

Coda Cluster Simplification and Its Interactions with Other Coda Processes in Korean*

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This paper offers an optimality theoretic analysis of Coda Cluster Simplification (CCS) in Korean. I show that the pattern of CCS is well explained through examining its interactions with other coda processes, which, I claim, are captured by a single constraint hierarchy. First, an analysis of the interaction between CCS and Neutralization is developed, which explains the simplification of a majority of the clusters. Secondly, the pattern of the rest of the clusters and the dialectal variation exhibited by them are accounted for by an interplay of two additional constraints both of which pertain to the syllable structure i.e., ALIGN-R and CODASON. Thirdly, the ‘following consonant effect’, by which the simplification pattern is affected by the consonant following a cluster, is accounted for in terms of an interaction between CCS and Assimilation.

1. Introduction

Korean does not permit consonant clusters within the syllable; underlying consonant clusters are subject to simplification, resulting in removal of either the first or the second consonant. It has been suggested that the pattern of cluster simplification interacts with several phonological processes affecting codas in Korean such as neutralization, syllabification, and assimilation (Whitman 1985, Cho 1990, Oh 1994, among others). The basic intuition about the interaction between neutralization and Coda Cluster Simplification (hereafter CCS) is that a cluster XY is simplified to X if Y independently undergoes neutralization while X does not. Association of CCS with syllabification, which correctly captures the basic fact that cluster simplification is syllable sensitive, is partly motivated by the fact that some clusters exhibit dialectal variation (e.g., /hǎk/ ‘soil’ → [hǎk] in the Seoul dialect; [hǎ] in the Kyungsang dialect). Several attempts have been made to attribute the dialectal difference to different syllabification algorithms between the dialects (Whitman 1988, Cho 1990, and Oh 1994).

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Cho (1990) claims further that CCS is mediated by assimilation between the two obstruents of a cluster (§2).

This paper analyzes CCS and its interactions with other coda processes in Korean within the framework of Optimality Theory (OT) and shows that OT, a theory of interactions of constraints, captures the interactions among Korean coda processes in the simplest and most elegant way. In OT, a phonological process is the result of an interaction of a pair (M, F), consisting of a markedness constraint M and a relevant faithfulness constraint F. Dominance of a markedness constraint on the coda over a relevant faithfulness constraint (IDENT, MAX, DEP, and UNIFORMITY) triggers a phonological process in the coda (McCarthy and Prince 1995). In this vein, neutralization, a feature change process in derivational terms, and CCS, a deletion process, can be (minimally) schematized as in (1), where CODACOND states that certain consonants are not allowed in the coda, and *COMPLEX states that a syllable internal consonant cluster is not allowed.

- (1) a. Neutralization
 CODACOND >> IDENT-IO (F) “A certain consonant undergoes some feature change(s) in the coda”
- b. Coda Cluster Simplification
 *COMPLEX >> MAX-IO “One consonant of a cluster is deleted”

The minimal task for providing a unified analysis of the two processes will be to posit a total constraint hierarchy of the four constraints in (1). I will show that this hierarchy accounts for the pattern of simplification for a majority of the clusters (Group I clusters). Those clusters consist of a consonant which is allowed in the coda in Korean, and a consonant which is not allowed in the coda and thus will independently undergo neutralization (e.g., /kaps/ → [kap] ‘price’). I argue that this is the simplest and most elegant way to implement the way neutralization interacts with CCS in Korean (§3).

The rest of the clusters (Group II clusters) consist of two consonants allowable in the coda. Interestingly, while Group I clusters do not show dialectal variation, two

clusters among the three in Group II (i.e., /lk/ and /lp/) exhibit dialectal variation. To analyze them, I will posit two additional constraints, both of which pertain to syllabification: ALIGN-R (Align the right edge of a stem with the right edge of a syllable) and CODASON (In syllable codas, parse sonorant segments). Both constraints will be ranked lower than the four constraints in (1). I show that the dialectal variation is explained by the constraint raking reversal between the two additional constraints. The fact that only members of Group II clusters exhibit dialectal variation follows from the constraint ranking where all of the constraints in (1) dominate ALIGN-R and CODASON (§ 4).

Recently, it has been noted that the simplification pattern of the /lp/ cluster is affected by the consonant following the cluster (Hong 1988, Ahn 1998). To my knowledge, this fact has not been given any satisfactory analysis so far. In this paper I attempt to account for this fact in terms of an interaction between CCS and Assimilation (§5). The analysis of the ‘following consonant effect’ will lead us to conclude that the present analysis is on the right track, compared to two previous OT analyses of CCS in Korean: Kenstowicz (1993) and Iverson and Lee (1994) (§6).

2. Background

2.1 Basic Facts

Korean has the consonant inventory as shown in (2).

(2) Korean Consonant Inventory

labial	alveolar	palatal	velar	laryngeal
p ^h	t ^h	c ^h	k ^h	
p	t	c	k	
p'	t'	c'	k'	
	s			h
	s'			
m	n		ŋ	
	l			
w		y		

As we see in (2), Korean has three stop series: voiceless unaspirated, voiceless aspirated, and voiceless tensed. In the syllable coda, this three-way distinction is neutralized in favor of the voiceless unaspirated series. For instance, /p, p^h, pʼ/ are realized as [p]. In addition to this laryngeal neutralization, coronal continuant obstruents are realized as [t] in the coda. Consequently, only the seven consonants in (3) surface in codas. The exhaustive list of Coda Neutralization in Korean and some examples are given in (4) and (5), respectively.

(3) Consonants allowed in codas

/ p, t, k, m, n, ŋ, l/

(4) Coda Neutralization in Korean

	p	p ^h	pʼ	→	[p]
{	t	t ^h	tʼ	→	[t]
	s	sʼ			
	c	c ^h	cʼ		
		h			
}					
	k,	k ^h	kʼ	→	[k]

(5)	ap ^h	[ap]	‘front’
	pakʼ	[pak]	‘outside’
	nas	[nat]	‘a scythe’
	nac	[nat]	‘a day’
	nah	[nat]	‘to give birth to’

The fact that Korean allows only seven consonants to surface in the coda position can be captured by the Coda Condition in (6) (cf. Ito 1986).

