

# The role of L1 phonemes in interlanguage segmental mapping: English /s/ in Korean\*

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## 1. Overview

(1) Adaptation of English /s/ in Korean (S. Kim 1999, Kim and Curtis 2002)

- **Preconsonantal /s/ → Lax /s/**  
*slump, smog, snack, spar, skate, test, toast, postcard, disk, mask*
- **Prevocalic /s/ → Tense /s\*/**  
*salary man, ceramic, single, size*
- **Word-final /s/ → Tense /s\*/**  
*gas, bus, peace, juice, DOS*
- Duration-based account: Korean adapters are sensitive to the duration of English /s/ in mapping English /s/ to Korean:
  - pre-consonantal /s/: shorter fricative duration → lax /s/
  - pre-vocalic & word-final /s/: longer fricative duration → tense /s\*/

(2) L1 contrast-based adaptation

- “[W]e consider that Korean utilizes duration of a segment as a primary, not secondary, cue in differentiating tense consonants, i.e., geminates, from the rest of the obstruent system. Kim’s recent finding from the phonology of borrowing is striking confirmation of that analytic conclusion [i.e., tense consonants are underlyingly geminates.]” (Ahn and Iverson 2004)  
cf. Also see Han (1992, 1996), Jun (1994) and Avery and Idsardi (2001) for a geminate analysis of tense consonants.
- **Principle of Phonological Perception:** “Phonetic representations are interpreted and structured according to the contrastive categories of the native language.” (Iverson and Lee 2004/2006)<sup>1</sup>

(3) Goals of the talk

- Examine and compare the acoustic properties of English /s/ and Korean /s/ & /s\*/  
→ **Voice quality of the vowel (H1-H2) not Fricative duration:** In Contemporary Korean, duration plays a very marginal role in predicting the loan adaptation pattern and the voice quality of the following vowel (H1-H2) seems to be a determining factor.

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<sup>1</sup> There are different assumptions about the exact ways in which the contrastive categories of native language may affect loanword adaptation. Implicit in Ahn and Iverson (2004)’s proposal quoted in (2) is an assumption that, other things being equal, the phonetic correlate that is directly related to the *underlyingly* contrastive feature (i.e., duration) has a more privileged role in speech perception and loanword adaptation than redundant or enhancement phonetic features ([const. glottis], [stiff v.f.] etc.). We can refer to this view as **underlying contrast-driven adaptation**. On the other hand, an alternative assumption is also found that phonetic correlates that are not underlyingly contrastive but are added as enhancement or redundant features, which may vary from context to context, (such as [lateral] for a geminate liquid in Korean) play just as important a role as the phonetic correlate that are directly related to the underlying contrast (cf. H. Kang and Dilley 2005, Iverson and Lee 2006). We can refer to this view as **surface contrast-driven adaptation**. See Kang (2007) and Kang and Rice (to appear) for more discussion on the role of underlying contrast of native phonology in loanword adaptation.

- Examine the adaptation pattern in 1930s Korean
- ➔ **Duration!:** In 1930s Korean, duration of /s/ seems to have played a more important role than in Contemporary Korean.
- ➔ **Indirect evidence for diachronic change:** The change in loan adaptation pattern reflects a change in primary cue for /s/ vs. /s\*/ distinction from a consonantal one (i.e., duration) to a vocalic one (i.e., H1-H2), similar to a shift in the primary cue for lax vs. tense distinction in stops (VOT → F0) cf. Silva 2006, Park and Iverson 2008, Y. Kang 2008a,b

## 2. Duration of English /s/

### (4) Phonological factors known to affect the duration of English /s/

- **Cluster effect:** /s/ is shorter in a consonant cluster (Haggard 1972, Klatt 1973, 1974, Lee and Iverson 2007)
  - Klatt (1973): “consonants in clusters are generally shorter than in a singleton environment, but the amount of shortening is dependent on certain features of adjacent consonants.”
  - Kim and Curtis (2002) only studied [s] in a [st] cluster (e.g., *sack* vs. *stack*), a context where shortening is likely most severe according to Klatt (1973).
- **Stress effect:** /s/ is longer when it is followed by a stressed vowel than by an unstressed vowel or no vowel (Klatt 1974, Crystal and House 1988)
- **Domain effect:** /s/ is shorter word-finally than word-medially but longer pre-pausally (Klatt 1974, Crystal and House 1988)
- Morphemic status: Morphemic /s/ is longer than nonmorphemic /s/ (Walsh and Parker 1983)
- Number of syllables in a word (for /s/ before a stressed vowel): /s/ is longer in a shorter word (Klatt 1974)

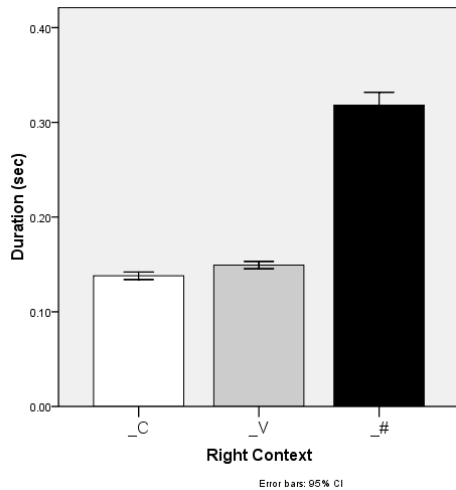
### (5) *American English Spoken Lexicon* (AESL) (<https://online.ldc.upenn.edu/aesl/>)

