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Variation in stem-final consonant clusters in Korean nominal inflection

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This study investigates how Korean stem-final consonant clusters /ps/, /ks/, /lp/, /lk/, /ls/, and /lm/ exhibit variation, when a vowel-initial inflectional suffix is attached to noun stems. It is well-established that the Korean stem-final consonant clusters are either fully faithfully preserved (i.e. conservative), or simplified by deleting one of the two consonantal elements C_1 and C_2 (i.e. innovative). However, there has been no study about dominant patterns across clusters: which consonant cluster is more prone to preservation or simplification when inflected. When it comes to simplification, it has also been unclear which of C_1 or C_2 undergoes deletion, and why. Results of a production experiment show that there is a stark dichotomy between the clusters that share the same [±sonorant] feature (/ps/, /ks/, /lm/) and those that do not (/lp/, /lk/, /ls/): the former preferred conservative forms, whereas the latter favored innovative forms. Innovative forms in particular are accounted for in relation to consonant cluster simplification in isolation forms of nouns, following Kenstowicz's (1996) Base-Identity effect. While the nature of the consonant cluster turned out to be a significant factor for variation in inflected forms, other factors (inflectional suffixes, speakers' regional dialects, and gender) did not. This study is significant, in that it sheds light on a blind spot in the discussions of variation in stem-final consonant clusters in Korean and provides a comprehensive analysis that connects consonant cluster simplification in isolation forms with conservative/innovative forms in inflected forms.

1 Introduction

Consonant clusters are universally more marked than simplex consonants in terms of syllable well-formedness. The problematic structures are resolved by different phonological strategies, such as consonant deletion or vowel epenthesis, in different languages (e.g. Côté 2000; Wilson 2001; Tamminga 2018). In Korean, mandatory consonant cluster simplification (CCS) occurs in the isolation forms of nouns (e.g. Kong-On Kim & Shibatani 1976): for example, /ka**ps**/ [ka**p**] 'price' and /ta**lk**/ [ta**k**] 'chicken' (1a). It also occurs when noun stems are followed by a consonant-initial suffix: for instance, /ka**ps**-to/ [ka**p**.to] 'price too' and /ta**lk**-to/ [ta**k**.to] 'chicken too' (1b).[1] This is due to the language-specific phonotactic restriction that consonant clusters are not allowed either in onset or in coda in Korean. In other words, tautosyllabic consonants that are adjacent to each other are ungrammatical, and thus simplification via deletion is motivated to resolve the illicit forms.

(1) *Consonant cluster simplification*

a.	In isolation	/ka**ps**/	*[ka**ps**], [ka**p**]	'price'
		/ta**lk**/	*[ta**lk**], [ta**k**]	'chicken'
b.	With a consonant-initial suffix	/ka**ps**-to/	*[ka**ps**.to], [ka**p**.to]	'price too'
		/ta**lk**-to/	*[ta**lk**.to], [ta**k**.to]	'chicken too'

However, CCS seems inconsistent across clusters. For example, for /ps/, it is always C_1 /p/ that is preserved, while C_2 /s/ is deleted (e.g. /ka**ps**/ [ka**p**], *[ka**s**] 'price'). However, this is not always the case for other clusters, such as /lk/, where C_1 /l/ is deleted, but C_2 /k/ is preserved (e.g. /ta**lk**/ *[ta**l**], [ta**k**] 'chicken'). Even though there has been an agreement on the obligatoriness of CCS in the isolation forms of nouns in Korean, not much analysis has recently been provided as to which consonant is deleted or preserved, except for research conducted over 30 years ago. Whitman (1985) and Young-mee Yu Cho (1988) argue for dialectal variation, mainly focusing on the fact that deleting consonants vary between Seoul Korean and Kyungsang Korean. They state that these two dialects exhibit the opposite patterns for the consonant clusters /lk/, /lp/, and /lp^h/: that is, the liquid /l/ is always preserved in the Kyungsang dialect (Whitman 1985; Young-mee Yu Cho 1988), while /l/ is always deleted but the stops /k/, /p/, and /p^h/ are preserved in the Seoul dialect (Young-mee Yu Cho 1988). It is, however, still unclear why one or the other consonant deletes. This paper casts doubt on whether the validity of dialectal variation raised

[1] Precisely speaking, /kaps-to/ 'price too' surfaces as [kap.t'o] due to Post-Obstruent Tensing (POT) by which lenis obstruents become tense when following another obstruent (e.g. Kim-Renaud 1974; Young-mee Yu Cho & Inkelas 1994). That is, the lenis coronal stop /t/ preceded by /p/ is tensified, resulting in [t']. However, no further discussion of POT is made in this paper, since this is a predictable process in Korean (Suyeon Yun 2013 based on Sang-Cheol Ahn 2009). For the same reason, broad transcriptions are used in this paper with lenis obstruents.

in Whitman (1985) and Young-mee Yu Cho (1988) still holds in isolation forms of present-day Korean and will provide up-to-date generalizations in CCS with a comprehensive analysis that involves phonology, morphology, phonetics, and frequency.

Another puzzle is the fact that stem-final consonant clusters in Korean nouns are sometimes simplified before vowel-initial suffixes. As we have seen so far, obligatory CCS occurs with no variation only when nouns are spoken in isolation or when they are followed by a consonant-initial suffix. On the other hand, variation occurs when a vowel-initial suffix is attached to noun stems (Kenstowicz 1996), such as *-i* (nominative: NOM), *-il* (accusative: ACC), and *-ɛ* (dative: DAT, locative: LOC). First, /C_1/ is syllabified to coda and /C_2/ to onset, as in [V$\underline{C_1}$.$\underline{C_2}$V], due to the syllabification algorithm (e.g. Youngdo Yun 2004), and this is referred to as the conservative form throughout this paper.

(2) *Consonant cluster preservation in conservative forms in inflection*

a.	/ka**ps**-i/	[ka**p**.**s**i]	'price-NOM'
b.	/ka**ps**-**i**l/	[ka**p**.**s**i**l**]	'price-ACC'
c.	/ka**ps**-ɛ/	[ka**p**.**s**ɛ]	'price-DAT/LOC'

Second, another form of the stem occurs, in addition to (2). That is, one of the two consonants can optionally be deleted, when combining with a vowel-initial suffix in innovative forms (3), as in the isolation forms in (1).

(3) *Variation in inflection (preserved ~ simplified)* (modified from Jin-hyung Kim 2005)

a.	/ka**ps**-i/	[ka**p**.**s**i]	~	[ka.**p**i]	'price-NOM'
b.	/h**i**l**k**-**i**l/	[h**i**l.k**i**l]	~	[h**i**.k**i**l]	'soil-ACC'
c.	/mo**ks**-**i**n/	[mo**k**.**s**i**n**]	~	[mo.k**i**n]	'share-TOP'

While it is well-established in Korean nominal inflection that simplified forms as well as fully faithful forms occur, there has been no study, to the best of my knowledge, as to the distribution of conservative and innovative forms. In this regard, this paper addresses whether conservative or innovative forms are preferred for particular consonant clusters, and if so, why. When it comes to innovative forms, things are more complicated since it has been unclear which consonant is retained and which is deleted in the simplified forms of different clusters. This paper builds on Kenstowicz's (1996) Base-Identity effect that innovative (i.e. simplified) variants in inflected forms depend on corresponding isolation forms.

Previous studies have focused on the younger generation's speech, mainly with regard to different phenomena in Korean, such as variation in final obstruents in noun stems (e.g. Jongho Jun & Jeehyun Lee 2007; Jongho Jun 2010), or tri-consonantal simplification in verb stems (e.g. Taehong Cho & Sahyang Kim 2009). However, the factors that affect younger speakers' choice

between conservative forms and innovative forms for stem-final consonant clusters in Korean nominal inflection have been understudied. Motivated by this gap in the literature, the current study aims to examine mechanisms behind the two major variants of stem-final consonant clusters in the inflected forms of nouns, conservative and innovative, in relation to the isolation forms of nouns. In addition to mainly focusing on different consonant clusters in noun stems, other factors that are purely linguistic (vowel-initial inflectional suffixes) or sociolinguistic (speakers' regional dialects and gender) are also examined.

This paper is organized as follows. Section 2 describes the uniqueness of stem-final consonant clusters in Korean nouns. Section 3 touches on obligatory CCS in isolation forms and seemingly inconsistent patterns in CCS. It also raises and evaluates two theoretically possible accounts and argues against them. Section 4 concerns variation in inflected forms in relation to linguistic and sociolinguistic accounts from previous research. Section 5 covers the procedures of a production experiment, followed by results and discussions in Sections 6 and 7. This paper concludes in Section 8 with its implications and directions for future research.

2 Uniqueness of stem-final consonant clusters in Korean nouns

In Korean, consonant clusters are prohibited in onset and coda. They, however, do exist underlyingly in the post-vocalic position. A list of 11 stem-final biconsonantal clusters are given in (4) (Heejeong Ko 2006 based on Yongsung Lee 1993).

(4) *Eleven underlying stem-final biconsonantal clusters in Korean*
/ps/, /ls/, /ks/, /nc/, /lt^h/, /lh/, /nh/, /lk/, /lp/, /lp^h/, /lm/

In order to verify the list, I conducted a dictionary survey by using the Sejong Corpus of Korean (National Institute of the Korean Language 2010). The segment statistics extracted from the corpus show the frequency of all segments that are allowed in the Korean phoneme inventory (i.e. vowels and consonants, whether simplex or complex) written in Korean orthography. The total frequency of all segments adds up to 611,319. In addition, a more fine-tuned search was conducted by sorting all segments in each of the three within-syllable positions, onset, nucleus, and coda. Since Korean orthography is faithful to underlying forms, it invariably maintains both C_1 and C_2 in consonant clusters, with no simplification at all. Thus, it is assumed in this paper that consonant clusters extracted from the written corpus represent underlying stem-final consonant clusters. The percentage of each stem-final consonant cluster was calculated as follows: percentage (%) = {(the raw counts of each consonant cluster)/611,319}*100. In **Table 1**, all 11 Korean underlying stem-final biconsonantal clusters are arranged in descending order of raw counts and percentages.

	Consonant clusters	Raw counts	Percentage (%)		Consonant clusters	Raw counts	Percentage (%)
a.	/ps/	192	$3.14*10^{-2}$	g.	/lm/	28	$4.58*10^{-3}$
b.	/lk/	144	$2.36*10^{-2}$	h.	/ks/	14	$2.29*10^{-3}$
c.	/nh/	47	$7.69*10^{-3}$	i.	/lp^{h}/	4	$6.54*10^{-4}$
d.	/lh/	38	$6.22*10^{-3}$	j.	/lt^{h}/	2	$3.27*10^{-4}$
e.	/lp/	34	$5.56*10^{-3}$	k.	/ls/	1	$1.64*10^{-4}$
f.	/nc/	30	$4.91*10^{-3}$				

Table 1: Segment statistics of Korean underlying stem-final consonant clusters.

As suggested in the absolutely low values both in raw counts and in percentages in **Table 1**, stem-final consonant clusters are in general very rare in Korean. This indicates that any stem with a consonant cluster is also rare in this language. However, this does not mean that stem-final consonant clusters have no significance in research. Nor does it mean that an agreement on the analysis of consonant clusters has been reached. Despite their rarity, stem-final consonant clusters exhibit phonologically interesting patterns, depending on the syntactic category of the stems which the consonant clusters belong to. Among the 11 stem-final consonant clusters, only six appear in nouns or numerals: /ps/, /ks/, /lp/, /lk/, /ls/, and /lm/ (based on Yongsung Lee 1993; Heejeong Ko 2006), as in (a–f) in **Table 2**. The other five appear in stems other than nouns or numerals (e.g. verbs): /lh/, /lp^{h}/, /lt^{h}/, /nc/, and /nh/, as in (g–k) in **Table 2**.

Stem-final consonant clusters that appear in nouns or numerals				Stem-final consonant clusters that do not appear in nouns or numerals			
	Clusters	Examples	Gloss		Clusters	Examples	Gloss
a.	/ps/	*kaps*	‘price’	g.	/lh/	*ilh-*	‘lose’
b.	/ks/	*saks*	‘wage’	h.	/lp^{h}/	*ilp^{h}-*	‘recite’
c.	/lp/	*jʌtʌlp*	‘eight’	i.	/lt^{h}/	*hult^{h}-*	‘skim’
d.	/lk/	*talk*	‘chicken’	j.	/nc/	*anc-*	‘sit’
e.	/ls/	*kols*	‘way’	k.	/nh/	*k’ɨnh-*	‘cut’
f.	/lm/	*salm*	‘life’				

Table 2: Stem-final consonant clusters that appear in nouns or numerals (a–f) and those that do not appear in nouns or numerals (g–k).

In this study, we focus only on the six consonant clusters that appear in nouns (including numerals) (i.e. **Table 2** (a–f)). Numerals are treated as nouns since they behave like nouns, in

that they have isolation forms as well as inflected forms (e.g. /jʌtʌlp/ [jʌ.tʌl] ‘eight’; /jʌtʌlp-i/ [jʌ.tʌl.pi]~[jʌ.tʌ.li] ‘eight-NOM’) in contrast to verbs, which appear only in inflected forms and lack isolation forms (e.g. Kenstowicz 1996). For this reason, numerals will be included in nouns throughout this paper.

3 Obligatory consonant cluster simplification in isolation

Complex consonants are structurally more marked than simplex consonants. It is encoded in the Optimality-theoretic (OT) markedness constraint *COMPLEX or *CC. Despite the unified motivation conditioned by phonological markedness, different languages employ different strategies to resolve complex consonants. Consonant deletion occurs in some languages, such as Korean and Québec French (5a), while vowel epenthesis occurs in other languages, such as Cairene Arabic and Chaha (5b).