(6) CODACOND (= Korean Coda Condition)

- a. * [Laryngeal]]_σ
- b. * [continuant]]_σ

Another syllable-sensitive phenomenon in Korean is Coda Cluster Simplification. Korean does not permit clustering of consonants in syllable codas (and onsets). When followed by a vowel, the cluster in a CVCC stem surfaces as a coda plus onset sequence (as in /kaps+i/ → [kap.si], per Onset Maximization). But before a consonant or pause the cluster is subject to simplification, resulting in deletion of one segment. Modern Korean has ten underlying coda consonant clusters. The exhaustive list of underlying clusters and the pattern of simplification are given in (7).

(7) Consonant Cluster Simplification (in the Seoul Standard dialect)¹

a.	p(s):	kaps	[kap]	‘price’
		kaps-to	[kap.t’o]	‘price-also’
	cf.	kaps+i	[kap.si]	‘price(nom.)’
	k(s):	nəks	[nək]	‘spirit’
	n(h):	k’inh+ko	[k’in.k ^h o]	‘cut-and’
	n(c):	anc+ko	[an.k’o]	‘sit-and’
	l(h):	alh+ko	[al.k ^h o]	‘sick-and’
	l(t ^h):	halt ^h +ta	[hal.t’a]	‘lick-Dec’
b.	(l)p:	c’alp+ta	[c’ap.t’a]	‘be short’
	(l)k:	h+k	[h+k]	‘soil’
	(l)m:	celm+ko	[cem.k’o]	‘young-and’
c.	(l)p ^h :	†lp ^h +ta	[†p.t’a]	‘recite’

The choice of which consonant deletes seems quite arbitrary. Various descriptive generalizations have been made in the literature. Anticipating the analysis in the following sections, I propose here to generalize the simplification pattern as follows. First, let us call C_{coda} a consonant which is allowed in the coda in Korean and C^*_{coda} a consonant which is not allowed and thus undergoes Neutralization. A set of clusters, which I will call Group I clusters, consists of $C_{\text{coda}}+C^*_{\text{coda}}$. Those are the clusters given in

¹ In the examples, the derived tensed consonant (e.g. [t’] in ‘kaps-to → [kap.t’o]’) results from ‘Post-Obstruent Tensification’ in Korean, which is immaterial to our discussion.

(7a). In the case of /ps/, for instance, /p/ is a C_{coda} and /s/ is a C^*_{coda} . Another set of clusters, which I will call Group II clusters, consists of two consonants both of which are allowed in codas, that is, $C_{\text{coda}}+C_{\text{coda}}$. Group II clusters are those given in (7b). For instance, both members of the /lk/ cluster are among the seven consonants in (3). Given this much, the following generalization describes the organization of the consonant types in (7):

- (8) Cluster Simplification (in the standard Seoul dialect)
- a. In Group I clusters, ($C_{\text{coda}}+C^*_{\text{coda}}$), C_{coda} survives and C^*_{coda} deletes.
 - b. In Group II clusters, ($C_{\text{coda}}+C_{\text{coda}}$), the first consonant deletes and the second one survives.

Here discussion of the cluster /p^h/ is in order. It is a $C_{\text{coda}}+C^*_{\text{coda}}$ cluster. According to (8a), it is expected to be realized as [l]. However, it is realized as [p]. This exceptional characteristic of /p^h/ will be dealt with in §4.3. The subsequent discussion will proceed putting aside the /p^h/ cluster until §4.3.

CCS in Korean exhibits dialectal variation. The list of clusters given in (7) obtains for the Seoul dialect, i.e., standard Korean. (9) shows the facts for the Kyungsang dialect (putting aside the /p^h/ cluster, which is realized as [l] in the Kyungsang dialect).

- (9) Cluster Simplification in the Kyungsang Dialect
- a. Group I: p<s> k<s> n<h> n<c> l<h> l<t^h>
 - b. Group II: l<p> l<k> <l>m

Note that clusters in Group I do not exhibit any dialectal differences. /lp/ and /lk/ among the three clusters in Group II show dialectal variation. For instance, /hɪlk/ ‘soil’ is pronounced as [hɪk] in Seoul and [hɪl] in Kyungsang.

2.2 Interactions among Coda Processes: View from Rule-Based Approaches

Traditionally, Neutralization and CCS were handled by two separate rules. However, since Whitman’s (1985) observation that the clusters where the second member

gets reduced (in the Seoul dialect), that is Group I clusters, are those whose second member undergoes Neutralization independently in the coda, several attempts have been made to analyze CCS in connection with Neutralization and other phonological processes (Whitman 1985, Cho 1990, Oh 1994, among others). A full-fledged analysis is proposed by Cho (1990), according to which CCS is the result of the rule ordering of Neutralization > Assimilation > syllabification. The derivations in (10) illustrate how Cho's (1990) system derives Group I clusters and Group II clusters, respectively.²

(10) Cho's (1990) analysis of CCS

/kaps/ → [kap]	/hɪlk/ → [hɪk] (in Seoul) or [hɪl] (in Kyungsang)	
/kaps/	/hɪlk/	
kapt	-	Neutralization
kapp	-	Assimilation
[kap]	[hɪk] or [hɪl]	Syllabification

The difference between the two dialects is attributed to the direction of coda syllabification as given in (11).

(11) Syllabification in Cho (1990)

- a. from right to left (e.g., [hɪk]) (Seoul)
- b. from left to right (e.g., [hɪl]) (Kyungsang)

² Cho (1990), on the basis of underspecification theory, proposes the parameters for Korean Assimilation as (i), in which the target has to be in the coda.

(i) Parameter for Korean Assimilation (Cho 1990: 109-10)

Site: any node

Target Specifications: target < trigger / coda-target

Locality Conditions: skeletal adjacency

Rule Order: spread before default

Directionality: 0

A problem with Cho's analysis is that it cannot deal with the cluster /lm/. According to her analysis, the cluster /lm/ is predicted to behave in the same way as the cluster /lk/ or /lp/, since Assimilation cannot apply between /l/ and /m/. Accordingly, it is predicted that /lm/ is realized as [l] in Kyungsang and [m] in Seoul, which is not the case.

In addition to this empirical problem, note that the rule-based derivational approach yields quite a complicated grammar. In Cho's analysis, Assimilation, as pointed out by Oh (1994), only functions to get rid of any difficulties which the different directionality of syllabification may cause. It only provides the precondition for the right application of syllabification. Moreover, as we see in section 5, in the Seoul dialect the actual choice of surface consonant is affected by the consonant following a cluster. The /lp/ cluster is realized as [p] when followed by /t/ and /c/, and it is realized as [l] when followed by [k]. The directionality of syllabification as suggested in (11) would not be expected to vary by this kind of environment at all.