- “The *American English Spoken Lexicon* (AESL) contains pronunciations captured in individual audio files for more than 50,000 of the most common words in English. ... Each word was read by an adult female native speaker of American English in a quiet recording studio. In addition, this CGI version contains a phonetic transcription of most words in a reference American pronunciation as extracted from the *LDC Call Home American English Lexicon*.”
- 513 words representing /s/ in various phonological contexts are selected from AESL
  - Preceding & following contexts  
: # (word boundary), T(stop), F(fricative), N(nasal), L(lateral), R(rhotic), G(glide = /w/), and V(vowel)
  - Stress on the following vowel: Stressed, Unstressed, No following vowel.  
\*Some of these combinations are impossible (e.g., #s#) or rare/unattested.
- All instances of /s/ are measured for
  - Duration of /s/
  - Centre of Gravity (COG) of fricative noise
  - Intensity of fricative noise
For pre-vocalic ones, also
  - F0 at the vowel onset and midpoint
  - H1-H2 at the vowel onset and midpoint
  - Duration of the following vowel

(6) Effect of following segmental context on fricative duration

- On average, pre-consonantal /s/ is shorter than pre-vocalic or word-final /s/ ( $\_C < \_V \lll \_#$ )
- Pre-pausal, word-final /s/ is almost twice as long as non-final /s/.

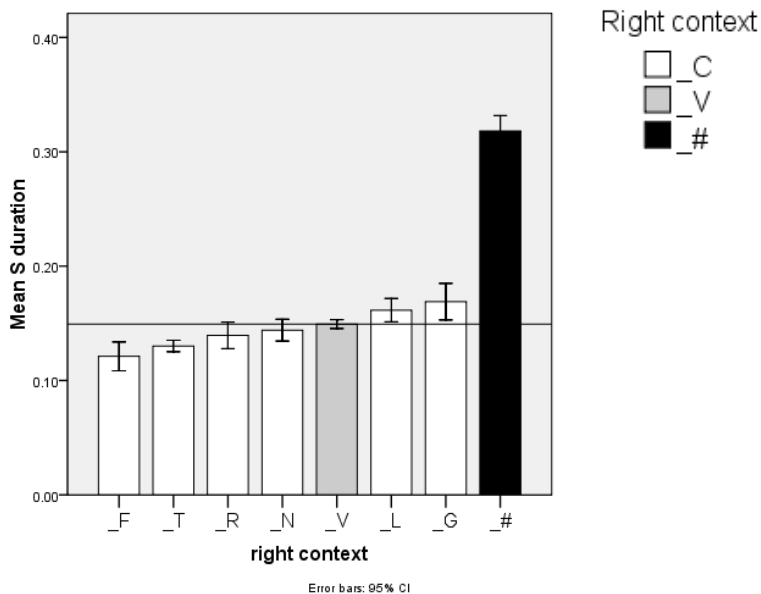
Figure 1: Mean duration of English /s/ by right-hand context I



(7) Segmental makeup of the cluster

- However!!!, not all pre-consonantal /s/ is shorter than pre-vocalic /s/.
  - /s/ preceding /l/ or /w/ is **longer!** than pre-vocalic /s/.
- But, in loanword adaptation, /s/ before /l/ or /w/ (*slump, swing...*) pattern with other preconsonantal /s/ and is adapted as lax /s/ of Korean.

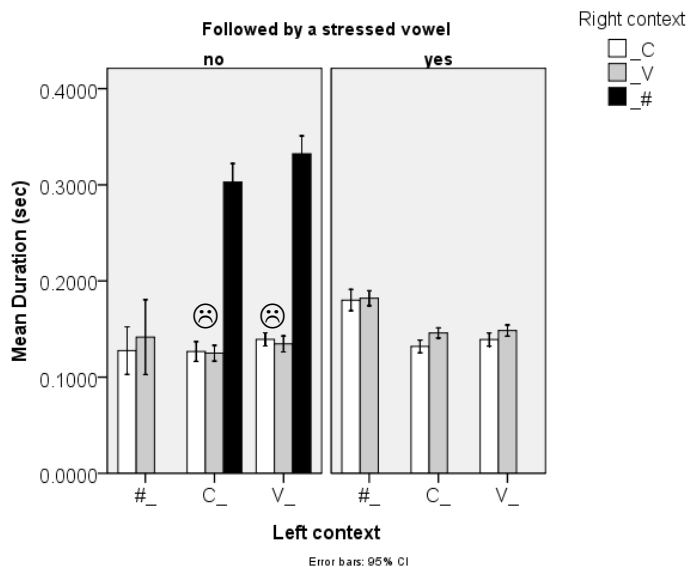
Figure 2: Mean duration of English /s/ by right-hand context II



(8) Context effect

- Pre-consonantal /s/ is not consistently longer than pre-vocalic /s/ in all contexts.
- Nevertheless, loanword adaptation seems to differentiate pre-consonantal vs. non-preconsonantal /s/ categorically.

