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The effects of L1 AP-initial boundary tones and laryngeal features in Korean adaptation of Japanese plosives followed by a H or L vowel

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The present study explores the magnitude of tonal effects and segmental voicing contrast in Korean categorization of Japanese plosives followed by a H or L vowel by conducting a perception experiment in which one hundred sixty native speakers of Seoul and Kyungsang Korean – eighty in each group (40 male and 40 female) – participated. The results have shown that, no matter whether they command a pitch-accent Kyungsang Korean or Seoul Korean which has no lexical pitch-accent, our subjects mostly categorized word-initial Japanese voiceless plosives as aspirated with the significant effect of H and word-medial voiceless plosives as either aspirated or fortis with no H/L effect. Their categorization of word-medial Japanese voiced plosives as lenis is not significantly affected by the H and L tonal difference, either, regardless of dialect differences. In their categorization of word-initial Japanese voiced plosives as lenis, however, the Seoul subjects favored L, and the Kyungsang subjects H.

From the results, we propose that the Korean prosodic unit of Accentual Phrase (AP) and laryngeal features interact in the Seoul subjects' categorization of word-initial Japanese plosives, such that the H/L tonal distinction is made in AP-initial position as enhancement with VOT primarily parsed for cues to the feature [\pm spread glottis]. As for their categorization of word-medial Japanese plosives with no tonal effect, we propose that closure duration is parsed for cues to the other feature [\pm tense]. The same proposal is made for the Kyungsang subjects' categorization except for the H effect in word-initial Japanese voiced plosives.

Keywords: AP-initial boundary tones; Seoul and Kyungsang Korean; Japanese plosives followed by a H or L vowel; articulatory features [\pm spread glottis] and [\pm tense]

1 Introduction

In loanword phonology the effects of L2 (i.e. donor language) prosody or segments on L1 (i.e. a host language) adaptation have been investigated (e.g. Polivanov 1931; 1974; Trubetzkoy 1939; Hyman 1970; Silverman 1992; Paradis & LaCharité 1997; Davis et al. 2012). In the Korean literature, for example, Kenstowicz & Sohn (2001), Lee (2009) and Davis & Lee (2010) among others have examined how English stress or Japanese pitch-accent is borrowed into Kyungsang Korean, and Kang (2003), Ito et al. (2006) and H. Kim (2006; 2007; 2008; 2009; 2014; 2017a; b) have discussed how English, French or Japanese consonants are borrowed into Korean. Some research has extended its focus on how prosodic and segmental factors do interact in L2 adaptation (e.g. Anderson-Hsieh et al. 1992; Munro & Derwing 1999; Cutler 2005; Munro 2008; Caspers & Horłóza 2012). It is in this vein that the present study is concerned with how Japanese H/L tones and segmental voicing contrast affect Korean categorization of Japanese plosives followed by a H or L vowel.

Japanese has a phonemic voicing contrast in plosives, as in (1a) (e.g. /hake/ ‘brush’ vs. /hage/ ‘bald’) (e.g. Shibatani 1990; Shimizu 1996; Tsujimura 1996), and Korean has no voicing contrast but the three-way phonation contrast (i.e. lenis, aspirated and fortis) in plosives which are all voiceless, as in (1b) (e.g. /tal/ ‘moon’, /t^hal/ ‘face mask’, /t’al/ ‘daughter’) (e.g. Kim et al. 2005; 2010; 2018).¹ Among the three-way phonation contrast, lenis plosives are often phonetically voiced in intervocalic position (e.g. Silva 1992; Jun 1994; Kim et al. 2018).

(1) Japanese (a) and Korean (b) plosives

- a. voiceless: p t k
voiced: b d g
- b. lenis: p t k
aspirated: p^h t^h k^h
fortis: p’ t’ k’

Another difference between the two languages is that Japanese is a pitch-accent language, whereas Korean is not except for a few dialects. Japanese has H and L tones of lexical pitch-accent (e.g. McCawley 1968; Haraguchi 1977; 1991; Shibatani 1990; Kubozono 1995; 2011; Tsujimura 1996). For example, the lexical pitch of Tokyo Japanese is a two-way contrast in (a) two-syllable words, a three-way contrast in (b) three-syllable words and a four-way contrast in (c) four-syllable words, when syllables are light, as shown in (2). Words with an accent are marked with ‘’ after an accented vowel, as in /a’mē/. The accented vowels have a H tone with preceding and following vowels having H and L, respectively. Yet, the pitch of the first syllable of a word is low unless the accent is placed on that syllable by virtue of the Initial Lowering Rule (Haraguchi 1977; 1991). The pitch of the first syllable of a Japanese word is also high when the syllable is heavy and has a sonorant in coda position (e.g. /kaisya/ HHH ‘company’; /kantan/ ‘ease’ HHH).

(2) Pitch-accent and tones in Tokyo Japanese (Shibatani 1990)

- a. two-syllable words
ame LH ‘candy’
a’mē HL ‘rain’
- b. three-syllable words
sakura LHH ‘cherry’
za’kuro HLL ‘pomegranate’
koko’ro LHL ‘heart’
- c. four-syllable words²
sirakaba LHHH ‘white birch’
ka’makiri HLLL ‘mantis’
iro’gami LHLL ‘color paper’
kagari’bi LHHL ‘torch’

However, Korean has no lexical pitch-accent except for the Kyungsang dialect in South Korea and the Hamkyung dialect in North Korea which are spoken in the southeastern and northeastern part, respectively, of the Korean peninsula (Ramsey 1978). Like Japanese, Kyungsang Korean which is further divided into two – the North Kyungsang

¹ In the text of the present paper, the notation ‘//’ is used for lexical representations, and in the list of loanwords the notation is not used, as in (2), for the simplicity of data presentation.

² The two words /sirakaba/ ‘white birch’ and /irogami/ ‘color paper’ are compounds. According to Kubozono (2011), most Japanese four-syllable words are compounds, at least etymologically, if they are Sino-Japanese and native words (e.g. /hirosima/ ‘Hiroshima’ and /yokohama/ ‘Yokohama’ for LHHH; /aza’rasi/ ‘seal (animal)’ and /naga’saki/ ‘Nagasaki’ for LHLL).

and South Kyungsang dialects – is a pitch-accent language (e.g. K. Chung 1980; G.-R. Kim 1988; Y.-H. Chung 1991; J.-W. Kim 1991; N.-J. Kim 1997; Lee 2009; Lee & Davis 2009, 2010). Thus, accent is lexically assigned to a specific syllable, and pitch patterns are predictable once lexical information such as accent locations or tone register is known in both the South and North Kyungsang dialects. The only difference between the two Kyungsang dialects is that there are no words beginning with LL in South Kyungsang Korean (e.g. Lee & Davis 2009). Unlike Kyungsang Korean, Seoul Korean has no lexical pitch-accent.

On the other hand, it is at a postlexical prosodic level that the H/L tonal distinction plays a role in both Seoul and Kyungsang Korean. According to Jun (1993; 1998; 2005a; b), the Korean three-way laryngeal contrast in plosives is correlated with a boundary tone in the first syllable of the post-lexical prosodic unit called Accentual Phrase (henceforth, AP) in Seoul Korean in intonational phonology (e.g. Pierrehumbert 1980; Beckman & Pierrehumbert 1986; Pierrehumbert & Beckman 1988). That is, words beginning with aspirated or fortis plosives systematically take a H-initial boundary tone and other words take a L-initial boundary tone in AP-initial position (e.g. H tones after the AP-initial aspirated and fortis plosives in /p^halɑŋ/ ‘blue’ and /p’alkɑŋ/ ‘red’ and a L tone after the AP-initial lenis plosive in /palam/ ‘wind’). Like Seoul Korean which has no lexical pitch-accent, (North and South) Kyungsang Korean has the same consonant-tone correlation in AP-initial position (e.g. G.-R. Kim 1988; Y.-H. Chung 1991; N.-J. Kim 1997; Kenstowicz & Park 2006; Lee 2009), though it has lexical tones as a pitch-accent language like Japanese. For example, Kenstowicz & Park (2006) have found that vowels after AP-initial aspirated and fortis consonants have higher F₀ values than those after their lenis counterparts in Kyungsang Korean, as in Seoul Korean. Therefore, regardless of the presence or absence of lexical pitch-accent, Seoul and Kyungsang Koreans are assumed to have boundary tones in AP-initial position.³

Given the differences between Japanese and Korean, we have come to raise two questions. One is how Japanese voiced and voiceless plosives followed by a H or L vowel are categorized into Seoul and Kyungsang Korean dialects in both word-initial and word-medial positions. The other question is how the H/L tonal distinction and segmental voicing contrast in Japanese affects their categorization. In order to explore these issues, a perception experiment was conducted by recruiting Seoul and Kyungsang Korean speakers.

The present study is structured as follows. In Section 2 and 3, the methods and results of our perception experiment are given, respectively; in Section 4 the results of the experiment are discussed; in Section 5 theoretical implications are made; and in Section 6 a brief conclusion is provided.

2 Methods

2.1 Materials

We used two-, three- and four-syllable Japanese words as test words, as shown in (3), because Japanese pitch accent occurs in those words (e.g. Shibatani 1990). In both word-initial and word-medial positions, the test words have the consonants /b, d, g, t, k/. Note that no test word begins with the voiceless plosive /p/ or has the consonant in word-medial position in (3), because there are few Japanese words with /p/ in word-initial and word-medial positions except for loanwords and mimetics. In order to avoid any spelling convention of Japanese loans frequently used in Korea, we selected real Japanese words which are not familiar at all to Koreans.

³ It has been reported that Korean speakers are sensitive to an L vs. H tonal distinction as a cue to AP-initial word (e.g. Jun 1993; 2005a; b; Jun & Fougeron 2000; S. Kim 2004). For example, S. Kim (2004) has found that the AP is an efficient unit for word segmentation in Korean, such that AP-initial H is attested when a word-initial consonant is either a fortis or an aspirated consonant, and AP-initial L when it is a lenis in her data corpus.

- (3) Japanese test words in the present experiment
- a. two-syllable words

bate'	LH	'being done in'
date	LH	'(family name, place name)'
gaka	LH	'painter'
kabe	LH	'wall'
tada	LH	'(family name, place name)'
mago'	LH	'grandchild'
 - b. three-syllable words

bake'ru	LHL	'to transform oneself'
dokuga	LHH	'poisonous moth'
gogaku	LHH	'study of languages'
kotoba'	LHH	'word, language'
tadami	LHH	'watching a game, etc. without paying the fee'
nakaba'	LHH	'middle, half'
 - c. four-syllable words

bakamono	LHHH	'idiot'
botebote	LHHH	'(onomatopoeia representing a heavy manner)'
dakareru	LHHH	'to be embraced'
gatagata	LHHH	'(onomatopoeia representing a rattling noise)'
katagami	LHHH	'(paper) pattern (for a dress)'
todoke'ru	LHHL	'to deliver, to report'

2.2 Participants

One hundred sixty native speakers of Seoul and Kyungsang Korean – eighty in each group (40 male and 40 female) – participated in the present perception experiment. Among the Kyungsang subjects, twenty-nine (16 male and 13 female) were from North Kyungsang and fifty-one from South Kyungsang (24 male and 27 female). All of the Korean subjects were university students in their twenties. The average age of the Seoul subjects was 22.6 years old and that of the Kyungsang subjects 21.1 years old when our experiment was conducted at a university in Seoul, Korea. As for our Kyungsang subjects, we recruited only Kyungsang subjects whose stay in Seoul was less than six months, because we assumed that their Kyungsang Korean would not have been contaminated yet by Seoul Korean since they just recently left their hometown for their undergraduate studies in Seoul. None of our Seoul and Kyungsang subjects had had any hearing impairments, and they had never learned Japanese, either.

