Statistical patterns in consonant cluster simplification in Seoul Korean: Within-dialect interspeaker and intraspeaker variation

Taehong Cho* · Sahyang Kim**

ABSTRACT

This study examines how young speakers of Seoul Korean produce tri-consonantal clusters /lkt/ and /lpt/ as in *palk-ta* ('to be bright') and *palp-ta* ('to step on'). Production data were collected from 20 speakers of Seoul Korean. The results of narrow transcription of the data showed that simplification is not obligatory as some speakers often preserve all three consonants. When simplified, there was a clear asymmetry between /lkt/ and /lpt/. Speakers showed no clear preference for either C1 preservation (C1=/l/) or C2 preservation (C2=/k/ in /lkt/ and /p/ in /lpt/) in production of /lkt/, but in production of /lpt/, strong preference was found for C1-preserved to C2-preserved variant. When compared with production data in Cho (1999), simplification patterns appear to have changed over the past 10 years, in a direction to preserve the first member of the cluster (/l/) more often, especially with /lkt/. There was no substantial between-item variation, indicating that simplification patterns are not lexically specified. Finally, the results suggest that the process of tri-consonantal simplification has not been fully phonologized in the grammar of the language as evident in substantial inter- and intra-speaker variation.

Keywords: consonant cluster simplification, frequency of occurrence, statistical patterns, Korean, intra-speaker variation, inter-speaker variation

1. Introduction

In Korean, occurrence of consonant clusters is phonotactically constrained. For example, two consonants may occur underlyingly in coda position, but they are realized as a single consonant, unless otherwise followed by a vowel-initial morpheme (e.g., *kaps* [kap] 'price' but *kaps-i* [kapʃi] 'price-Nominative'). When three consonants occur due to morpheme concatenation (e.g., *kaps-to* 'price-too'), either the first or the second member of the cluster is deleted. The occurrence of one of the two variants is known to be dependent on the type of consonant sequence or dialect (e.g., Kim-Renaud 1974, Cho 1990).

In Seoul Korean, there are two groups of tri-consonant clusters that show obligatory simplification: The first group of clusters undergoes simplification by deletion of the first consonant (e.g., *ko{l}m-ta,* 'to pester-DEC', *ku{l}m-ta,* 'to skip food-DEC', where '{}' refers to a deleted underlying segment and DEC means declarative), and the second group by deletion of the second consonant (e.g., *kap{s}-to*, 'price-too', *an{tʃ}-ta*, 'to sit-DEC, *hal{t^h}ta*, 'to lick-DEC). The simplification applies to these two types systematically, such that little variation occurs among speakers (e.g., Kim-Renaud 1974).

There are, however, a third group of consonant clusters (i.e., /lkt/ and /lpt/) that are produced in a more complex way. According to impressionistic observations by Korean linguists (e.g., Kim-Renaud 1974, Cho 1990, Iverson & Lee 1994, Jun 1998, Martin 2006), simplification of /lkt/ and /lpt/ is optional, so that all three consonants may be kept or either the first consonant (C1: /l/) or the second consonant (C2: /k/ or /p/) may be deleted. But whether C1 or C2 is deleted is phonologically determined, which is conditioned by the identity of the second consonant (/k/ vs. /p/), as shown in (1).

(1) a. /lkt/ → [{l}kt] or [lkt]
(e.g., *ilk-ta* 'to read-DEC', *malk-ta* 'to be clear-DEC')
b. /lpt/ → [l{p}t] or [lpt]
(e.g., *jalp-ta* 'to be thin-DEC', *tʃ*alp-ta* 'to be short-DEC')

As in (1a), C2 is preserved when it is /k/, but as in (1b), C1 (/l/) is preserved when C2 is /p/ (e.g., Kim-Renaud 1974, Cho 1990, Iverson & Lee 1994, Jun 1998). Furthermore, according to the regulations of the Standard Pronunciation of Korean (The National Institute of the Korean Language. *Dictionary of Standard Korean* (국립국어원 표준국어대사전)), a tri-consonantal cluster must be simplified as in (1), but for /lpt/, some lexical items such as *palp-ta* 'to step-DEC' should be pronounced as *pa{l}p-ta*, which is an exception to the general simplification pattern of [l{p}t].

In a production study, Cho (1999) has examined simplification

*Hanyang University, tcho@hanyang.ac.kr
**Hongik University, sahyang@hongik.ac.kr, corresponding author
This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD, Basic Research Promotion Fund) (KRF-2007-327-A00312).
received: February 8, 2009
revision received: March 9, 2009
accepted: March 15, 2009

patterns of tri-consonantal clusters. The relative frequency distribution of three variants (C1-preserved, C2-preserved, C1&C2-preserved) reported in his study is shown in Figure 1. The general findings were that for /lkt/, it was C2 (/k/) that was more likely preserved (47% of {l}kt), but for /lpt/, it was C2 (/p/) that was *least* likely preserved (12% of {l}pt). C1&C2-preserved variants also occurred (27% for /lkt/ and 31% for /lpt).