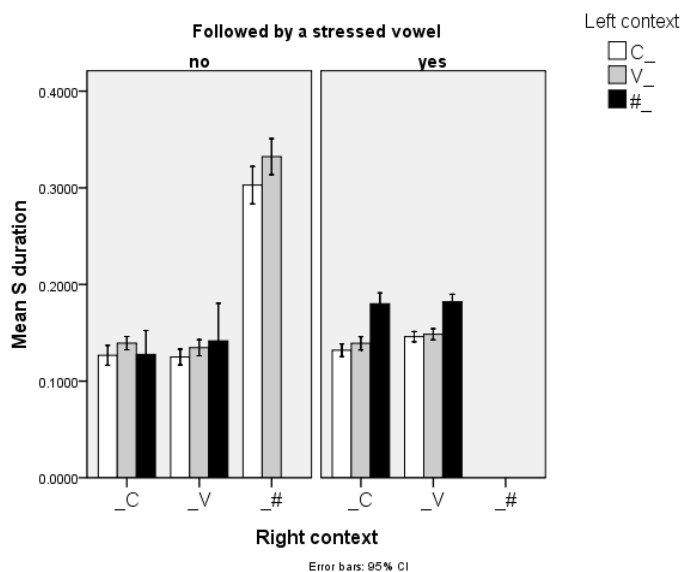
Figure 3: Mean duration of English /s/ by right-hand context in different left-hand and stress contexts



(9) Other factors: Preceding context and Stress on a following vowel

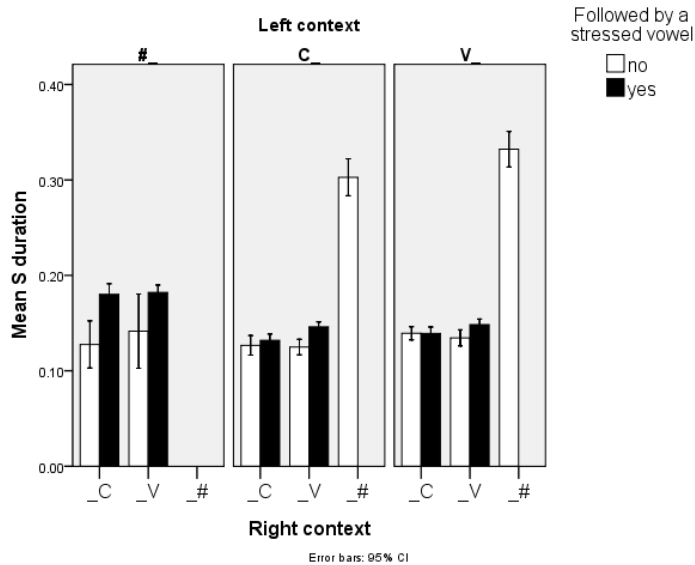
- Preceding context has a systematic effect on the duration of /s/ in English (C\_ < V\_ < #\_): Post-consonantal /s/ (e.g., *fancy*) is systematically shorter than post-vocalic /s/ (e.g. *asset*).
- But, this difference in duration of /s/ is not reflected in Korean loans. cf. Davis and Cho (2006)

Figure 4: Mean duration of English /s/ by left-hand context



- Stress on a following vowel also has a fairly systematic effect on the duration of /s/ (**\_no stressed V < \_stressed V**): /s/ followed by stressed vowel (e.g., *percéption*) is systematically longer than /s/ followed by an unstressed vowel (e.g., *person*).
- Again, this difference in duration of /s/ as conditioned by stress is not reflected in Korean loans.

Figure 5: Mean duration of English /s/ by stress context



- (10) A summary on the duration of English /s/
- Right-hand context does have an effect but not as systematic as a duration-based account of borrowing pattern may suggest.
  - Left-hand context and stress are also important predictors of the duration of English /s/ but they do not have any effect on the borrowing pattern.

### 3. Comparison of English /s/ and Korean /s/ and /s\*/

- (11) BOLA (Bank of Language Resources) Korean phonetic database (PBW1) (<http://bola.or.kr/>)

- Two professional announcers (one male and one female) reading a list of 2000 words
- The word list contains 557 instances of /s/ or /s\*/ occurring in various segmental contexts
- All instances of /s/ and /s\*/ are measured for
  - **Duration of /s/** (including aspiration)
  - **H1-H2 at the vowel onset** and midpoint
  - Centre of Gravity (COG) of fricative noise
  - Intensity of fricative noise
  - F0 at the vowel onset and midpoint
  - Duration of the following vowel

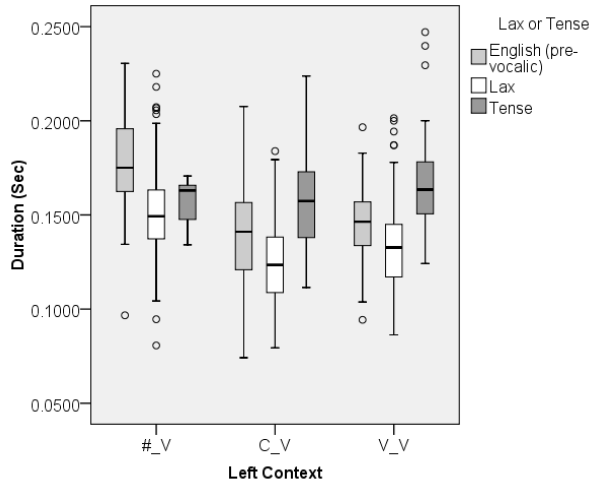
- (12) Phonetic correlates of /s/ vs. /s\*/ contrast in Korean based on the BOLA data (See the appendix for more details.)