2.3 Procedure

The test words were put in a frame sentence /korewa __desu/ 'This is __' and randomized. When followed by other words, the distinction between unaccented and final-accented words are realized on the surface in Japanese, as in /date desu/ LH HL vs. /bate' desu/ LH LL. Since the test words in (3) were cut off from the frame sentence in the present experiment, the distinction was not considered in this study. A male native speaker of Tokyo Japanese in his early 30s recorded the test words five times with no pause in the frame sentence at the soundproof recording room in the Laboratory of Phonetics and Phonology, CNRS/Sorbonne-Nouvelle (University of Paris 3). The recording was made at a sampling rate of 48 kHz and at a quantization of 16 bit using an Audio-technica AT8033 microphone. The recorded data were then resampled at 24 kHz.

The third repetitions of the five-time recorded test words were selected, and then F0 manipulations were made, using PSOLA in the phonetic analysis software Praat, as follows: HL for the two-syllable words; HLL for the three-syllable words except for /bake'ru/

as HLH; and HLLL for the four-syllable words except for /todoke'ru/ in (3) as HLLH. When pitch contours were changed, the Japanese speaker who recorded the test words in (3) and who is a trained phonetician checked all F0 manipulations and determined which resynthesized stimuli sounded natural in Tokyo Japanese. Thus, the resynthesized stimuli used for the present perception experiment were selected as natural based on the hearing judgment of the native speaker. In addition to the resynthesized stimuli, we also used the original pitch contours in the test words in (3) as Japanese stimuli in the present experiment. Therefore, the H and L distinction was made not only in word-initial position but also in word-medial position in the Japanese stimuli (i.e. LH vs. HL for two-syllable words; LHH vs. HLL or LHL vs. HLH for three-syllable words; LHHH vs. HLLL or LHHL vs. HLLH for four-syllable words).

The average F0 difference between H and L in the first and second vowels of all the Japanese stimuli was 30.9 Hz, and those between H and H, and L and L in the second, third and fourth vowels of the three- and four-syllable test words were 4.6 Hz and 6.2 Hz, respectively, when F0 was measured in the middle of each vowel. For example, Figure 1 shows the alignment of F0 movements in the Japanese word /katagami/ with the original pitch LHHH (Figure 1a) and a HLLL F0 manipulation (Figure 1b).

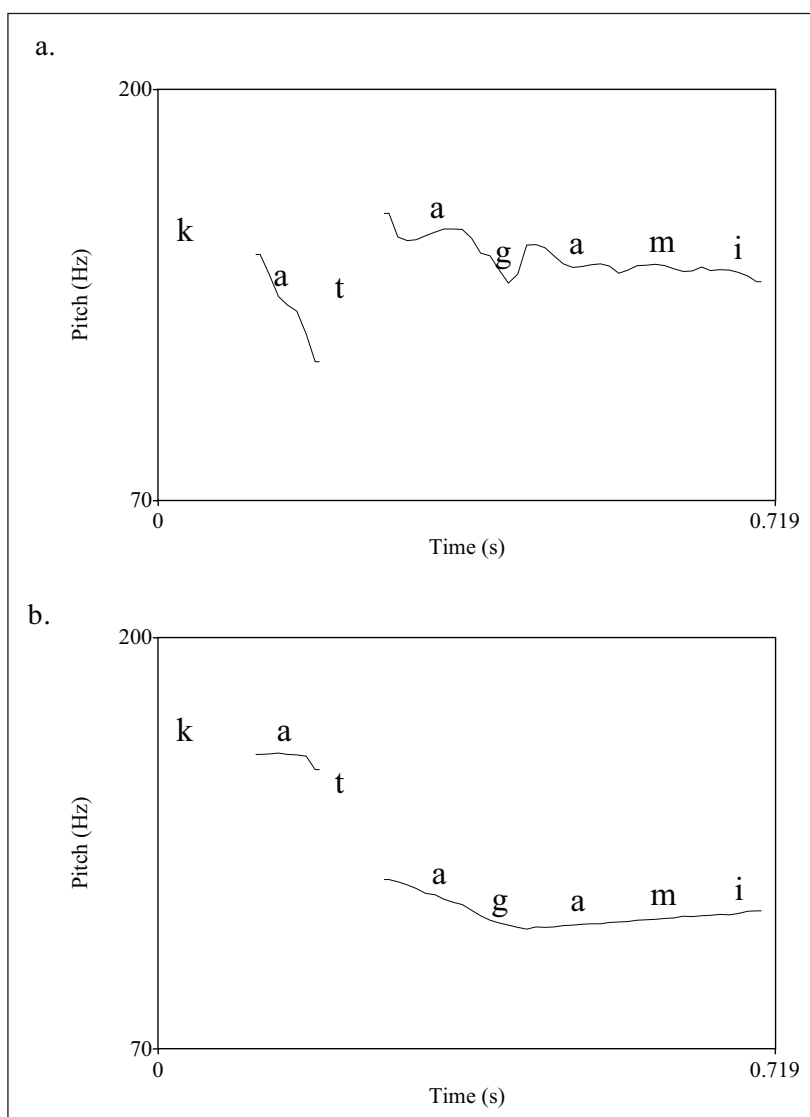


Figure 1: The alignment of F0 movements in the Japanese word katagami with (a) its original LHHH pitch and (b) a HLLL F0 manipulation.

The total number of stimuli was 36 (18 test words with original pitch contours in (3) + 18 resynthesized ones), and two repetitions of the stimuli were randomized at a four-second interval for one session. A total of 216 trials ((36 stimuli × 2 repetitions for one session) × 3 sessions) was presented to each participant. Thus, each stimulus was repeated six times in succession when each subject participated in the present perception experiment. In a quiet room, each subject was notified that Japanese words would be given and asked to listen to the prepared stimuli, using a headphone (HD 202 SENNHEISER or Shure SRH440) and to write them down in Korean orthography. The perception experiment was run using Praat’s ExperimentMFC facility.

3 Results

For the comparison of the Seoul and Kyungsang subjects’ categorization of Japanese plosives followed by a H or L vowel, we conducted a mixed-effect logistic regression model with Dialect (Seoul, Kyungsang), H/L and Dialect by H/L interaction as independent variables and the subjects’ categorization as a dependent variable.

3.1 Korean subjects’ responses for word-initial Japanese voiced plosives

Both Seoul and Kyungsang subjects mostly perceived the word-initial Japanese voiced plosives [b], [d], and [g] as lenis, no matter whether they are followed by a H or L vowel, as shown in Figure 2. Among the total four thousand eight hundred tokens (10 test words (i.e. *bate*, *date*, *gaka*, *bakeru*, *dokuga*, *gogaku*, *bakamono*, *botebote*, *dakareru* and *gatagata*) × 80 subjects (in each dialect group) × 6 repetitions) of the word-initial Japanese voiced plosives with a H vowel, the Seoul and Kyungsang subjects perceived 89% and 90.8%,

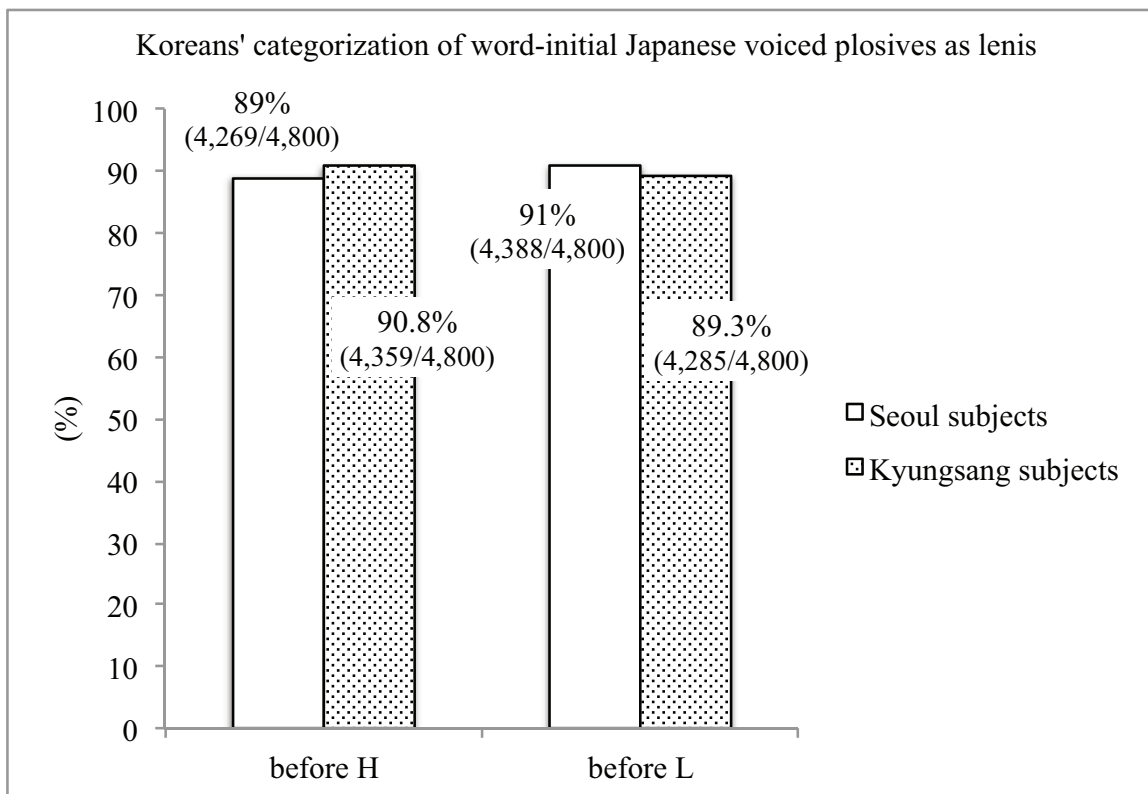


Figure 2: The overall percentage of Seoul and Kyungsang subjects’ categorization of word-initial Japanese voiced plosives as lenis when a following vowel is H or L.

respectively, as the lenis /p/, /t/ or /k/.⁴ As for the Japanese plosives with a L vowel, the Seoul subjects perceived 91%, and the Kyungsang subjects perceived 89.3% as lenis.⁵

Table 1(a) shows that there is no statistical difference in L between the Seoul and Kyungsang subjects' responses as lenis ($\beta = 0.358, p = 0.170$), and that the Kyungsang subjects' responses are significantly higher when the Japanese plosives are followed by H ($\beta = 0.207, p = 0.006$).⁶ The H/L difference is significant between the Seoul and Kyungsang subjects' responses ($\beta = -0.449, p < 0.001$), indicating that the Seoul subjects' are significantly higher when the plosives are followed by L ($\beta = -0.242$, i.e., $-0.449 + 0.207$).

The statistical results of Seoul subjects' categorization are shown in Table 1(b). They significantly categorized the word-initial voiced plosives as lenis in the four-syllable words when followed by a L vowel rather than when followed by a H vowel ($\beta = -0.548, p < 0.001$). Their responses as lenis are statistically higher in the two- and three-syllable words than in the four-syllable words when followed by L ($\beta = 0.614, p < 0.001$ for Syllable 2; $\beta = 0.654, p < 0.001$ for Syllable 3). The interaction of H/L and Syllable is also statistically higher in the two- and three-syllable words than in the four-syllable words ($\beta = 0.853, p < 0.001$ for H*Syllable 2; $\beta = 0.430, p = 0.029$ for H*Syllable 3). This means that the magnitude of H/L difference significantly reduces to 0.305 (i.e. $-0.548 + 0.853$) in the two-syllable words and to -0.118 (i.e. $-0.548 + 0.430$) in the three-syllable words, favoring H in the former and L in the latter. The probability of their categorization as lenis is shown in Figure 3(a). In the two- and three-syllable words, there is no tonal effect. Yet, the word-initial Japanese voiced plosives in the four-syllable words were significantly perceived as lenis, when followed by L.⁷

The Kyungsang subjects' categorization is not statistically different in the four-syllable words, no matter whether the plosives are followed by a H or a L vowel ($\beta = -0.194, p = 0.070$), as shown in Table 1(c). Their responses as lenis are statistically higher in the two- and three-syllable Japanese words than in the four-syllable words when followed by L ($\beta = 0.358, p = 0.004$ for Syllable 2; $\beta = 0.498, p < 0.001$ for Syllable 3). The interaction of H/L and Syllable is also significant in the two-syllable words ($\beta = 1.041, p < 0.001$ for H*Syllable 2) and in the three-syllable words ($\beta = 0.646, p = 0.001$ for H*Syllable 3), compared to the four-syllable words. This indicates that the magnitude of H/L difference significantly reduces to 0.847 (i.e. $-0.194 + 1.041$) and 0.452 (i.e. $-0.194 + 0.646$) in the two- and three-syllable words, respectively, favoring H. The probability of their categorization as lenis is given in Figure 3(b). The Kyungsang subjects significantly perceived word-initial

⁴ One might raise the question of whether there are any individual differences in their categorization. For this, we examined each subject's responses and found that there is no big difference among the subjects. For example, no subject had 40 or 30 responses as lenis among the 60 stimuli of word-initial Japanese voiced plosives followed by a H vowel. The same is true of the other categorizations in the following subsections.