In sum, even though it seems intuitively clear that CCS interacts with Neutralization and syllabification, it is not clear exactly how they interact and how the pattern of simplification is accounted for in connection with Neutralization and syllabification. In what follows, I propose a novel analysis which captures the interactions among CCS, Neutralization and syllabification in the framework of OT. I also show that Assimilation plays a role in the pattern of simplification in a way different from Cho's analysis.

3. CCS and Neutralization: Group I Clusters

3.1 Constraints on Codas

Optimality Theory is a general model of constraints and constraint interactions. Constraints impose conflicting demands on candidates and are violable. As a result, constraints are minimally violated in optimal outputs (Prince and Smolensky 1993). A phonological process is the result of an interaction of a pair (M, F), consisting of a markedness constraint M and a relevant faithfulness constraint F. Dominance of a markedness constraint on the coda over a relevant faithfulness constraint (IDENT, MAX, DEP, and UNIFORMITY) triggers a coda process (McCarthy and Prince 1995).

Among faithfulness constraints, which demand a tight relation between input and output, MAX-IO and IDENT-IO (F) are crucial in the following discussion:

(12) MAX-IO

Every segment of the input has a correspondent in the output.

(No phonological Deletion)

(McCarthy and Prince 1995)

(13) IDENT-IO(F)

Output correspondents of an input [γ F] segment are also [γ F].

(No featural changes)

(McCarthy and Prince 1995)

The MAX-IO constraint militates against deletion of a segment. Accordingly, deletion results only when MAX-IO is dominated by a markedness constraint. The IDENT-IO(F) constraint requires that correspondent segments be featurally identical to one another. Unless dominated, the constraint will require complete featural identity between correspondent segments. A process involving the change of one or more features results when IDENT(F) is dominated by a markedness constraint. IDENT (F) is a constraint family. By varying features for (F), different members of the IDENT family arise: IDENT (Lar) for Laryngeal, IDENT(cont) for the [continuant] feature, IDENT(Place) and so on.

Given the Korean facts presented in §2.1 and the basic methodology of OT, Coda Neutralization and CCS can be explained as a constraint ranking putting some markedness constraint over a faithfulness constraint. The relevant markedness constraints are CODACOND which was suggested in §2, and *COMPLEX, which captures the fact that Korean does not allow clustering of consonants in the syllable coda and in the onset:

(14) CODA COND (=Korean Coda Condition)³

a. * [Laryngeal]]_σ

b. * [Continuant]]_σ

(15) *COMPLEX

Consonant clusters are prohibited in the coda/onset.

*COMPLEX and CODA COND are never violated in Korean, and are therefore not crucially dominated in the ranking, since the only evidence of domination is violation in OT:

(16) Undominated constraints

*COMPLEX, CODA COND

CODA COND forces featural change of a coda consonant, Coda Neutralization, by crucially dominating IDENT(Lar/Cont). This gives us the constraint ranking in (17).

(17) Neutralization to resolve violations of the coda condition

CODA COND >> IDENT-IO(Lar), IDENT-IO(cont)

Due to this ranking, /pat^h/ ‘field’, for instance, is realized as [pat], at the price of a IDENT(Lar) violation as tableau (18) shows.

³ Ito and Mester (1994) and Lombardi (1995) argue for a treatment of Coda Condition cases in OT as a constraint left-aligning consonants with syllable. For example, a language that has laryngeal neutralization in the coda would have the constraint (i).

(i) ALIGN-LEFT(Laryngeal, σ) (Lombardi 1995: 232)

Applying this alignment type of analysis to Korean Coda Condition, we would have the following:

(ii) CODA COND (in Korean)

a. ALIGN-LEFT(Laryngeal, σ)

b. ALIGN-LEFT([+continuant], σ)

In this paper, I use an old-fashioned Coda Condition (cf. Ito (1986)), since the choice does not affect the analysis here.

(18) /pat^h/ → [pat] ‘field’

/pat ^h /	CODACOND	IDENT-IO(Lar)
pat ^h	*!	
☞ pat		*

Similarly, /os/ ‘clothes’ is realized as [ot], at the price of violating IDENT(cont) as tableau (19) shows.

(19) /os/ → [ot] ‘clothes’

/os/	CODACOND	IDENT-IO(cont)
os	*!	
☞ ot		*

*COMPLEX triggers segment deletion in consonant clusters, which suggests that this constraint dominates MAX-IO, as represented in (20).

(20) Cluster simplification triggered by *COMPLEX
*COMPLEX >> MAX-IO

The input sequence CVCC is realized as CVC(C) or CV(C)C, in spite of a MAX-IO violation, to satisfy the higher ranked constraint *COMPLEX. Tableau (21) shows the evaluation of /nəks/ → [nək] ‘life’.

(21) /nəks/ → [nək] ‘spirit’

/nəks/	*COMPLEX	MAX-IO
nəks	*!	
☞ nək		*

Now let us consider the relative ranking between MAX-IO and IDENT-IO(Lar)/IDENT-IO(cont). Note that in Korean the violation of CODACOND is resolved by neutralization (=feature change) rather than deletion. Given that CODACOND is top-

ranked in Korean, this fact can be captured by the ranking in (22), as illustrated by tableau (23).

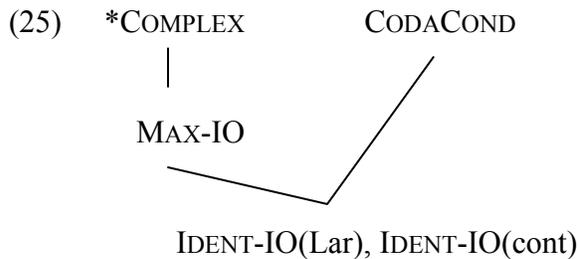
- (22) Neutralization rather than deletion in the coda
 MAX-IO >> IDENT-IO(Lar), IDENT-IO(cont)

- (23) /nas/ → [nat] ‘scythe’

/nas/	MAX-IO	IDENT-IO (cont)
na	*!	
☞ nat		*

Now if we take into consideration simultaneously the relative rankings suggested so far as summarized in (24), we get the constraint ranking in (25).

