

English Coda /s/ in Korean Loanword Phonology

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1 Introduction

This paper investigates the role of durational differences among instances of English /s/ occurring in the syllable coda, and seeks to correlate these with its adaptation as one of two different phonemes in Korean, either lax /s/ or tense /s'/. The adaptation of foreign /s/ presents an interesting perceptual match-up inasmuch as Korean contrasts two types of voiceless strident alveolar fricatives, either of which, depending on context, may serve as the rendition of English /s/. That is, one source language phoneme (English /s/) is interpreted as one or the other of two recipient language phonemes (Korean /s/ or /s'/).

Independently, Ahn & Iverson (2004:353) argued again recently that Korean's phonetically tense consonants (produced with a constricted glottis) form phonological geminates rather than simplex segments, based in part on the fact that the closure duration of tense obstruents in Korean overall is considerably longer than that of lax and aspirated ones (for the stops, 207 ms vs. 145 ms and 146 ms, respectively, per H. Ahn 1999b:30). On this interpretation, the Korean tense fricative is represented phonologically as geminate /ss/. Surprisingly, the durational difference between lax and tense consonants in Korean also appears to play a determining role in the adaptation of English /s/. Kim (1999) showed that English words are borrowed consistently with tense /ss/ when the fricative is not in a cluster in the source language ([s'ɪŋgɪl] 'single', [bəs'ɪ] 'bus'), whereas the result is lax /s/ when the source fricative forms part of a consonant cluster ([sɪt^hɒp] 'stop', [p^hɛsɪt^hɪ] 'fast'). In experimental work, Kim found that the duration of English [s] in a consonant cluster was substantially less than when it is before or after a vowel. Hypothesizing that Koreans are sensitive to this durational difference, she observed that the phonetically shorter fricative (average

133 ms) in English clusters is consistently adapted as lax /s/ but the phonetically longer fricative in English singletons (average 170 ms) is adapted as tense /ss/ (or [s']). Though Kim's studies on the adaptation of English /s/ did not consider the Korean tense fricative to be a phonological geminate, its period of turbulence or friction is generally longer than that of lax /s/ (albeit insignificantly so, per H. Ahn 1999a:69 — 199.0 ms for [s'], 194.1 ms for [s] — but significantly so in the more comprehensive studies of Kim & Curtis 2002 and T. Cho et al. 2002). The closure duration of the tense stops is appreciably longer than that of the lax and aspirated stops, moreover, which parallels the generally reported friction difference between tense /ss/ and lax /s/ (as well as the distinct geminate versus singleton difference among medial nasals and liquids: Heo & Lee 2004, 2005). Thus, it would appear that perceived duration strongly correlates with tenseness in the Korean obstruent system overall, which in turn supports the view that the positional sub-phonemic length differences in the English fricative are apprehended directly by Korean listeners (Iverson & Lee 2004), and so presumably are contrastive in the language.

Davis & Cho (2005), on the other hand, maintain that the correlation is not robust, noting specifically that Kim was troubled by the adaptation of final sonorant consonant plus /s/ clusters in words like [tens'i] 'dance' or [p^hols'i] 'false', which have the tense (or phonologically geminate) fricative despite being part of a source language cluster. Kim did not measure durations in these final clusters, however, but merely assumed that English [s] should also be phonetically short in sonorant consonant plus /s/ clusters because it is short in obstruent clusters involving [s]. If the duration of English [s] in these environments is in fact relatively long, though, then these sounds would follow the same general pattern of adaptation that Kim had identified. In fact, in a comprehensive acoustic study of English /s/ over a full range of environments, Klatt (1974) showed that /s/ is shorter by 40% in clusters with stops (the [s] that Koreans adapt as lax), but shorter by only 15% in clusters with sonorant consonants (the [s] which Koreans adapt as tense). Thus, it would appear that Koreans adapt instances of the English fricative following a sonorant as tense [s'] (= /ss/) because these are above the threshold of brevity that marks the non-tense obstruents in Korean, with appreciably longer duration of friction than occurs in English [s] in an obstruent cluster. The remainder of this paper reports on a production and perception experiment further testing the hypothesis that source language durational differences correlate with the variable adaptation of English /s/ as either lax (simplex) or tense (geminate) in Korean.