⁵ See Appendix 1 for the distribution of Seoul and Kyungsang subjects' responses when the word-initial Japanese voiced plosives are followed by a H or L vowel.

⁶ In the present study, we used GENLIN MIXED analysis in SPSS v21 which provides *t* statistics for fixed effects (logistic regression coefficient) (see Heck et al. 2012). This is because *t* or *z* statistics is used in testing fixed effects in logistic regression, depending on which statistic package is used (see again Heck et al. 2012 for this). In the case of random effects in Table 1 and following tables, the statistics package we used provides *z* statistics. In addition, categorical variables are dummy-coded in this study. For example, for the two-syllable words beginning with /b, d, g/ in the test words /bate/, /date/ and /gaka/ with a H or L vowel, if a subject's response was lenis, 1 was coded, and otherwise, 0 was coded. Then the dummy-coded variables were treated as dependent variables, and we conducted mixed effect logistic regression model, using binomial logistic link function.

⁷ The *z*-test ($z = 5.306, p < 0.001$) in Table 1(b) suggests that there is a statistically significant variability in intercepts across the Seoul subjects (the results of the other *z*-tests in the following tables and Appendix 2 are interpreted in the same way).

Table 1: The statistical results of (a) Dialect (Seoul, KS), H/L and the interaction of Dialect and H/L in Seoul and Kyungsang (KS) subjects' responses as lenis for the word-initial Japanese voiced plosives [b, d, g], (b) Seoul and (c) Kyungsang subjects' responses for H/L, Syllable and the interaction of H/L and Syllable.

a.					
Fixed effect	coefficient	std.Error	t	sig.	
Seoul	0.358	0.261	1.372	0.170	
H	0.207	0.076	2.746	0.006	
Seoul*H	-0.449	0.11	-4.096	0.000	
(reference= KS, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.286	0.304	7.526	0.000	
b.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	-0.548	0.112	-4.887	0.000	
Syllable					
Syllable 2	0.614	0.143	4.290	0.000	
Syllable 3	0.654	0.144	4.535	0.000	
HL*Syllable					
H*Syllable 2	0.853	0.205	4.163	0.000	
H*Syllable 3	0.430	0.197	2.179	0.029	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.712	0.511	5.306	0.000	
c.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	-0.194	0.107	-1.812	0.070	
Syllable					
Syllable 2	0.358	0.125	2.863	0.004	
Syllable 3	0.498	0.128	3.883	0.000	
HL*Syllable					
H*Syllable 2	1.041	0.194	5.368	0.000	
H*Syllable 3	0.646	0.189	3.42	0.001	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.108	0.391	5.384	0.000	

Japanese voiced plosives as lenis when followed by a H vowel in the two- and three-syllable words, and there is no such H/L effect in the four-syllable Japanese words.

Recall that there were fifty-one from South Kyungsang (SK) and twenty-nine from North Kyungsang (NK) among our eighty Kyungsang subjects. From our mixed-effect logistic regression model with Dialect (SK, NK), H/L and Dialect by H/L interaction as independent variables and the subjects' categorization as lenis plosives as a dependent variable, we

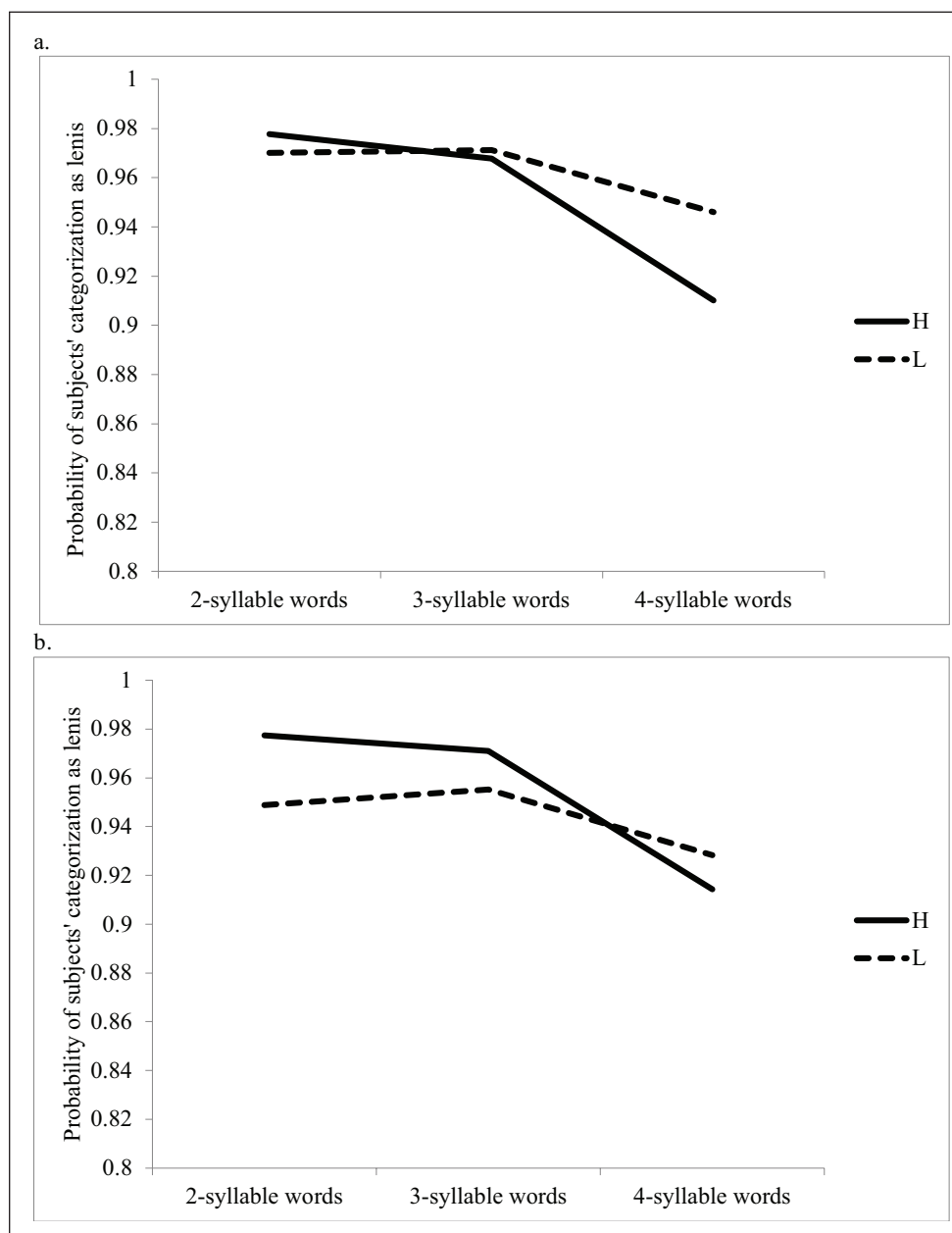


Figure 3: The probability of (a) Seoul and (b) Kyungsang subjects' categorization of word-initial Japanese voiced plosives as lenis when a following vowel is H or L.

have found that there is no statistical difference in L between South and North Kyungsang subjects ($\beta = 0.645, p = 0.068$) and that the H/L difference in the NK subjects' responses is not statistically different from that in the SK subjects' ($\beta = -0.068, p = 0.655$), as shown in Appendix 2(a) (see also Appendix 2b, c and d for the other examined contexts). This leads us to consider the South and North Kyungsang subjects as a homogeneous group in the present study.

3.2 Korean subjects' responses for word-initial Japanese voiceless plosives

When Japanese words begin with the voiceless plosives [k] and [t], our Seoul and Kyungsang subjects largely perceived the plosives as aspirated, regardless of whether the plosives are followed by a H or a L vowel, as in Figure 4. Among the total two thousand eight hundred eighty tokens (6 test words (i.e. *kabe*, *tada*, *kotoba*, *tadami*, *katagami* and *todokeru*) \times 80 subjects (in each dialect group) \times 6 repetitions) of the word-initial Japanese

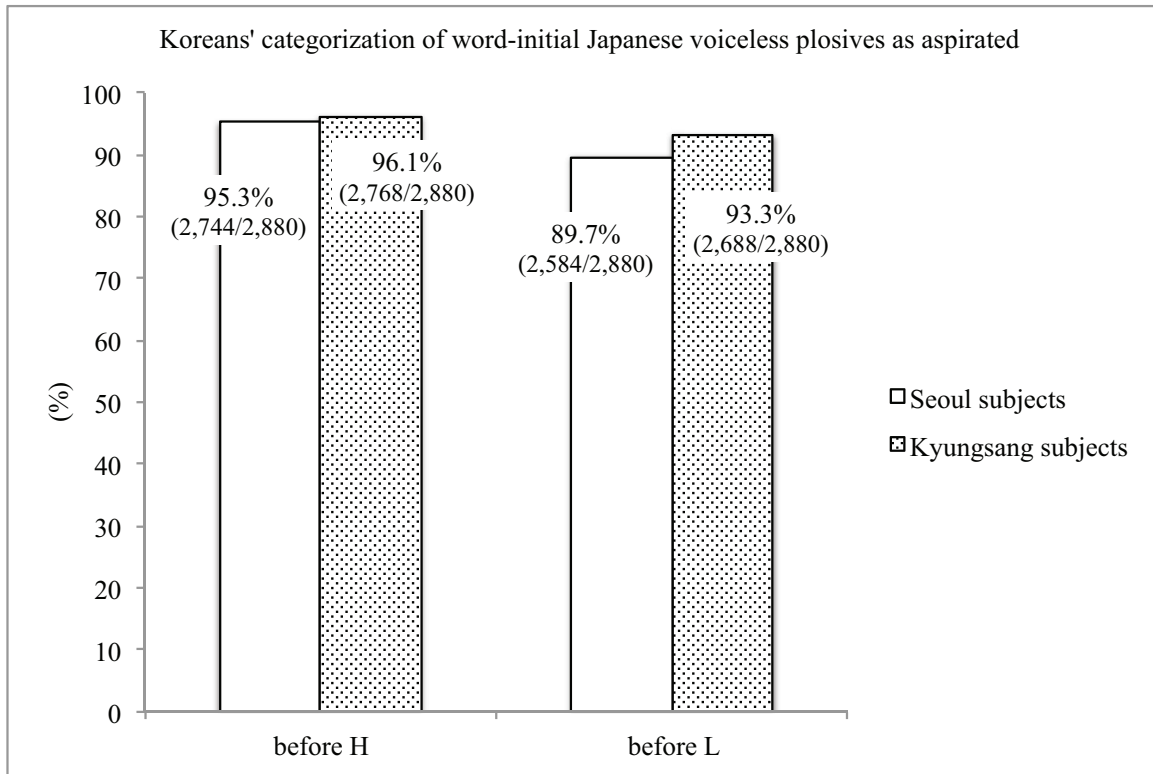


Figure 4: The overall percentage of Seoul and Kyungsang subjects' categorization of word-initial Japanese voiceless plosives as aspirated when a following vowel is H or L.

voiceless plosives with a H vowel, the Seoul and Kyungsang subjects perceived 95.3% and 96.1%, respectively, as the aspirated /k^h/ or /t^h/. When the Japanese plosives are followed by a L vowel, the Seoul subjects perceived 89.7%, and the Kyungsang subjects 93.3% as aspirated.⁸

The difference in L between the Seoul and Kyungsang subjects' categorization of the Japanese plosives is statistically significant ($\beta = -0.825, p = 0.007$), as in Table 2(a). Kyungsang subjects' categorization is significantly higher when the Japanese plosives are followed by H than when followed by L ($\beta = 0.797, p < 0.001$). The interaction of H/L and Dialect is not significant ($\beta = 0.346, p = 0.077$), indicating that the H/L difference is not significant between the Seoul and Kyungsang subjects' responses. That is, the Seoul subjects' responses favor H ($\beta = 1.13$, i.e. $0.346 + 0.797$) like the Kyungsang subjects'.