- (24) a. Undominated Constraints: *COMPLEX, CODA COND (= (16))
 b. CODA COND >> IDENT-IO(Lar), IDENT-IO(cont) (= (17))
 c. *COMPLEX >> MAX (= (20))
 d. MAX-IO >> IDENT-IO(Lar), IDENT-IO(cont) (= (22))



Note that the constraint hierarchy in (25) is derived on the basis of Coda Neutralization and the simple fact that one consonant of a coda cluster is deleted. We have not considered at all which consonant of a cluster is realized in the output. In the next section I will show that the constraint ranking in (25) correctly accounts for the pattern of simplification of Group I clusters without any need to posit more constraints.

3.2 CCS of Group I Clusters

In Group I clusters, which consist of C_{coda} and $C_{*\text{coda}}$, $C_{*\text{coda}}$ is deleted, as repeated in (26).

(26) Group I clusters

p(s) k(s) n(h) n(c) l(h) l(t^h)

The tableau in (27) illustrates how the constraint ranking in (25) gives us the correct results for Group I clusters.

(27) Simplification of Group I clusters: e.g. /kaps/ → [kap] ‘price’

/kaps/	*COMPLEX	CODACOND	MAX-IO	IDENT-IO(cont)
a. kaps	*!	*		
b. kapt	*!			*
c. kas		*!	*	
d. ☞ kap			*	
e. kat			*	*!

The realization of both consonants, as in (27a) and (27b), violates *COMPLEX, one of the top-ranked constraints. The realization of /s/, a $C_{*\text{coda}}$, fatally violates CODACOND as in (27c). The realization of [p], a C_{coda} , as in (27d), violates only MAX-IO, which is ranked lower than *COMPLEX and CODACOND. The realization of [t] (the product of Coda Neutralization) violates both MAX-IO and IDENT-IO(cont) as in (27e).⁴

Note that IDENT-IO(cont) plays a crucial role in choosing (27d) over (27e). IDENT-IO(cont) ensures that the satisfaction of *COMPLEX and CODACOND should be achieved through minimal feature change. (27d) involves no feature change, while (27e) involves a change in the specification of continuity. In this way, we can account for the simplification pattern of other Group I clusters. To take another example, the cluster /lt^h/

⁴ We can take the candidate [kat] as being derived through deletion of /s/. The process of /p/→[t], however, involves violation of IDENT(Place), which is not incurred by the optimal output [kap]. Incidentally, note that the ranking of IDENT(Place) and the other constraints with respect to one another is totally irrelevant to the outcome in (27). Wherever IDENT(Place) is located in the ranking hierarchy, the optimal output [kap] will win over [kat]. In section 5, however, I will show that IDENT(Place) should be located lower than MAX.

is realized as /l/, because retention of /t^h/ must involve violation of IDENT-IO(Lar) which is forced by CODACOND (i.e., /t^h/ → [t]).

So far I have shown that the simplification pattern of Group I clusters is explained straightforwardly by unifying the basic markedness/faithfulness constraints which work in Neutralization (i.e., CODACOND and IDENT-IO(F)) and CCS (i.e., *COMPLEX and MAX-IO) without any need to invoke additional constraints specifically regulating the choice of a retained consonant.

4. CCS and Syllabification: Group II Clusters and Dialectal Variation

4.1 Two Constraints on Syllabification

Unlike Group I clusters, CCS of Group II Clusters, namely, /lp/, /lk/, and /lm/, cannot be explained by the constraint ranking in (25). Because Group II clusters consist of two consonant allowable in the coda, retention of either member will violate only MAX-IO, while satisfying *COMPLEX, CODACOND, and IDENT-IO(Lar/cont). Clearly, some other constraint(s) are called on to decide which consonant is chosen in CCS of Group II clusters. Another fact to be explained, which is related to Group II clusters, is the dialectal variation mentioned in §2.

In order to account for the pattern of Group II cluster simplification and the dialectal variation, I propose that two additional constraints are active in CCS, both of which pertain to syllabification. One of them is ALIGN-R, which belongs to the constraint family which governs the relation between prosodic and grammatical structure. The other is CODASON, which is suggested by Iverson and Lee (1994):⁵

(28) ALIGN-R: ALIGN (stem, R, σ, R) (McCarthy and Prince 1993)

‘Align the right edge of a stem with the right edge of a syllable.’

(29) CODASON (=Coda Sonority)

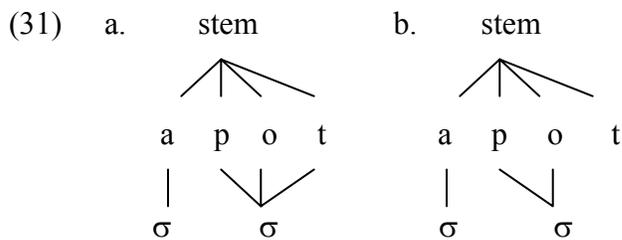
In syllable codas, parse sonorant segments. (Iverson and Lee 1994)

⁵ Iverson and Lee (1994) will be discussed in detail in section 6.

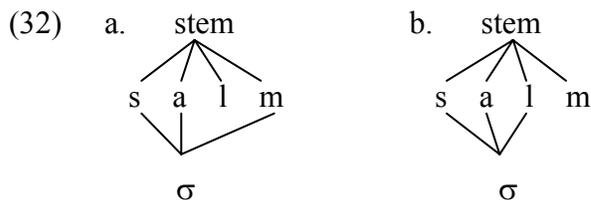
The constraint ALIGN-R requires that the right edge of a stem must coincide with the right edge of a syllable. McCarthy and Prince (1993) show that ALIGN-R explains so-called edge-of-stem effects in many languages, where expected phonotactic patterns are disrupted in stem peripheral position. For instance, they discuss the case of languages which allow only open syllables, except stem finally, where closed syllables are permitted. They propose the ranking in (30).⁶

(30) ALIGN-R >> No CODA >> MAX

In the following representations, (31a) shows right-alignment and (31b) does not; if ALIGN-R dominates No-Coda as in (30), (31a) will be optimal.



Even though (31) deals with the case of CVC syllables, it is reasonably expected that ALIGN-R plays some role in CVCC syllables. A specific case is given in (32):



⁶ Lombardi (1995) also employs ALIGN-R to account for the word-edge exceptions to laryngeal neutralization, that is, neutralization of other laryngeal features in word-internal syllables but not word finally. For more instances of application of the ALIGN constraint, see also Prince and Smolensky (1993: 103ff) and Ito and Mester (1994: 30ff), among many others.