2 Experiment 1: English coda [s] as spoken by native speakers of Korean

Experiment 1 was designed to test the hypothesis that Korean listeners perceive phonetically long English [s:] as tense or geminate /ss/ and phonetically short English [s] as lax or singleton /s/ in Korean. To provide an accurate description of the perception of English /s/ in word-final position, I had native speakers of Korean who know English produce English words with a word-final /s/ instead of going through a written list of English loanwords in Korean. The reason for this is that, in most cases, English /s/ is represented by a single <s> in Korean orthography irrespective of its phonetic or phonemic realization, i.e., lax [s] (/s/) or tense [s'] (/ss/). The practice in Korean to select the grapheme <s> in loanword adaptation of foreign /s/ presumably has to do with aesthetic reasons in the orthography (<ss> is graphically more complex and less legible at a distance), so in order to minimize the effect of spelling, the stimuli in Experiment 1 were not displayed orthographically to the subjects, either in English or in Korean.

2.1 Methods

2.1.1 Subjects

Eight native Korean-speaking undergraduates from the University of Wisconsin-Milwaukee (UWM) voluntarily participated in the experiment, none of whom had any linguistics background. All of them had had experience with English as a second language in the United States for six months to three years at the maximum, and their age ranged from twenty-two to thirty-eight years. However, the subjects in this experiment are not entirely naïve speakers since, to some extent, they are aware of differences between English and Korean in terms of pronunciation even though they were not told what was intended to be measured in the study. For this reason, I expect to conduct a larger-scale experiment in the future with native speakers of Korean who have not been exposed to an English-speaking environment in order to elicit more reliable and robust data.

2.1.2 Procedure

Each of the subjects was digitally recorded using a Belkin voice recorder microphone in a quiet conference room at UWM, and the frication duration of the /s/ was measured using the speech analysis application, Praat (version 4.1.9). Pictures with an English sentence and a blank at the bottom were presented to the subjects, who were asked to say the English-sourced word for the blank, but

pronounced in Korean. To elicit the word ‘Greece’, for example, a map of the country was shown to them with the sentence, “Athens is the capital of _____” on the picture. I also verbally translated the sentence into Korean to them, which means that they had not only visual cues to produce a word for each picture but also auditory cues in Korean in order to help them produce each word with a more natural Korean pronunciation. The words that they were to produce are given in Table 1.

Table 1: English test words with coda /s/

V__#	VC__#	V__C#
Greece	dance	crust
tennis	France	desk
bus	ambulance	breakfast
terrace	false	breast
rice	SARS	first
virus	Alps	fast
asparagus	Matrix	disk
sauce	(Boston Red) Sox	just
Swiss	sense	last
slice	license	paste

The target words thus consisted of thirty tokens of English words with /s/ in coda position. These can be grouped into three types: ten words contained word-final /s/ preceded by a vowel, another ten had final /s/ after a consonant, and the third group of 10 positioned /s/ between a vowel and a final consonant. Words of the third type with /s/ occurring in coda position but not word-finally (*crust*, etc.) were used as a control condition, as the duration of /s/ is known to be shorter here than word-final /s/ in the first and the second type (T. Cho et al. 2002). In addition, the word ‘SARS’, an acronym for ‘Severe Acute Respiratory Syndrome’, was included in the list despite the fact that the final ‘s’ is not actually pronounced as [s] in English, but as [z], because the word is borrowed into Korean as [s’as’i], with tense [s’] for both fricatives.

2.2 Results

Measurements revealed that the duration of final [s] is longer than that of preconsonantal [s] in coda position for all speakers although the durational range of the segments showed individual variation. The duration of [s] in the target words for all Korean subjects (A through H) is presented in Table 2. Table 2A list the measurements of final [s] following a vowel, Table 2B final [s] following a

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consonant, and Table 2C coda [s] before a consonant.