(5) *Repair strategies to consonant clusters* (Côté 2000: 17)

a. *Consonant deletion*

Korean	/ka**ps**/	[ka**p**]	‘price’
Québec French	/pu**tr**/	[pʊ**t**]	‘beam’

b. *Vowel epenthesis*

Cairene Arabic	/kata**b-t-l**-ha/	[ka.ta**b.til**.ha]	‘I wrote to her’
Chaha	/**srt**/	[**sɨrt**]	‘cauterize!

Korean is a representational language that undergoes obligatory stem-final CCS when nouns are spoken in isolation, citation, or Base form (Kenstowicz 1996; Yongsung Lee 2001; Heejeong Ko 2006; Jiwon Yun 2008). However, the selective deletion and preservation phenomena between C_1 and C_2 in the six stem-final consonant clusters in nouns vary from cluster to cluster, which makes it hard to draw a unified generalization. This paper assumes that there is no variation in isolation forms, as in **Table 3** (except for the dialectal variation for the cluster that has /l/, which was raised in Whitman 1985 and Young-mee Yu Cho 1988).

	Clusters	**Deleted**	**Preserved**	**Noun stems**	**Isolation**	**Gloss**
a.	/ps/	/s/	[p]	*kaps*	[ka**p**]	‘price’
b.	/ks/	/s/	[k]	*saks*	[sa**k**]	‘wage’
c.	/lp/	/p/	[l]	*jʌtʌlp*	[jʌ.tʌ**l**]	‘eight’
d.	/lk/	/l/	[k]	*talk*	[ta**k**]	‘chicken’
e.	/ls/	/s/	[l]	*kols*	[ko**l**]	‘way’
f.	/lm/	/l/	[m]	*salm*	[sa**m**]	‘life’

Table 3: Six stem-final consonant clusters and isolation forms of nouns (no variation).

There has been agreement that CCS is motivated by structural well-formedness. In particular, CCS occurs to conform to the (C)V(C) template. Related to the template principle is Vennemann's (1988) preference laws for syllable structure. The Coda Law, in particular, states that it is more preferred if a syllable coda consists of a smaller number of sounds. Likewise, Korean nouns undergo CCS by deleting one of the two consonants in stem-final position in order to conform to the phonological constraint on simplex codas.

Contrary to the consensus on the structural motivation of CCS in Korean, however, the quality of the consonants involved with CCS has remained as a puzzle: which consonant survives, and which one gets deleted? Two segmentally similar clusters, /lk/ and /lp/, for example, show contrasting patterns.

(6) *Preservation and deletion of different consonants from different clusters*

a. Cluster /lk/ /ta**lk**/ [ta**k**] 'chicken'
   - Linear order of consonants: C_1 /l/ deleted; C_2 /k/ preserved
   - Sonority relationship: more sonorous C /l/ deleted; less sonorous C /k/ preserved

b. Cluster /lp/ /jʌtʌ**lp**/ [jʌ.tʌ**l**] 'eight'
   - Linear order of consonants: C_1 /l/ preserved; C_2 /p/ deleted
   - Sonority relationship: more sonorous C /l/ preserved; less sonorous C /p/ deleted

Despite the agreement on the obligatory nature of CCS in isolation forms of Korean nouns, there has been no unified analysis of why certain consonants delete or survive, and why this varies across clusters. In the next section, I raise and evaluate two theoretically possible accounts, each of which concerns the linear order and the sonority relationship between C_1 and C_2, and argue against them.

3.1 Against linear order and sonority relationship

Due to the inconsistency as to which consonant is subject to deletion or preservation on the surface, it seems at first glance hard to systematically explain the mechanism of CCS in the isolation forms of Korean nouns. One might argue for a linear order approach or a sonority relationship approach. However, neither of them works for CCS in Korean.

First, the linear order between two input consonants does not provide a consistent account since it is not always C_1 or C_2 that is preserved or deleted. In some clusters like /lk/ (e.g. /ta**lk**/ [ta**k**] 'chicken'), C_1 is deleted, while C_2 is preserved (9a), suggesting that ANCHOR-IO (7) dominates CONTIGUITY-IO (8). In other clusters like /lp/ (e.g. /jʌtʌ**lp**/ [jʌ.tʌ**l**] 'eight'), the conflicting ranking is observed (9b), indicating that ANCHOR-IO is dominated by CONTIGUITY-IO (definitions are based on Kager 1999).

(7) ANCHOR-IO
No epenthesis or deletion of input segments at edges of output.

(8) CONTIGUITY-IO
No medial epenthesis or deletion of input segments in output.

(9) *Linear order for /lk/ and /lp/*

a. Cluster /lk/ /ta**lk**/ [ta**k**] 'chicken'
- Linear order of consonants: C_1 /l/ deleted; C_2 /k/ preserved (ANCHOR-IO >> CONTIGUITY-IO)

b. Cluster /lp/ /jʌtʌ**lp**/ [jʌ.tʌ**l**] 'eight'
- Linear order of consonants: C_1 /l/ preserved; C_2 /p/ deleted (CONTIGUITY-IO >> ANCHOR-IO)

The discrepancy between /lk/ and /lp/ contradicts Whitman (1985) and Young-mee Yu Cho (1988) that the clusters /lk/, /lp/, and /lp^h/ pattern together, either deleting /l/ in Seoul Korean or preserving it in Kyungsang Korean.

Second, the sonority relationship between C_1 and C_2 also fails to account for CCS in Korean. It is true, though, that sonority is an important factor that accounts for certain shapes of output forms in phonology.

(10) *Sonority hierarchy* (Ohala 1999 based on Clements 1990; Jespersen 1904; Steriade 1982)
Stops < Fricatives < Nasals < Liquids < Vowels

There are languages in which underlying consonant clusters fully surface in a way that they are syllabified through vowel epenthesis, as shown in the examples from Côté (2000) for Cairene Arabic and Chaha (5b). Crucially, the position of the epenthetic vowel may depend on the sonority of the consonants so that low sonority onsets and high sonority codas are created, as in the Vediceto dialect of Italian.

(11) *Vowel epenthesis in the Vediceto dialect of Italian* (Repetti 1995)

/larg/	*[la.rge],	[lar.ge],	*[la.reg]	'wide'
/magr/	*[ma.gre],	*[mag.re],	[ma.ger]	'thin'

Sonority has also been investigated as a motivation for word-final cluster simplification via deletion. Given that falling sonority is universally preferred from a peak, Côté (2000) shows how CCS occurs when final clusters are of increasing sonority in Québec French. In obstruent + liquid clusters, it is invariably the second consonant that gets deleted, as in /livr/ [liv], *[lir] 'deliver-PRES' and /sufl/ [sʊf], *[sʊl] 'blow-PRES' (Côté 2000: 234). This is because the general faithfulness constraint MAX-C is dominated by a markedness constraint that militates against rising sonority

and the positional faithfulness constraint MAX-C/V_ ('no consonant deletion immediately after a vowel'). In other word, what motivates CCS is sonority, but how it is embodied is determined by the linear order of the consonants, in the way that the consonant that does not immediately follow a vowel undergoes deletion. Preference for the consonant in proximity to a vowel is in agreement with Wilson's (2001) argument for first consonant deletion in intervocalic position (i.e. $VC_1C_2V \rightarrow VC_2V$) in Diola-Fogny and West Greenlandic.

However, sonority relationship between the two members of a consonant cluster does not provide a unified explanation for Korean nouns. Sometimes less sonorous consonants delete (e.g. /jʌtʌ**lp**/ [jʌ.tʌ**l**] 'eight'), which would be predicted by the preference for high sonority codas (Vennemann 1988), while other times more sonorous consonants delete (e.g. /ta**lk**/ [ta**k**] 'chicken').

In sum, neither the order between two input stem-final consonants nor their sonority relationship is uniformly decisive in the different CCS patterns in the isolation forms of nouns in Korean. Arguing against the two theoretically possible accounts, I provide a comprehensive analysis of isolation forms in Section 7.2.

4 Variation in inflected forms

Extending the analysis of invariable CCS in isolation forms of Korean nouns, this section discusses variation in inflected forms of nouns. Unlike in isolation forms (12), variation occurs when a vowel-initial suffix is attached to stem-final consonant clusters in Korean nouns. Examples are shown in (13a-b) with the nominative suffix *-i* attached to the noun stem *talk* 'chicken'.

(12)	*Isolation form*	/ta**lk**/	[ta**k**]	'chicken'

(13)	*Inflected forms*	/ta**lk**-i/	'chicken-NOM'
	a.	[ta**l**.**ki**]	Conservative form
	~b.	[ta.**ki**]	Innovative form

In the inflected forms of nouns, it is standard to preserve both elements of input consonant clusters (13a). The stem-final consonants C_1 /l/ and C_2 /k/ of the input are syllabified as the coda and the onset, respectively: /$V_1\underline{C_1}\underline{C_2}]_{\text{Noun stem}}$ + $V_{2]\text{Suffix}}$/ [$V_1\underline{C_1}.\underline{C_2}V_2$]. In addition, CCS can occur as if consonant clusters were in the isolation form (13b). The consonant that is preserved in innovative forms is the one that remains in isolation forms (Kenstowicz 1996). In other words, [ta.**ki**] but not *[ta.**li**] is the optimal output of the innovative variant for /ta**lk**-i/ 'chicken-NOM' because it is [ta**k**] but not *[ta**l**] that occurs as the isolation form /ta**lk**/ 'chicken'. The present study thus accounts for the quality associated with the surviving consonant in innovative forms in inflection (e.g. [k] in (13b)) in relation to the output consonant in isolation forms (e.g. [k] in (12)). This is, in other words, a special kind of output-output correspondence. This will be verified with the results of a production experiment.

4.1 Previous research on variation in inflected forms

There have been attempts to account for variation in inflected forms of Korean nouns. However, it is noteworthy that there has also been an asymmetry in the amount of attention that conservative forms and innovative forms have received in the literature. While much previous research focused on the emergence of innovative forms, conservative forms were taken for granted since they are fully faithful to input forms. This eluded a complete understanding of variation with important questions, such as whether different clusters prefer conservative forms or innovative forms, and if so, why. In Section 7.1, this paper fills this gap.

In previous studies, some researchers have explained inflectional variation as phonological opacity, arguing that there is no phonological motivation to delete one of the two consonants in a particular context. Jin-hyung Kim (2005) notes that complex codas are forbidden in Korean and that this leads to CCS both in isolation forms (e.g. /ka**ps**/ [ka**p**] 'price') and inflected forms with a consonant-initial suffix attached (e.g. /ka**ps**-to/ [ka**p**.to] 'price too'), as in (1). This alternation is phonologically predictable by the language-specific restriction on syllabification. She points out that CCS also occurs in a context where it would not be predicted, such as in inflected forms with a vowel-initial suffix attached (e.g. /ka**ps**-i/ [ka.**p**i] 'price-NOM'). Even though the standard form (e.g. /ka**ps**-i/ [ka**p**.**s**i] 'price-NOM') does not violate the syllable well-formedness restriction, the unexpected output form with CCS does occur. She accounts for such opacity by claiming that the younger generation has restructured underlying forms from the ones with a consonant cluster /CC/ (i.e. complex) to the ones with a single consonant /C/ (i.e. simplex). For example, /ka**ps**/ 'price' has undergone leveling in a set of uninflected and inflected forms, as in {ka**p**, ka.**p**i, ka.**p**il, ka.**p**in…}. Furthermore, she reports that younger speakers never preserve both elements in consonant clusters, thus distinguishing their speech from older speakers' production. However, Jin-hyung Kim's (2005) argument for total leveling toward innovative forms is extreme in some sense, since both conservative and innovative forms do occur in the younger generation's speech. This is supported by the results of a production experiment of the present study.

Others have argued for a relation between innovative forms and isolation forms. Kenstowicz (1996) accounts for variation in inflected forms by relating output forms at the two different morphological levels: isolation and inflection. First, at the isolation level, the markedness constraint *COMPLEX outranks the faithfulness constraint PARSE-C (i.e. *COMPLEX >> PARSE-C). For /ta**lk**/ 'chicken', for example, *COMPLEX penalizes the candidate with a complex coda *[ta**lk**], and thus the simplified candidate [ta**k**] is chosen as the optimal output, at the expense of parsing every element in input to output. He claims that this ranking also works in evaluating candidates at the level of inflection, especially for the conservative forms (e.g. /ta**lk**-i/ [ta**l**.**k**i] 'chicken-NOM'), as it satisfies *COMPLEX by syllabifying C_2 /k/ as the onset to /i/. Additionally, there are innovative forms, as in [ta.**k**i]. What plays a crucial role to select innovative forms as an optimal output form is the BASE-IDENTITY constraint, which requires a similarity between the Base (i.e. isolation form) and derived forms, by the ranking of *COMPLEX >> BASE-IDENTITY >> PARSE-C. In

other words, innovative forms satisfy not only *COMPLEX but also BASE-IDENTITY because the consonant that survives in the innovative form is simplex but not complex via deletion, and it is the very consonant that appears in the isolation form, as in [ta**k**]. The Base-Identity-based analysis resolves the opacity issue raised above since what seems to be phonologically opaque is in fact predicted by other morphologically related forms. The present study follows Kenstowicz's (1996) Base-Identity analysis of innovative forms in Korean nominal inflection. However, it still remains mysterious why one over the other consonant is deleted or preserved even in isolation forms, and under what mechanisms the quality related to CCS in both isolation and innovative inflection is determined. This is discussed in Sections 7.2 and 7.3.

4.1.1 Variation by speakers' regional dialects

Regional dialectal variation has been discussed, mainly focusing on the fact that which consonant to delete varies between the Seoul dialect and the Kyungsang dialect, which is spoken in the southeastern part of Korea (e.g. Whitman 1985; Young-mee Yu Cho 1988; Mira Oh 1994).