The statistical results of Seoul subjects' categorization are shown in Table 2(b). H is significantly favored in the four-syllable words ($\beta = 0.789, p < 0.001$), and their responses are statistically higher in the two-syllable words than in the four-syllable words when followed by L ($\beta = 0.499, p = 0.008$) and not significant in the three-syllable words ($\beta = -0.299, p = 0.071$). The interaction of H/L and Syllable is significant in the two-syllable words ($\beta = 1.256, p < 0.001$ for H*Syllable 2) and not significant in the three-syllable words ($\beta = 0.349, p = 0.210$ for H*Syllable 3), compared to the four-syllable words. This indicates that the magnitude of H/L difference significantly reduces to 2.045 (i.e. $0.789 + 1.256$) in the two-syllable words and non-significantly to 1.138 (i.e. $0.789 + 0.349$) in the three-syllable words. In other words, H is significantly favored in the two- and three-syllable words, as in the four-syllable words. The probability of their categorization as aspirated is presented in Figure 5(a). It is noteworthy that the two lines

⁸ See Appendix 3 for the distribution of Seoul and Kyungsang subjects' responses when the Japanese word-initial voiceless plosives are followed by a H or L vowel.

Table 2: The statistical results of (a) Dialect (Seoul, KS), H/L and the interaction of Dialect and H/L in Seoul and Kyungsang (KS) subjects' responses as aspirated for the word-initial Japanese voiceless plosives [k, t], (b) Seoul and (c) Kyungsang subjects' responses for H/L, Syllable and the interaction of H/L and Syllable.

a.					
Fixed effect	coefficient	std.Error	t	sig.	
Seoul	-0.825	0.308	-2.678	0.007	
H	0.797	0.148	5.388	0.000	
Seoul*H	0.346	0.195	1.770	0.077	
(reference= KS, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.752	0.388	7.084	0.000	
b.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.789	0.199	3.962	0.000	
Syllable					
Syllable 2	0.499	0.188	2.663	0.008	
Syllable 3	-0.299	0.165	-1.807	0.071	
HL*Syllable					
H*Syllable 2	1.256	0.386	3.252	0.001	
H*Syllable 3	0.349	0.278	1.254	0.210	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.534	0.496	5.112	0.000	
c.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.642	0.235	-2.733	0.006	
Syllable					
Syllable 2	0.885	0.246	3.598	0.000	
Syllable 3	-0.109	0.208	-0.521	0.603	
HL*Syllable					
H*Syllable 2	0.470	0.405	1.161	0.246	
H*Syllable 3	0.209	0.332	0.628	0.530	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	3.285	0.664	4.945	0.000	

for H and L fall apart at each level of syllable length with the line for H above that for L. This means that the Seoul subjects significantly perceived the word-initial Japanese voiceless plosives as aspirated when the plosives are followed by H rather than by L, regardless of the number of syllables in Japanese words.

In the Kyungsang subjects' categorization, H is significantly favored in the four-syllable words ($\beta = 0.642, p = 0.006$), and their responses as aspirated are statistically higher in

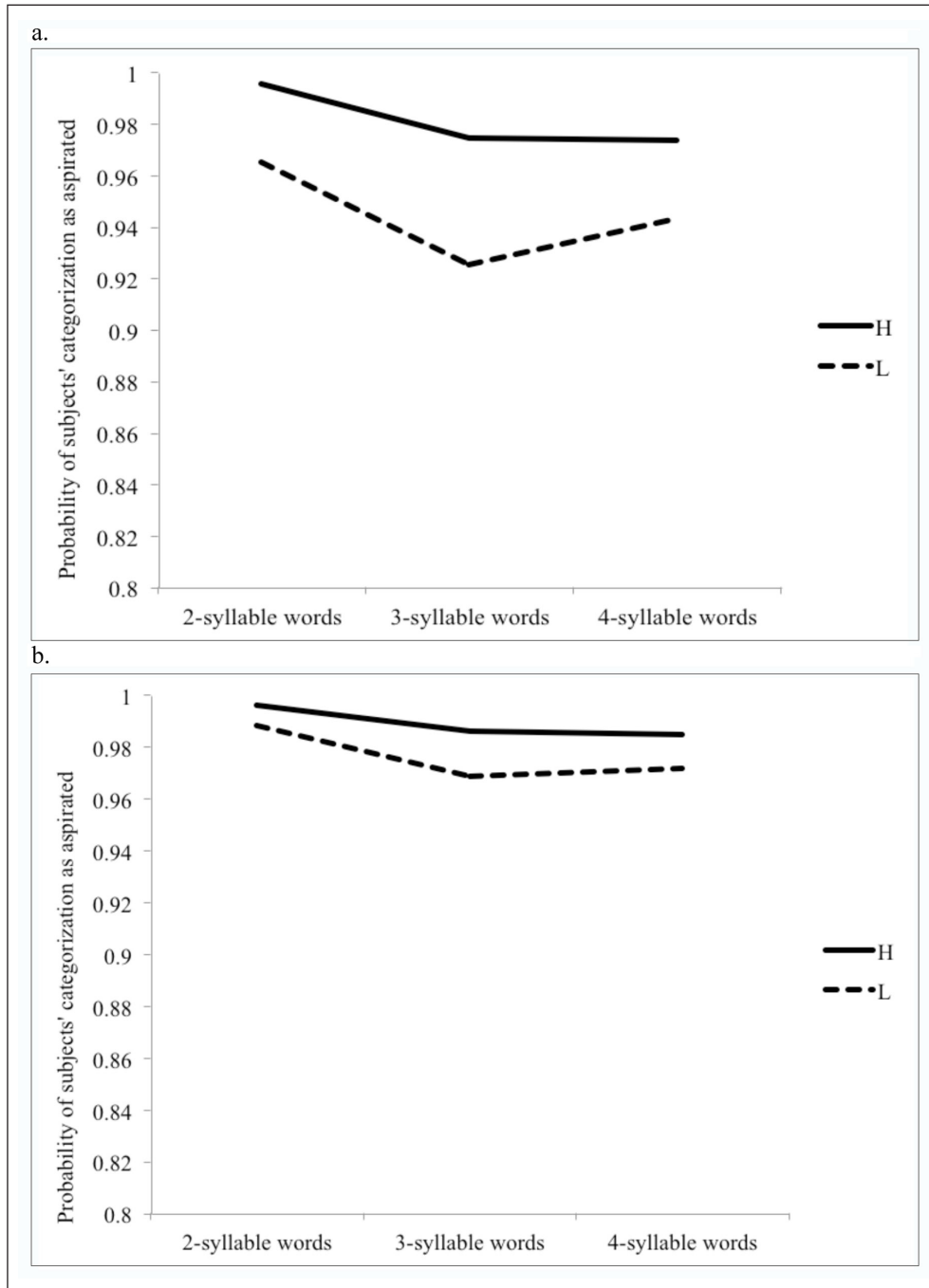


Figure 5: The probability of (a) Seoul and (b) Kyungsang subjects' categorization of word-initial Japanese voiceless plosives as aspirated when a following vowel is H or L.

the two-syllable words than in the four-syllable words when followed by L ($\beta = 0.885, p < 0.001$) and not significant in the three-syllable words ($\beta = -0.109, p = 0.603$), as in Table 2(c). The interaction of H/L and Syllable is not statistically higher in the two- and three-syllable words than in the four-syllable words ($\beta = 0.470, p = 0.246$ for H*Syllable 2; $\beta = 0.209, p = 0.530$ for H*Syllable 3), indicating that H is significantly favored in the two- and three-syllable words, as in the four-syllable words. The probability of their categorization reveals that the two lines for H and L fall apart at each level of syllable length with the line for H above that for L, as in Figure 5(b). Like the Seoul subjects, the Kyungsang subjects had better categorization of the word-initial Japanese voiceless plosives at each level of syllable length when a tone in a following vowel is H.

3.3 Korean subjects' responses for word-medial Japanese voiced plosives

As in word-initial position, both the Seoul and Kyungsang subjects largely tended to perceive the word-medial Japanese voiced plosives [b], [d] and [g] as the lenis /p/, /t/, and /k/, respectively, regardless of whether a following vowel has H or L, as shown in Figure 6. Among the total five thousand seven hundred sixty tokens (12 test words (i.e. *kabe*, *tada*, *mago*, *kotoba*, *nakaba*, *tadami*, *dokuga gogaku*, *botebote*, *todokeru*, *katagami* and *gatagata*) × 80 subjects (in each dialect group) × 6 repetitions) of the word-medial Japanese voiced plosives with a H vowel, the Seoul and Kyungsang subjects perceived 92.2% and 93.6%, respectively, as the lenis /p/, /t/ or /k/. When the Japanese plosives are followed by a L vowel, the Seoul subjects perceived 91.5%, and the Kyungsang subjects 93.2% as lenis.⁹

From the statistical results in Table 3(a), we can note that the difference in L between the Seoul and Kyungsang subjects' responses is not significant ($\beta = -0.406, p = 0.096$) and that there is no tonal effect in Kyungsang subjects' responses ($\beta = 0.090, p = 0.253$). The H/L difference is not significant either ($\beta = -0.015, p = 0.886$), indicating that there is no tonal effect in the Seoul subjects' responses as in the Kyungsang subjects'.