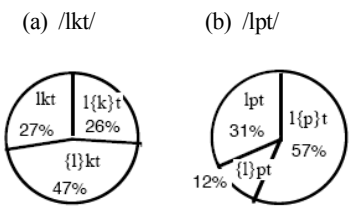

Figure 1. Frequency of three variants of tri-consonant cluster simplification for /lkt/ and /lpt/ (from Cho, 1999).

Cho's (1999) study was based on production data collected from 8 Seoul speakers who were 28 to 36 years old back then. Since then, no production data have been available that could capture how contemporary young speakers resolve tri-consonantal clusters. Building on Cho's study, the present study further addresses questions with respect to inter- and intra-speaker variation by looking at relatively large production data of 20 young speakers of Seoul Korean with 14 lexical items.

Our first question is how simplification process of the tri-consonantal clusters is conditioned by the identity of C2 (viz., whether it is /k/ or /p/ (/lkt/ vs. /lpt/)). The phonological specification of C2 preservation as in (1) (i.e., /k/ is preserved but /p/ is deleted in C2 position) is in line with cross-linguistic tendency: velars undergo phonological alteration less often than labials (Jun 2004). As illustrated in Figure 1, Cho (1999) has shown that C2 deletion in Korean indeed occurs less frequently when C2 is velar (/k/) than when it is labial (/p/). This has been interpreted as reflecting the role of perceptual robustness in speech production: Velars are perceptually more salient than labials because of the compactness (e.g., Jacobson, Fant & Halle 1963, Stevens 1989) and convergence of F2 and F3 in a neighboring vowel; therefore, all else being equal, speakers prefer to preserve the perceptually stronger velars for the listeners' benefit (Jun 1995, 2004, Cho 1999; cf. Kohler 1990, 1991, Steriade 1993, Byrd 1994). Under this production hypothesis, the present study is expected to confirm that /k/ will be preserved more often than /p/.

Sohn (1999) casually noted that some young speakers may prefer to preserve both C1 and C2, implying inter-speaker variation. Cho's study concluded that speakers indeed differed, but his work simply highlighted intra-dialect variation without reporting production patterns of individual speakers. Our second question is then how young speakers of the same dialect (Seoul Korean) differ in producing tri-consonantal sequence. This question may be considered from the phonological point of view. If the patterns given in (1) have been phonologized in the language as suggested by some phonologists (Kim-Renaud 1974, Cho 1990, Iverson & Lee 1994, Jun 1998), only two variants will be produced for each cluster type: /{l}kt/~/lkt/ or /l{p}t/~/lpt/. There will then be neither /k/-deleted variant of /lkt/ nor /l/-deleted variant of /lpt/ as these variants are not phonologically specified. Under this hypothesis, speakers will differ only in terms of the relative frequency of occurrence of the two phonological viable variants for each cluster type. In connection with inter-speaker variation, we also examine intra-speaker variation—i.e., how consistent the simplification process is within a speaker. Again, if the process is phonologized within the grammar of each speaker, only the two phonologically viable variants should be produced.

Finally, we examine how consistent simplification process is between lexical items. Cho (1999) has included just two lexical items for each consonant type in his study, so that it is not clear whether simplification occurs across the board between lexical items. While phonology assumes no variation between lexical items, the Standard Pronunciation of Korean regulates that some lexical items (e.g., *palp-ta* → *pa{l}p-ta* 'to step on') pattern differently from other /lpt/-bearing lexical items, indicating the possibility that simplification pattern is lexically specified. If the simplification pattern is lexically specified irrespective of the phonological content, the simplification patterns will differ systematically even among words that share the same cluster. We will test this by examining how the specific lexical item *palp-ta* is simplified as compared to other /lpt/-bearing lexical items such as *tʃ*alp-ta* ('to be short').

2. Data Acquisition

2.1 Participants

Twenty undergraduate students (ten male and ten female) from Hanyang University in Seoul were paid for their participation. They were all native speakers of Seoul Korean who were born and raised in the Seoul metropolitan area.