- **Fricative duration** separates the two categories well in word-medial position but marginally so in word-initial position (cf. Ahn 1999, Cho et al. 2002, Kang and Kang 2002, Kang and Yoon 2005)
- **H1-H2** separates the two categories well in all contexts. (cf. Ahn 1999, Cho et al. 2002, Chang 2008)
- **F0** is not different. (cf. Cho et al. 2002) Not discussed further.

**3.1. Pre-vocalic /s/ of English:** adapted as tense /s\*/

(13) Duration

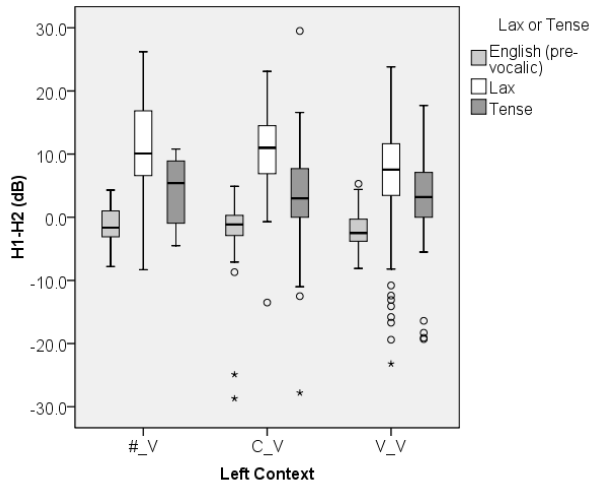
**Figure 6: Duration of English pre-vocalic /s/ and Korean /s/ and /s\*/ by left-hand context (AESL and BOLA Female speakers)**



- Word-initial (#\_V): English /s/ is closer to Korean tense /s\*/ in its duration but Korean /s/ and /s\*/ themselves are not well separated → **ambiguous ~ correct**
- Word-medial (C\_V, V\_V): English /s/ is ambiguous between Korean /s/ and /s\*/ in terms of duration. → **ambiguous**

(14) H1-H2

**Figure 7: H1-H2 of English pre-vocalic /s/ and Korean /s/ and /s\*/ by left-hand context (AESL and BOLA Female speakers)**



- In all contexts, English /s/ has a very low H1-H2 and is closer to Korean tense /s\*/. → **Correct!**

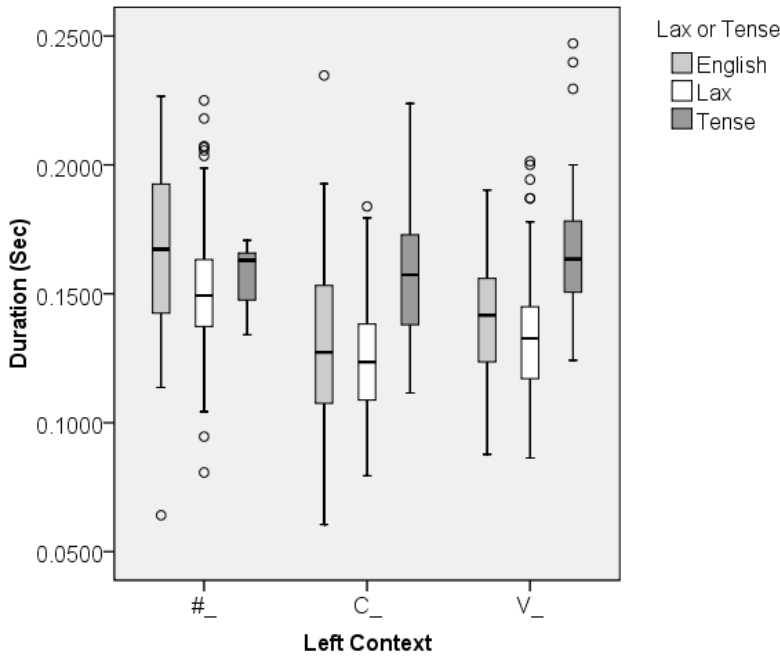
Fricative duration		H1-H2 ☆!	
Word-initial	Word-medial	Word-initial	Word-medial
Correct ~ Ambiguous	Ambiguous	<b>Correct</b>	<b>Correct</b>

**\*\*\*H1-H2 on the following vowel, not fricative duration, makes a better prediction for the borrowing pattern of pre-vocalic /s/.\*\*\***

### 3.2. Preconsonantal /s/ of English: adapted as lax /s/ in Korean

#### (15) Duration

Figure 8: Duration of English **pre-consonantal** /s/ and Korean /s/ and /s\*/ by left-hand context (AESL and BOLA Female speakers)



- Word-initial (#\_): Significant overlap. If anything, the median is closer to Korean tense /s\*/ than to lax /s/ → **ambiguous ~ wrong**
- Word-medial (C\_, V\_): some overlap. But, better matched by Korean lax /s/. → **correct**

#### (16) H1-H2

- H1-H2 cannot be compared because pre-consonantal /s/ does not have a following vowel. ... No explanation for the mapping pattern of word-initial pre-consonantal /s/.