In the Seoul subjects' categorization, H is significantly favored in the four-syllable words ($\beta = 0.315, p = 0.026$), and their responses as lenis are statistically higher in the three-syllable words ($\beta = -0.515, p < 0.001$ for Syllable 3) than in the four-syllable words when followed by L and not significant in the two-syllable words ($\beta = 0.060, p = 0.680$ for Syllable 2), as in Table 3(b). The interaction of H/L and Syllable is not statistically higher in the two-syllable words than in the four-syllable words ($\beta = -0.060, p = 0.783$ for

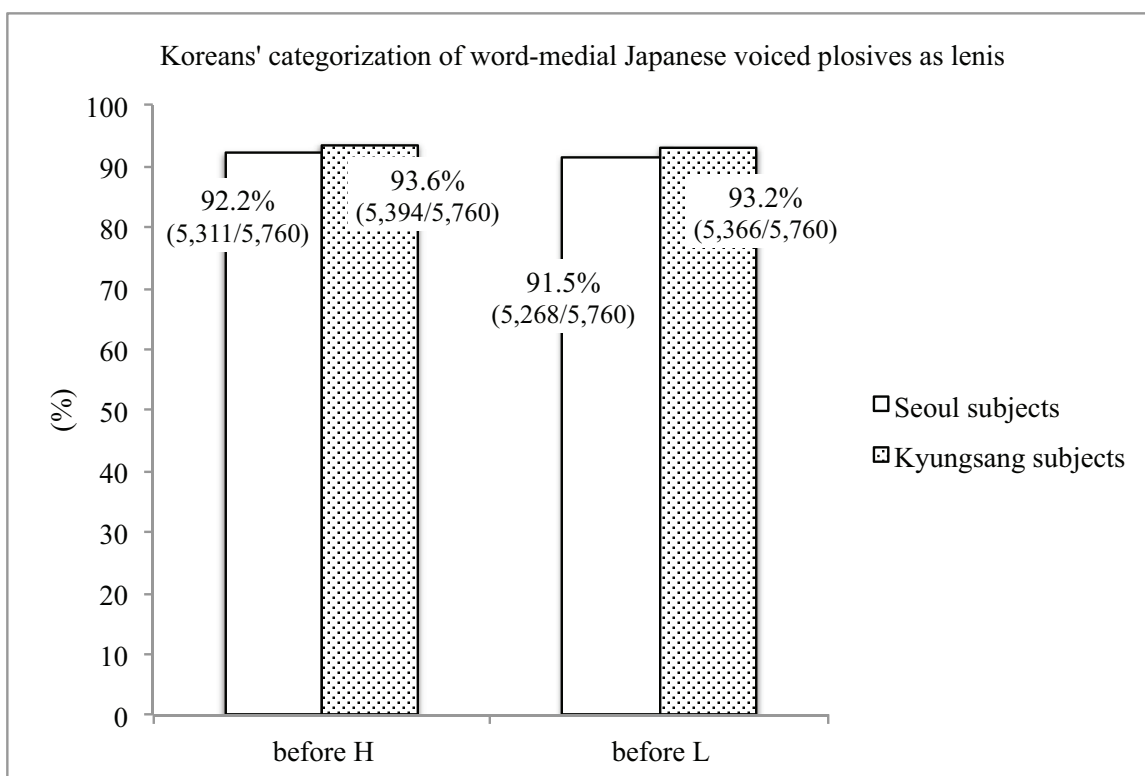


Figure 6: The overall percentage of Seoul and Kyungsang subjects' categorization of word-medial Japanese voiced plosives as lenis when a following vowel is H or L.

⁹ See Appendix 4 for the distribution of Seoul and Kyungsang subjects' responses when the word-medial Japanese voiced plosives are followed by a H or L vowel.

Table 3: The statistical results of (a) Dialect (Seoul, KS), H/L and the interaction of Dialect and H/L in Seoul and Kyungsang (KS) subjects' responses as lenis for the word-medial Japanese voiced plosives [b, d, g], (b) Seoul and (c) Kyungsang subjects' responses for H/L, Syllable and the interaction of H/L and Syllable.

a.					
Fixed effect	coefficient	std.Error	t	sig.	
Seoul	-0.406	0.244	-1.666	0.096	
H	0.090	0.079	1.144	0.253	
Seoul*H	-0.015	0.106	-0.143	0.886	
(reference= KS, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	1.956	0.273	7.166	0.000	
b.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.315	0.141	2.233	0.026	
Syllable					
Syllable 2	0.060	0.145	0.412	0.680	
Syllable 3	-0.515	0.117	-4.403	0.000	
HL*Syllable					
H*Syllable 2	-0.060	0.217	-0.275	0.783	
H*Syllable 3	-0.414	0.172	-2.415	0.016	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	1.682	0.334	5.034	0.000	
c.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.015	0.174	0.087	0.931	
Syllable					
Syllable 2	-0.889	0.160	-5.575	0.000	
Syllable 3	-0.912	0.146	-6.266	0.000	
HL*Syllable					
H*Syllable 2	0.460	0.235	1.961	0.050	
H*Syllable 3	-0.081	0.206	-0.397	0.692	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.329	0.456	5.108	0.000	

H*Syllable 2) and statistically higher in the three-syllable words ($\beta = -0.414, p = 0.016$ for H*Syllable 3). This means that the magnitude of H/L difference significantly reduces to -0.099 (i.e. $-0.414 + 0.315$) in the three-syllable words, favoring L. The probability of their categorization as lenis is given in Figure 7(a). The only significant tonal effect is in the four-syllable words when followed by a H vowel. In the two- and three-syllable words, there is no tonal effect.

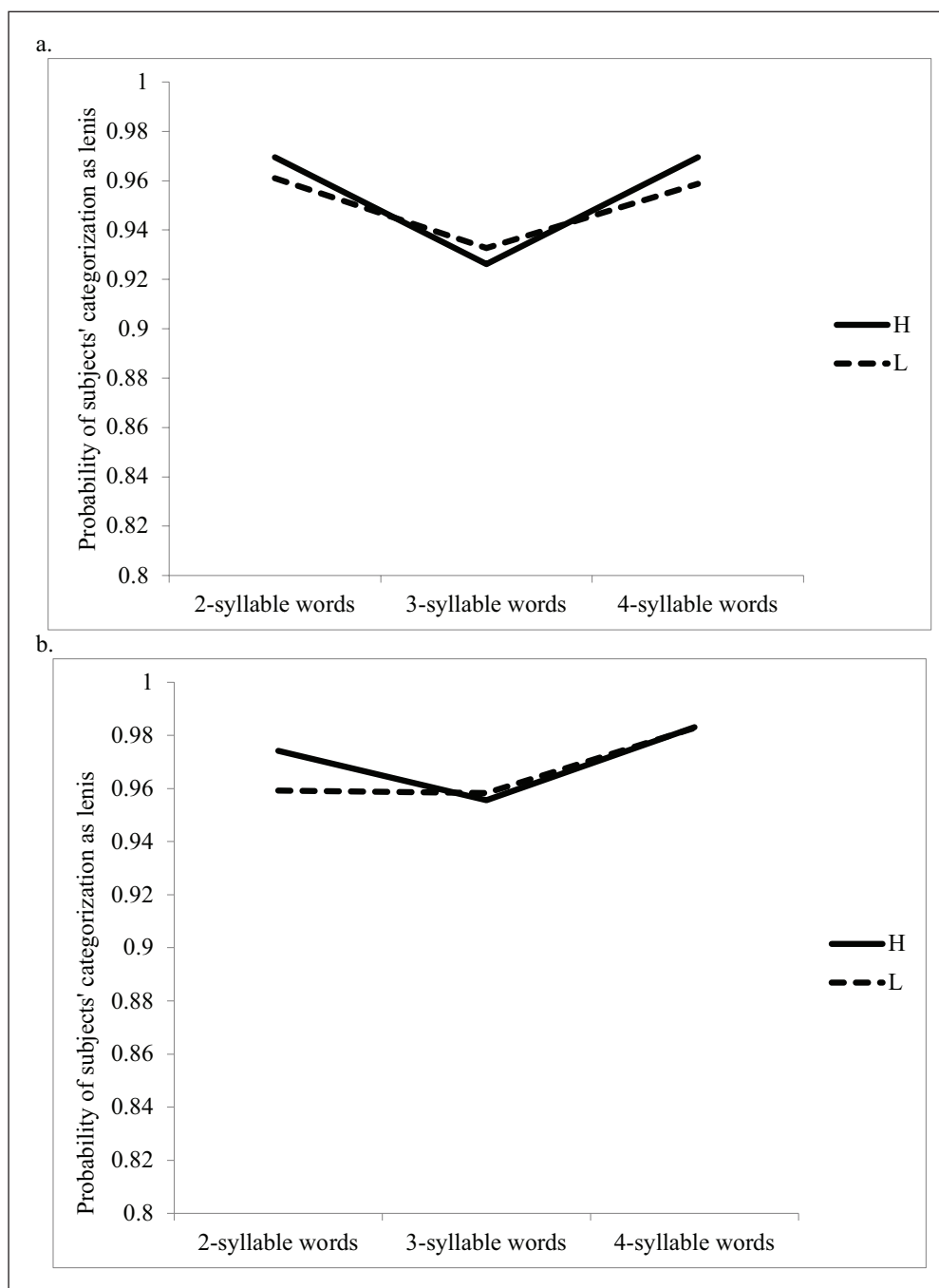


Figure 7: The probability of (a) Seoul and (b) Kyungsang subjects' categorization of word-medial Japanese voiced plosives as lenis when a following vowel is H or L.

In the Kyungsang subjects' categorization, there is no tonal effect in the four-syllable words ($\beta = 0.015, p = 0.931$), and their responses as lenis are statistically higher in the two- and three-syllable words than in the four-syllable words when followed by L ($\beta = -0.889, p < 0.001$ for Syllable 2; $\beta = -0.912, p < 0.001$ for Syllable 3), as in Table 3(c). The interaction of H/L and Syllable is statistically higher in the two-syllable words than in the four-syllable words ($\beta = 0.460, p = 0.050$ for H*Syllable 2) and not significant in the three-syllable words ($\beta = -0.081, p = 0.692$ for H*Syllable 3). That is, the magnitude of H/L difference significantly reduces to 0.475 (i.e. $0.460 + 0.015$) in the two-syllable words, favoring H. The probability of their categorization as lenis is shown in Figure 7(b). The Kyungsang subjects significantly perceived word-medial Japanese voiced plosives as

lenis when followed by a H vowel only in the two-syllable words. In the three- and four-syllable Japanese words, the difference in H and L did not affect their categorization of the plosives as lenis.

3.4 Korean subjects' responses for word-medial Japanese voiceless plosives

In the case of the word-medial Japanese voiceless plosives [k] and [t], both the Seoul and Kyungsang subjects largely perceived them as either aspirated or fortis, that is, /k^h/ or /k'/ and /t^h/ or /t'/, respectively, no matter whether the plosives are followed by a H or L vowel, as in Figure 8(a). Among the total seven thousand six hundred eighty tokens (16 test words (i.e. *gaka*, *bate*, *date*, *bakeru*, *dokuga*, *gogaku*, *nakaba*, *kotoba*, *bakamono*, *botebote*, *dakareru*, *gatagata*, *katagami* and *todokeru*) × 80 subjects (in each dialect group) × 6 repetitions) of the word-medial Japanese voiceless plosives with a H vowel, the Seoul and Kyungsang subjects perceived 97% and 96.4%, respectively, as either aspirated or fortis. When the Japanese voiceless plosives are followed by a L vowel, the Seoul subjects perceived 96.4%, and the Kyungsang subjects 95.8%.¹⁰

The distribution of Seoul subjects' responses showed that, when followed by a H vowel, 56.9% were perceived as fortis and 43.1% as aspirated, and that when followed by a L vowel, 59.2% as fortis and 40.8% as aspirated, as shown in Figure 8(b).¹¹ The similar distribution of Kyungsang subjects' responses was found: when followed by a H vowel, 53% were perceived as fortis and 47% as aspirated, and when followed by a L vowel, 50.7% were perceived as fortis and 49.3% as aspirated, as in Figure 8(c).

The difference in L between Seoul and Kyungsang subjects' responses is not statistically significant ($\beta = 0.265$, $p = 0.405$), and there is no tonal effect in Kyungsang subjects' categorization of the word-medial Japanese voiceless plosives ($\beta = 0.157$, $p = 0.080$), as shown in Table 4(a). The interaction of H/L and Dialect is not significant either ($\beta = 0.077$, $p = 0.565$), indicating that the H/L difference in the Seoul subjects' responses is not statistically different from that in the Kyungsang subjects'.

The statistical results of Seoul subjects' categorization are shown in Table 4(b). The Seoul subjects had no H/L tonal effect in the four-syllable words ($\beta = 0.212$, $p = 0.080$). The interaction of H/L and Syllable is not significantly higher in the two- and three-syllable words ($\beta = -0.127$, $p = 0.639$ for H*Syllable 2; $\beta = 0.309$, $p = 0.268$ for H*Syllable 3) than in the four-syllable words, indicating that the H/L difference in the former is not statistically different from that in the latter. The probability of their categorization as either aspirated or fortis is presented in Figure 9(a). The two lines for H and L are almost overlapped at each level of syllable length. In other words, there is no tonal effect on the Seoul subjects' categorization of the Japanese plosives as either aspirated or fortis, regardless of the number of syllables in Japanese words.