2.2 Speech materials

Eight /lkt/-bearing words and six /lkp/-bearing words were selected as test words. The basic forms of the test words are given in (2) and (3):

(2) /lkt/ (8 /lkt/-bearing words)

a. (읽다) ilk-ta ('to read') b. (맑다) malk-ta ('to be clear')
c. (긁다) kulk-ta ('to be thick') d. (밝다) palk-ta ('to be bright')
e. (긁다) kilk-ta ('to scratch') f. (늙다) nilk-ta ('to get old')
g. (묽다) mulk-ta ('to be diluted') h. (붉다) pulk-ta ('to be red')

(3) /lpt/ (6 /lpt/-bearing words)

a. (밟다) palp-ta ('to step on') b. (떫다) t*əlp-ta ('to be bitter')
c. (넓다) nəlp-ta ('to be wide') d. (얇다) jalp-ta ('to be thin')
e. (짧다) tʃ*alp-ta ('to be short') f. (엷다) jəlp-ta ('to be light/pale')

The words in (2) and (3) are morphologically complex in that they are composed of verbal or adjectival stems and a suffix '-ta.' The actual production data were obtained in a full frame sentence as given in (4):

(4) [contextual word] + [test word] + [*sangkwanəpsə*]
not^{h}i-lil *il**k-t**əlato* *sangkwanəpsə*
'notebook'-Acc 'read'-although 'I don't care'
'Although someone reads the notebook, I don't care'

As shown in (4), the frame sentence consists of a contextual word (before the test word), a morphologically complex test word and a fixed phrase *sangkwanəpsə* ('I don't care'). The full list of test words and their corresponding contextual words is given in Table 1. In addition to test sentences, fourteen filler sentences with no tri-consonantal sequences were constructed (e.g.,*kamtəlato*) to reduce a possible bias.

Table 1. List of cluster-bearing test words in a clause

(a) /lkt/-bearing two-word phrases	
(읽다) *not^{h}i-lil il**k-t**əlato*	'although reading the notebook'
(맑다) *koŋki-ka ma**lk-t**əlato*	'although the air is clear'
(굵다) *kituŋ-i ku**lk-t**əlato*	'although the pillar is thick'
(밝다) *tʃomjəŋ-i pa**lk-t**əlato*	'although the light is bright'
(긁다) *kaljəwə ki**lk-t**əlato*	'although scratching, because it's itchy'
(늙다) *əntʃen-ka ni**lk-t**əlato*	'although (we) get old some day'
(묽다) *noŋto-ka mu**lk-t**əlato*	'although the concentration is diluted'
(붉다) *noil-i pulk-təlato*	'although the sky is red'
(b) /lpt/-bearing two-word phrases	
(밟다) *kutu-lo pa**lp-t**əlato*	'although stepping (on it) with the shoes'
(떫다) *tʃatu-ka t*ə**lp-t**əlato*	'although the plum is bitter'
(넓다) *sija-ka nə**lp-t**əlato*	'although the view is wide'
(얇다) *tuk*e-ka ja**lp-t**əlato*	'although the thickness is thin'
(짧다) *tʃ^{h}ima-ka tʃ*a**lp-t**əlato*	'although the skirt is short'
(엷다) *pitʃ^{h}k*al-i jə**lp-t**əlato*	'although the color is light (pale)'

Note: The basic forms of cluster-bearing words are provided in parenthesis in Korean; '*' refers to the fortis (tensed) consonant.

2.3 Procedures

Before the recording session, speakers were trained to recover the test words through contexts. The purpose of having such a training session was to minimize potential orthographic influence on speaker's production during the recording session.

In the training session, speakers were first presented with a contextual word (e.g., *not^{h}i,* 'notebook') visually on a computer screen. The contextual words were semantically related to the cluster-bearing test word (e.g., *not^{h}i,* 'notebook' and *ilk-ta,* 'to read'). Immediately after the visual presentation of the contextual word, the test word appeared on the screen. Speakers were then asked to combine the two words to form a basic declarative sentence (e.g., *not^{h}i-lul ilkta*, 'to read a notebook'). This procedure was performed with 14 test words and 14 filler words. Speakers had to go through the entire list (with different orders) several times until they were fully confident about collocating the contextual and the test words. The training session continued for 20-30 minutes.

During the actual recording session, speakers were told that they had to make a full sentence using the frame in (4). They were then prompted aurally just with a contextual word (e.g., *not^{h}i,* 'notebook') which was spoken by an experimenter. Given the training session, speakers were able to produce its corresponding clause naturally with the aural prompt alone.

Each speaker repeated 14 test word-bearing sentences along with additional 14 filler-bearing sentences twelve or thirteen times in randomized order. The multiple repetitions were made in order to observe intra-speaker variability. This yielded a total of 3375 test sentences for data transcription (14 cluster-bearing words x 20 speakers x 12-13 repetitions).