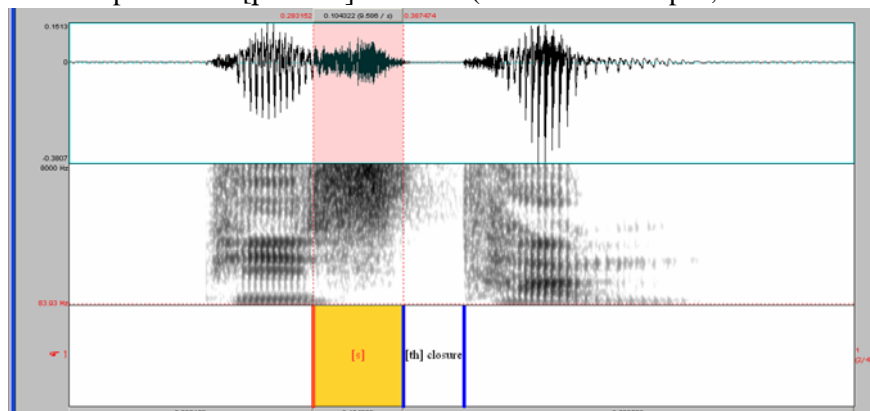
#### (17) Phonotactic restriction

- Unlike pre-vocalic /s/, pre-consonantal /s/ is always followed by an epenthetic vowel in Korean.

stick → s<sup>h</sup>i<sup>h</sup>ik  
slump → s<sup>h</sup>i<sup>h</sup>l<sup>h</sup>amp<sup>h</sup>i  
swing → s<sup>h</sup>i<sup>h</sup>wiŋ  
test → t<sup>h</sup>es<sup>h</sup>i<sup>h</sup>t<sup>h</sup>i  
mask → mas<sup>h</sup>i<sup>h</sup>k<sup>h</sup>i

(18) Epenthetic vowel quality

- A high vowel is frequently devoiced after /s/ but not following a tense /s\*/ (Jun & Beckman 1994, Jun et al. 1997)
- /pisis-han/ [pisi<sup>h</sup>an] ‘similar’ (from BOLA corpus, male announcer)



- **Avoidance of salience on an epenthetic vowel:** Breathy and devoiced [i̥] is less distinct from ∅ and makes a better epenthetic vowel than non-breathy [i] with clear formant structure. (cf. HEAD-DEP of Alderete 1995; Shinohara 1997; Kenstowicz 2003; Kang 2008b)

s∅lump is more similar to [s̥i̥lʌmp<sup>h</sup>i]  
 than to [s\*ilʌmp<sup>h</sup>i]

3.3. Word-final /s/ of English: adapted as tense /s\*/ in Korean

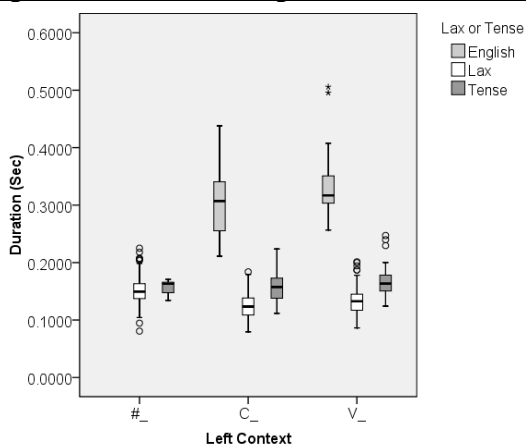
(19) Epenthetic vowel quality

- In utterance final position, vowels are often breathy or creaky and a high central vowel [i̥] may be nonsalient even when the preceding consonant is [s\*].

miss∅ is no more similar to [mis̥i̥]  
 than to [mis\*i̥]

- Also, the drastically longer duration of /s/ in final position may push the perception to tense /s\*/.

Figure 9: Duration of English word-final /s/ and Korean /s/ and /s\*/ by left-hand context



3.4. Summary

- (20) In Contemporary Korean, H1-H2 is a better predictor of the adaptation pattern than fricative duration. Duration plays only a marginal role, if any.

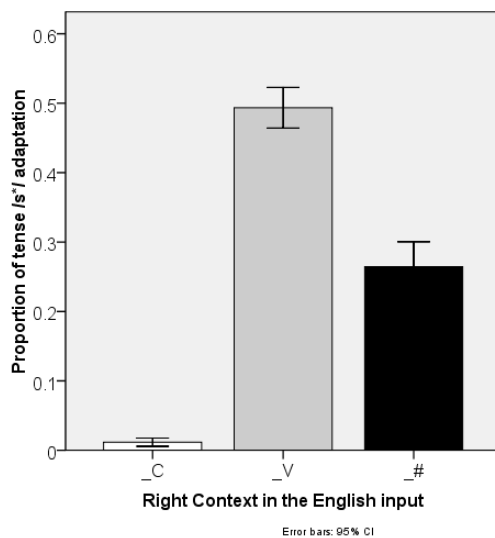
#### 4. English /s/ in 1930s Korean

(21) *Modern Chosun Loanword Dictionary* (1937) by Lee Jong-Keuk

- Compilation of loanwords from written sources in the 1930s: over 18,000 loanforms
- This dictionary was published before the establishment of “Convention on loanword transcription (1941)” by *Hangeul Hakhoe* and likely reflects the pronunciation fairly closely. (cf. Yu 1988, M. R. Kim 2000)
- High variability: e.g., 19 different variants for ‘stadium’
- About 90% of the data are analyzed for adaptation of /s/: A total of 2,343 unique English input words or phrases containing /s/ resulting in 4,953 instances of English /s/ adaptation are identified.
- The rate of tense /s\*/ vs. lax /s/ adaptation is calculated for each English input.