(32a) shows right-Alignment and (32b) does not. Everything else being equal, ALIGN-R requires that [sam], instead of [sal], be chosen as an optimal output, which is the real case in Korean as we will see in detail momentarily.⁷

The constraint CODASON in (29) is proposed by Iverson and Lee (1994) in their analysis of CCS in Korean. This constraint, according to Iverson and Lee (1994), expresses a cross-linguistic preference for segments of higher rather than lower sonority in syllable codas.⁸ It has also been claimed in Clements (1990) and Prince and Smolensky (1993) that syllabification basically follows the sonority hierarchy: onsets prefer a less sonorant segment and codas prefer a sonorant. In this vein, Zec (1995) employs ONSETSON ('A less sonorous onset consonant is preferred to a more sonorous one'), which is a counterpart of CODASON, in the analysis of cluster simplification in Pali. The effect of CODASON is that when given a choice between an obstruent and a sonorant consonant, the latter is preferred in the coda. For instance, CODASON requires /l/ to be chosen in /palp/.

ALIGN-R and CODASON come in conflict when a cluster consists of a sonorant and an obstruent following it, as tableaux (33) and (34) show.

(33) ALIGN-R >> CODASON

/hɪlk/	ALIGN-R	CODASON
☞ hɪ<l>k		*
Hɪl<k>	*!	

⁷ Incidentally, note that positing ALIGN-R depends on the fact that underlying consonant clusters appear only in stem-final position in Korean.

⁸ Iverson and Lee point out the following facts which lend support for positing the CODASON constraint: "The implications of this principle for language change have been laid out by Vennemann (1988), and for language typology by Goldsmith (1990). Goldsmith observed that some languages permit only sonorant consonants in the coda, like Hausa and Mandarin Chinese, while others, like English, permit (essentially) any consonant in the inventory in this position; but apparently no languages exist which allow only obstruents in the syllable coda. Iverson and Salmons (1992) have introduced the Coda Sonority idea into a comparative analysis of limitations on Proto-Indo European root structure (where a surprising 83% of CVC root reconstructions are sonorant or laryngeal-final)."

(34) CODASON >> ALIGN-R

/hɪlk/	CODASON	ALIGN-R
hɪ<l>k	*!	
☞ hɪ<k>		*

It is here that I suggest that the alternate constraint rankings given in (35) are responsible for the dialectal variation in CCS.

(35) a. Standard Seoul dialect

ALIGN-R >> CODASON

b. Kyungsang dialect

CODASON >> ALIGN-R

The remaining task is to unify the two additional constraints and the constraints considered in the previous sections, producing a single overall constraint ranking. The crucial ranking is given in (36).

(36) IDENT-IO(Lar), IDENT-IO(cont) >> ALIGN-R

This ranking is supported by the tableau in (37).

(37) /moks/ → [mok] ‘share’ (in both dialects)

/moks/	IDENT-IO(cont)	ALIGN-R
a. ☞ mok		*
b. mot	*!	

(37a) violates ALIGN-R, and (37b) does not. The choice of [mok] as the optimal form is dependent on the crucial ranking of IDENT-IO(cont) dominating ALIGN-R. The candidate (37b) involves changing of the continuant feature, while (37a) does not. Note that the relative ranking in (36) is not undermined by other constraints, since (37a) and (37b) tie

Let us examine the cluster /lk/ against the constraint hierarchies in (39):

(41) /hɨlk/ → [hɨk] ‘soil’ (in Seoul)

/hɨlk/	*COMPLEX	CODACOND	MAX	IDENT-IO	ALIGN-R	CODASON
a. hɨlk	*!					
b. hɨl			*		*!	
c. [☞] hɨk			*			*

(42) /hɨlk/ → [hɨl] (in Kyungsang)

/hɨlk/	*COMPLEX	CODACOND	MAX	IDENT-IO	CODASON	ALIGN-R
a. hɨlk	*!					
b. [☞] hɨl			*			*
c. hɨk			*		*!	

The tableaux in (41) and (42) show that the proposed ranking in (39) correctly generates the optimal output for each dialect. In Seoul, ALIGN-R dominates CODASON, which is crucial for the retention of /k/ instead of /l/ as in (41). The candidate (41c) satisfies ALIGN-R and fares better than (41b), which satisfies CODASON. On the other hand, the tableau in (42) shows that the ranking between the two constraints is reversed in Kyungsang, and the retention of the sonorant /l/ is the optimal output.

The cluster /lp/ shows exactly the same pattern as /lk/. In Seoul, the stem final /p/ is retained, satisfying ALIGN-R (e.g., /palp-ta/ → [pap.t'a]) and in Kyungsang, the sonorant consonant /l/ is retained, satisfying CODASON (e.g., /palp-ta/ → [pal.t'a]).

Among the Group II clusters, /lm/ is realized as [m] in both dialects. This is also correctly predicted by the present analysis, as the tableaux in (43) show.

(43) /lm/ does not show dialectal variation: e.g., /salm/ → [sam] ‘life’

a. Seoul

/salm/	*COMPLEX	CODACOND	MAX	IDENT-IO	ALIGN-R	CODASON
salm	*!					
sal			*		*!	
☞ sam			*			

b. Kyungsang

/salm/	*COMPLEX	CODACOND	MAX	IDENT-IO	CODASON	ALIGN-R
salm	*!					
Sal			*			*!
☞ sam			*			

The stem final /m/ satisfies both ALIGN-R and CODASON, while /l/ satisfies only CODASON. Therefore, the stem final /m/ is the optimal output regardless of how the relative ranking between the two constraints is determined.

The alternate rankings in (39) also correctly predict that Group I clusters exhibit no dialectal variations, because ALIGN-R and CODASON, which are responsible for different rankings, are ranked low enough and do not play a role. Due to the higher-ranked IDENT-IO(Lar/cont) dominating ALIGN-R and CODASON, the possibility is ruled out that an offensive coda consonant (e.g. /s/ in /kaps/) wins over a consonant which is allowed in codas (e.g. /p/ in /kaps/), regardless of relative rankings between ALIGN-R and CODASON. The present analysis thus provides a principled explanation for the fact that Group I clusters never show dialectal variation.