2.4 Data transcription

The tri-consonantal portions of the obtained data were transcribed by two trained Korean phoneticians. Out of 3375, 24 mispronounced tokens were eliminated, giving 3351 sentence tokens for further analyses. The transcription was made with three possible options: C1-preserved (/l{k}t/, /l{p}t/), C2-preserved (/{l}kt/, /{l}pt/) and C1&C2-preserved (/lkt/, /lpt/). Out of 3351, 3250 tokens reached agreement by the two transcribers, showing reliable (97%) inter-transcriber agreement. The disagreement was mostly on whether both /l/ and the following C are preserved (i.e., C1&C2-preserved) or only /l/ is preserved (i.e., C1-preserved). These remaining 101 tokens (3%) were further checked by four graduate students of phonetics. The final decision for each of the 101 tokens was made between the two possibilities (i.e., C1-preserved and C1&C2-preserved), only when four out of six transcribers (two original and four additional) reached an agreement. In this way, further 70 tokens were included, yielding 3320 tokens (3250+70) for analyses. It should be noted here that subtle differences which may exist in the data could not be observable nor identifiable in spectrograms.

2.5 Statistical Analyses

The frequency of occurrence for each variant (C1-preserved, C2-preserved, C1&C2-preserved) was first calculated for each test word by each speaker. They were then grouped into two main factors: C2 Type (/lkt/ vs. /lpt/) and Simplification Pattern (C1-preserved, C2-preserved, C12-preserved). In order to examine how tri-consonantal simplification is conditioned by C2 type, the obtained frequency scores were submitted to Repeated Measures

ANOVAs. Both by-subjects and by-items analyses were carried out to evaluate how much observed patterns could be generalized across the speaker and the item (test word). Between-speaker and between-item variations were then examined qualitatively based on mean values for conditions.

3. Results

3.1 Overall patterns pooled across speakers and items

The results with data pooled across speakers and items showed that all three variants occurred with different frequencies of occurrence, showing the pattern of C1-preserved (50.8%) > C1&C2-preserved (31.4%) > C2-preserved (17.8), as shown in Figure 2a. When C1-preserved and C1&C2-preserved conditions were combined, the frequency of tokens that preserved C1 was 82.2%, showing a strong tendency to preserve the first consonant /l/, regardless of whether C2 is preserved or not.

Repeated measures ANOVAs, however, revealed that Simplification Pattern interacted with C2 Type (F1[2,38]=7.84, $p<0.001$; F2[2,24]=14.05, $p<0.001$). The interaction stemmed mainly from the fact that the frequency of C2-preserved tokens varied with C2 Type—i.e., whether C2 was /k/ or /p/. As shown in Figure 2b, there was a clear asymmetry between /lkt/ and /lpt/. For /lkt/, C2 (/k/) was preserved with frequency of 30.9%, but for /lpt/, only 4.7% of C2(/p/)-preserved tokens were observed. Put differently, in C1-preserved condition, the difference between /l{k}t/ and /l{p}t/ (44.6% vs. 57.0%) was only marginal (diff. 12.4%, t1(19)=-1.88, $p<0.075$; t2(12)=-2.19, $p<0.05$), but the difference between /{l}kt/ and /{l}pt/ was large and significant in C2-preserved condition (30.9% vs. 4.7%, diff. 26.2%, t1(19)=4.00, $p<0.001$; t2(12)=4.600, $p<0.001$).

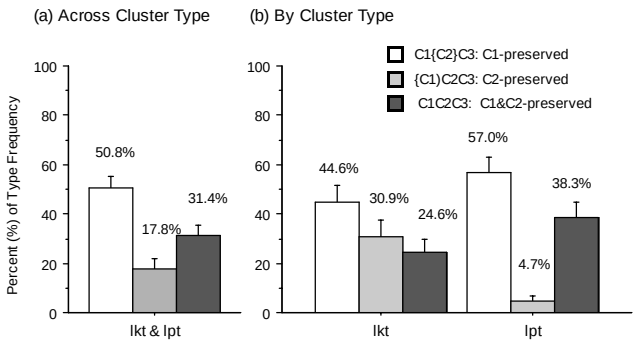

Figure 2. Overall patterns of consonant cluster simplification as a function of C2 Type (/k/ vs. /p/).

3.2 Inter-speaker variation

The effects of C2 Type on cluster simplification, however, was not consistent across speaker. Figure 3 illustrates inter-speaker variation with distribution of speakers along the frequency continuum. The most striking inter-speaker variation was found in C1-preserved condition (Figure 3a, 3b) where speakers were distributed quite evenly on the frequency continuum. For /lkt/, some speakers rarely preserved /l/ (with 3 speakers showing less than 10%), others preserved it about 50% of the time (4 speakers), and still others preserved it most of the time (2 speakers with more than 90%) (Figure 3a). A similar distribution was found for /lpt/ (Figure 3b) in C1-preserved condition as well as for /lkt/ in C2-preserved condition (Figure 3c). Speakers also differed in how often they preserved both C1 and C2 (Figure 3e-f).