Table 2: Duration of [s] for all subjects and individual average (in milliseconds)

A. English coda /s/ after a vowel

Subjects	A	B	C	D	E	F	G	H
Greece	159	162	127	198	197	128	131	234
tennis	140	192	152	187	176	180	152	180
bus	248	188	143	262	184	178	144	188
terrace	201	191	138	279	199	139	142	192
rice	151	193	131	277	205	163	132	199
virus	185	204	124	220	209	171	153	167
asparagus	206	165	150	243	191	159	119	182
sauce	145	172	139	197	182	172	147	199
Swiss	153	167	110	205	169	159	130	175
slice	233	195	125	244	162	175	148	194
Average	182	183	134	231	187	162	140	191

B. English coda /s/ after a consonant

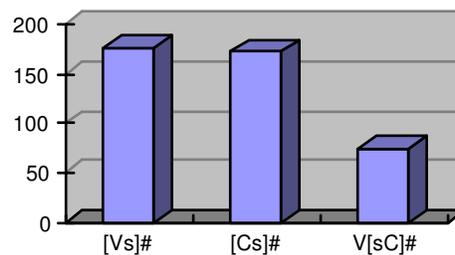
Subjects	A	B	C	D	E	F	G	H
dance	184	148	154	212	178	110	163	167
France	144	175	140	208	179	115	133	161
ambulance	192	196	148	278	202	153	215	159
false	188	150	150	203	181	169	190	160
SARS	183	190	129	196	220	233	145	167
Alps	216	170	141	188	186	192	182	148
Matrix	215	154	122	175	177	146	197	145
(Red) Sox	217	141	129	199	212	189	252	141
sense	131	183	136	179	182	138	196	153
license	141	166	107	185	190	155	147	169
Average	181	167	136	202	191	160	182	157

C. English coda /s/ before a consonant

Subjects	A	B	C	D	E	F	G	H
crust	38	98	41	96	83	77	38	95
desk	85	79	66	102	107	47	66	89
breakfast	83	92	57	40	63	72	99	48
breast	99	92	48	68	69	59	49	79
first	88	104	63	108	93	77	73	87
fast	104	60	59	59	89	64	62	60
disk	95	62	60	66	71	72	80	55
just	106	85	45	82	83	69	72	79
last	107	73	64	73	72	71	65	58
paste	87	83	55	69	91	70	77	80
Average	89	83	56	76	82	68	68	73

The minimum and the maximum duration of final [s] after a vowel was 110 ms and 279 ms, respectively, and that of final [s] after a consonant was 107 ms and 278 ms, respectively. That is to say, the final [s] sounds in the Table A and Table B words showed a similar durational range in Korean, both longer than preconsonantal coda [s] in Table 3B, whose minimum and maximum duration was 38 ms and 108 ms, respectively. The shortest duration of word-final [s] is from subject C, and the longest is from subject D. Overall, the average duration of final [s] after a vowel (*Greece*, etc.) was about 176 ms and that of [s] after a consonant (*dance*, etc) was about 172 ms across speakers. The average duration of preconsonantal [s], namely in s-clusters word-finally, was about 74 ms, which is 40% of the duration of word-final [s]. Figure 1 graphs a summary of the average duration of [s] in three different positions, with the y-axis representing milliseconds.

Figure 1: Average duration of coda [s] by position for all Korean subjects



As shown in Figure 1, the duration of word-final /s/ (176 ms postvocally, 172ms postconsonantly) in English is consistently almost 60% greater than that of preconsonantal final /s/ (74 ms) when produced by the Korean speakers. In sum, measurements of the data showed that the duration of coda [s] in the speech of Koreans was shorter when it appeared as the final element in a final cluster.

3 Experiment 2: Perception of coda [s] as spoken by native speakers of English

This perception experiment attempts to examine how Korean speakers categorize English /s/ into two different native phonemes, viz., /s/ and /ss/, and how the segment duration in the source language affects the categorization. It is expected that subjects are to judge phonetically longer fricatives to be the tense or geminate /ss/ and the shorter one to be the singleton /s/. The subjects (n=8) were the same as in the previous experiment, all of whom participated in this experiment after they completed the first one.

3.1 Methods

The stimuli in the present study consisted of the same words as presented in Table 1, but this time the subjects were to listen to the recordings of two native speakers of English pronouncing the words in English. The subjects then were asked to select between /si/ and /ssi/ (the epenthetic vowel [i] is necessary word-finally as a coda fricative is not possible in Korean). A piece of paper was given to the subjects with the two choices of /si/ and /ssi/ for each word, all of which were presented in the same order as in the previous experiment. The words were spoken in the sentence “Say _____ again” in order to avoid the durational variability that can occur in the utterances of words in isolation (phrase-final lengthening, chiefly). Four words in the first type (*sauce, Swiss, slice, asparagus*) have /s/ both word-initially or word-medially and word-finally, but the measurements were all made on the final. The subjects listened to the recording one time from each native speaker except for subject C, who requested to hear it again after listening to each speaker.