4.3 The Cluster /lp^h/

The cluster /lp^h/, being a cluster of C_{coda}+C*_{coda}, is expected to be realized as [l] in both dialects, because the realization of [p] (from /p^h/ by Neutralization) violates IDENT-IO(Lar), while [l] does not induce any violation of IDENT-IO(F). This prediction is borne out in the Kyungsang dialect.¹⁰ Contrary to this prediction, however, [p] is retained in the Seoul dialect.

There is only one lexical item which bears the cluster /lp^h/ in modern Korean, namely, the verb stem *ʃlp^h* ‘cite’. Moreover, *ʃlp^h* has an idiosyncratic property that is not shared by other lexical items bearing a cluster. *ʃlp^h* was originally *ʃp^h* in Middle Korean. Lee (1997) argues that the historical change from *ʃp^h* to *ʃlp^h* took place due to a kind of backformation with hypercorrection. In the transition from Middle Korean to Modern Korean, there was a process by which /l/ was deleted before /p^h/: for example, *alp^hʃ* → *ap^hʃ* ‘be.sick’, and *kolp^hʃ* → *kop^hʃ* ‘be.hungry’. According to Lee (1997), as a hypercorrection of this *l*-deletion, /l/ was added to *ʃp^h*, yielding *ʃlp^h*.

Based on this historical fact, I claim that unexpected retention of [p] in the /lp^h/ cluster is due to the fact that *ʃlp^h* was pronounced as [ʃp] before /l/ is added. The Seoul

¹⁰ Tableau (i) shows the retention of /l/ is the optimal form in the Kyungsang dialect.

- (i) /ʃlp^h-ta/ → [ʃlt'a] ‘cite’ (in the Kyungsang dialect)

/ʃlp ^h -ta/	*COMPLEX	CODACOND	MAX	IDENT-IO(Lar)	CODASON	ALIGN-R
ʃlp ^h .ta	*!	*				
ʃp ^h .t'a		*!	*			
ʃp.t'a			*	*!	*	
☞ ʃl.t'a			*			*

dialect is conservative in that it preserves the original pronunciation of [p] (←/p^h/) for *ɦp^h*, even after that /l/ is added before /p^h/.¹¹

5. CCS and Assimilation: the Following Consonant Effect

So far we have analyzed Cluster Simplification under the assumption that the choice of a retained consonant in a cluster is categorical in each dialect. However, a further pattern of variation is noted for the cluster /lp/ in the Seoul dialect: the simplification pattern is affected by the following consonant (Hong 1988, Ahn 1994, 1998). Ahn (1998) reports the following contrast:

- (44) CCS of /lp/ is conditioned by the following consonant
- a. /palp-ta/ [papt'a] ‘step.on-Declartive’
 - /palp-ci/ [pap-c'i] ‘step.on-CI’
 - b. /palp-ko/ [palk'o] ‘step.on-and’
 - /palp-kera/ [palk'era] ‘step.on-Imperative’ (from Ahn 1998: 97)

If /lp/ is followed by coronals /t/ and /c/, /p/ is retained as in (44a). In contrast, when it is followed by /k/, /l/ is retained as shown in (44b). This fact seems truly puzzling and to my knowledge, no satisfactory analysis has been given in the literature. Incidentally, note that this ‘following consonant effect’ poses a real problem for approaches which adopt a syllabification algorithm simply based on directionality to account for dialectal variation in CCS (see §2.2). According to Cho (1990), the Seoul dialect has ‘right-to-left’

¹¹ The idiosyncrasy of /lp^h/ may be expressed by a lexically specified constraint ranking (cf. Tranel 1996; Iverson and Lee 1994). If we assume the ranking ‘ALIGN-R >> IDENT-IO(Lar)’ for /lp^h/, we get the correct result as shown in (i).

- (i) /ɦlp^h-ta/ → [ɦpt'a] ‘cite’ (in the Seoul dialect)

/ɦlp ^h -ta/	*COMPLEX	CODACOND	MAX	ALIGN-R	IDENT-IO(Lar)	CODASON
ɦlp ^h .ta	*!	*				
ɦp ^h .t'a		*!	*			
ɦl.t'a			*	*!		*
ɦp.t'a			*		*	*

syllabification. In other words, in C_1C_2 clusters, C_2 is expected to be realized in the coda position. This simple parametric directional syllabification could not help making a stipulation: say, when /lp/ is followed by /k/ the direction of syllabification is ‘left-to-right’, contrary to ordinary cases.

In order to analyze the following consonant effect, we need to first consider (place) Assimilation in Korean. In Korean, labials are assimilated to the following adjacent velars (as in (45b)), but they are not assimilated to the following coronals (as in (45a)).¹²

(45)	Assimilation		
a.	/ip-ta/	[ipt’a]	‘wear-Declarative’
	/ip-ci/	[ipc’i]	‘wear-CI’
b.	/ip-ko/	[ikk’o]	‘wear-and’
	/ip-kera/	[ikk’era]	‘wear-Imperative’

Note that the pattern of assimilation in (45) and the pattern of CCS in (44) have something in common in terms of environments. When followed by /t/ or /c/, /p/ does not undergo Assimilation and the cluster /lp/ is realized as [p]. On the other hand, when followed by /k/, /p/ is assimilated to /k/ and the /lp/ cluster is realized as /l/. Suppose that in the examples (44b) /p/ is retained instead of /l/. Given Assimilation, the final output will be [pakk’o] (/pap-ko/ → [pakk’o]) and [pakk’era] (/pap-kera/ → [pakk’era]), respectively. On the other hand, in the cases in (44a), Assimilation does not occur, just as in (45a). I think this difference is the key to understanding the contrast noted in (44). Informally speaking, when /lp/ is followed by /k/, /l/ is retained because if /p/ is realized, it undergoes Assimilation, yielding [k].

Now how can we capture the difference in the present analysis? To achieve this, we need first to formalize the process of Assimilation. To analyze Assimilation in Korean in its full range is beyond the scope of this paper (see note 11). In what follows, I

¹² Place Assimilation in Korean can be characterized as in (i), using the derivational rules:

- (i) a. Coronal → Labial / ____ Labial
- b. Coronal → Velar / ____ Velar
- c. Labial → Velar / ____ Velar

The examples in (45) are instances of (ic).

will give a minimal OT-analysis of Assimilation just to meet our expository purpose, only focusing on the fact noted in (45):

(46) Labial Assimilation in Korean:

When a labial obstruent is followed by a velar obstruent, it is assimilated to the velar consonant; while when followed by a coronal obstruent, it is not.