Like the Seoul subjects, the Kyungsang subjects had no H/L tonal effect in the four-syllable words ($\beta = 0.108$, $p = 0.385$) and no significant interaction of H/L and Syllable in the two- and three-syllable words, compared to the four-syllable words ($\beta = 0.011$, $p = 0.959$ for H*Syllable 2; $\beta = 0.199$, $p = 0.373$ for H*Syllable 3), as in Table 4(c). The probability of their categorization is presented in Figure 9(b) where the two lines for H and L at each level of syllable length is almost completely overlapped, as in Figure 9(a). Thus, the H and L tonal distinction has no effect on the Kyungsang subjects' categorization of the word-medial Japanese voiceless plosives, regardless of the number of syllables in Japanese words, as in the Seoul subjects' categorization.

¹⁰ See Appendix 5 for the distribution of Seoul and Kyungsang subjects' responses when the word-medial Japanese voiceless plosives are followed by a H or L vowel.

¹¹ The Korean adaptation of the word-medial Japanese voiceless plosives as either fortis or aspirated is a free alternation (e.g. H. Kim 2008).

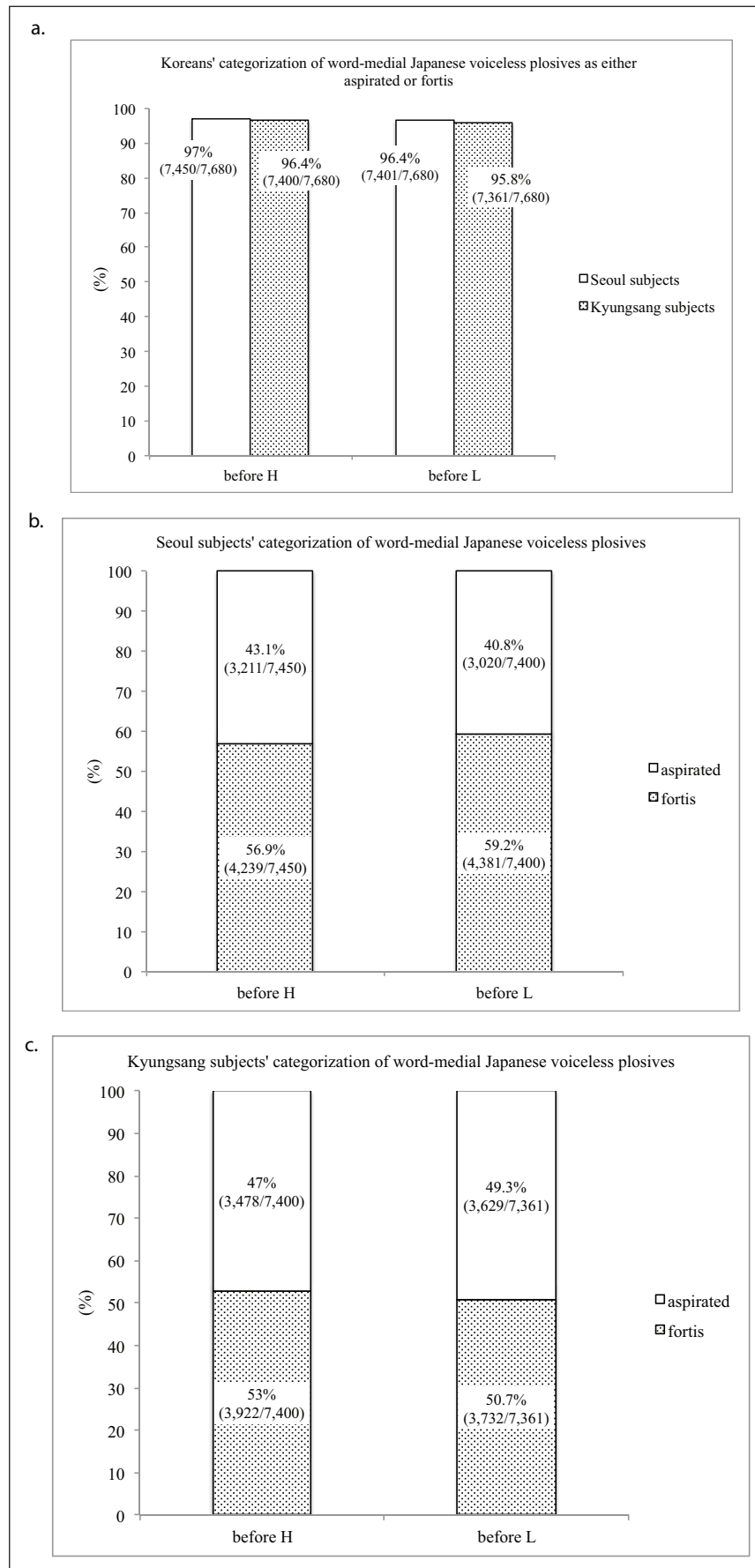


Figure 8: The overall percentage of (a) Seoul and Kyungsang subjects' categorization, (b) Seoul and (c) Kyungsang subjects' categorization of word-medial Japanese voiceless plosives as either aspirated or fortis when a following vowel is H or L.

Table 4: The statistical results of (a) Dialect (Seoul, KS), H/L and the interaction of Dialect and H/L in Seoul and Kyungsang (KS) subjects' responses as either aspirated or fortis for the word-medial Japanese voiceless plosives [k, t], (a) Seoul and (b) Kyungsang subjects' responses for H/L, Syllable and the interaction of H/L and Syllable.

a.					
Fixed effect	coefficient	std.Error	t	sig.	
Seoul	0.265	0.319	0.833	0.405	
H	0.157	0.090	1.750	0.080	
Seoul*H	0.077	0.133	0.575	0.565	
(reference= KS, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	3.089	0.438	7.053	0.000	
b.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.212	0.121	1.751	0.080	
Syllable					
Syllable 2	0.643	0.188	3.423	0.001	
Syllable 3	1.168	0.180	6.499	0.000	
HL*Syllable					
H*Syllable 2	-0.127	0.271	-0.469	0.639	
H*Syllable 3	0.309	0.279	1.108	0.268	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	3.404	0.686	4.963	0.000	
c.					
Fixed effect	coefficient	std.Error	t	sig.	
HL					
H	0.108	0.124	0.870	0.385	
Syllable					
Syllable 2	-0.286	0.154	-1.852	0.064	
Syllable 3	0.332	0.150	2.208	0.027	
HL*Syllable					
H*Syllable 2	0.011	0.222	0.051	0.959	
H*Syllable 3	0.199	0.223	0.890	0.373	
(reference= Syllable 4, L)					
Random effect	variance	std.Error	Z	sig.	
intercept	2.885	0.573	5.032	0.000	

To sum up, we have noted in this section that the Seoul and Kyungsang subjects' categorization of word-initial Japanese voiceless plosives as aspirated is significantly affected by H and that their categorization of word-medial Japanese voiceless plosives as either aspirated or fortis is not affected by the H/L difference, no matter whether Japanese words are two, three or four syllables in length. Their categorization of word-medial Japanese voiced plosives as lenis is not significantly affected by the H and L tonal difference, either.

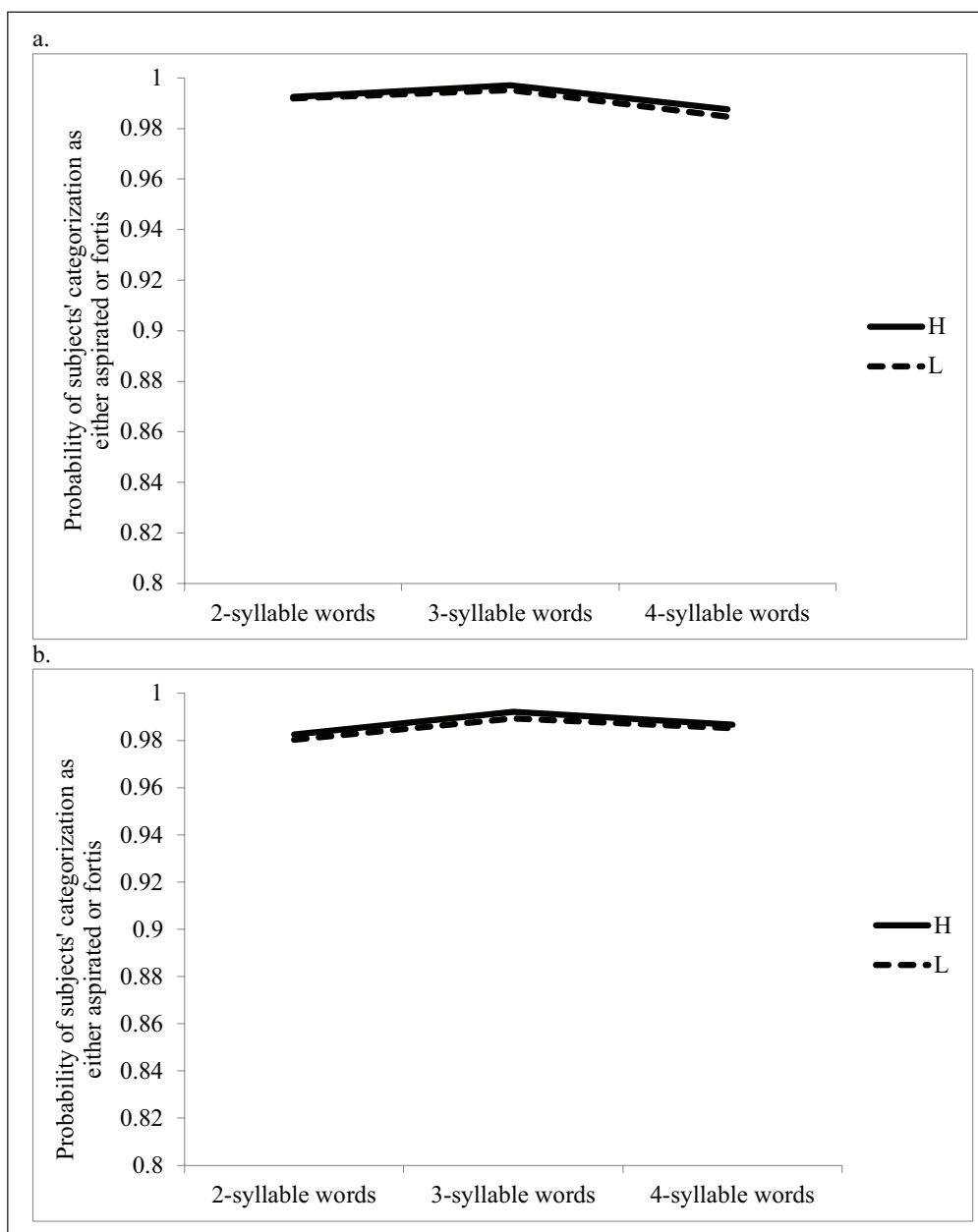


Figure 9: The probability of (a) Seoul and (b) Kyungsang subjects' categorization of word-medial Japanese voiceless plosives as either aspirated or fortis when a following vowel is H or L.

In the case of word-initial Japanese voiced plosives, the Seoul and Kyungsang subjects' categorization as lenis showed that the former favored L and the latter H. In the next section, these results are discussed.

4 Discussion

First, as for Seoul subjects' categorization of Japanese plosives followed by a H or L vowel, we propose that the Korean prosodic unit of AP and laryngeal features do interact, such that the H/L tonal distinction is made, as enhancement, in AP-initial position, and other acoustic properties (i.e. VOT and closure duration) are primarily parsed for cues to Korean laryngeal features.