(14) *Consonant preservation and deletion according to regional dialects* (based on Young-mee Yu Cho 1988)

(a) Both Seoul and Kyungsang	(b) Seoul	(c) Kyungsang
p(s)	(l)k	l(k)
k(s)		
l(s)		

The consonants in parentheses are subject to deletion. It is notable that the Seoul dialect and the Kyungsang dialect exhibited opposite patterns for /lk/ in 1980-90's: C_1 /l/ was always deleted in the Seoul dialect (14b), while it was preserved in the Kyungsang dialect (Whitman 1985) (14c). This shows that there used to be a dialectal difference. It will be worth investigating whether there has been a diachronic change since the previous studies were conducted about thirty years ago.

There have been phonetic investigations into which element of consonant clusters is subject to preservation or deletion. Taehong Cho & Sahyang Kim (2009) examined variation in within-dialect tri-consonantal cluster simplification. In particular, they compared the clusters /lkt/ and /lpt/ in verb stems in Seoul Korean, as in /ilk-ta/ 'to read' and /palp-ta/ 'to step on'. Their results show that C_2 was preserved to a greater extent in /l**k**t/ (i.e. /k/-preservation) than in /l**p**t/ (i.e. /p/-preservation) since velars are phonetically more salient than labials, following Stevens (1989): the prominence in amplitude and spectral peak is greater for velars than labials. In addition, they claim that speakers are more likely to preserve the perceptually stronger segments for listeners' benefit. This is referred to as the perceptual robustness for /k/. Their analysis of the asymmetry in /k/ versus /p/ also stems from Jongho Jun's (2004) hypothesis of phonetically-driven velar preference, which states that speakers tend to preserve /k/ more often than /p/. This suggests that some regional varieties of Korean exhibit a difference in preservation and deletion of specific consonants (at least by Seoul Korean speakers, as was claimed previously

(14b)). Whether there is a dialectal difference or not, it is still understudied why one or the other consonant deletes in CCS in Korean, and why this varies across clusters. In addition, previous studies lack comprehensiveness since there has been no mention about the other clusters that appear in noun stems, /lp/ and /lm/, which this study includes.

4.1.2 Variation by vowel-initial inflectional suffixes

In addition to intrinsic properties of consonants, vowel-initial inflectional suffixes that are attached to noun stems might also be relevant to the current issue. Jongho Jun & Jeehyun Lee (2007) and Jongho Jun (2010) investigated variants of stem-final obstruents in Korean native nouns and loanwords. They found that the underlying coronal obstruents /s, t, t^h, c, c^h/ are realized as diverse variants, depending on the three kinds of vowel-initial suffixes *-i* (NOM), *-ɨl* (ACC), and *-ɛ* (DAT/LOC). For example, it is highly likely that /t^h/, as in /pat^h/ 'field', surfaces as [c^h] before *-i* and *-ɨl*, as in [pac^h-i] 'field-NOM' and [pac^h-ɨl] 'field-ACC', respectively, and as [t^h] before *-ɛ*, as in [pat^h-ɛ] 'field-DAT/LOC'.

Stem-final coronal obstruents	**Vowel-initial suffixes**	**Dominant surface forms**	**Examples**
/t^h/	*-i*	[c^h]	[pac^{h}i] 'field-NOM'
	-ɨl		[pac^{h}ɨl]'field-ACC'
	-ɛ	[t^h]	[pat^{h}ɛ] 'field-DAT/LOC'

Table 4: Variants of stem-final coronal obstruents in Korean native nouns (based on Jongho Jun & Jeehyun Lee 2007; Jongho Jun 2010).

Jongho Jun & Jeehyun Lee (2007) and Jongho Jun (2010) account for the variants in a frequency-based approach in which [c^h] occurs frequently before *-i* and *-ɨl*, while [t^h] before *-ɛ* in Korean. The suffix-specific account along with the frequency effects for stem-final coronal obstruents might also hold for stem-final consonant clusters, when suffixed with different vowel-initial case markers. To the best of my knowledge, there has been no study that investigates such a relation. The present study thus examines whether there is variation in Korean nominal inflected forms in which stems combine with different vowel-initial suffixes.

4.1.3 Variation by speakers' gender

Sociolinguistic factors, such as gender might also be relevant. According to Labov's (1990) Principle I, male speakers use nonstandard forms more frequently, while female speakers use a higher frequency of standard forms, in order to comply with the overt prestige related to them. For the English sociolinguistic variable *-ing*, when unstressed, males use the colloquial form [in] more than females do in New England (Labov 1966). If the generalization found in

English is universal and thus applies to variation in Korean nominal inflection, it is expected that female speakers use more conservative forms, preserving both stem-final consonants, while male speakers use more innovative forms, deleting one of the two consonants.

5 Experiment

A production experiment was conducted to examine the effects of consonant clusters, suffixes, regional dialects, and gender on variation in Korean nominal inflection. The experiment was performed in two formats due to the global health crisis, COVID-19, which inevitably impacted the modalities of the experiment: an in-person format (pre-pandemic) and an online format over the Zoom web conferencing platform (version: 5.6.6) (during the pandemic). Other than the modalities, the experiment was conducted with the consistent procedures by the same experimenter.

5.1 Participants

Participants were recruited using social media. Forty-four native speakers of Korean who were at the age of 19 or in their 20's at the time of participation participated in the production experiment (mean age: 22.48; range: 19-28). There were 22 male speakers and 22 female speakers. Twenty-three participants were native speakers of Seoul Korean who were from Seoul and Kyunggi area, and the other 21 were native speakers of Kyungnam Korean from Busan and South Kyungsang area. Ten of them participated in the in-person format, whereas the other 34 participated in the online format. Participants were paid compensation that is commensurate with $5 for their time.

5.2 Stimuli

Eleven native Korean monosyllabic nouns and one disyllable numeral that occur with one of the six consonant clusters /ps/, /ks/, /lp/, /lk/, /ls/, and /lm/ were selected for target noun stems. For the sake of convenience, the clusters were grouped into three types, based on the [±sonorant] feature of the elements, whether they are obstruents (Obs.) or sonorants (Son.): "Obs.+Obs." for /ps/, /ks/, "Son.+Obs." for /lp/, /lk/, /ls/, and "Son.+Son." for /lm/. Although the cluster "Son.+Son." has only one cluster that falls into this category (i.e. /lm/), which could lack representativeness, there is uniqueness of the cluster /lm/ that has something to do with morphology: it is in fact not a monomorphemic cluster but a combination of part of the verb stem /l/ from *al-* 'to know' or *sal-* 'to live' and the noun-forming morpheme *-m*. This will be elaborated in Section 7.2.4.

Thirty-six inflected forms of target items were prepared (= 12 nouns stems × 3 suffixes), as presented in **Table 5**: one noun stem with /ps/ (*kaps* 'price'), three with /ks/ (*saks* 'wage', *moks* 'share', *nʌks* 'soul'), one with /lp/ (*jʌtʌlp* 'eight'), four with /lk/ (*talk* 'chicken', *salk* 'leopard cat', *cʰilk* 'arrowroot', *hɨlk* 'soil'), one with /ls/ (*kols* 'way'), and two with /lm/ (*alm* 'knowledge', *salm* 'life'), each of which was followed by the three vowel-initial inflectional suffixes *-i* (NOM), *-ɨl*

(ACC), and *-ɛ* (DAT/LOC). The inflected forms of target noun stems were embedded in the medial position of present tense declarative sentences.

Cluster types	Consonant clusters[2]	Target noun stems	Isolation forms of nouns[3]	Nouns with inflectional suffixes			Gloss
				NOM suffix *-i*	ACC suffix *-il*	DAT/LOC suffix *-ɛ*	
Obs. + Obs.	/ps/	*kaps*	[kap]	/kaps-i/	/kaps-ɨl/	/kaps-ɛ/	'price'
	/ks/	*saks*	[sak]	/saks-i/	/saks-ɨl/	/saks-ɛ/	'wage'
		moks	[mok]	/moks-i/	/moks-ɨl/	/moks-ɛ/	'share'
		nʌks	[nʌk]	/nʌks-i/	/nʌks-ɨl/	/nʌks-ɛ/	'soul'
Son. + Obs.	(/lp/)	*jʌtʌlp*	[jʌ.tʌl]	/jʌtʌlp-i/	/jʌtʌlp-ɨl/	/jʌtʌlp-ɛ/	'eight'
	/lk/	*talk*	[tak]	/talk-i/	/talk-ɨl/	/talk-ɛ/	'chicken'
		salk	[sak]	/salk-i/	/salk-ɨl/	/salk-ɛ/	'leopard cat'
		cʰilk	[cʰik]	/cʰilk-i/	/cʰilk-ɨl/	/cʰilk-ɛ/	'arrowroot'
		hɨlk	[hɨk]	/hɨlk-i/	/hɨlk-ɨl/	/hɨlk-ɛ/	'soil'
	/ls/	*kols*	[kol]	/kols-i/	/kols-ɨl/	/kols-ɛ/	'way'
Son. + Son.	(/lm/)	*alm*	[am]	/alm-i/	/alm-ɨl/	/alm-ɛ/	'knowledge'
		salm	[sam]	/salm-i/	/salm-ɨl/	/salm-ɛ/	'life'

Table 5: Inflected forms of target noun stems by suffixes.

[2] In the "Consonant clusters" column of Table 5, /lp/ and /lm/ are in parentheses since they were originally excluded from the in-person format of the experiment because their occurrences are restricted not purely to noun stems but to numerals (e.g. /lp/ in *jʌtʌlp* 'eight') or to derived forms of verb stems (e.g. /lm/ in *al-m* 'knowledge' and *sal-m* 'life'). They were, however, included in the online format since numerals and nouns that are derived from verbs in fact behave like nouns, as pointed out in Section 2. Also, as discussed in Section 2, there are eleven consonant clusters in Korean, and nouns or verbs with any of them are very rare in the language. In addition, only six of the eleven consonant clusters appear in nouns. Taking this rarity into consideration, the complete list of 12 target noun stems presented in Table 5 is as exhaustive as possible, excluding only those that are infrequently or never used in contemporary Korean, such as *sʌks* 'sudden feeling of anger' and *tols* 'first birthday'. Although the list is exhaustive, it is not balanced in mainly two aspects, as two anonymous reviewers pointed out. First, the number of target noun stems per cluster varies (i.e. difference in type frequency) (e.g. 1 noun stem for /ps/, /lp/, and /ls/; 2 for /lm/, 3 for /ks/, and 4 for /lk/). Second, some target noun stems are not necessarily as frequent as others (i.e. difference in token frequency). For example, *salk* 'leopard cat' is less frequent than *talk* 'chicken'. In addition, as a reviewer pointed out, *kols* 'way' is rarely used in contemporary Korean. However, compared to even rarer lexical items like *sʌks* 'sudden feeling of anger', *kols* is still actively used in derived forms in present-day Korean, as in *økols* 'the only way' and *økolsu* 'single-minded person'. In order to consider the overall rarity of consonant clusters in Korean and to include as many consonant clusters and target items as possible for analysis, this study puts more emphasis on achieving the exhaustiveness of target items than on balancing them out. I thank the reviewers for pointing these out and suggesting me to include more diverse and balanced lexical items for target noun stems.

[3] In the "Isolation forms of nouns" column of Table 5, the output consonants that survive in the isolation forms of nouns are based on the standard pronunciations from the Great Dictionary of Standard Korean (National Institute of the Korean Language 2022).

There were also fillers, which included five stem-final consonant clusters /lp^h/, /lt^h/, /lh/, /nc/, and (/nh/) in verb stems, as in /ɨlp^h-/ 'to recite', /hult^h-/ 'to skim through', /alh-/ 'to suffer', /anc-/ 'to sit', and (/k'ɨnh-/ 'to quit') in three verbal inflections.[4] Fillers also ended in a consonant cluster, as target noun stems did. This could have explicitly led to participants' overall attention to consonant clusters, as a reviewer suggested. However, I chose fillers with a consonant cluster because if fillers with a simplex consonant had been used, it would have provided participants with a more stark contrast between simplex (fillers) and complex (target items) consonants.

Fillers were embedded in declarative sentences in a random order as were the target noun stems. In this way, 15 sentences for fillers were prepared (= 5 verb stems × 3 inflections). Combining all target items and fillers, 39 sentences were prepared for the in-person format of the experiment: (9 target noun stems excluding those with /lp/ and /lm/ × 3 suffixes) + (4 fillers excluding those with /nh/ × 3 verbal inflections). For the online format, 51 sentences were prepared: (12 target noun stems including those with /lp/ and /lm/ × 3 suffixes) + (5 fillers including those with /nh/ × 3 verbal inflections). (See the supplementary file.)

5.3 Procedure

The 51 sentences that contain target items and fillers were written in Korean orthography and prepared in a random order prior to the experiment. Experimental sentences in written forms were presented to participants.[5] For the in-person format of the experiment, the 39 sentences (excluding the target items with /lp/ and /lm/ and the fillers with /nh/) were printed on a sheet of paper and shown to participants. For the online format, the 51 sentences (including the target items with /lp/ and /lm/ and the fillers with /nh/) were presented on the participants' computer screen using the screen-sharing function that is built in the Zoom web conferencing platform. For both formats of the experiment, participants were asked to read aloud the sentences with three repetitions in a natural tone and at a normal speed as they spoke in daily conversations, either in the Seoul dialect or in the Kyungnam dialect depending on the areas they are originally from.

For the in-person format, recordings took place by using a Zoom H2n Handy Recorder in a quiet room on a university campus. The recorded files were automatically saved as a Waveform

[4] The cluster /nh/ and the verb stem /k'ɨnh-/ 'to quit' are in parentheses since they were not included in the list of fillers for the in-person format of the experiment. They were included in the online format, as more target noun stems were also included in the online format.

