1998 "Are Korean Fortis and Aspirated Consonants Geminates?", *Language Research* 34, No.3.

Clements, George N. 1985 "The geometry of phonological features", *Phonology* 2: 225-252.

Clements, George N. 1987 "Phonological feature representation and the description of intrusive stops", *Papers from the Twenty-third Meeting, Chicago Linguistic Society*, vol. 2, 29-50.

Clements, George N. & Elizabeth Hume. 1995 "The internal organization of speech sounds", in John Goldsmith (ed.), *Handbook of Phonological Theory*. Oxford: Blackwell.

Darzi, Ali. 1991 "Compensatory Lengthening in Modern Colloquial Tehrani Farsi", *Studies in the Linguistic Science* 21.

Davis, Stuart. 1999 "On the moraic representation of underlying geminates: evidence from Prosodic Morphology" *The Prosody-Morphology Interface.*

Davis, Stuart. 1999 "On the representation of initial geminates", *Phonology* 16.

Gess, Randall. 1998 "Compensatory Lengthening and structure preservation revisited", *Phonology* 15.

De Chene, E. Brent, & Stephen R. Anderson. 1979 "Compensatory lengthening" Language 55: 505-535.

Han, Jeong-Im. 1996 "*The Phonetics and Phonology of "Tense" and "Plain" Consonants in Korean*", Ph.D. dissertation. Cornell University.

Hawkins, John & Anne Cutler. 1988 "Psycholinguistics in factors in morphological asymmetry", in John Hawkins (ed.), *Explaining language universals*. Oxford: Blackwell.

Hayes, Bruce. 1989 "Compensatory Lengthening in Moraic Phonology", *Linguistic Inquiry* 20.

Hock, Hans Henrich. 1986 "Compensatory Lengthening: In Defense of the Concept 'Mora' ", *Folia Linguistica* 20

Hong, Soonhyun. 1997 "*Prosodic domains and ambisyllabicity in optimality theory*", Ph.D. dissertation. Univ. of Pennsylvania.

Huh, W. 1965 "*Kuk Umwunhak (Korean Phonology)*", Seoul: Cengkumsa.

Hyman, Larry. 1985. *A theory of phonological weight*. Dordrecht: Foris

Hyman, Larry. 1992 "Moraic mismatches in Bantu", *Phonology* 9.

Ingram, J.C. & Park, S.G. 1997 "Cross-language vowel perception and production by Japanese and Korean learners of English", *Journal of Phonetics*, Vol.25, No.3, 343-370.

Jun, Jong-ho. 1989 "Prosodic Approach on Korean Partial Reduplication", *Japanese/Korean Linguistics* 2.

Jun, Jong-ho. 1991 "Metrical Weight Consistency in Partial Reduplication of Korean Mimetics", *Harvard Studies in Korean Linguistics* IV, Seoul: Hanshin.

Jun, Jong-Ho. 1994 "Metrical Weight Consistency in Korean Partial Reduplication", *Phonology* 11.

Kager, Rene. 1999. *Optimality Theory*. Cambridge University Press

Kang, Hyeon-Seok. 1998 "The deletion of the Glide y in Seoul Korean: Towards its explanations", *Language Research* 34.

Kang, Ongmi. 1992 "Word-internal prosodic words in Korean", *NELS* 22. 243-257.

Kavitskaya, Darya. 2001 "Disentangling Compensatory Lengthening" NYU Department of Linguistics: Colloquia Series.)

Kim, Chin-Wu. 1965 "On the Autonomy of the Tensity Feature in Stop Classification", *Word* 21: 339-359.

Kim, Chin-Wu. 1967 "Some Phonological Rules in Korean", *E.Mun.Yen.Ku (A study of Languages & Literature)* 5: 163-177.

Kim, Chin-Wu. 1970 "A Theory of Aspiration", *Phonetica* 21.

Kim, Chin Wu and Hyoung-Youb Kim. 1991 "The character of Korean Glides", *Studies in the Linguistic Sciences, Vol. 21, No. 2,* 113--125.

Kim, Jong-mi. 1986 "*Phonology and syntax of Korean morphology*", PhD. dissertation. University of Southern California.

Kim-Renaud, Young-key. 1974 "*Korean Consonantal Phonology*" Ph.D. dissertation, University of Hawaii, Honolulu.

Kim-Renaud, Young-key. 1995 "*Korean Consonantal Phonology*", Hanshin Publishing Co.

Kim, Sookon. 1976 "*Palatization in Korean*", PhD. dissertation. University of Texas at Austin.

Kim, Sunhee. 1989 "The behavior of *h* in Korean", *Harvard Studies in Korean Linguistics III*, Seoul: Hanshin.

Kim, Sunhee. 1990 "*Phonologie des Consonnes en Coreen",* Ph.D. dissertation. L'Ecole des Hautes Etudes en Sociales, Paris.