(22) General pattern of /s/ adaptation

Figure 10: Mean Proportion of tense /s\*/ adaptation of English /s/ in 1930s



- **Pre-consonantal /s/** is almost categorically adapted as lax /s/, similar to Contemporary Korean.
- **Prevocalic and Word-final /s/** is variably adapted as tense or lax /s/. Unlike Contemporary Korean, the rate of tense /s\*/ adaptation in these contexts is lower than 50%. Why?<sup>2</sup>

<sup>2</sup>Some external factors that may account for the low rate of tense /s\*/ adaptation.

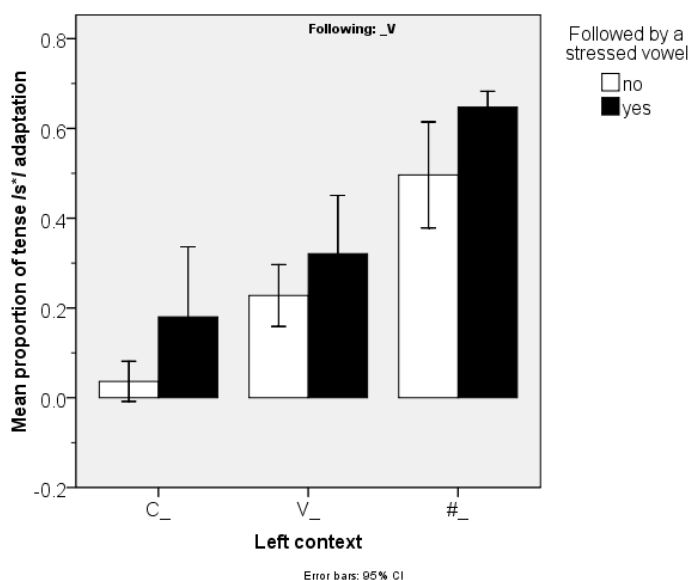
- Borrowings through Japanese: E. /s/ → J. /s/ → K. lax /s/ (Ito, Kang and Kenstowicz 2006).
  - Possible orthographic bias against double consonants?
  - But, these still do not explain away the lower than 50% rate of tense adaptation.
    - Word-initial voiced stops in the dictionary, subject to the comparable external factors (Japanese influence, orthographic bias) that favor lax realization, nevertheless shows the rate of tense adaptation well over 70% (Soo-hyun Kim 2003, Kang 2008a, b).
- ➔ There is a genuine difference in the adaptation pattern of English non-preconsonantal /s/ in 1930s and in Contemporary Korean.

(23) Duration?

- Recall that the duration characteristic of English pre-vocalic /s/ was quite ambiguous between lax /s/ and tense /s\*/ of Korean. (cf. Figure 6)
- Tense adaptation rate in pre-vocalic /s/ systematically differ by the preceding context (C < V < #) and stress context (unstressed < stressed) mirroring the durational characteristics of English /s/ found in the AESL data (Figure 4, Figure 5)

\*Note: The “C\_” context excludes those that are realized with Stop-s sequence in Korean, where post-obstruent tensification applies.

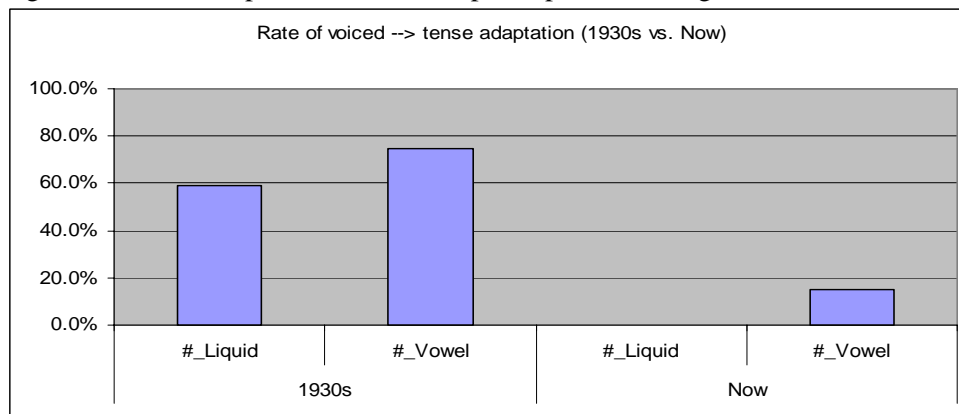
Figure 11: Mean Proportion of tense /s\*/ adaptation of English pre-vocalic /s/ in 1930s



(24) Discussion

- Duration of fricative likely played a more central role in 1930s Korean than in Contemporary Korean.
- The loanword data may be reflecting the restructuring of the primary phonetic cues for the /s/ and /s\*/ distinction from a consonantal one (i.e., fricative duration) to a vocalic one (i.e., H1-H2), similar to a tonogenesis-like change in stops (VOT → F0) (Silva 2006, Park and Iverson 2008).
- Soohyun Kim (2003), Kang (2008ab): word-initial voiced stops are predominantly adapted as tense stops in the 1930s while in Contemporary Korean, lax stop adaptation is the norm.

Figure 12: Mean Proportion of tense stops adaptation of English word-initial voiced stops (Kang 2008b)



- Kang (2008ab): The change in the word-initial voiced stop adaptation is a reflection of a tonogenesis like change for laryngeal contrast in stops (VOT → F0).