[5] As a reviewer pointed out, written forms might bias participants and result in spelling pronunciations. In order to avoid this, other studies used picture presentations for stimuli (e.g. Youngah Do's (2012) picture-description task for children). This method can be advantageous when written forms are not an efficient way to elicit productions from those who cannot read. It is, however, hard to include abstract nouns, such as *alm* 'knowledge', for the experiment of the present study. Furthermore, nouns, concrete or abstract, should all be included since there are only a handful of nouns with a stem-final consonant cluster in Korean (Youngah Do et al. 2014). For this reason, this study presented participants with written forms of stimuli, despite the possibility of spelling pronunciation. (For more details about spelling effect (especially on conservative forms), see Section 6.1.1.)

Audio File Format (.wav). The online format was conducted by having both the experimenter's and the participants' videos turned off throughout the recordings in order to obtain only audios, excluding videos that were unnecessary to the experiment. Participants' audio was recorded by using their computer's microphone and Zoom's built-in recording function. Since the recorded files were automatically saved by Zoom as an Audio-only MPEG-4 file (.m4a), they were converted by the experimenter to a Waveform Audio File Format (.wav) after all recording sessions were complete, in order to make the files readable in Praat.

This resulted in reading and recording 6,372 sentences that consist of 1,170 recorded tokens from the in-person format (= 39 sentences × 10 participants × 3 repetitions) and 5,202 recorded tokens from the online format (= 51 sentences × 34 participants × 3 repetitions). Out of the 1,170 recorded tokens from the in-person format, 810 tokens were examined (= 9 target noun stems × 3 suffixes × 10 participants × 3 repetitions), excluding the 360 tokens of fillers. Among the 5,202 recorded tokens from the online format, 3,672 tokens were examined (= 12 target noun stems × 3 suffixes × 34 participants × 3 repetitions), excluding 1,530 fillers. In sum, a total of 4,482 tokens (= 810 tokens from the in-person format + 3,672 tokens from the online format) were analyzed.

5.4 Acoustic analysis

Recordings were analyzed acoustically using Praat (Boersma & Weenink 2021, version: 6.1.54) as well as impressionistically in order to overcome inconsistency, if any, of the sound files that were recorded via different means (i.e. with a Zoom H2n Handy Recorder and over Zoom). In what follows, I provide criteria of the acoustic analysis of two output forms (i.e. conservative or innovative) with some samples. Below spectrograms, there are three levels: the uppermost level is for the sentence that was read by a participant, the one in the middle is for the input form of the inflected noun, and the bottom shows segmentation of the inflected form.

First, for /ps/, /ks/, and /ls/, the output forms were either with an [s] or not. If there was a frication noise, this indicates the presence of [s] in the output form (left in **Figure 1**). Otherwise, it suggests the absence of [s] (right in **Figure 1**).

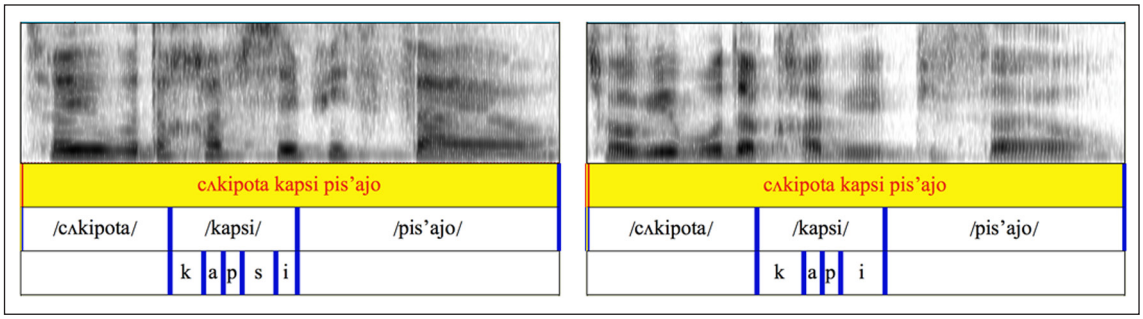

Figure 1: /ka**ps**-i/ [ka**p**.**s**i] (conservative) vs. [ka.**p**i] (innovative) 'price-NOM'.

Second, the output forms of /lp/ were either with a [p] or not. Thus, the criterion was whether there is a stop closure and/or a release burst for [p] (left in **Figure 2**) or not (right in **Figure 2**).

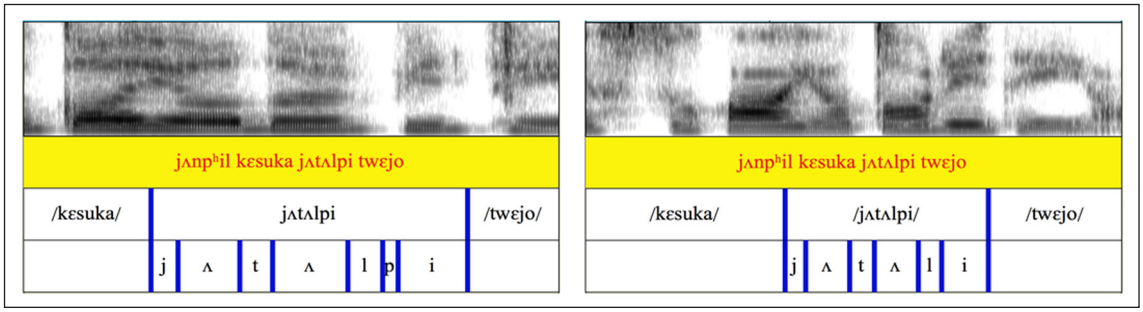

Figure 2: /jʌtʌ**lp-**i/ [jʌ.tʌ**l.p**i] (conservative) vs. [jʌ.tʌ.**l**i] (innovative) 'eight-NOM'.

Lastly, the output forms of /lk/ were [lk] or [k], and those of /lm/ were [lm] or [m]. Therefore, the criterion was whether there is an [l] or not. Miyeon Ahn (2017) shows the trajectories of the first formant (F_1) and the second formant (F_2) of post-vocalic /l/ in Korean under the assumption that the formant frequencies of the lateral approximant are affected by preceding vowels due to a coarticulatory effect; for example, if /l/ is preceded by the high vowel /i/ (e.g. /il/ in /cʰ**il**k-i/ 'arrowroot-NOM'), F_2 increases slightly (as the tongue moves slightly forward from /i/ to /l/), whereas there is not much change in F_1. Following the criterion, if such a change in spectral properties was observed in the present spectrograms, this indicates the presence of [l], as in [cʰi**l**.ki] (left in **Figure 3**). Otherwise, it suggests the absence of [l], as in [cʰi.ki] (right in **Figure 3**).

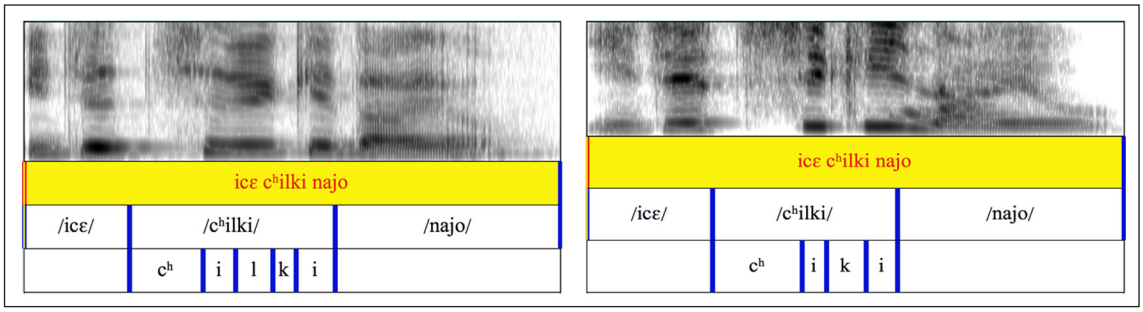

Figure 3: /cʰi**lk**-i/ [cʰi**l.k**i] (conservative) vs. [cʰi.**k**i] (innovative) 'arrowroot-NOM'.

Based on the above analysis, the number of conservative forms (with stem-final consonant clusters intact) and the number of innovative forms (with simplified stem-final consonant clusters) were counted, and the percentages were calculated. Results of the production experiment are presented in Section 6.

6 Results

This section reports the overall distribution of output forms in the raw data obtained from the production experiment by various factors (6.1): consonant clusters (6.1.1), clusters and suffixes (6.1.2), clusters and dialects (6.1.3), and clusters and gender (6.1.4). A statistical analysis with a mixed effects logistic regression model is provided in Section 6.2.

6.1 Results of raw data

In the raw data, there were three output consonant types: conservative, innovative, and other forms. Conservative forms are those with both input consonants preserved (e.g. /ka**ps**-i/ [ka**p**.**s**i] 'price-NOM'), whereas innovative forms are those with one of the input consonants being deleted and the other being preserved, which is produced even with different laryngeal features (e.g. /ta**lk**-i/ [ta.**k'**i] (tense) and [ta.**k^{h}**i] (aspirated) as well as [ta.**k**i] (lenis)) since this is not considered to be important. Other forms include output forms with an unexpected consonant that does not occur in the corresponding isolation forms. For /jʌtʌ**lp**/ 'eight', for example, [l] survives in the isolation form [jʌtʌ**l**], but there were instances in the recorded tokens where the other consonant [p] appeared in the suffixed forms, as in [jʌ.tʌ.**p**i] 'eight-NOM'. In addition, there were cases where the non-etymological consonant [s] is inserted, as in /ta**lk**-i/ [ta**k**.**s**i] 'chicken-NOM', which were also included in the "other" category. (See Ji Yea Kim 2019 for [s]-insertion in Korean.) The "other" category was excluded from both the raw data analysis and the statistical analysis since it is rare and out of the scope of this study. (See Section 6.1.1 for more details.)

6.1.1 Clusters

Percentages of conservative, innovative and other forms across the six stem-final consonant clusters were calculated by dividing the raw count of each of the three output types by the total number of output forms produced by the participants (% rounded to the nearest tenth). They are shown in **Table 6** and **Figure 4**.

	Consonant clusters					
Output types	**/ps/**	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**
Conservative	99.0 (392)	75.0 (891)	10.8 (33)	10.2 (162)	12.6 (50)	97.2 (595)
Innovative	1.0 (4)	25.0 (297)	84.6 (259)	86.8 (1375)	82.3 (326)	2.8 (17)
Other	0.0 (0)	0.0 (0)	4.6 (14)	3.0 (47)	5.0 (20)	0.0 (0)

Table 6: Percentages (%) of output forms by clusters. (Raw counts are provided in parentheses, and dominant output consonant types are highlighted.)

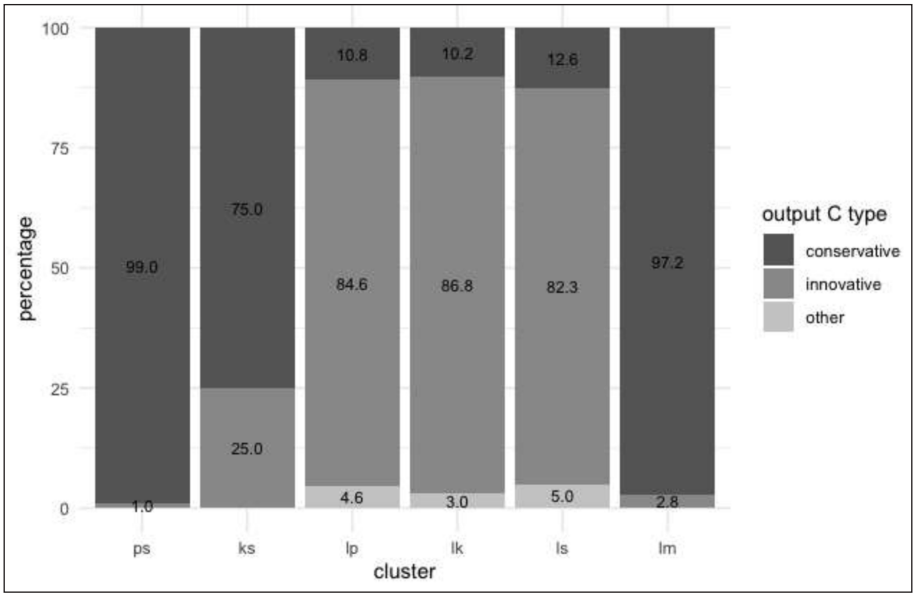

Figure 4: Percentages (%) of output forms by clusters.

Interestingly, a stark dichotomy was observed by consonant clusters. Conservative forms were dominant for /ps/, /ks/, and /lm/, while innovative forms were favored for /lp/, /lk/, and /ls/. Note that, as a reviewer suggested, it is highly likely that for some speakers noun stems with final /lp/, /lk/, and /ls/ have been lexicalized as the ones with a simplex consonant: /lp/ and /ls/ to /l/ (e.g. /jʌtʌ**lp**/ > /jʌtʌ**l**/ 'eight', /ko**ls**/ > /ko**l**/ 'way') and /lk/ to /k/ (e.g. /ta**lk**/ > /ta**k**/ 'chicken'). This is supported by /to**ls**/ > /to**l**/ 'first birthday'. (See 7.1.) One might claim that such restructuring in underlying representations (URs) would not predict conservative forms, since the restructured URs are no longer with a consonant cluster but with a simplex final consonant. However, conservative forms did occur to a less extent (10.2–12.6%), though, for these clusters. This might be due to a spelling effect, since written forms were used in the current experiment.

It seems reasonable at this point to roughly group the clusters into two, based on the results and the [±sonorant] feature of the consonantal elements of the clusters: conservative-dominant ("Obs. + Obs." and "Son. + Son.") and innovative dominant ("Son. + Obs."). Since the percentages of output forms that fall into the "other" category are negligibly low (4.6% for /lp/, 3.0% for /lk/, and 5.0% for /ls/) and they are out of the scope of this study, "other" was excluded, and only "conservative" and "innovative" forms were analyzed and will be discussed henceforth.