Given that it is only in word-initial position that the difference in H and L affects the Seoul subjects' categorization of Japanese plosives, we suggest that the H/L tonal

distinction is made in AP-initial position in their adaptation of the Japanese plosives followed by a H or L vowel. Recall that the Japanese test words in (3) were put in the frame sentence /korewa __desu/ ‘This is __’ and that they were cut from the frame sentence and presented in isolation in the present experiment. The Japanese carrier sentence is phrased as one *Intonational Phrase* (henceforth, IP) with two APs in a lower prosodic domain, that is, ${}_{IP} [{}_{AP} [korewa] {}_{AP} [_desu]]$ in an autosegmental-metrical model of intonation (e.g. Pierrehumbert 1980; Beckman & Pierrehumbert 1986; Pierrehumbert & Beckman 1988).¹² Following the Strict Layer Hypothesis (Selkirk 1986) that the beginning and end of each higher domain is also the beginning and end of lower domains, the word-initial plosives of the Japanese test words presented to Korean subjects are in IP- and hence AP-initial position.¹³ Thus, our Seoul subjects’ sensitivity to the H vs. L distinction in word-initial Japanese plosives suggests that the Korean prosodic unit of AP plays a role in their categorization of the Japanese plosives, as in the native grammar.

We also propose that other acoustic properties are primarily involved in the Seoul subjects’ categorization of word-initial Japanese plosives with the AP-initial H and L tones as enhancement. As for the other acoustic properties, the examination of Voice Onset Time (VOT) (i.e. the time between the release of a consonant and the onset of voicing in a following vowel) (e.g. Ladefoged 2001) and closure duration of the five-repeated Japanese tokens in (3) revealed that the difference in VOT between word-initial Japanese voiced and voiceless plosives is 31 ms and that in closure duration is 2 ms, as shown in Table 5(a). In the case of word-medial Japanese voiced and voiceless plosives, the difference in closure duration is 28 ms and that in VOT is 9 ms, as in Table 5(b).¹⁴

The acoustic properties of VOT and closure duration are articulatorily correlated with glottal opening and linguopalatal or lip contact duration, respectively, in Korean (Kim et al. 2005; 2010; 2018).¹⁵ Given that VOT results from glottal opening and that glottal opening peak is significantly higher in aspirated plosives than in non-aspirated plosives (Kim et al. 2018), aspirated plosives are specified as [+spread glottis] (henceforth, [+s.g.]), and

Table 5: The average of closure duration and VOT with standard deviations in parentheses in our Japanese test words (a) word-initially and (b) word-medially (unit: ms).

		closure duration	VOT
a.	voiced plosives:	75 (22.7)	16 (11.6)
	voiceless plosives:	77 (13.8)	47 (12.3)
b.	voiced plosives:	54 (10.9)	10 (7.4)
	voiceless plosives:	82 (12.7)	19 (7.2)

¹² In intonational phonology, it has been assumed that *Syllables* are grouped into *Words*, *Words* into APs, and APs into IPs.

¹³ In Korean, most APs have three or four syllables and one or two content words (e.g. Jun & Fougeron 2000; S. Kim 2004), and in Japanese most APs have four or five syllables (e.g. Pierrehumbert & Beckman 1988; Venditti 2005; Ueyama & Jun 1998; Warner et al. 2010).

¹⁴ Recall that the closure duration of word-initial Japanese voiceless plosives could be measured, because in our recording of the test words in (3), the native speaker of Tokyo Japanese was asked not to make a pause in the whole frame sentence /korewa __desu/ ‘This is __’.

¹⁵ According to MRI studies on Korean stops, Kim et al. (2005; 2010) have found that glottal opening is larger in aspirated than in lenis and fortis plosives and that lip closure or linguopalatal contact is longer in aspirated and fortis plosives in concomitant with vertical laryngeal movements higher than in lenis counterparts in both word-initial and word-medial plosives. See also Kim et al. (2018) for ePGG, aerodynamic and acoustic data for the three-way phonation contrast in Korean plosives. What they have found is that aspirated plosives are significantly different from lenis and fortis ones in glottal opening peak, airflow peak height and duration of aspiration as well as VOT.

lenis and fortis plosives as [-s.g.], as in (4a). The acoustic property of closure duration is accounted for by the feature [\pm tense], that is, long closure duration in aspirated and fortis stops by [+tense], and short closure duration in lenis ones by [-tense], as in (4b).¹⁶

(4) The laryngeal feature specification of Korean stops (Kim et al. 2005; 2010; 2018)

		lenis	aspirated	fortis
a.	[s.g.]	-	+	-
b.	[tense]	-	+	+

From the data in Table 5 and the primary acoustic cues of VOT and closure duration to the features [\pm s.g.] and [\pm tense], respectively, as in (4), we suggest that the difference in VOT between the word-initial Japanese voiceless and voiced plosives is primarily parsed for cues to the Korean laryngeal feature [\pm s.g.] with the enhancement of the AP-initial H and L tones by virtue of the feature [\pm tense], as schematized in (5a). That is, in the Seoul subjects' categorization of word-initial Japanese voiceless plosives as aspirated, long VOT ([+s.g.]) plays a primary role, being parsed for cues to the feature [+s.g.], and the AP-initial H enhances it by virtue of the feature [+tense]. Thus, the Japanese plosives are categorized as aspirated ([+s.g., +tense]), as in (5a i). In the case of their categorization of word-initial Japanese voiced plosives, we suggest that the feature [-tense] is activated as the enhancement of the AP-initial L tone with relatively short VOT primarily parsed for cues to the feature [-s.g.], as in (5a ii). Therefore, word-initial Japanese voiced plosives are categorized as lenis ([-s.g., -tense]).¹⁷

As for the Seoul subjects' categorization of word-medial voiced and voiceless Japanese plosives as lenis and as either aspirated or fortis, respectively, with no tonal effect, we suggest that it is the difference in closure duration that is parsed for cues to the feature [\pm tense], as in (5b). Long closure duration of word-medial Japanese voiceless plosives is parsed for cues to the Korean laryngeal feature [+tense], and therefore, the voiceless plosives are categorized as either aspirated or fortis ([+tense]), as in (5b i). Short closure duration of word-medial Japanese voiced plosives is parsed for cues to [-tense], as in (5b ii), resulting in their adaptation of the Japanese plosives as lenis.

(5) Seoul subjects' categorization of Japanese voiceless and voiced plosives (a) in word-initial and (b) in word-medial position.

	Japanese (L2)	cues	Korean (L1)
a. i.	[-voice]	↔ long VOT with the enhancement of AP-initial H ([+tense])	↔ [+s.g., +tense]
ii.	[+voice]	↔ short VOT with the enhancement of AP-initial L ([-tense])	↔ [-s.g., -tense]
b. i.	[-voice]	↔ long closure duration	↔ [+tense]
ii.	[+voice]	↔ short closure duration	↔ [-tense]

¹⁶ As for the laryngeal-oral coordination that the linguopalatal contact or lip contact is concomitant with vertical larynx movements, Kim et al. (2010) have suggested that it is associated with the tensing of both the primary articulator (i.e. lips, tongue blade or dorsum) and the vocal folds, and that the tensing of both the primary articulator and the vocal folds is accounted for by the articulatory feature [\pm tense]. Accordingly, they have newly modified the traditional feature [\pm tense] in Jakobson et al. (1952) according to whom the tension of the whole vocal tract is accounted for by the feature [tense]. See Kim & Clements (2015) for a literature review of the feature [tense] as well as H. Kim (2003; 2005; 2011) for the new interpretation of the feature.

¹⁷ See Kong et al. (2011) for the primary role of VOT and an additional F0 in word-initial plosives when their Seoul Korean speakers heard native words and a few English loans. Note that in word-initial position, closure duration of the Japanese test words, which were given in isolation, is not detected with its very slight difference between Japanese voiced and voiceless plosives, as in Table 5(a).

Second, recall that, like the Seoul subjects, the Kyungsang subjects had better categorization of the word-initial Japanese voiceless plosives as aspirated at each level of syllable length when a tone in a following vowel is H, as shown in Figure 5(b), and word-medial Japanese voiced and voiceless plosives as lenis and as either aspirated or fortis with no tonal effect, respectively, as in Figures 7(b) and 9(b). Therefore, we suggest that the Kyungsang subjects' categorization of word-initial Japanese voiceless plosives and word-medial Japanese plosives can be accounted for in the same way to the Seoul subjects', as in (5a i) and (5b), respectively.

Unlike the Seoul subjects, however, the Kyungsang subjects favored H though they categorized word-initial Japanese voiced plosives as lenis like the Seoul subjects. As for the different tonal effects between the Kyungsang and the Seoul subjects' categorization of word-initial Japanese voiced plosives, we may leave them for further research, because there has been no research of tonal effect on native Korean or loan words of different syllable length in the two dialects in the literature. Therefore, we tentatively suggest that short VOT is primarily parsed for cues to the feature [-s.g.] with the feature [-tense] by default in the Kyungsang subjects' categorization of word-initial Japanese voiced plosives as lenis.

Before closing this section, we may note that the Seoul and Kyungsang subjects' categorization of the word-initial Japanese voiceless plosives [k, t] as the aspirated /k^h, t^h/ is of interest in that it is different from the regulations on the Korean adaptation of the word-initial Japanese voiced and voiceless plosives as lenis by the National Institute of the Korean Language (NIKL) (2012). When Japanese words beginning with voiced and voiceless plosives are borrowed and lexicalized in current Korean, the word-initial voicing contrast of the source language is constrained to be neutralized, no matter whether the word-initial plosives are followed by a H or L vowel, as shown in the lexical representations of some Korean adapted forms with word-initial plosives in bold in (6).

(6) Korean adaptation of word-initial Japanese voicing contrast (H. Kim 2005; 2008)

	Japanese words		Korean adapted form	
a.	tookyoo	HHHH~LHHH	tok^h (k')jo	'Tokyo'
	keioo	HHHH~LHHH	keio	'Keio (University)'
	kyo'oto	HLL	kjot^h (t')o	'Kyoto'
	kimono	LHH	kimono	'kimono'
	tarai	LHH	talai	'washing basin'
	tama'	LH	tama	'glass beads'
	tanaka	LHH	tanak^h (k')a	'Tanaka (name)'
b.	ba'kufu	HLL	pak^h uhu	'government in Shogun period'
	bu'shi	HL	pusi	'soldier'
	da'shi	HL	tasi	'seasoning, soup stock'
	do'ozo	HLL	totso	'please'
	geisha	HHH~LHH	keisja	'geisha'
	goma	LH	koma	'sesame'

The discrepancy between the present results and the NIKL regulations indicates that the regulations, that is, spelling conventions made by NIKL, do not affect our subjects' categorization of Japanese words at all.¹⁸ Recall that we selected real Japanese words which are not familiar at all to Koreans in order to avoid any spelling convention of Japanese loans frequently used in Korea. To be specific, we assume that our Seoul subjects were faith-

¹⁸ See also H. Kim (2017a) for no effect of the NIKL regulations on Korean speakers' perception of Japanese geminates.

ful to the phonetic difference in VOT and in AP-initial L vs. H between the word-initial Japanese voiced and voiceless plosives when given Japanese words which are not lexicalized in Korean. Thus, the acoustic cues are parsed to the features [\pm tense] and [\pm s.g.] with the former as an AP-initial enhancement, as in (5a), rather than to the NIKL regulations.¹⁹ Another example wherein spelling conventions do not affect our subjects' adaptation of Japanese words comes from their categorization of word-medial Japanese voiceless plosives. According to the NIKL regulations, we are advised to use aspirated plosives for word-medial Japanese voiceless plosives. However, an almost equal distribution of fortis and aspirated plosives was found in both the Seoul and Kyungsang subjects' responses for the Japanese voiceless plosives [k, t] in intervocalic position as a free alternation, which is shown in Figure 8(b) and (c).

5 Theoretical implications

Some theoretical implications can be made in this section.