To account for (46), I posit the following constraint:

- (47) *_{[lab][vel]} : * C C
 | |
 [labial][velar]
 ‘No labial plus velar obstruent sequences.’

Given this constraint, the examples of Assimilation in (45) can be explained by the constraint ranking in (48), as the tableau in (49) illustrates.¹³

- (48) MAX-IO >> *_{[lab][vel]} >> IDENT-IO(Place)

(49) Assimilation: e.g. /ipko/ → [ikk'o] ‘wear-and’

/ip-ko/	MAX-IO	* _{[lab][vel]}	IDENT-IO (Place)
i.k'o	*!		
ip.k'o		*!	
☞ ik.k'o			*

Considering Assimilation and CCS altogether, I now posit the following constraint ranking:

- (50) *COMPLEX, CODACOND >> MAX >> *_{[lab][vel]} >> IDENT-IO(Place) >> ALIGN-R >> CODASON

¹³ As I mentioned, the analysis here is just for expository purpose. The tableau (49) cannot determine the optimal form between, say, [ipp'o] and [ikk'o]. To achieve this, some additional constraints are called on, which, say, guarantee that onset is more faithful than coda in the process of Assimilation. See H. Cho (1997) for an analysis of Assimilation in Korean in OT framework.

The evaluation of /palp-ta/ → [pap.t'a] and /palp-ko/ → [palk'o] are given in the tableaux (51) and (52), respectively.

(51) /palp-ta/ → [pap.t'a]

/palp+ta/	*COMPLEX	CODAC OND	MAX	*[lab][vel]	IDENT- IO(Place)	ALIGN-R	CODAS ON
a. palp.ta	*!						
b. pal.t'a			*			*!	
c. \curvearrowright pap.t'a			*				*

(52) /palp-ko/ → [pal.k'o]

/palp+ko/	*COMPLEX	CODAC OND	MAX	*[lab][vel]	IDENT- IO(Place)	ALIGN-R	CODA SON
a. palp.ko	*!						
b. \curvearrowright pal.k'o			*			*	
c. pap.k'o			*	*!			*
d. pak.k'o			*		*!		*

In (51) the optimal form is (51c) [pap.t'a]. The addition of *[lab][vel] does not make any difference in determining the optimal form, because the sequence of /p/ and /t/ does not violate *[lab][vel]. In (52), on the other hand, the constraint of *[lab][vel] plays a role. If we did not consider *[lab][vel], the optimal output would be (52c) [pap.k'o], since it satisfies ALIGN-R. Due to *[lab][vel], however, the optimal output is [pal.k'o] in (52b) rather than [pap.k'o] in (52c). The latter violates *[lab][vel], which is not incurred in the optimal output [pal.k'o]. [pak.k'o] in (52d), which corresponds to the form that is derived from [pap.k'o] by Assimilation, induces a violation of IDENT-IO(Place), which is not incurred by the optimal form in (52b). In this way, the unified analysis of CCS and Assimilation correctly predicts that [l], rather than [p], is retained when /lp/ is followed by a velar obstruent.

The present analysis does not add any complication to CCS. All we have done is simply consider CCS together with Assimilation which works independently in Korean phonology. Furthermore, the present analysis provides a natural explanation for an otherwise puzzling fact. That is, the 'following consonant effect' observed in (44) is

actually not absolute. The cluster /lp/ can be realized as [p] in Seoul even when it is followed by /k/. This kind of variation or optionality poses a problem for virtually any theory. However, the present analysis, which explains the contrast by considering Assimilation, provides a natural explanation for this optionality. Let us return to the Assimilation examples in (45). This kind of Place Assimilation occurs universally in casual speech rather than in careful speech or in dictation form (Ahn 1998:100). Under the present analysis, the optionality of Assimilation means that the constraint *[lab][vel] optionally works, conditioned by speech style. If *[lab][vel] is at work, then we get ‘/ip-ko/ → [ikk’o]’ as in (45b). Alternatively, if *[lab][vel] is not at work, then no Assimilation occurs, with [ipk’o] being the optimal output.

Now let us return to CCS in (52). If *[lab][vel] is not at work in (52), then [pap.k’o] will be the optimal output, as shown by (53).

(53) /palp-ko/ → [pal-ko’]

/palp-ko/	*COMPLEX	CODACOND	MAX	IDENT-IO(Place)	ALIGN-R	CODASON
palp.ko	*!					
pal.k’o			*		*!	
☞ pap.k’o			*			*
pak.k’o			*	*!		*

The alternation between ‘/palp-ko/ → [pal.k’o] and ‘/palp-ko/ → [pap.k’o]’ thus follows from the optionality of Assimilation, more precisely from the optional application of *[lab][vel].

6. Comparison with Previous Optimality Theoretic Analyses

The present analysis is not the first attempt to account for CCS within the OT framework. Two previous analyses were proposed. Kenstowicz (1993) and Iverson and Lee (1994) account for CCS by the constraint rankings in (54) and (55), respectively.

(54) Kenstowicz (1993)

- a. PARSE-PLACE (=PERIPHERALITY): When given a choice, parse a more salient consonant following place of articulation hierarchy: labial > coronal > velar.
- b. CONTIGUITY: If /...xy.../ are contiguous in lexical structure then avoid [...xay....] in prosodic structure, where [a] is either [] (epenthetic material) or <a> (underparsed material).
- c. Ranking: Parse-Place >> Contiguity (in Seoul)
Contiguity >> Parse-Place (in Kyungsang)

(55) Iverson and Lee (1994)

- a. PERIPHERALITY (=PARSE-PLACE): When given a choice, Parse a more salient consonant following place of articulation hierarchy: labial > coronal > velar
- b. CODASON: In syllable codas, parse sonorant segments.
- c. Ranking: PERIPHERALITY >> CODASON (in Seoul)
CODASON >> PERIPHERALITY (in Kyungsang)

One problem with Kenstowicz's account, as pointed out by Kenstowicz himself, is that it makes a wrong prediction about the /lm/ cluster in Kyungsang dialect, as shown in (56). According to (54), *[sal], rather than [sam], is predicted to be the optimal form.