6.1.2 Clusters and suffixes

Percentages of conservative and innovative forms by the six stem-final consonant clusters and the three vowel-initial inflectional suffixes were calculated, as shown in **Table 7** and **Figure 5**.

	Suffixes																	
	NOM -*i*						**ACC -*il***						**DAT/LOC -*ɛ***					
	Consonant clusters						**Consonant clusters**						**Consonant clusters**					
	/ps/	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**	**/ps/**	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**	**/ps/**	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**
Conservative	97.7 (129)	74.7 (296)	11.2 (11)	13.5 (69)	12.9 (16)	97.5 (199)	100 (132)	77.5 (307)	8.4 (8)	8.2 (42)	14.1 (18)	97.5 (199)	99.2 (131)	72.7 (288)	14.1 (14)	9.9 (51)	12.9 (16)	96.6 (197)
Innovative	2.3 (3)	25.3 (100)	88.8 (87)	86.5 (442)	87.1 (108)	2.5 (5)	0.0 (0)	22.5 (89)	91.6 (87)	91.8 (469)	85.9 (110)	2.5 (5)	0.8 (1)	27.3 (108)	85.9 (85)	90.1 (464)	87.1 (108)	3.4 (7)

Table 7: Percentages (%) of output forms by clusters and suffixes. (Raw counts are provided in parentheses, and dominant output consonant types are highlighted.)

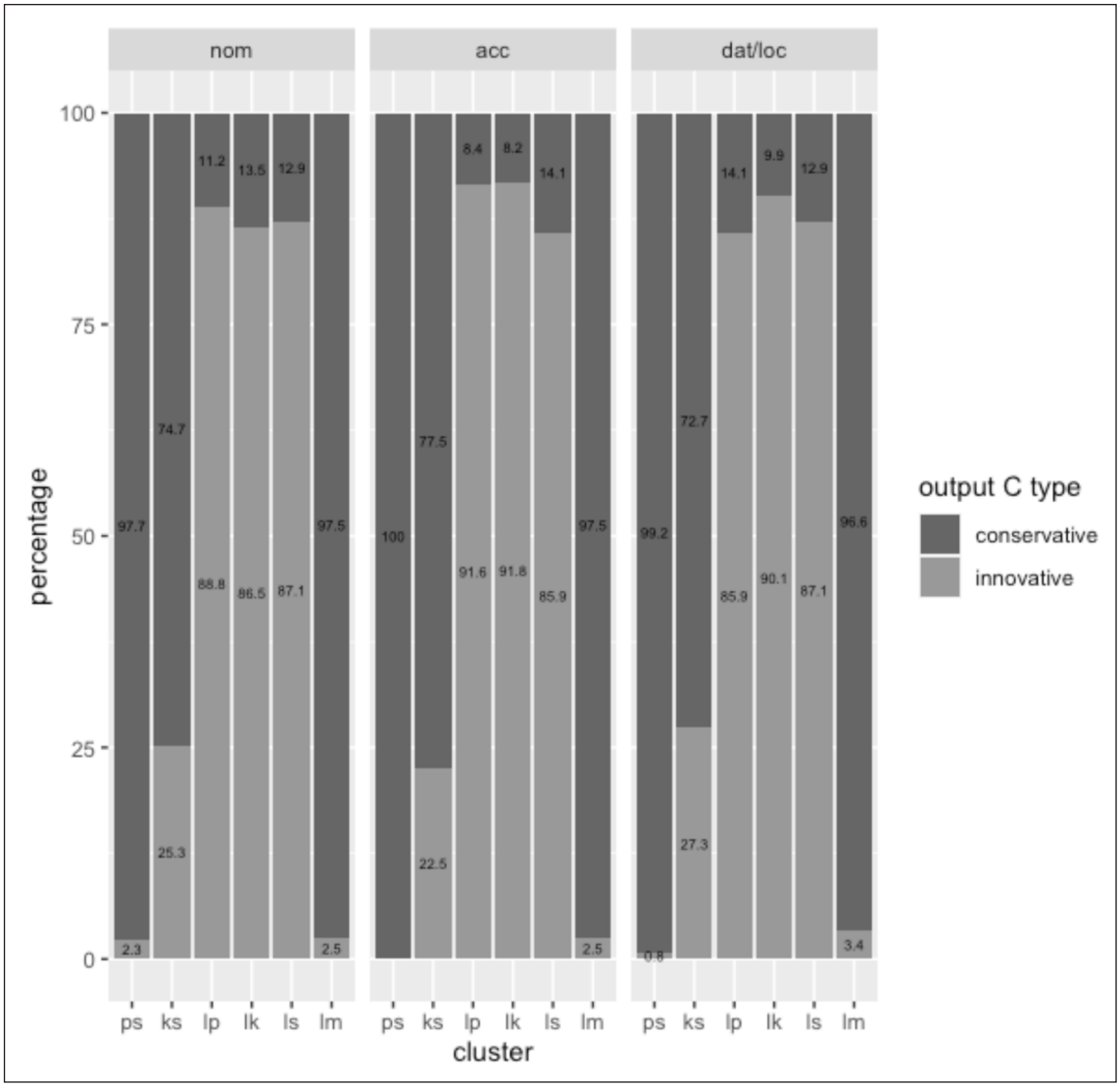

Figure 5: Percentages (%) of output forms by clusters and suffixes.

The general patterns by clusters and suffixes are identical to those by clusters only. That is, conservative forms were favored for /ps/, /ks/, and /lm/, while innovative forms were dominant for /lp/, /lk/, and /ls/. These patterns were observed regardless of whether the suffix was NOM *-i*, ACC *-il*, or DAT/LOC *-ɛ*.

6.1.3 Clusters and dialects

Percentages of conservative and innovative forms by the six stem-final consonant clusters and the two regional dialects are presented in **Table 8** and **Figure 6**.

	Dialects											
	Seoul						**Kyungnam**					
	Consonant clusters						**Consonant clusters**					
	/ps/	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**	**/ps/**	**/ks/**	**/lp/**	**/lk/**	**/ls/**	**/lm/**
Conservative	99.0 (205)	77.0 (478)	14.3 (22)	11.8 (96)	15.3 (31)	95.7 (310)	98.9 (187)	72.8 (413)	8.0 (11)	9.2 (66)	11.0 (19)	99.0 (285)
Innovative	1.0 (2)	23.0 (143)	85.7 (132)	88.2 (720)	84.7 (172)	4.3 (14)	1.1 (2)	27.2 (154)	92.0 (127)	90.8 (655)	89.0 (154)	1.0 (3)

Table 8: Percentages (%) of output forms by clusters and dialects. (Raw counts are provided in parentheses, and dominant output consonant types are highlighted.)

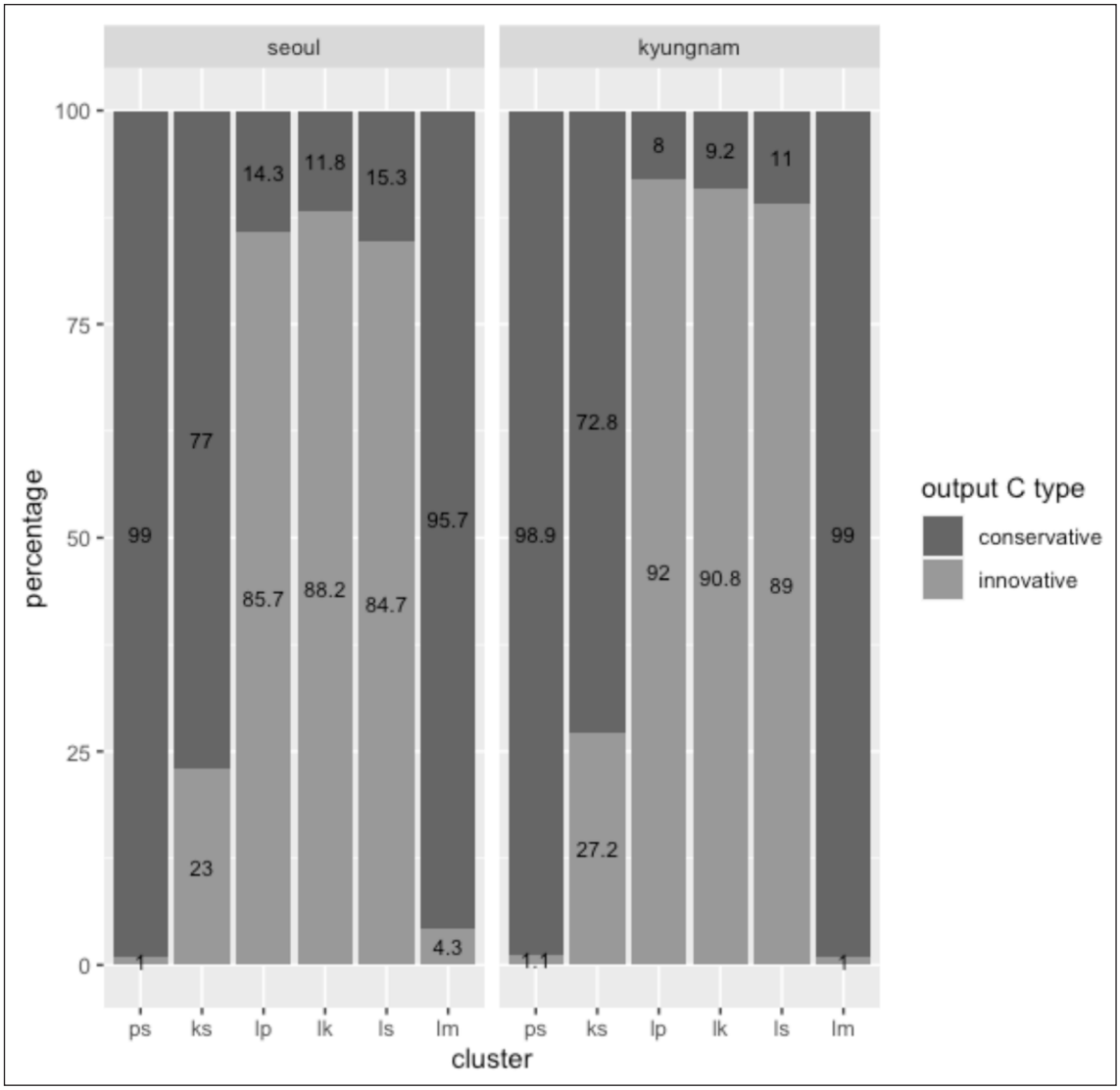

Figure 6: Percentages (%) of output forms by clusters and dialects.

Output forms by clusters and dialects were overall identical to those by clusters only, and by clusters and suffixes: conservative forms were dominant for /ps/, /ks/, and /lm/, whereas innovative forms were for /lp/, /lk/, and /ls/. Such a dichotomy was found regardless of participants' dialects (i.e. Seoul or Kyungnam).

6.1.4 Clusters and gender

Percentages of conservative and innovative forms by the six stem-final consonant clusters and participants' gender were calculated, as shown in **Table 9** and **Figure 7**.

	Gender											
	Male						Female					
	Consonant clusters						Consonant clusters					
	/ps/	/ks/	/lp/	/lk/	/ls/	/lm/	/ps/	/ks/	/lp/	/lk/	/ls/	/lm/
Conservative	98.0 (194)	74.1 (440)	14.8 (22)	11.6 (91)	16.1 (30)	95.4 (292)	100.0 (198)	75.9 (451)	7.7 (11)	9.5 (71)	10.5 (20)	99.0 (303)
Innovative	2.0 (4)	25.9 (154)	85.2 (127)	88.4 (696)	83.9 (156)	4.6 (14)	0.0 (0)	24.1 (143)	92.3 (132)	90.5 (679)	89.5 (170)	1.0 (3)

Table 9: Percentages (%) of output forms by clusters and gender. (Raw counts are provided in parentheses, and dominant output consonant types are highlighted.)

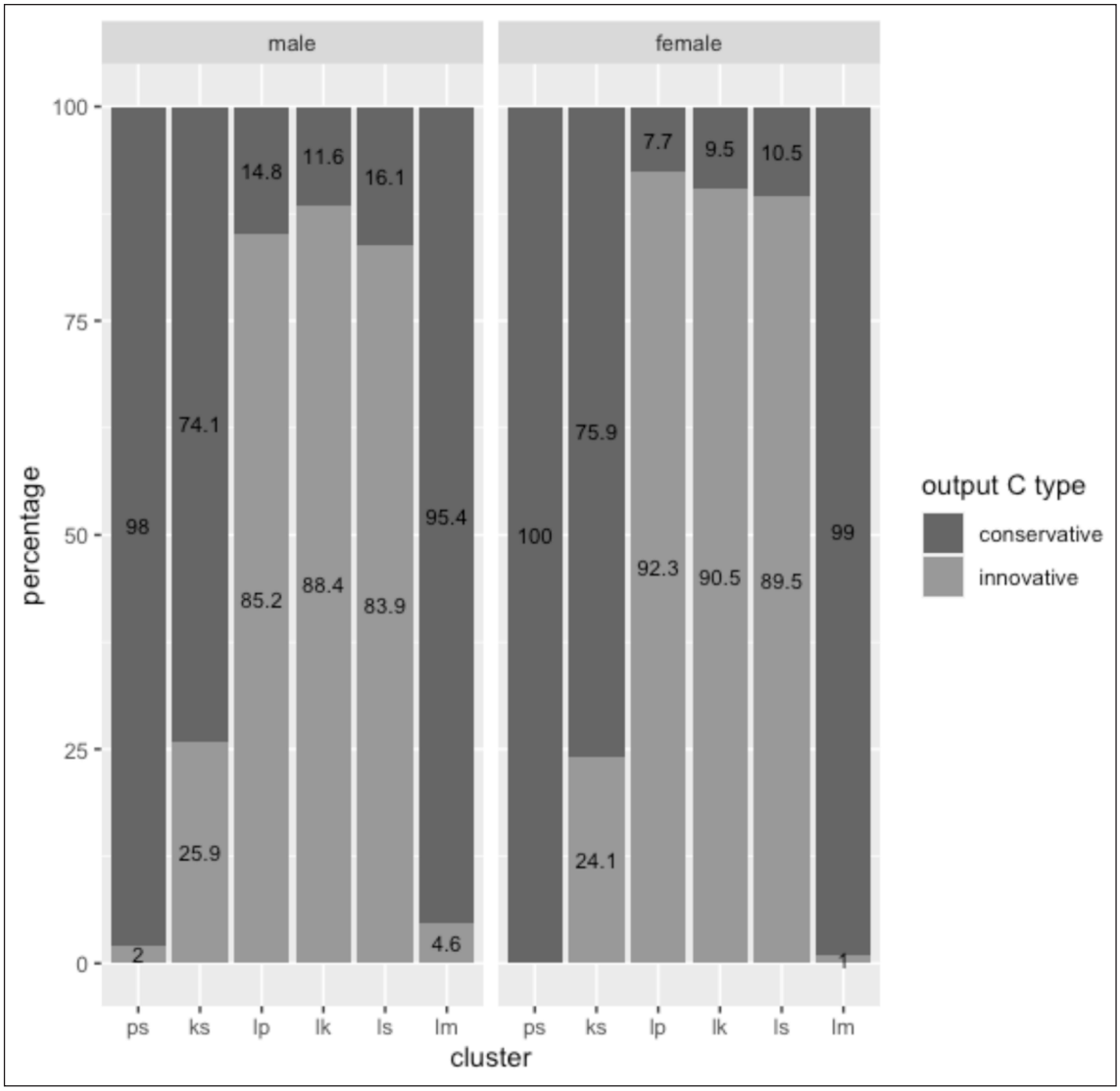

Figure 7: Percentages (%) of output forms by clusters and gender.