However, there was one clear pattern consistent across speakers. As can be seen in Figure 3d, most speakers seldom produced /{l}pt/ with /p/ preserved, and a closer look at the data shows that each and every speaker indeed preferred to preserve C1 (/l/).

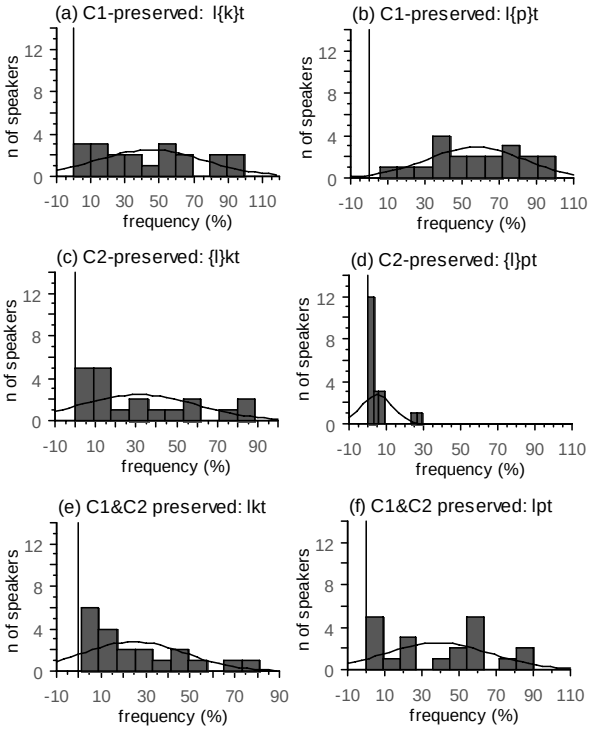

Figure 3. Inter-speaker variation of consonant cluster simplification as a function of C2 Type (/k/ vs. /p/).

3.3 Intra-speaker variation

In order to determine the extent to which both /C1{C2}C3/ (C1-preserved) and /{C1}C2C3/ (C2-preserved) are produced within a speaker, each speaker's frequency data were considered with C1&C2-preserved tokens excluded. Table 2 shows distribution of speakers who produced both C1-preserved and C2-preserved tokens for each cluster type. (See Appendix for the entire data.) For /lkt/, 13 out of 20 speakers produced both C1-preserved (/l{k}t/) and C2-preserved (/{l}kt/) variants with 10% ~ 19% of frequency. Five speakers produced both with 20% ~ 29% of frequency, and three speakers with 30% or higher. For /lpt/, 15 speakers produced both C1-preserved (/l{p}t/) and

C2-preserved (/{l}pt/) variants with 10% ~ 19%; 12 speakers with 20% ~ 29%; and 8 speakers with 30% or higher. However, there were some speakers who consistently produced one type of variant. Strong preference (more than 90% of frequency) for one variant type over the other was found for seven speakers with /lkt/ and five speakers for /lpt/. Taken together, quite a few speakers showed no phonologized simplification pattern for a particular variant while only a few speakers showed fixed phonological patterns of simplification.

Table 2. Distribution of speakers who produce both C1-preserved and C2-preserved tokens with at least 10% or higher frequency of occurrence for each variant (C1&C2-preserved tokens excluded).

type	*n* of speakers 10% ~ 19%	*n* of speakers 20% ~ 29%	*n* of speakers 30% ~	total *n* of speakers (10% ~)
/lkt/	8	2	3	13
/lpt/	3	4	8	15

Table 3. Production frequencies (%) of three variants for each test word. (Values in parenthesis indicate the number of tokens.)

Type	Test Words	C1-preserved	C2-preserved	C1&C2-preserved
/lkt/	ilk-ta	48.1% (112)	21.9% (51)	30% (70)
	malk-ta	54.6% (131)	19.6% (47)	25.8% (62)
	kulk-ta	43.4% (102)	39.1% (92)	17.4% (41)
	palk-ta	65.4% (157)	14.6% (35)	20% (48)
	kilk-ta	26.8% (64)	54% (129)	19.2% (46)
	nilk-ta	34.6% (82)	40.5% (96)	24.9% (59)
	mulk-ta	41.7% (98)	30.6% (72)	27.7% (65)
	pulk-ta	42.3% (101)	26.4% (63)	31.4% (75)
/lpt/	palp-ta	49.8% (119)	11.3% (27)	38.9% (93)
	t*əlp-ta	70.5% (167)	1.7% (4)	27.8% (66)
	nəlp-ta	61.4% (145)	0% (0)	38.6% (91)
	jalp-ta	51% (122)	4.6% (11)	44.4% (106)
	tʃ*alp-ta	60.2% (145)	0% (0)	39.8% (96)
	jəlp-ta	49.6% (114)	10.9% (25)	39.6% (91)