The English speakers, one female and one male, were asked to pronounce each word in the sentence “Say _____ again” at normal speed and were recorded as in Experiment 1. The duration of /s/ for the two native speakers in each of the tokens was measured as presented in the first two columns of Table 4, with the results of the judgment task for the Korean subjects (choosing between Korean lax /s/ and tense /ss/) presented in the last two columns.

3.2 Results

As Table 4 reveals, both speakers showed longer duration for English /s/ in word-final position than in preconsonantal position, which confirms previous studies of English that found [s] to be longer in word-final position and shorter in consonant cluster sequences (Klatt 1974). The following tables show the result of the perception experiment where Korean speakers presented sensitivity to durational differences of English /s/ depending on different position in a word when they categorize the segment as either a singleton /s/ or a geminate /ss/. In Table 4, the durations of the final /s/ of the words pronounced by the two English speakers are presented with the number of the subjects who made a choice between /si/ and /ssi/.

The average duration of coda /s/ for Speaker A was 152 ms word-finally after a vowel (*Greece*), 140 ms word-finally after a consonant (*Alps, dance*) and 91 ms before a consonant (*crust*). The average duration of /s/ for Speaker B in these three environments was 163 ms, 129 ms and 92 ms, respectively. Thus, both speakers showed the longest duration of coda /s/ in word-final position after a vowel, and the shortest duration of coda /s/ in preconsonantal position. The durational difference between postconsonantal (140/129 ms) and postvocalic final /s/ (152/163 ms) is not substantial, however, but it runs about 40-50% longer than the average duration of preconsonantal coda /s/ (91/92 ms).

Table 4: Duration of coda /s/ for two native speakers of English

A. After a vowel

Word	Speaker A	Speaker B	/s/	/s'/
Greece	150 ms	143 ms	1	7
Tennis	155 ms	157 ms	2	6
Bus	166 ms	177 ms	--	8
Terrace	179 ms	154 ms	1	7
Rice	134 ms	168 ms	--	8
Virus	144 ms	159 ms	--	8
Asparagus	168 ms	201 ms	--	8
Sauce	159 ms	160 ms	1	7
Swiss	122 ms	164 ms	3	5
Slice	144 ms	150 ms	2	6
Average	152 ms	163 ms	13%(10/80)	87%(70/80)

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B. After a consonant

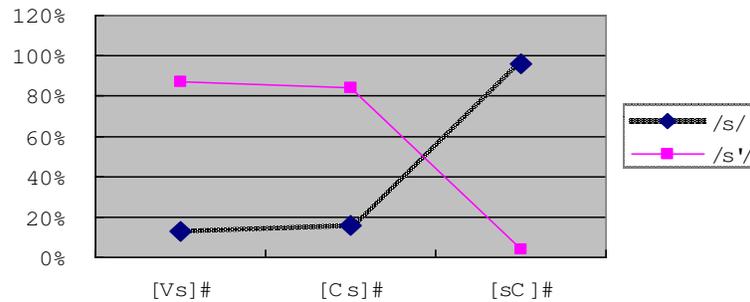
Word	Speaker A	Speaker B	/s/	/s'/
Dance	139 ms	110 ms	2	6
France	168 ms	125 ms	2	6
Ambulance	155 ms	129 ms	--	8
False	145 ms	152 ms	--	8
*SARS	70 ms	67 ms	4	4
Alps	108 ms	105 ms	--	8
Matrix	153 ms	118 ms	--	8
(Boston red) sox	142 ms	125 ms	--	8
Sense	110 ms	172 ms	3	5
License	122 ms	127 ms	2	6
Average	140 ms	129 ms	16% (13/80)	84%(67/80)

C. Before a consonant

Word	Speaker A	Speaker B	/s/	/s'/
Crust	92 ms	85 ms	8	--
Desk	98 ms	103 ms	8	--
Breakfast	90 ms	87 ms	7	1
Breast	78 ms	97 ms	8	--
First	93 ms	97 ms	7	1
Fast	81 ms	99 ms	7	1
Disk	95 ms	87 ms	8	--
Just	92 ms	96 ms	8	--
Last	96 ms	75 ms	8	--
Paste	97 ms	98 ms	8	--
Average	91 ms	92 ms	96%(77/80)	4%(3/80)

In fact, most of the Korean subjects in this experiment categorized the phonetically longer word-final /s/ of English (*Greece, Alps, dance*) as tense or geminate /ss/ in Korean (87% /ss/ for English postvocalic final /s/, 84% /ss/ for English postconsonantal final /s/), whereas they dominantly categorized the phonetically shorter preconsonantal coda /s/ of English (*crust, desk*) as lax or simplex /s/ (just 4% /ss/ for English preconsonantal coda /s/). Figure 2 presents this finding in graphic form.