The overall distribution of conservative and innovative forms by clusters and gender was identical to the findings by clusters only, and by clusters with either suffixes or dialects. In other words, conservative forms were dominant for /ps/, /ks/, and /lm/, whereas innovative forms were preferred for /lp/, /lk/, and /ls/. Such patterns were observed regardless of participants' gender (i.e. male or female).

6.2 Mixed effects analysis

A statistical analysis was conducted in order to examine whether and to what extent stem-final consonant clusters, vowel-initial inflectional suffixes, speakers' regional dialects, and gender have

an impact on the choice between conservative forms and innovative forms in Korean nominal inflection. A mixed effects logistic regression model was fitted using R (R Core Team 2021) and the glmer function in the lmerTest package (Kuznetsova et al. 2017). In the model, the dependent variable was the binary categorical factor "output consonant type" (conservative or innovative). I included the following four independent variables (i.e. fixed effects): "clusters" (6 levels: /ps/, /ks/, /lp/, /lk/, /ls/, /lm/), "suffixes" (3 levels: NOM *-i,* ACC *-il,* DAT/LOC *-ɛ*), "dialects" (2 levels: Seoul, Kyungnam), and "gender" (2 levels: male, female). Since all independent variables were categorical, appropriate coding processes were done as follows: two 2-level factors (i.e. "dialects", "gender") were sum-coded, whereas the other two tri-or-more-level factors (i.e. "clusters", "suffixes") were treatment-coded. The reference level of each independent variable was reordered: /ps/ for "clusters"; NOM *-i* for "suffixes", Seoul for "dialects", and male for "gender". In the previous section, results of the raw data suggested that interactions may not be significant since the general patterns of output forms, either conversative or innovative, were not different when suffixes (6.1.2), dialects (6.1.3), and gender (6.1.4) were calculated with each of the six consonant clusters. However, I included the interactions in the statistical analysis to examine whether there is any significance. Participants and target noun stems (i.e. test items) were included as random effects, which indicate that there was variation depending on participants (variance = 1.067) and target noun stems (variance = 1.128). By running a mixed effects model with these random effects, results show that "clusters" is the only main effect that is statistically significant and that no interactions turned out to be significant. Results of the significant factor (i.e. "clusters") are shown in (15), leaving out those of the insignificant ones.

(15) *Results of statistical analysis (significant effect (i.e. "clusters") only)*

	Estimate	Pr(>|z|)	
(Intercept)	–2.279e+00	> .05	
cluster (ks)	7.019e–01	> .05	
cluster (lp)	4.136e+00	< .05	*
cluster (lk)	4.132e+00	< .01	**
cluster (ls)	3.836e+00	< .05	*
cluster (lm)	–8.552e–01	> .05	

Among the six clusters, it is notable that the reference level /ps/ is significantly different from /lp/ ($p < .05$), /lk/ ($p < .01$) and /ls/ ($p < .05$) for the output consonant types. On the other hand, it is not significantly different from /ks/ and /lm/ (both $p > .05$). This dichotomy agrees with the results of the raw data: /ps/, /ks/, and /lm/ pattern together by preferring conservative forms, while /lp/, /lk/, and /ls/ are identical by favoring innovative forms. As was expected from the raw data, neither of the three predictors other than "clusters" (i.e. "suffixes", "dialects", and "gender") nor any of their interaction with "clusters" impacts output consonant types of the stem-final consonant clusters in Korean nominal inflection.

In sum, these results suggest that different clusters prefer different output consonant types in Korean nominal inflection, either conservative or innovative. When it comes to innovative forms, it is noteworthy that they include only one stem-final consonant via simplification and that the very consonant is identical to what surfaces in the corresponding isolation form. (cf. The consonants that survive in the "other" forms in inflection are not the ones that surface in the isolation forms.) This suggests that there is a relation between consonants in the innovative forms in inflection and those in the isolation forms. These results will be discussed in Section 7.

7 Discussion

It is widely accepted that stem-final consonant clusters in Korean nominal inflection show variation, either as conservative forms or as innovative forms. However, this dichotomy only shows the number of surfacing consonants, either two or one, but nothing about the consonant quality: which clusters prefer conservative forms or innovative forms, and for innovative forms, which consonantal element of a cluster is deleted or preserved. Also unknown in Korean nominal inflection has been whether different suffixes, speakers' regional dialects, or gender make a difference. As the experimental results indicated in Section 6, not all consonant clusters show the same pattern, and yet variation is not random but systematic.

This section consists of four parts. First, it discusses the two dominant patterns (conservative and innovative) in Korean nominal inflection, which clusters prefer which pattern, and why (Section 7.1). Second, arguing against the two theoretically possible accounts that were raised and evaluated in Section 3.1 (linear order and sonority relationship), I provide a comprehensive analysis of CCS in isolation forms, with a special focus on which consonant is preserved or deleted in different clusters (Section 7.2). Third, following Kenstowicz (1996), I show how the Base-Identity effect plays a role in innovative forms in inflection (Section 7.3). Last, this section touches on the factors that did not turn out to be statistically significant: vowel-initial inflectional suffixes, speakers' regional dialects, and gender (Section 7.4).

7.1 Inflected forms: conservative-dominant and innovative-dominant clusters

Results showed in Section 6 that conservative forms were dominant for /ps/, /ks/, and /lm/, and innovative forms were for /lp/, /lk/, and /ls/. Conservative forms are accounted for by the ranking in which the anti-deletion faithfulness constraint MAX-C-IO (16) is ranked higher than the universal markedness constraint NOCODA (17): MAX-C-IO >> NOCODA (definitions are based on Kager 1999).

(16) MAX-C-IO: Input consonants must have output correspondents. ('No consonant deletion')

(17) NOCODA: *C]$_{\sigma}$ ('Syllables are open.')

Despite the shared pattern, what distinguishes the "Obs. + Obs." clusters /ps/ and /ks/ from the "Son. + Son." cluster /lm/ is that the former are rising sonority clusters that are prohibited by SYLLABLE CONTACT (SYLLCON) in Korean (Davis & Seung-Hoon Shin 1999: 286 based on Bat-El 1996: 304).

(18) SYLLABLE CONTACT (SYLLCON): "Avoid rising sonority over a syllable boundary."

SYLLCON is dominated by NOCODA, which is ranked lower than MAX-C-IO, as illustrated in the tableaux for "Obs. + Obs" clusters (19) and "Son. + Son." cluster (20).

(19) *Tableau for "Obs. + Obs." clusters (conservative-dominant)*

/kaps-i/ 'price-NOM'		MAX-C-IO	NOCODA	SYLLCON
☞	a. [kap.si]		*	*
	b. [ka.pi]	*!		

(20) *Tableau for "Son. + Son." cluster (conservative-dominant)*

/salm-i/ 'life-NOM'		MAX-C-IO	NOCODA	SYLLCON
☞	a. [sal.mi]		*	
	b. [sa.mi]	*!		

The constraint ranking for inflected forms that work for conservative-dominant output forms at this point is summarized in (21).

(21) MAX-C-IO >> NOCODA >> SYLLCON (*to be revised*)

However, this ranking fails to predict innovative forms, which are dominant for the "Son. + Obs." clusters.

(22) *Incorrect ranking for "Son. + Obs." clusters (should predict the innovative output)*

/talk-i/ 'chicken-NOM'		MAX-C-IO	NOCODA	SYLLCON
💣	a. [tal.ki]		*	
☹	b. [ta.ki]	*!		

Recall that the six stem-final consonant clusters can be grouped based on the [±sonorant] feature of the consonantal elements. The clusters in which consonantal elements share the same [±sonorant] feature (i.e. "Obs. + Obs." for /ps/, /ks/, and "Son. + Son." for /lm/) were conservative-dominant, which indicates that both of the input consonants were more likely to be preserved in inflected forms. In contrast, those of which elements do not agree in the

[±sonorant] feature (i.e. "Son.+Obs." for /lp/, /lk/, /ls/) were innovative-dominant with only one of the input consonants preserved in inflection. As can be expected from the generalization, the agreement in the [±sonorant] feature between the consonantal elements of a cluster is the core that distinguishes "Son.+Obs." clusters from the other two cluster types. This is stated in AGREE(son), which is a kind of IDENTICAL CLUSTER CONSTRAINTS that require a sequence of consonants be identical in a particular featural dimension (Pulleyblank 1997).

(23) AGREE(son): A sequence of consonants must be identical in [±sonorant].

AGREE(son) contrasts with SYLLCON, which is a special kind of Obligatory Contour Principle (Leben 1973) that is specific to sonority. AGREE(son) should outrank MAX-C-IO in order for innovative forms to win over conservative forms for the "Son.+Obs." clusters.[6]

(24) *Tableau for "Son.+Obs." clusters (innovative-dominant)*

/talk-i/ 'chicken-NOM'	AGREE(son)	MAX-C-IO	NOCODA	SYLLCON
a. [tal.ki]	*!		*	
☞ b. [ta.ki]		*		

The final ranking for the two dominant inflected forms (conservative for /ps/, /ks/, /lm/, and innovative for /lp/, /lk/, /ls/) is in (25).[7]

(25) AGREE(son) >> MAX-C-IO >> NOCODA >> SYLLCON

It will be helpful at this point to further discuss the peculiarity of the "Son.+Obs." clusters /lp/, /lk/, and /ls/. If they preferred conservative forms, they would have /l/ as the coda, followed by an obstruent as an onset. This is not problematic at all from a synchronic perspective, since it does not violate SYLLCON (24a). However, it seems that the /l/+Obs. sequences have recently undergone simplification. It was reported that speakers who were in their 80's at the time of a survey conducted in early 2015 were highly likely to pronounce conservative forms for /lp/ and

[6] SYLLCON was originally proposed by Davis & Seung-Hoon Shin (1999) in their analysis of Korean nasalization and lateralization in the ranking in which SYLLCON is undominated. Arguing against the undominated status of SYLLCON in Korean, AGREE(son) is proposed in this paper, which crucially dominates SYLLCON, in order to account for different dominant patterns for different consonant clusters. This ranking is consistent throughout the language: not only for inflected forms of nouns but also for nasalization and lateralization in Korean. For example, the high-ranking constraint AGREE(son) rules out *[kuk.mul] for /kuk+mul/ 'broth' (cf. the optimal output: [kuŋ.mul]).

[7] This ranking also works for the "Obs.+Obs." and Son.+Son." clusters by vacuously satisfying AGREE(son). In addition to the dominant variety, there are other varieties that are not dominant. They are accounted for by different rankings, which is beyond the scope of this study: varieties that are always conservative do not have AGREE(son) ranked high, and varieties that are always innovative have NOCODA ranked high. Variation also occurs within speakers and across speakers.

/lk/: /jʌtʌ**lp**-i/ [jʌ.tʌ**l**.**p**i] ‘eight-NOM’, /hi**lk**-i/ [hi**l**.**k**i] ‘soil-NOM’, and /ta**lk**-i/ [ta**l**.**k**i] ‘chicken-NOM’ (Seok-kyu Lim 2016). This suggests a diachronic change from conservative forms produced by speakers in their 80’s (e.g. Seok-Kyu Lim 2016) to innovative forms for /lp/ and /lk/ produced by speakers in their 20’s (e.g. the present study). Such a change is even more obvious for /ls/, of which evidence is found in orthography. For the noun meaning ‘first birthday’, what had been written as <tols> was revised to <tol> by the Standard Language Rules that were enacted in Korea in 1988. This shows that there was a stark discrepancy between the written form <tols> and the spoken forms not only in isolation /to**ls**/ [to**l**] but also in inflection /to**ls**-i/ [to.**l**i] (i.e. innovative) ‘first birthday-NOM’. These pieces of evidence for the change in progress as well as the synchronic analysis provided in this section support the preference for innovative forms for the “Son. + Obs.” clusters, as opposed to the two other cluster types (i.e. “Obs. + Obs.” and “Son. + Son.”) that favor conservative forms in inflected forms.