## 5. Conclusion

- (25) Loanword adaptation as a probe into nature of native language categories
- Contemporary Korean: **H1-H2** and Epenthetic vowel quality are the primary factors that guide /s/ adaptation. Fricative duration plays only a marginal role.
  - 1930s Korean: Epenthetic vowel quality and Duration are the primary factors that guide /s/ adaptation.

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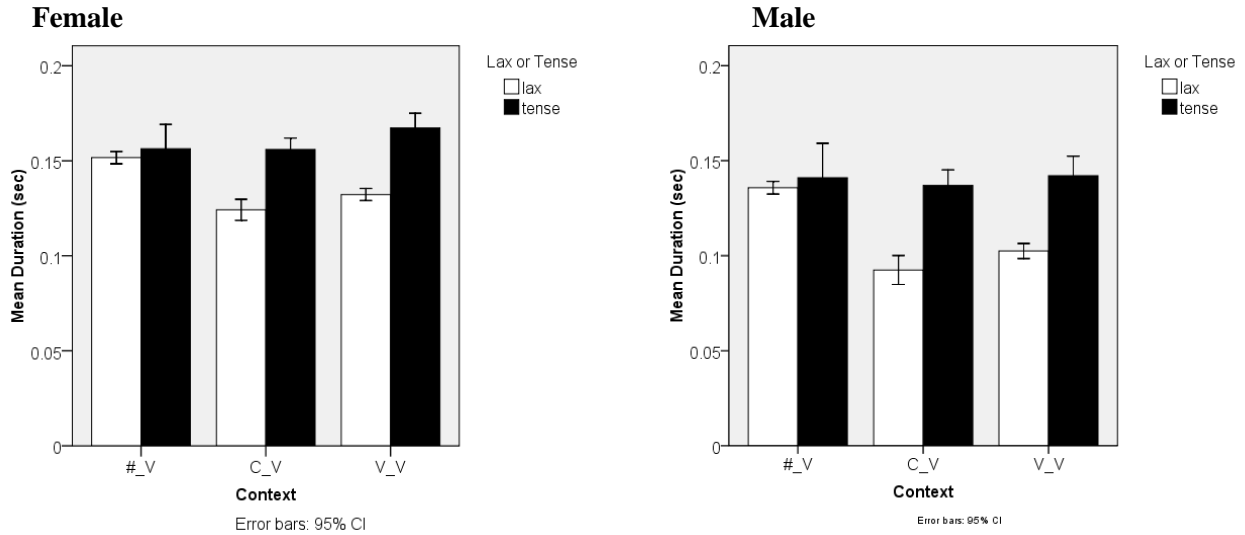
**Appendix: acoustic properties of Korean /s/ and /s\*/ based on BOLA corpus**

(26) Fricative duration

- The duration of /s/ tends to be shorter than that of /s\*/.
- But, the duration difference is not significant in word-initial position (when aspiration is included) (Ahn 1999, Cho et al 2002).

cf. Chang (2008) finds significant difference, even in the initial position.

Figure 13: Duration of Korean /s/ and /s\*/ by left-hand context

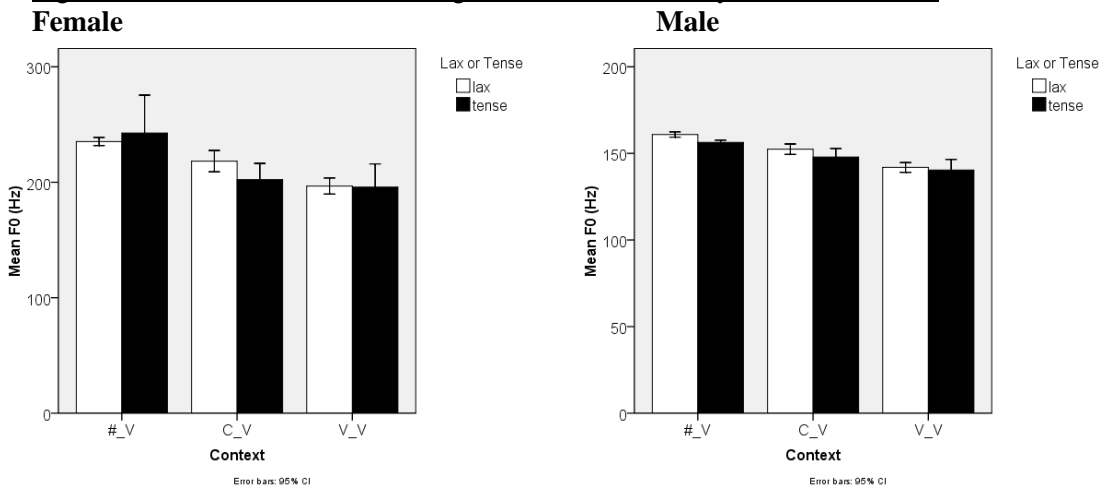


- Kim & Curtis (2002) also note that when asked to categorize word-initial /s/ into Korean /s/ and /s\*/ solely based on fricative duration, the subjects find the task very difficult.
- Moreover, according to Kang & Kang (2002, as reported in Kang and Yoon 2005) fricative duration in word-initial position does not affect Korean speakers' perception.