3.4 Between-item variation

Frequency distribution of all three variants for each test word was analyzed in order to examine whether the observed general pattern (i.e., no strong preference for one variant type over the other for /lkt/; a strong preference for C1-preserved tokens for /lpt/) was consistent across item. Production frequencies of all three variants for each test word are given in Table 3. As can be inferred from the table, there was no striking between-item variation for both /lkt/ and /lpt/, but there are some points worth addressing. First, for /lkt/, two lexical items *malk-ta* and *palk-ta* showed relatively strong preference for C1-preservation (/l{k}t/) over C2-preservation (/{l}kt/) (54.6% vs. 19.6% for *malk-ta* and 65.4% vs. 14.6% for *palk-ta*). On the other hand, for the lexical item *kilk-ta* the opposite was true (26.8% for /l{k}t/ vs. 54.0% for /{l}kt/). Second, for /lpt/, all lexical items showed strong preference for C1-preservation (/l{p}t/), including the item *palp-ta* which is prescribed to be pronounced with C2 preservation. Four out of six items showed less than 5% of production frequency for C2 preservation (/{l}pt/). The remaining two items (*palp-ta* and *jəlp-ta*) showed occurrence frequencies that are slightly higher than 10% with C2-preserved tokens (11.3% and 10.9%, respectively), but still there was a strong preference for C1-preservation.

4. Summary and Discussion

4.1 Summary

In this study, we have examined how young speakers of Seoul Korean produce tri-consonantal clusters /lkt/ and /lpt/. The results are recapitulated as follows.

First, speakers often simplified the clusters by deleting either the first or the second member of the cluster, but they also preserved all three consonants 31.4% of the time.

Second, there was an asymmetry in simplification patterns between /lkt/ and /lpt/. For /lkt/, speakers deleted either the first consonant (/l/) or the second consonant (/k/), showing no strong preference for either case. But for /lpt/, speakers showed strong preference to preserve the first consonant (/l/), frequently deleting the second consonant (/p/).

Third, when C1-preserved and C1&C2-preserved variants were combined, about 82% of tokens showed preservation of the first consonant /l/.

Fourth, there was inter-speaker variation. Speakers differed in terms of which member of the cluster was preserved, regardless of whether the second consonant was /k/ or /p/. The only consistent pattern was found in that all speakers showed a strong preference to preserve /l/ over /p/ in simplifying /lpt/.

Fifth, there was intra-speaker variation. About 70% of speakers produced both C1-preserved and C2-preserved variants for each cluster type: 15 out of 20 speakers (75%) produced both variants for /lkt/ and 13 speakers (65%) for /lpt/.

Sixth, the simplification patterns found across speaker were by and large consistent across test word, showing no substantial between-item variation. One noteworthy difference is that for /lkt/ speakers tended to preserve /l/ more often than /k/ with lexical items *palk-ta* ('to be bright') and *malk-ta* ('to be clear'), but they tend to preserve /l/ less often than /k/ with *kilk-ta* ('to scratch').

Seventh, the lexical item *palp-ta*, which was prescribed to be pronounced as [pa{l}p-ta] by the Standard Pronunciation of Korean, patterned with other /lpt/-bearing lexical items, showing a

strong preference for /l{p}t/.

4.2. General Discussion

Our first question was whether /k/ would be more frequently preserved than /p/ (relative to /l/ preservation). Cho (1999) showed that for /lkt/, it was /k/ that was preserved more often than /l/, but for /lpt/, it was /l/ that was preserved more often than /p/. Cho interpreted this asymmetry as attributable to differential perceptual robustness associated with /k/ versus /p/, following Jun (2004). The hypothesis is that speakers tend to preserve /k/ more often for the listeners' benefits from its perceptual robustness. The present study, however, does not appear to provide as strong production evidence as Cho (1999). Cho showed that speakers preserved /k/ more often (47%) than /l/ (26%) within the /lkt/ cluster, but the pattern has been reversed: the frequency was 30.9% for /k/-preserved variant (/{l}kt/) but 44.6% for /l/-preserved variant (/l{k}t/). However, when direct comparison is made between absolute frequency values of /{l}kt/ versus /{l}pt/, the present study still shows that speakers prefer to preserve /k/ more than /p/ (30.9% versus 4.7%), in line with Cho's earlier findings. Thus, the asymmetry between /lkt/ and /lpt/ found in the present study can still be accounted for by the hypothesis of phonetically-driven velar preference, although it is still subject to further corroboration.