7.2 Isolation forms

Variation occurs in inflected forms of nouns in Korean: while conservative forms are fully faithful to the input stem-final clusters, innovative forms are simplified outputs as isolation forms are. Due to the close relation of innovative forms with isolation forms, it is important to address isolation forms first, in order to provide a unified account of innovative forms in the end. This section thus discusses isolation forms of nouns in Korean. It is crucial to note that there is no variation in isolation forms, as opposed to inflected forms. The output consonants that survive obligatory CCS in isolation forms are based on the standard pronunciations from the Great Dictionary of Standard Korean (National Institute of the Korean Language 2022) (footnote 3).

As discussed in Section 3.1, neither the linear order nor the sonority relationship consistently accounts for the different CCS patterns in isolation forms. In this section, I propose a comprehensive analysis that shows the interaction among phonology (Sections 7.2.1 and 7.2.2), phonetics and segmental frequency (Section 7.2.3), and morphology (Section 7.2.4) that determines which consonant is deleted or preserved in the isolation forms of nouns.

7.2.1 Language-specific segmental markedness: /s/-deletion from /ps/, /ks/, and /ls/

CCS obligatorily occurs in isolation forms of Korean nouns. It is the markedness constraint *CC that militates against complex onsets and codas, which is undominated in Korean.

(26) *CC: No complex onsets and codas.

In the clusters that have an /s/ as C_2 (i.e. /ps/, /ks/, and /ls/), it is always /s/ that is deleted in the isolation forms of nouns. An important question to ask is why it is invariably /s/ that undergoes deletion. This is due to language-specific segmental markedness that prohibits /s/ as a coda consonant in Korean (e.g. Kabak and Idsardi 2003). This requires the input stem-final

simplex consonant /s/ to surface as [t] via manner neutralization (e.g. /ko**s**/ [ko**t**] 'place' in contrast to /ko**s**-i/ [ko.**s**i] 'place-NOM'). From a broader perspective, it is in fact not only the particular consonant /s/ but also fricatives in general that are prohibited in coda. In the Korean phoneme inventory, there are three fricatives /s/, /s'/ and /h/, and they are neutralized in coda to the unreleased lenis stop [t] (Young-mee Yu Cho 2016).[8]

(27) *Neutralization of stem-final fricatives in coda*

a. /na**s**/ [na**t**] 'sickle'

b. /hii**h**/ [hi.i**t**] 'the letter /h/'

Prohibition of coda fricatives, regardless of dialect, is in agreement with Whitman (1985), whether or not one agrees to his argument for dialectal variation. I thus propose *FRICCODA, a positional segmental markedness constraint, which is also undominated in Korean.

(28) *FRICCODA: No fricatives syllable-finally.

Deletion of /s/ as a resolution to the consonant clusters /ps/, /ks/, and /ls/ is accounted for by the constraint ranking in which MAX-C-IO is dominated by both *CC and *FRICCODA (29). This is easily predictable since *CC and *FRICCODA are undominated in the language.

(29) *Tableau for clusters with C_2 /s/*

/kaps/ 'price'	*CC	*FRICCODA	MAX-C-IO
a. [kaps]	*! (ps)	* (s)	
☞ b. [kap]			* (s)
c. [kas]		* (s)!	* (p)
d. [ka]			**! (p, s)

The candidates [kaps] (29a) and [kas] (29c) are ruled out by the undominated constraint *FRICCODA. Candidate (29d) [ka] is also ruled out, assuming that MAX-C-IO is a gradient constraint: the more deletion, the worse. Therefore, [kap] is selected as the optimal output for the noun *kaps* 'price' (29b). The same mechanism works for the two other stem-final consonant clusters with C_2 being /s/, /ks/, and /ls/. The constraint ranking for CCS in the isolation forms of nouns, particularly with C_2 /s/, is in (30).[9]

[8] There is no noun stem that ends in the coronal tense fricative /s'/ in Korean (e.g. Albright 2008).

[9] A reviewer raised a question as to why [ka**t**] is not optimal for /ka**ps**/ 'price'. It would tie with [ka**p**] for optimality if we simply considered *FRICCODA. However, in order to select [ka**p**] over [ka**t**], it is crucial that *FRICCODA dominate IDENT-IO(cont): while [ka**p**] satisfies IDENT-IO(cont) because there is identity in continuancy between input /p/ and output [p], [ka**t**] violates it (cf. input: /s/). This ranking consistently accounts for the optimal output forms of noun stems not only with final /Cs/ but also with simplex final /s/ (e.g. /na**s**/ *[na**s**], [na**t**] 'sickle' (27a)).

(30) *CC, *FricCoda >> Max-C-IO (*to be revised*)

7.2.2 Sonority preference in coda: /p/-deletion from /lp/

The CCS pattern of /lp/ is that the more sonorous consonant /l/ remains, while the less sonorous consonant /p/ deletes. That is, it is always [jʌ.tʌ**l**] but not *[jʌ.tʌ**p**] for /jʌtʌ**lp**/ 'eight'. In this regard, I adopt two sub-constraints of *Coda, *Coda(obs) and *Coda(liq), to account for the selection of a higher sonority element in coda (Goodin-Mayeda 2015 based on McCarthy 2002).

(31) *Coda(obs): "No obstruents in coda position."

(32) *Coda(liq): "No liquids in coda position."

It is crucial that *Coda(liq) be dominated by *Coda(obs).

(33) *Tableau for /lp/*

/jʌtʌlp/ 'eight'	*CC	*FricCoda	Max-C-IO	*Coda(obs)	*Coda(liq)
a. [jʌ.tʌlp]	*! (lp)			* (p)	* (l)
☞ b. [jʌ.tʌl]			* (p)		* (l)
c. [jʌ.tʌp]			* (l)	*! (p)	
d. [jʌ.tʌ]			**! (l, p)		

[jʌ.tʌp] (33c) is ruled out because it violates *Coda(obs), which the winner [jʌ.tʌl] (33b) satisfies. Also, [jʌ.tʌ] (33d) loses since it has two violations for Max-C-IO. In order for the ranking to be consistent across clusters throughout the language, it is necessary that *Coda(obs) be dominated by Max-C-IO, which is particularly important to the clusters /ps/ and /ks/ that are discussed in Section 7.2.1. Otherwise, the candidates with no coda consonant at all would survive in isolation, as in *[ka] for /kaps/ 'price' and *[sa] for /saks/ 'wage', which are ill-formed.

(34) *Tableau for /ps/*

/kaps/ 'price'	*CC	*FricCoda	Max-C-IO	*Coda(obs)
a. [kaps]	*! (ps)	* (s)		* (p)
☞ b. [kap]			* (s)	* (p)
c. [kas]		*! (s)	* (p)	
d. [ka]			**! (p, s)	

In sum, the updated constraint ranking for CCS in the isolation forms of nouns in Korean is in (35).

(35) *CC, *FRICCODA > > MAX-C-IO > > *CODA(obs) > > *CODA(liq) (*to be revised*)

7.2.3 Phonetic saliency and segmental frequency: /l/-deletion from /lk/

Unlike the cluster /lp/ for which the sonority preference in coda works, the input cluster /lk/ shows the opposite pattern. That is, the more sonorous consonant /l/ is always deleted, while the less sonorous consonant /k/ is preserved. For example, the noun *talk* 'chicken' is produced in isolation not as *[ta**l**] but as [ta**k**]. Results of previous studies suggest that there is a phonetic reason for the preservation of /k/. Following Jongho Jun's (2004) and Taehong Cho & Sahyang Kim's (2009) velar preference (Section 4.1.1), I propose that the phonetic saliency of the velar obstruent /k/ also plays a role in CCS in the isolation forms of nouns with /lk/.

The hypothesis of velar preference in Korean is also supported by the results of previous studies on segmental frequencies. They show the predominant status of /k/ in frequency. According to Jiyoung Shin's (2010) analysis of phonemes in 47,401 entries in Yonsei Korean Dictionary, /k/ is the most frequent consonant (13.3%) among 19 consonants in Korean, as shown in **Figure 8**.

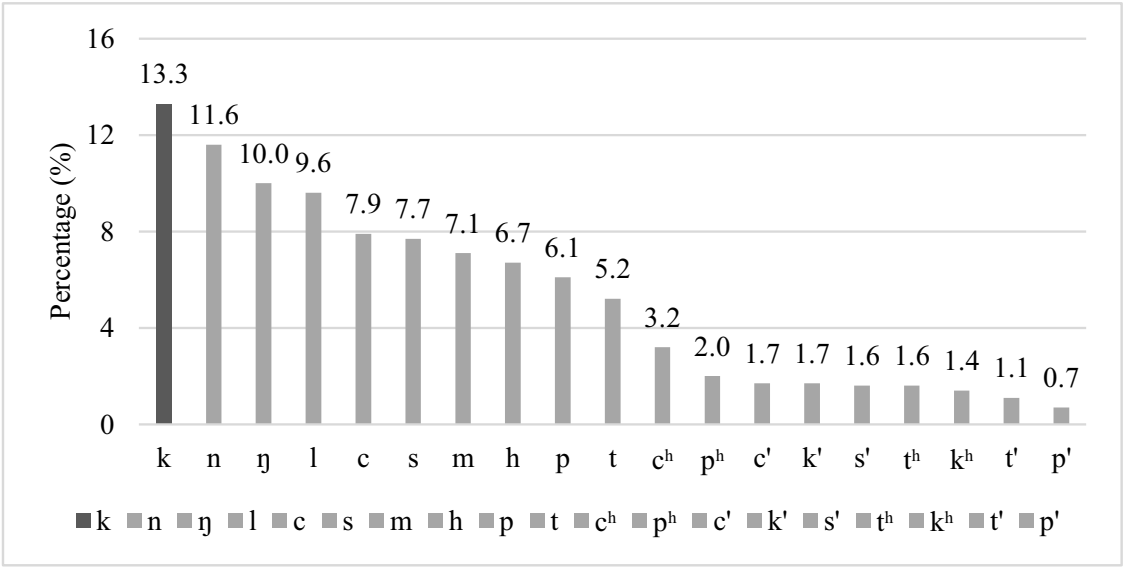

Figure 8: Frequency of 19 consonants in Korean (Jiyoung Shin 2010: 98).

In addition, Jongho Jun (2010) provides the frequency of 14 obstruents that appear in Korean nouns, based on corpus counts and dictionary counts. It is clear that /k/ is by far the most frequent obstruent, as highlighted in **Tables 10, 11**, and **12**.

Labial		Coronal		Velar	
p	1,360	t	1	k	5,994
p^h	64	t^h	113	k^h	18
p’	0	t’	0	k’	6
		c	17		
		c^h	160		
		c’	0		
		s	375		
		s’	0		

Table 10: Corpus counts of 14 output obstruents in Korean nouns. (Jongho Jun 2010: 149 based on Albright 2008: 171 citing Heung-Gyu Kim & Beom-Mo Kang 2000).

Labial		Coronal		Velar	
p	2,515	t	2	k	7,537
p^h	84	t^h	116	k^h	24
p’	0	t’	0	k’	9
		c	18		
		c^h	164		
		c’	0		
		s	308		
		s’	0		

Table 11: Corpus counts of 14 output obstruents in Korean nouns. (Jongho Jun 2010: 149 based on Beom-Mo Kang & Heung-Gyu Kim 2004).

Labial		Coronal		Velar	
p	935	t	4	k	1,234
p^h	96	t^h	184	k^h	17
p’	0	t’	0	k’	10
		c	38		
		c^h	171		
		c’	0		
		s	473		
		s’	0		

Table 12: Dictionary counts of 14 output obstruents in Korean nouns. (Jongho Jun 2010: 149 based on Jaewon You 1985).

On the basis of the prominence of /k/ observed in both phonetic and frequency-based analyses, I propose MAX-k-IO, a more detailed version of anti-deletion constraint, which penalizes deletion of the specific segment /k/.

(36) MAX-k-IO: Input /k/ must have the correspondent [k] in output. ('No /k/-deletion')

The optimal output form of /talk/ 'chicken' is [tak], and it is chosen as the winner in the ranking in which MAX-k-IO dominates *CODA(obs). Between MAX-k-IO and MAX-C-IO, there is no crucial ranking.

(37) *Tableau for /lk/*

/talk/ 'chicken'	*CC	*FRICCODA	MAX-C-IO	MAX-k-IO	*CODA(obs)	*CODA(liq)
a. [talk]	*! (lk)				* (k)	* (l)
b. [tal]			* (k)	*! (k)		* (l)
☞ c. [tak]			* (l)		* (k)	
d. [ta]			**! (l, k)	* (k)		

In sum, the updated ranking for CCS in the isolation forms of nouns in Korean is in (38).

(38) *CC, *FRICCODA >> MAX-C-IO, MAX-k-IO >> *CODA(obs) >> *CODA(liq) (*to be revised*)

7.2.4 Morphology trumps phonology: /l/-deletion from /lm/

As in /lk/, sonority preference is disregarded in /lm/. If it were obeyed, /l/, which is more sonorous than /m/, should be preserved in coda, whereas the nasal should be deleted, as in *[sa**l**] for /salm/ 'life'. However, the optimal output is [sa**m**], which is the opposite to what is expected by the sonority preference approach.

We have so far discussed phonological, phonetic, and frequency-based reasons for CCS in different consonant clusters, but the cluster /lm/ has a unique story of its own: it is morphology that drives CCS for /lm/. There are two noun stems with this cluster, *alm* 'knowledge' and *salm* 'life', and it is necessary to analyze their morphological structure. In fact, these stems are not monomorphemic but bimorphemic, consisting of a verb stem that ends in /l/ followed by the nominal suffix *-m*.

(39) *Morphological structure of alm 'knowledge' and salm 'life'*

a. *al-* $_{\text{verb stem}}$ + *-m* $_{\text{nominal suffix}}$ → *[al-], [a-**m**]
'to know (v.)' 'knowledge (n.)'

b. *sal-* $_{\text{verb stem}}$ + *-m* $_{\text{nominal suffix}}$ → *[sal-], [sa-**m**]
'to live (v.)' 'life (n.)'