(27) F0 at the onset of the following vowel

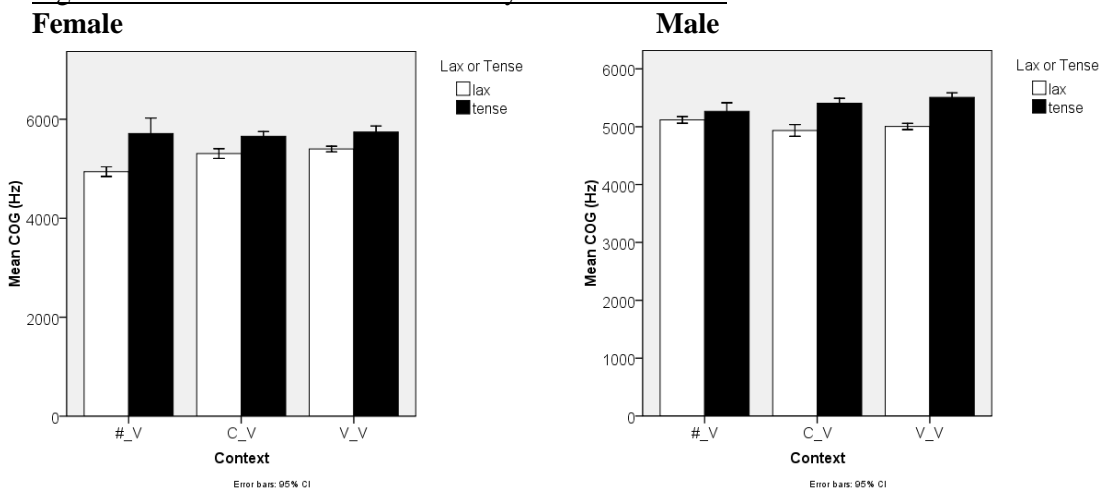
- No systematic difference in F0 is found (Kagaya 1973, Cho et al. 2002, Chang 2008)
- cf. Ahn (1999) found statistically significant difference in F0 (/s\*/ > /s/).

Figure 14: F0 of the vowel following Korean /s/ and /s\*/ by left-hand context



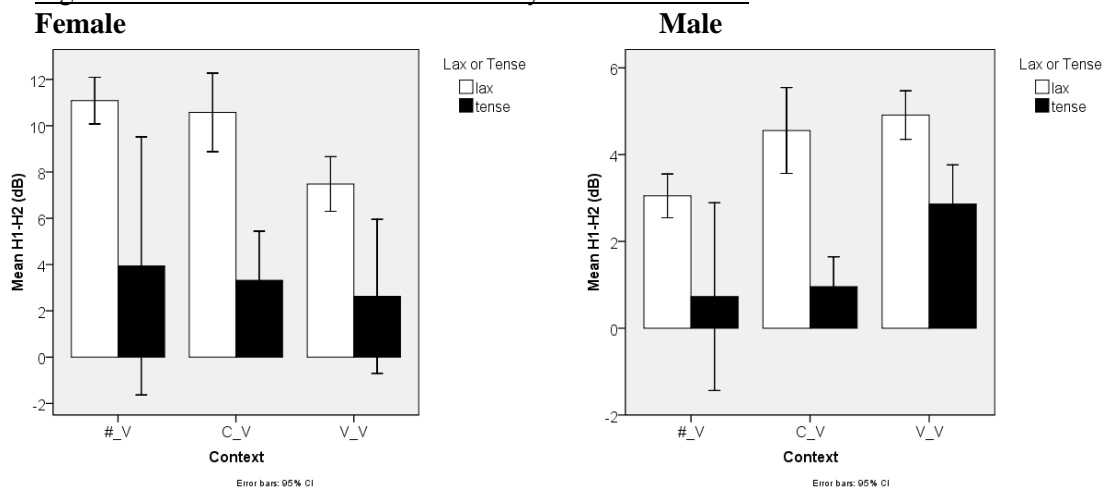
- (28) COG (Centre of gravity) of the fricative noise
- An indication of the size of the front cavity
  - /s\*/ shows a systematically higher centroid frequency than /s/ (Cho et al 2002).
- cf. Kim et al. (2005)'s MRI study on stops and affricates

Figure 15: COG of Korean /s/ and /s\*/ by left-hand context



- (29) H1-H2 at the onset of the following vowel
- A measure of breathiness of the vowel
  - H1-H2 is systematically higher for /s/ (i.e., breathier) than for /s\*/. (Cho et al. 2002, Ahn 1999, Chang 2008)

Figure 16: H1-H2 of Korean /s/ and /s\*/ by left-hand context



- (30) Summary: Reliability of different phonetic attributes in differentiating /s/ and /s\*/ or Korean.
- **Duration** separates the category well in word-medial position but marginally so in word-initial position
  - **F0** is not different.
  - **COG** and **H1-H2** separates the category well in all contexts.

		BOLA	Cho et al. (2002)	Ahn (1999)	Chang (2008)
Fricative duration	Word-initial	Not significant (including aspiration)	<b>Significant (excluding aspiration)</b>	Not significant (including aspiration?)	<b>Significant (including aspiration)</b>
	Word-medial	<b>Significant</b>	<b>Significant</b>	--	--
H1-H2	Word-initial	<b>Significant</b>	<b>Significant</b>	<b>Significant</b>	<b>Significant</b>
	Word-medial	<b>Significant</b>	(Significant)	--	--
F0	Word-initial	Not significant	Not significant	<b>Significant</b>	Not significant
	Word-medial	Not significant	(Not significant)	--	--
COG	Word-initial	<b>Significant</b>	<b>Significant</b>	--	--
	Word-medial	<b>Significant</b>	(Significant)	--	--