Figure 2: Perception of /s/ and /ss/



These results confirm the hypothesis that, in source language codas, at least, Koreans perceive phonetically long English [s:] as tense, phonologically geminate /ss/ but phonetically short English [s] as lax, single /s/. Interestingly, as noted above, the test word ‘SARS’ has a word-final voiced fricative [z] in English, not [s] (though the extent of voicing in English final /z/ is in fact quite marginal; cf. Iverson & Salmons 2003). This voiced or lenis fricative, which does not occur phonologically in Korean, was perceived by the half of the subjects as singleton /s/ even though the word has been borrowed into Korean as [s’as’i], with tense /ss/. What triggered the subjects to consider the phonetically partially voiced [z] as a short /s/ in Korean is presumably the effect of the short duration of the segment in English, which was just 70 ms for Speaker A and 67 ms for Speaker B. This lends further support to the idea that source language fricative duration differences, though redundant, make up a key perceptual property in Korean, where consonantal duration is contrastive according to many analyses of Korean phonology, most recently Ahn & Iverson (2004).

4 Discussion

The overall results of the experiments in this study suggest that there is a systematic length difference in the articulation of English /s/ in coda position, and that this difference determines a consistent adaptation of the English fricative as either tense /ss/ or lax /s/ in Korean. Specifically, English coda /s/ is borrowed as tense /ss/ when it appears in word-final position, whether it appears postvocally (*tennis, bus, etc.*) or postconsonantly (*dance, false, etc.*), whereas it is borrowed as lax /s/ when it is the first element of a cluster (*fast, disk, etc.*). This corresponds to the durational differences in the production of English /s/ in syllable-internal clusters by native speakers, for whom /s/ followed by an obstruent shows much shorter duration than /s/ preceded by a consonant, either

obstruent or sonorant. Klatt (1974:60) uncovered this phenomenon in a comprehensive study of English /s/ duration more than thirty years ago: “If [s] is followed by a plosive in a two-element cluster, the [s] duration is shortened to 60% of the value [of prevocalic [s]: AL]. If [s] is preceded by a nasal or plosive, the [s] duration is shortened to 85 %.” In other words, it is not that /s/ is short in a cluster, but that it is short when it occurs as the first element in the cluster, as the data in the previous section bear out. Kim’s (1999) claim that the duration of English [s] in a cluster was significantly shorter than it is when before or after a vowel and that Koreans are sensitive to the duration differences in the adaptation of English /s/ still holds true, but it needs to be refined: in a syllable-internal cluster, the English fricative is short enough to be perceived as lax singleton /s/ in Korean when it occurs before another consonant in the source word (*stop, snap; desk, fast*), but not when it occurs after (*dance, false, matrix*), where it is long enough to be perceived as tense or geminate /ss/.

Davis & Cho’s (2005) view that the adaptation of English /s/ is not dependent on duration is based on the misunderstanding that a postconsonantal fricative in words like *dance* or *false* is as short as the preconsonantal fricative in words like *desk* and *fast*. But, in fact, as shown first by Klatt (1974) and confirmed here, the duration of postconsonantal /s/ is appreciably greater than that of preconsonantal /s/ within the English syllable, approaching that of prevocalic /s/, which is regularly adapted as /ss/ in Korean. The general thesis put forward by Kim (1999) thus still holds, namely, that the phonetic duration of /s/ in various English environments is the determining factor for its adaptation in Korean.

The systematic but variable adaptation of English /s/ in Korean suggests that the native phonological system plays a primary role in perceiving source language sounds. Specifically, the durational differences in surface expressions of /s/ are a subphonemic, redundant feature in the English source language; but these differences are perceptually salient in the Korean recipient language, where they contrast phonemes across the system, including two kinds of fricatives, lax or short /s/ and tense or long /ss/. This is the basis for the consistent adaptation of one English fricative as either of two Korean equivalents, singleton /s/ or geminate /ss/.

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