Our results also indicate that speakers in the present study produce consonant clusters differently from those speakers who participated in Cho's (1999) study. A crucial difference between the two populations lies in the production of /lkt/ clusters. The present-day speakers tend to preserve the first consonant /l/ more frequently than the speakers of Cho's study (about 76% vs. about 53% when both C1-preserved and C1&C2-preserved variants were combined). It is not clear why speakers have changed over time in a direction to preserve the first consonant /l/ more often. One possible phonetic explanation is that the first consonant may be perceptually more salient than the second consonant because it is adjacent to the vowel which carries information for the first consonant. Speakers may prefer to produce the segments with richer phonetic information (Steriade, 1993, 1997).

The results that showed substantial inter-speaker and intra-speaker variation have implications for phonological nature of consonant cluster simplification in Korean. The tri-consonantal cluster simplification in Seoul Korean has been assumed to be a phonological process (Kim-Renaud 1974, Cho 1990, Iverson & Lee 1994, Jun 1998), with only two variants allowed for each cluster type (/{l}kt/~/lkt/ or /l{p}t/~/lpt/). However, the speakers in the present study, who were born and raised in Seoul with higher education, showed between-speaker (within-dialectal) variation, producing all three possible variants regardless of the cluster type. One might argue that because cluster simplification patterns are different from dialect to dialect, some speakers who claimed themselves as Seoulites may model other dialects of Korean. This is a reasonable assumption, given that speakers of different dialects live in Seoul. However, there was also substantial intra-speaker variation. A number of speakers produced all three variants interchangeably. Thus, inter- and intra-speaker variations together suggest that the process of consonant cluster simplification is not phonologized within the grammar of each speaker, at least for young speakers of Seoul Korean.

Finally, we also explored the possibility that cluster simplification patterns may be lexicalized—i.e., different lexical items have different simplification patterns which may be specified in the lexicon. This was in part motivated by the Standard Pronunciation of Korean which regulates that some lexical items containing /lpt/ (e.g., *palp-ta* → *pa{l}p-ta* 'to step on') should be simplified differently from other /lpt/-bearing lexical items. Our results, however, showed no evidence in supporting the view that cluster simplification patterns are lexically determined.

We are now left with a question about the nature of consonant cluster simplification process: To what extent is it phonological? It appears to be phonological to the extent that tri-consonantal clusters are not optimal in the language, so that they often undergo simplification. It is also phonological in that all three variants are allowed within the language, Seoul Korean, but which variants should be chosen in the language has not yet been fully internalized in the phonological grammar of the language within and across speaker.

5. Conclusion

We have examined production patterns of tri-consonantal clusters /lkt/ and /lpt/. Our results showed that simplification is not obligatory as speakers often preserve all three consonants. When simplified, there is a clear asymmetry between /lkt/ and /lpt/. Production of /lkt/ showed no clear preference for either C1 preservation or C2 preservation, but in production of /lpt/, there is a strong preference for C1-preserved to C2-preserved variant. This asymmetrical pattern may be accounted for by the perceptual robustness hypothesis for /k/. Comparison of the present results with those in Cho (1999), simplification patterns appear to have changed over the past 10 years, in a direction to preserve the first member of the cluster (/l/) more often. We have also found no substantial between-item variation, indicating that simplification patterns are not lexically specified. Finally, substantial inter- and intra-speaker variation was observed, which suggests that the process of tri-consonantal simplification has not been fully phonologized in the grammar of the language. We propose that the phonological nature of the tri-consonantal cluster simplification should be reconsidered with its statistical production patterns taken into account.

References

Byrd, D. 1994. *Articulatory Timing in English Consonant Sequences.* Ph.D. dissertation, UCLA.

Cho, T. 1999. Intra-dialectal variation in Korean consonant cluster simplification: A stochastic approach. C*hicago Linguistics Society* 35 (*CLS* 35), 43-57. (Also appeared in UCLA Working Papers in Linguistics, vol. 2, *Papers in Phonology* 3, 207-226, edited by M. Gordon.)

Cho, Y. Yu. 1990. *Parameters of Consonantal Assimilation*. Ph.D. dissertation, Stanford University.

Iverson, G., and S. Lee. 1994. Variation as optimality in Korean cluster reduction. In ESCOL '94.

Jakobson, R., Fant, G. and M. Halle. 1963. *Preliminaries to Speech Analysis*. Cambridge MA: MIT Press.

Jun, J. 1995. *Perceptual and Articulatory factors in Place Assimilation: An Optimality Theoretic Approach.* Ph.D. dissertation, UCLA.

Jun, J. 1998. Restrictions on consonant clusters. In B.-S. Park and J. H.-S. Yoon (eds.), *Proceedings of 11th International Conference on Korean Linguistics* (11th ICKL):382-390.

Jun, J. 2004. Place assimilation. In B. Hayes, R. Kirchner and D. Steriade (eds.) *Phonetically Based Phonology*. Cambridge University Press, pp.58-86.