Kiparsky, Paul. 1982 "Lexical morphology and phonology", *Linguistics in the morning calm.* 3-91.

Kiparski, Paul. 1983. *Word Formation and the Lexicon.*

Kiparsky, Paul. 1985 "Some consequences of Lexical Phonology", *Phonology* Yearbook 2: 85-138.

Ko, Eun-Suk. 1998 "A Two-Root Theory of Korean Geminate Consonants", *WECOL*.

Ko, Eun-Suk. 2001 "Acoustic Effects of Stress in Korean: With a Focus on the Status of Vowel Length", *NELS*.

Lee, Byung-Gun. 1982 "A well-formedness condition on syllable structure", *Linguistics in the Morning Calm*. 489-506.

Lee, Hyun-bok. 1974 "Rhythm and intonation of Seoul language", *Language Research* 10: 15-23.

Lee, Se-Chang. 1998 "On the irregular behavior of h in Korean", *Harvard Studies in Korean Linguistics* 7.

Lombardi, Linda. 1994 "Laryngeal neutralization and alignment". Ms. University of Maryland, College Park.

Lombardi, Linda. 2001 "Why place and voice are different: constraint-specific alternations in Optimality Theory", *Segmental phonology in Optimality Theory: Constraints and Representations*, Cambridge University Press.

Martin, Samuel. 1951 "Korean Phonemics", *Language* 21: 511-33.

Martin, Samuel. 1954 "Korean Mophophonemics", *LSA*, Baltimore.

Martin, Samuel. 1982 "Features, Markedness, & Order in Korean Phonology", *Linguistics in the Morning Calm*.

McCarthy, John & Alan Prince. 1993 "Generalized alignment", *Yearbook of Morphology*, ed. Geert Booij and Jaap van Marle, 79-153. Dordrecht: Kluwer.

McCarthy, John, and Alan Prince 1995 "Faithfulness and reduplicative identity", *Papers in optimality theory* 18, ed. By Jill N. Beckman et al., 249-385. Amherst, MA: GrLSA.

McCarthy, John. 1998 "Coalescence or Fusion", Handout for LING 215: Phonological Theory.

Mohanan, K.P. 1982. *Lexical Phonology*. Ph.D. dissertation, MIT. Distributed by Indiana University Linguistics Club.

Noote-boom, Sieb G. 1981 "Lexical Retrieval from fragments of spoken words: beginnings vs. endings", *Journal of phonetics* 9: 407-424.

Oh, Mira. 1989 "Aspiration in Korean Phonology", *Japanese/Korean Linguistics* 6.

Oh, Mira. 1989 "The prosodic Analysis of Intervocalic Tense Consonant Lengthening in Korean", *Japanese/Korean Linguistics* 8.

Ohala, John J. & Kawasaki, H. 1984 "Phonetics and prosodic phonology", *Phonology* 1:113-127

Ohala, John J. 1990 "The phonetics and phonology of aspects of assimilation", *Papers in Laboratory phonology I: Between the grammar and physics of speech*. 258-275.

Pae, Juchae. 1996 "*Korean Phonology Introduction*", Shinku.

Prince, Alan. & Paul Smolensky, 1993 "Optimality Theory: Constraint interaction in generative grammar", *Technical Report 2 of the Rutgers Center for Cognitive Science.*

Rhee, Seok-Chae. 1989 "Constraints on Post-Obstruent Tensification in Korean", *Japanese/Korean Linguistics* 6.

Selkirk, Elisabeth. 1991 "A Two Root Theory of Length", *University of Massachusetts Occasional Papers* 14. 123-171.

Shaw, Patricia A. 1992 "Templatic Evidence for the Syllable Nucleus", *NELS* 23.

Shaw, Patricia A. 2002 "On the edge: Obstruent Clusters in Salish", *WSCLA* 7.

Shin, Seung-Hoon. 1989 "Umlaut in Kyungsang Korean: The Optimal Domains Theoretic Account", *Japanese/Korean Linguistics* 6.

Sohn, Hyang-Sook. 1987 "*Underspecification in Korean Phonology*", Ph.D. dissertation, University of Illinois, Urbana.

Sumner, Meghan. 1999 "Compensatory lengthening as coalescence: analysis & implications", *WCCFL* 18 *(Proceedings of the 18th West Coast Conference on Formal Linguistics).*

Yip, Moira. 1989 "Feature Geometry and cooccurrence restrictions", *Phonology* 6.

Yu, Jaewon. 1989 "A Study on Korean Glottalized Tense Sounds and Aspirates", *HanGeul* 203, The Korean Language Society.

Zec, Draga 1995 "Sonority Constraints on syllable structure", *Phonology* 12. 85-129.