First, the present study is the first in examining a cross-dialect difference in the magnitude of H/L tonal effects and segmental voicing contrast in Korean categorization of Japanese plosives followed by a H or L vowel, using two-, three- and four-syllable Japanese words. In the literature on AP-initial tones in accordance with the three-way phonation contrast in plosives, there has been no study which explicitly examines any cross-dialect differences in Korean. So far AP-initial tones have been investigated in the Seoul and Chonnam dialects (e.g. Jun 1993) and in Kyungsang Korean (e.g. Kenstowicz & Park 2006). In addition, there has been no research on how H/L tonal effects and segmental voicing contrast do interact in Korean categorization of Japanese plosives followed by a H or L vowel. In this aspect, the present study could be considered as the first attempt to examine a cross-dialect difference in the interaction of Japanese H/L tonal effects and segmental voicing contrast between Seoul and Kyungsang Korean.

Second, the H and L tonal distinction in AP-initial position in the Seoul subjects' categorization of Japanese plosives indicates that it is not specified in the lexical representation of Korean consonants even among young Seoul Koreans. Recently, Silva (2006) has proposed that lenis plosives are specified as [$+$ s.g.] like aspirated plosives and that H and L are underlyingly specified for aspirated and lenis plosives, respectively, in contemporary Seoul Korean. This is because his three young Korean subjects, who were born after 1982, do not have any difference in VOT between word-initial lenis and aspirated plosives. However, it is noteworthy that among the subjects (80 male and 80 female) in the present study, one hundred forty-seven of them were born between 1985 and 1992 with nine between 1982–1984 and five in 1981. If the tonal distinction were lexically specified in distinguishing lenis from aspirated plosives with no phonological function of the feature [s.g.], then our young Seoul subjects would have perceived the word-initial Japanese voiceless plosives as either aspirated or fortis, in that fortis consonants are also assumed to have H tones like aspirated consonants. But this is not the case.

In addition, the lexical specification of the H and L distinction cannot account for sound patterns, either. Korean, including not only Seoul Korean but also Kyungsang Korean, changes some word-initial lenis consonants into their fortis counterparts in order to convey speakers' intensified feelings, as shown in (7a).²⁰ No aspirated counterparts occur. The alternation of lenis consonants with fortis counterparts does also occur to the exclusion of

¹⁹ This adaptation is supported by Korean speakers' recent tendency to borrow word-initial Japanese voiceless plosives as aspirated (e.g. /^hak^hoyak'i/ for [takoyaki] 'a kind of pancake with octopus'; /k^hanemaja/ for [kanemaya] (a Japanese noodle restaurant)), though they are advised to borrow the Japanese plosives as lenis by the regulations of the NIKL (2012).

²⁰ See H. Kim (2014) for the same sound pattern in English and French loans in Korean adaptation.

aspirated ones in Kyungsang Korean, as in Seoul Korean. For example, as shown in (7b), North Kyungsang Korean also replaces lenis consonants with fortis counterparts in word-initial position, regardless of whether a following vowel is H or L.^{21,22}

- (7) Word-initial lenis stops in (i) non-intensified expressions and fortis stops in (ii) intensified expression in (a) native Korean words (H. Kim 2003; 2005; 2011) and (b) the lexical tones of the words in North Kyungsang Korean.

a.		b.	
i.	ii.		
pɛ.k'i.ta	p'ɛ.k'i.ta	* p ^h ɛ.k'i.ta	HLL 'to copy'
taŋ.ki.ta	t'aŋ.ki.ta	* t ^h aŋ.ki.ta	HLL 'to pull'
tsuŋ.kuk	ts'uŋ.kuk	* ts ^h uŋ.kuk	HL 'China'
tsa.sik	ts'a.sik	* ts ^h a.sik	HH 'chap'
ka.si	k'a.si	* k ^h a.si	HL 'thorn'
pʌn.tɛ.ki	p'ʌn.tɛ.ki	* p ^h ʌn.tɛ.ki	LHL 'chrysalis, pupa'
po.k'im.pap	p'o.k'im.pap	* p ^h o.k'im.pap	LHL 'fried rice'
tsal.li.ta	ts'al.li.ta	* ts ^h al.li.ta	LHL 'to be laid off'
kop.p'æ.ki	k'op.p'æ.ki	* k ^h op.p'æ.ki	LHL 'double'

Moreover, according to Kim et al. (2018), glottal opening peak, airflow peak height, duration of aspiration and VOT of word-medial lenis plosives are significantly reduced, as compared to those in word-initial lenis plosives, in their four subjects of Seoul Korean. In contrast, aspirated and fortis plosives have no statistical difference in them across the contexts. The significant difference in the phonetic properties between word-initial and word-medial lenis plosives is proposed to be due to their laxness ([–tense]), and it is due to the tenseness ([+tense]) of aspirated and fortis plosives that there is no difference in them.

Third, the activation of the Korean prosodic unit of AP as enhancement and laryngeal features [±tense] and [±s.g.] in (5) supports the view that L2 acoustic outputs are computed by an L1 grammar (e.g. Polivanov 1931; 1974; Trubetzkoy 1939; Hyman 1970; Peperkamp 2005; Yip 2006). So far previous studies on the prosodic unit have focused on native or nonsense word segmentation in Korean (e.g. Jun 1993; 1998; 2005a; b; Jun & Kim 2004; S. Kim 2004). In this aspect, the tonal effect in AP-initial position in the Seoul subjects' categorization of word-initial Japanese plosives provides a case where the prosodic unit of AP is also psychologically real in loanword adaptation, as in native word segmentation. In addition, recently, based on the Korean adaptation of English, French and Japanese voiced and voiceless consonants, H. Kim (2006; 2007; 2008; 2009; 2014; 2017a) has suggested that L1 grammar such as L1 distinctive features, syllable structure and lexical restrictions plays a role in the adaptation of L2 sounds. The present study further supports the view of an L1 grammar-driven perception of L2 sounds, in that Korean AP-initial boundary tones as well as Korean laryngeal features are employed in the Seoul subjects' categorization of Japanese plosives followed by a H or L vowel.

The other two linguistically-motivated views on loanword adaptation in the literature – (a) the phonological view and (b) the phonetic approximation view – would be hard to account for the results of the present perception experiment. If loanword adaptation is based on phonological category mappings between the L2 and L1 languages (e.g. Paradis & LaCharité 1997; LaCharité & Paradis 2005; Paradis & Tremblay 2009), the H/L tonal

²¹ The tone data in (7b) were provided by Y.-H. Chung who is a native speaker of North Kyungsang Korean.

²² Korean affricates are transcribed as alveolar, that is, /ts, ts^h, ts'/ in line with H. Kim (1997; 1999; 2001a; b; 2004; 2012) as well as Skaličková (1960).

distinction in Japanese test words would be borrowed across the contexts by Kyungsang subjects whose dialect has a lexical pitch-accent like Japanese. Yet, this is not the case, as shown in Figures 7 and 9.

The role of the tonal distinction in word-initial position in the Seoul subjects' categorization (5a) would not be accounted for either in the phonetic approximation view wherein L1 speakers perceive and produce the native segment which most closely approximates the L2 input in articulatory and/or acoustic properties, when confronted with an L2 sound (e.g. Silverman 1992; Steriade 2001; Kenstowicz 2003; Kang 2003; Peperkamp & Dupoux 2003). In this view, the tonal distinction only in word-initial Japanese plosives by the Seoul subjects would not be expected in that the phonetic difference in H and L after Japanese plosives is made in the Japanese acoustic outputs in both word-initial and word-medial positions.²³

6 Conclusion

In the present study, we have found that our Seoul and Kyungsang subjects mostly categorized word-initial Japanese voiceless plosives as aspirated with the significant effect of H and word-medial voiceless plosives as either aspirated or fortis with no H/L effect. Their categorization of word-medial Japanese voiced plosives as lenis is not significantly affected by the H and L tonal difference, either, regardless of dialect differences. In their categorization of word-initial Japanese voiced plosives as lenis, however, the Seoul subjects favored L, and the Kyungsang subjects H.

Based on these results, we have proposed that the Korean prosodic unit of AP and laryngeal features interact in the Seoul subjects' categorization of word-initial Japanese plosives, such that the H/L tonal distinction is made in AP-initial position as enhancement with VOT primarily parsed for cues to the feature [\pm s.g.]. Regarding their categorization of word-medial Japanese plosives with no tonal effect, we have proposed that closure duration is parsed for cues to the other laryngeal feature [\pm tense]. The same proposal is made for the Kyungsang subjects' categorization except for the H effect in word-initial Japanese voiced plosives which needs further research.

The effect of L1 (i.e. Korean) AP-initial boundary tones as enhancement in the Seoul subjects' categorization suggests that the prosodic unit of AP is also psychologically real in loanword adaptation, as in native word segmentation, and that the H/L tonal distinction is not underlyingly specified in aspirated and lenis plosives across the contexts in current Seoul Korean. In addition, not only the activation of the L1 AP-initial boundary tones but also that of L1 laryngeal features [\pm tense] and [\pm s.g.] supports the view that L2 acoustic outputs are computed by L1 grammar in the literature. As the first cross-dialect study on the interaction of H/L tonal effects and segmental voicing contrast in Korean categorization of Japanese plosives followed by a H or L vowel, the present study leaves, in the future, further relevant research such as the tonal effects in Seoul and Kyungsang subjects' perception of native Korean or loan words in different syllable lengths for a supplement to the present study.

²³ In addition, the average 16ms VOT of word-initial Japanese voiced plosives and 47 ms VOT of Japanese voiceless plosives in Table 5(a) would acoustically approximate Korean fortis and lenis plosives, respectively, given that the average VOT of fortis plosives is 25 ms, that of lenis plosives 33 ms and that of aspirated plosives 105 ms in word-initial position (Lisker & Abramson 1964). But this is not the case, as in Figures 2 and 4. Moreover, the long closure duration and 19 ms VOT of word-medial Japanese voiceless plosives (Table 5b) would phonetically approximate Korean fortis plosives. This is because the average VOT is 13 ms for fortis, 26 ms for lenis and 82 ms for aspirated plosives in word-medial position with the closure duration of fortis and aspirated plosives longer than lenis (e.g. Lisker & Abramson 1964; C.-W. Kim 1965) (See also Kim et al. 2018 for duration of aspiration as well as VOT and closure duration of the three-way phonation contrast in Korean plosives). Yet, the Japanese plosives were categorized as either aspirated or fortis plosives as a free alternation, as in Figure 8.

Additional Files

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

- **Appendix 1.** Seoul (1) and Kyungsang (2) subjects' responses of word-initial Japanese voiced plosives in (a) two-syllable, (b) three-syllable and (c) four-syllable words. Relevant sounds, pitches and highest responses are marked in bold. DOI: <https://doi.org/10.5334/gjgl.628.s1>
- **Appendix 2.** The statistical results of Dialect (SK, NK), H/L and the interaction of Dialect and H/L in South Kyungsang (SK) and North Kyungsang (NK) subjects' responses (a) as lenis for the word-initial Japanese voiced plosives [b, d, g], (b) as aspirated for the word-initial Japanese voiceless plosives [k, t] and (c) as lenis for the word-medial Japanese voiced plosives and (d) as either aspirated or fortis for the word-medial Japanese voiceless plosives. DOI: <https://doi.org/10.5334/gjgl.628.s2>
- **Appendix 3.** Seoul (1) and Kyungsang (2) subjects' responses of word-initial Japanese voiceless plosives in (a) two-syllable, (b) three-syllable and (c) four-syllable words. Relevant sounds, pitches and highest responses are marked in bold. DOI: <https://doi.org/10.5334/gjgl.628.s3>
- **Appendix 4.** Seoul (1) and Kyungsang (2) subjects' responses of word-medial Japanese voiced plosives in (a) two-syllable, (b) three-syllable and (c) four-syllable words. Relevant sounds, pitches and highest responses are marked in bold. DOI: <https://doi.org/10.5334/gjgl.628.s4>
- **Appendix 5.** Seoul (1) and Kyungsang (2) subjects' responses of word-medial Japanese voiceless plosives in (a) two-syllable, (b) three-syllable and (c) four-syllable words. Relevant sounds, pitches and highest responses are marked in bold. DOI: <https://doi.org/10.5334/gjgl.628.s5>

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Competing Interests

The author has no competing interests to declare.

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