Since liquids are more sonorous than nasals, one might predict that they could survive in coda position, following Vennemann (1988). However, the sonority preference in coda is overridden by a stronger morphological requirement that the nominal suffix *-m* be preserved on the surface in order to explicitly show that the syntactic category of the derived form is a noun. For this reason, I argue for the hypothesis that morphology trumps phonology to explain CCS in noun stems with this particular cluster /lm/. The morphological consideration of preserving the derivational suffix can give a unified account even for CCS in tri-consonantal sequences in verbs. For example, when the adjective stem *jalp-* 'thin' is followed by the declarative suffix *-ta* (DEC), three consonants appear consecutively, as in the input /ja**lp** + **t**a/ 'to be thin (DEC)'. Here, variation occurs between /l/ and /p/: the standard suffixed form is [ja**l**.t'a] where /l/ is preserved and /p/ is deleted (40a), while the nonstandard suffixed form is [ja**p**.t'a] where /l/ is deleted and /p/ is preserved (40b) (Taehong Cho & Sahyang Kim 2009). Whichever final consonant is deleted from the adjective stem *jalp-* 'thin', it is notable that the consonantal part of the declarative suffix *-ta* is invariably preserved and never deleted in either of the suffixed forms (i.e. /t/-preservation).

(40) *Morphological structure of jalpta 'to be thin (DEC)'*

jalp- adjective stem	+	*-ta* DEC suffix	→	a. [jal.**t**'a] (standard)
'thin' (adj.)				~ b. [jap.**t**'a] (nonstandard)
				'to be thin (DEC)'

This type of affix phenomenon has been referred to as morpheme realization and studied extensively with constraints, such as Affix Realization (Samek-Lodovici 1992) and REALIZE MORPHEME (RM) (Kurisu 2001). They are faithfulness constraints that require an input affix or morpheme have phonological exponence in output. The requirement for preserving affixes can be roughly explained by the constraint ranking in which AFFIX-FAITH dominates STEM-FAITH (or ROOT-FAITH). This is a kind of violation of the universal "Root-Affix Faithfulness Metaconstraint" (McCarthy & Prince 1994; 1995). This metaconstraint states that the ranking ROOT-FAITH over AFFIX-FAITH must be universally fixed since roots are always unmarked compared to affixes. McCarthy & Prince's (1994; 1995) focus was on the correspondence relation in reduplication in which the dominance of roots over affixes is exerted, but it is in fact acknowledged that the ranking ROOT-FAITH over AFFIX-FAITH can be overridden by a higher-ranked constraint, as in the hypothetical example /pati-a/ [pata].

Going back to the cluster /lm/ in Korean, the preservation of *-m*, which is morphologically an affix (i.e. nominal suffix), is also the case of violating the universal "Root-Affix Faithfulness Metaconstraint". In order to state this, I use a modified version of the constraint RM for /lm/ based on Kurisu (2001).

(41) REALIZEMORPHEME (RM) (based on Kurisu 2001 and modified): Input affix has phonological exponence in output.

Deleting /m/ from the cluster /lm/ violates RM since it is a deletion of the entire morpheme (i.e. nominal suffix *-m*), while deleting a segment of a morpheme that consists of multiple segments does not violate RM. RM contrasts with *CODA(nas) (Goodin-Mayeda 2015 based on McCarthy 2002).

(42) *CODA(nas): "No nasals in coda position."

It is predicted that *CODA(nas) dominates *CODA(liq), based on the sonority hierarchy (10). It is crucial that RM dominate *CODA(nas) in order to rule out *[sa**l**] but to choose [sa**m**] for the isolation form of /sa**l**-**m**/ 'life'. The ranking of RM in relation to *CODA(obs) is not crucial.

(43) *Tableau for /lm/*

/sal-m/ 'life'	*CC	*FRIC CODA	MAX-C-IO	MAX-k-IO	*CODA(obs)	RM	*CODA(nas)	*CODA(liq)
a. [salm]	*! (lm)						* (m)	*(l)
b. [sal]			* (m)			* (m)		*(l)
☞ c. [sam]			* (l)				* (m)	
d. [sa]			**! (l, m)			* (m)		

To summarize this section, CCS that occurs in the isolation forms of nouns in Korean is a complicated phenomenon that necessitates a comprehensive analysis involving interactions among phonology, phonetics, frequency, and morphology. The finalized ranking for CCS is in (44).

(44) *CC, *FRICCODA >> MAX-C-IO, MAX-k-IO >> *CODA(obs), RM >> *CODA(nas) >> *CODA(liq)

7.3 Non-dominant innovative forms in inflection: in relation to isolation forms

In order to account for non-dominant innovative forms in Korean nominal inflection, isolation forms should be referred to, since the very consonant that survives in an isolation form also appears in corresponding innovative forms. For example, the isolation form of the noun /kaps/ 'price' is [ka**p**], and the inflected form /kaps-i/ 'price-NOM' can be either [ka**p**.**s**i] (conservative) or [ka.**p**i] (innovative) but not *[ka.**s**i], which is ungrammatical because there is no isolation form like *[ka**s**]. This is the gist of Kenstowicz's (1996) Base-Identity effect. Otherwise, CCS in innovative forms might seem opaque, as Jin-hyung Kim (2005) points out (Section 4.1). Heejeong Ko (2006) argues for the Base-Output Correspondence Theory, following Kager (1999). Similarly, by adopting Kenstowicz's (1996) BASE-IDENTITY constraint, which is one kind of segmental

output-output correspondence constraint, I show in this paper that isolation forms are the Base to which innovative forms in inflection make reference.

(45) BASE-IDENTITY (taken from Kenstowicz 1996 and modified): Given an isolation form (i.e. Base) [X], output candidates of inflected forms must have segments that are identical to the segments in the isolation form (i.e. segmental identity).

BASE-IDENTITY requires the consonants in innovative inflected forms be segmentally identical to those in isolation forms (i.e. Base). In other words, it states that inflected forms should be equal to the structure "isolation form + inflectional suffix". Therefore, a violation mark should be given if any consonant in an inflected form does not have a segmental correspondent in the isolation form. BASE-IDENTITY is vacuously satisfied when selecting the optimal output of nouns in isolation because there is no Base for isolation forms to refer to.

(46) *Tableau for isolation forms*

/kaps/ 'price'	*CC	*FRICCODA	BASE-IDENTITY	MAX-C-IO
a. [kaps]	*(ps)!	*(s)		
☞ b. [kap]				* (s)
c. [kas]		*(s)!		* (p)
d. [ka]				**! (p, s)

While BASE-IDENTITY is not in effect for isolation forms, it is important in the selection of the optimal output of innovative forms in inflection.

(47) *Tableau for innovative forms in inflection*

/kaps-i/ 'price-NOM' (Base (isolation): [kap])	*CC	*FRICCODA	BASE-IDENTITY	MAX-C-IO
a. [kap.si]			*(s)!	
☞ b. [ka.pi]				* (s)
c. [ka.si]			*(s)!	* (p)
d. [ka.i]				**! (p, s)

Candidates (47a) [ka**p**.**s**i] and (47c) [ka.**s**i] are ruled out because they violate BASE-IDENTITY. These two candidates lose since [s] does not make reference to the final consonant in the isolation form [ka**p**]. Since candidate (47b) [ka.**p**i] satisfies BASE-IDENTITY by having [p] in the inflected form as well as in the isolation form [ka**p**] at the expense of deleting /s/, it is the optimal output for innovative inflection.

The effect of the constraint BASE-IDENTITY is in line with Steriade's (2000) principle of *Lexical Conservatism*, which states that novel forms must find a precedent in a listed form. The existing isolation form [ka**p**] 'price' is the precedent in our case, and for this reason, [ka.**p**i] is selected for 'price-NOM'. On the other hand, *[ka.**s**i] and *[ka**p**.**s**i] are ruled out because there is no listed isolation form *[ka**s**] or *[ka**ps**] in Korean. (cf. For the constraint ranking that selects conservative forms as an optimal output form, see Section 7.1.)

The constraint rankings established for dominant inflected forms (either conservative or innovative), isolation forms, and non-dominant innovative inflected forms are summarized in (48).

(48) Final constraint rankings

a. Dominant inflected forms (Section 7.1)
AGREE(son) >> MAX-C-IO >> NOCODA >> SYLLCON

b. Isolation forms (Section 7.2)
*CC, *FRICCODA >> MAX-C-IO, MAX-k-IO >> *CODA(obs), RM >> *CODA(nas) >> *CODA(liq)

c. Non-dominant innovative forms (Section 7.3)
*CC, *FRICCODA, BASE-IDENTITY >> MAX-C-IO

The final constraint rankings are consistent with the rest of Korean phonology. First, (48a) holds for Korean nasalization and lateralization. (See footnote 6.) Second, (48b) also works, particularly in that *CC and *FRICCODA are undominated in Korean, and high sonority codas are universally preferred (Vennemann 1988) (i.e. *CODA(obs) >> *CODA(nas) >> *CODA(liq)). Lastly, the ranking in which BASE-IDENTITY dominates MAX-C-IO accounts for non-dominant innovative forms (e.g. /kaps-i/ [ka.pi]>[kap.si]) (48c). This is consistent with other parts of Korean, such as verbal inflection, since BASE-IDENTITY is vacuously satisfied in that case due to the lack of isolation forms for verb stems. (See Section 2.)

7.4 Notes on non-significant factors

Experimental results show that, in contrast to "clusters", the other three predictors "suffixes", "dialects", and "gender" were not statistically significant. First, some studies have suggested a relationship between vowel-initial inflectional suffixes and surface forms of stem-final consonants. Jongho Jun & Jeehyun Lee (2007) and Jongho Jun (2010) show that suffixes of different vowel qualities *-i*, *-il*, and *-ɛ* have an impact on variation in stem-final coronal obstruents /s, t, t^h, c, c^h/ in Korean. They ascribe this to a frequency effect: [c^h] occurs frequently before *-i* and *-il*, while [t^h] before *-ɛ* in Korean, which results in the preference for a particular output consonant before different vowel-initial suffixes. However, as for variation in stem-final consonant clusters, we observed that vowel-initial inflectional suffixes had no significant effect on conservative

forms and innovative forms in Korean nominal inflection. As a reviewer suggested, I ascribe this to the nature of consonant clusters, as opposed to the nature of simplex coronal obstruents. The frequency-based analysis works for variation in coronal obstruents since the speakers' job is to choose the quality of the output consonants among [s, t, t^h, c, c^h] that occurs frequently before a particular vowel. In other words, their decision is based on the extension of dominant patterns in the language to this particular phenomenon. On the other hand, speakers undergo a different kind of decision process for variation in consonant clusters: it is either conservative with two consonants or innovative with one consonant. More importantly, the quality of output consonants in innovative forms is not something that speakers can choose: it is predetermined in isolation forms and extended to innovative forms due to the Base-Identity effect. Thus, it makes no sense that some output consonants prefer some suffixes since the former in our case are preset for consonant clusters.

Second, another factor that was of interest to previous researchers is speakers' regional dialects. There might have been a dialectal difference between Seoul Korean and Kyungsang Korean at least until early to mid 1990's (e.g. Whitman 1985; Young-mee Yu Cho 1988; Mira Oh 1994). However, this study shows that there is no such difference among younger speakers of Korean. Even though there used to be dialectal variation in the past, it is likely that it has been diminished over time. Although discussing a different topic, Jongho Jun & Jeehyun Lee (2007) mention that their participants who were from the North Kyungsang area and in their 20's had been exposed to standard Seoul Korean via the mass media, consequently showing patterns that were similar to Seoul speakers. This can also be a plausible account for the lack of dialectal variation for consonant clusters in nominal inflection.

Lastly, there was no significant difference between male speakers and female speakers in the variants surfacing stem-final consonants, either conservative or innovative. What was expected from Labov's (1990) Principle I is that male speakers would use more innovative forms in which one of the two consonants was dropped, whereas female speakers would favor conservative forms in which both consonants were preserved. However, results of the production experiment did not turn out to be so in this study. This suggests that, for the younger generation in Korea, male and female speakers do not show a significant difference in variation in nominal inflection.

8 Conclusion

In this paper, I have investigated variation in stem-final consonant clusters in Korean nominal inflection and the consonant quality involved in CCS in isolation forms, which have been puzzles in phonology. Responding to these gaps, I have shown that the phenomena involved with consonant clusters in Korean are not simple but multi-faceted. To be specific, I have provided a comprehensive analysis that subsumes two forms in inflection (conservative and innovative) and isolations forms (in relation to innovative forms, following Kenstowicz 1996) at the same time by

examining interactions among various linguistic components of phonology, phonetics, segmental frequency, and morphology.

It is notable that younger speakers of Korean are actively creating new words with a final consonant cluster: *nalm* (the name of a main character of the online comic strip "The life story of Nalm"), *pwɛlk* (an exclamation of not being in a good mood), and *olk-olk* (onomatopoeia of a barking dog in the YouTube channel "RuPong house"). This indicates that consonant clusters are real and active in Korean speakers' grammar, which rejects the possibility of leveling in underlying forms from /CC/ to /C/. In this regard, for future research, it will be meaningful to conduct a production experiment with nonce words with a consonant cluster in order to examine whether the generalizations and implications found in the present study are extended to new words in Korean. This will further broaden our perspectives on the typology of consonant clusters in general.

Abbreviations

ACC = accusative, C = consonant, DAT = dative, DEC = declarative, LOC = locative, NOM = nominative, PRES = present, TOP = topic

Additional file

The additional file for this article can be found as follows:

- **Supplementary file.** Experimental sentences. DOI: https://doi.org/10.16995/glossa.5784.s1

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Competing Interests

The author has no competing interests to declare.

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