Kim-Renaud, Y. -K. 1976. *Korean Consonantal Phonology.* Ph.D. dissertation, University of Hawaii.

Kohler, K. 1990. Segmental reduction in connected speech in German: Phonological facts and phonetic explanations. In W.J. Hardcastle and A. Marchal (eds.), *Speech Production and Speech Modeling*. Netherlands: Kluwer, pp. 69-92.

Kohler, K. 1991. The phonetics/phonology issue in the study of articulatory reduction. *Phonetica* 49, 205-221.

Martin, S. E. 2006. *A Reference Grammar of Korean: A Complete Guide to the Grammar and History of the Korean Language*. Tuttle Publishing.

Sohn, H. 1999. *The Korean Language*. Cambridge: Cambridge University Press.

Steriade, D. 1993. Neutralization and the expression of contrast. Paper presented at NELS 24.

Steriade, D. 1997. Phonetics in phonology: the case of laryngeal neutralization. Ms., UCLA, Los Angeles,

Stevens, K. N. 1989. On the quantal nature of speech. *Journal of Phonetics* 17, 3-45.

The National Institute of the Korean Language (국립국어원). *Dictionary of Standard Korean* (표준국어대사전). http://stdweb2.korean.go.kr/main.jsp

Acknowledgement

We thank Nam-Seok Yong, Ji-Young Park and Eun-Bin Lee for their assistance with data acquisition.

Appendix. Simplification patterns by each speaker.

Subj	Clusters	C1-preserved	C2-preserved	C1&C2-preserved
S01	lkt	53.7% (51)	2.1% (2)	44.2% (42)
	lpt	26.4% (19)	0% (0)	73.6% (53)
S02	lkt	12.0% (11)	54.3% (50)	33.7% (31)
	lpt	74.3% (52)	0% (0)	25.7% (18)
S03	lkt	37.9% (36)	34.7% (33)	27.4% (26)
	lpt	73.6% (53)	5.6% (4)	20.8% (15)
S04	lkt	49.5% (48)	1% (1)	49.5% (48)
	lpt	40.8% (29)	0% (0)	59.2% (42)
S05	lkt	7.3% (7)	11.5% (11)	81.3% (78)
	lpt	41.1% (30)	0% (0)	58.9% (43)
S06	lkt	57.9% (55)	32.6% (31)	9.5% (9)
	lpt	65.7% (46)	25.7% (18)	8.6% (6)
S07	lkt	6.1% (6)	88.8% (87)	5.1% (5)
	lpt	35.2% (25)	8.5% (6)	56.3% (40)
S08	lkt	99% (95)	0% (0)	1% (1)
	lpt	78.9% (56)	0% (0)	21.1% (15)
S09	lkt	63.5% (61)	13.5% (13)	22.9% (22)
	lpt	54.9% (39)	0% (0)	45.1% (32)
S10	lkt	86.2% (81)	1.1% (1)	12.8% (12)
	lpt	61.1% (44)	0% (0)	38.9% (28)
S11	lkt	87.6% (85)	10.3% (10)	2.1% (2)
	lpt	70.8% (51)	29.2% (21)	0% (0)
S12	lkt	97.9% (95)	0% (0)	2.1% (2)
	lpt	100% (72)	0% (0)	0% (0)
S13	lkt	37.2% (35)	45.7% (43)	17% (16)
	lpt	44.9% (31)	0% (0)	55.1% (38)
S14	lkt	25% (24)	71.9% (69)	3.1% (3)
	lpt	87.3% (62)	8.5% (6)	4.2% (3)
S15	lkt	66.7% (64)	24% (23)	9.4% (9)
	lpt	91.5% (65)	7% (5)	1.4% (1)
S16	lkt	47.6% (40)	44% (37)	8.3% (7)
	lpt	34.7% (25)	5.6% (4)	59.7% (43)
S17	lkt	21.3% (20)	60.6% (57)	18.1% (17)
	lpt	50% (36)	0% (0)	50% (36)
S18	lkt	16.1% (15)	15.1% (14)	68.8% (64)
	lpt	84.7% (61)	0% (0)	15.3% (11)
S19	lkt	18.8% (18)	50% (48)	31.3% (30)
	lpt	17.6% (12)	0% (0)	82.4% (56)
S20	lkt	0% (0)	84.5% (82)	15.5% (15)
	lpt	5.7% (4)	4.3% (3)	90% (63)

• **Taehong Cho**
Department of English Language and Literature
Hanyang University,
Haengdang-dong 17, Seongdong-gu, Seoul (133-791), Korea
Email: tcho@hanyang.ac.kr

• **Sahyang Kim**
Department of English Education
Hongik University,
Sangsu-dong 72-1, Mapo-gu, Seoul (121-791), Korea
Email: sahyang@hongik.ac.kr