(56)

/salm/	CONTIGUITY	PARSE-PLACE
sa<l>m	*!	
☞ sal<m>		*

On the other hand, Iverson and Lee (1994) correctly account for all the clusters. Considering that the analysis proposed in this paper cannot help treating /lp^h/ as a kind of exceptional case, one might argue that Iverson and Lee's (1994) analysis is empirically supported more than the present analysis. In what follows, I will argue that the present analysis is in fact on the right track, compared to Iverson and Lee (1994).

A crucial feature of the present analysis that differentiates it from the previous two OT analyses of CCS is that it analyzes CCS together with Neutralization and Assimilation. As we have seen, the unified analysis of CCS and Neutralization provides a simple and natural explanation for the fact that Group I clusters do not show dialectal

variation. The ultimate goal of OT for a particular language might be taken to make a total single constraint hierarchy for the language by which we explain various processes in the language. In this sense, the present analysis makes a further step toward this ultimate goal by considering CCS together with Neutralization, syllabification, and Assimilation.

Furthermore, there is an empirical fact which is in favor of the present analysis over Iverson and Lee's analysis. I showed in § 5 that the unified analysis of CCS and Assimilation provides a natural account for the 'following consonant effect' and its optionality. The relevant examples are repeated in (57).

- (57) CCS conditioned by the following consonant
- | | | |
|--------------|----------|-----------------------|
| a. /palp-ta/ | [papt'a] | 'step.on-Declarative' |
| b. /palp-ko/ | [palk'o] | 'step.on-and' |

Note that there is no simple way to account for the 'following consonant effect' in Iverson and Lee's analysis (and in Kenstowicz's). Both /palp-ta/ and /palp-ko/ are expected to retain /p/ in the Seoul dialect, as the following tableaux show:

- (58) /palp-ta/ → [pap.t'a] (in Seoul)

/palp-ta/	PERIPHERALITY	CODASON
a. pal.t'a	*!	
b. ☞ pap.t'a		*

- (59) /palp-ko/ → [pal.k'o] (in Seoul)

/palp-ko/	PERIPHERALITY	CODASON
a. pal.k'o	*!	
b. ☞ pap.k'o		*

The tableau in (59) chooses [pap.k'o] as the optimal output, contrary to the fact.¹⁴

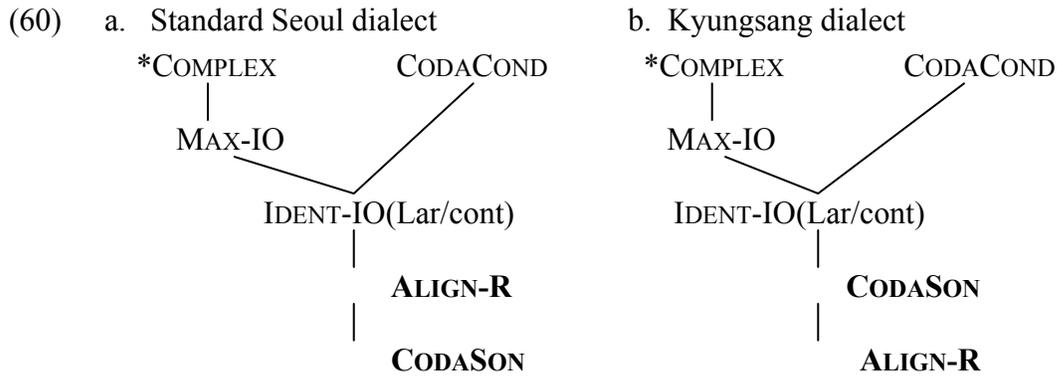
¹⁴ One might argue that Iverson and Lee's analysis may come up with an analysis which captures the contrast in (58) and (59) through the interaction of PERIPHERALITY and CODASON with other constraints which regulate Assimilation. However, Iverson and Lee argue that their constraint PERIPHERALITY is independently motivated by Assimilation. If PERIPHERALITY regulate assimilation in Korean,

7. Conclusion

Since Whitman's (1985) attempt to analyze Cluster Simplification in terms of its interaction with Neutralization and syllabification in Korean, there have been several additional attempts to account for the pattern of simplification by considering other phonological processes affecting codas such as Neutralization and Assimilation (e.g., Cho 1990, Oh 1994). In this paper I have shown that an Optimality theoretic approach captures the nature of interactions among CCS, Neutralization, syllabification, and Assimilation in the simplest and most elegant way.

I have shown that the pattern of the majority of clusters (i.e., Group I clusters: /ps/, /ks/, /nh/, /nc/, /lh/, and /lt^h/) can be explained by simply unifying the basic markedness/faithfulness constraints which work in Neutralization (i.e., IDENT-IO(F) and CODACOND) and CCS (i.e., *COMPLEX and MAX-IO) without positing any additional constraints regulating the choice of a retained consonant. For the rest of the clusters (i.e., Group II clusters: /lk/, /lp/, and /lm/), I have adopted two additional constraints, namely, ALIGN-R and CODASON, both of which are ranked lower than the four basic constraints. Positing two additional constraints, however, does not undermine the simplicity and elegance of the analysis of Group I clusters. On the contrary, the two additional constraints provide not only an account for a dialectal variation in CCS but also a principled explanation for why only Group II clusters exhibit dialectal variation. Specifically, I have proposed the following constraint hierarchies for the Standard Seoul dialect and the Kyungsang dialect, which are minimally different from each other:

PERIPHERALITY (or similar constraint(s) which guarantees a “peripherality effect”) must dominate IDENT-IO(Place) to account for assimilation (e.g. /ip-ko/ → [ik.k'o]). Once it dominates IDENT-IO(Place), then it is impossible to rule out /palp-ko/ → [pak.k'o] by recourse to Ident-IO(Place) as my analysis does. It is highly doubtful that one would be able to make a hierarchy, which allows ‘/palp-ta/ → [pap.t'a]’ but rules out ‘/palp-ko/ → [pak.ko]’, if PERIPHERALITY does regulate both Assimilation and CCS.



I also have shown that the present analysis can readily explain the fact that CCS may vary depending on the consonant which follows a cluster. The interaction between CCS and Assimilation explains it without adding any complication to CCS itself. Overall, I have shown that OT, a theory of constraints and constraint interactions, captures interactions between coda processes in Korean in a simple and natural way.

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