말소리와 음성과학 제2권 제3호 (2010)
pp. 91~99

Sensitivity to Phrase-initial Tone and Laryngeal Feature Identification of Foreign Learners of Korean

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ABSTRACT

This paper reports on an identification test where KFL learners identified the Korean three-way laryngeal contrast in the phrase-initial position, when the phrase-initial tone was systematically manipulated. It turns out that heritage learners have some sensitivity to phrase-initial tone and show a plain-aspirated alternation in their identification according to the phrase-initial tone, as native speakers do, whereas non-heritage students do not show such tone sensitivity. However, after a weekly prosody training, second-year non-heritage students have shown a significant improvement in their performance. This paper clearly shows that the phrase-initial tone plays a critical role in distinguishing laryngeal features of Korean obstruents, and also suggests that prosody including the tone-segment correlation should be incorporated in the KFL curriculum.

Keywords: phrase-initial tone, laryngeal contrast, KFL, heritage learners, prosody

1. Introduction

The three-way laryngeal contrast in the Korean obstruents has been a challenge for learners of Korean as a foreign language (KFL). Kim et al. (2006) found that English learners of Korean find the lenis stops hardest to identify, the aspirated stops the second hardest and the fortis stops the least hard. Such perceptual difficulty is strongly related to the small difference in VOT between the lenis and aspirated stops, especially in younger Korean speakers (Silva, 2006; Wright, 2007; Kang & Guion, 2008). As the segmental information is not as salient a perceptual cue, the distinction between those laryngeal series relies more heavily on non-segmental features. Jun (2000) showed that if a phonological phrase begins with an aspirated and tense obstruent or a fricative in Korean, the phrase-initial tone should be High, whereas the phrase-initial tone should be Low otherwise. She argued that such correlation between tone type and consonant laryngeal type is phonologized in Korean. Silva (2006) argued that the lenis stops and aspirated stops are neutralized phrase-initially in terms of VOT in modern Korean and that the distinction between the two stop series is marked mostly by the phrase-initial tone (see also Wright, 2007). M. R. Kim (2001) also suggested the importance of Fundamental Frequency (F0) in the identification of the stop laryngeal features. In her same- and cross-spliced data, appropriate F0 plays a significant role in the perception of the lenis stops, although other acoustic properties such as VOT are also important for the perception of the aspirated and fortis stops.

Since the three-way laryngeal distinction in the Korean obstruents is realized with the combination of segmental and prosodic features, it would be more challenging for KFL learners to acquire the distinction without proper knowledge of Korean prosody. Generally speaking, with relatively less emphasis on prosody in the KFL curriculum, KFL learners may have more difficulty acquiring prosodic features than segmental features. Poor prosodic behaviors have been reported on KFL learners who did not have enough exposure to or explicit instruction on Korean native prosody. Jun & Oh (2000) showed that English learners of Korean have different prosodic patterns than native speakers of Korean. According to them, English learners of Korean are poor not only in grouping words in accordance to syntactic constraints but also in producing appropriate phrasal tones, such as phrase-initial high tone and phrase-final high tone. Shin (2005) also found prosodic differences between heritage

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Received: August 15, 2010
Revision: September 22, 2010
Accepted: September 24, 2010

and non-heritage learners of Korean such that heritage students who have been exposed to native Korean at their early age are better in producing native-like tonal and phrasing patterns.

To my knowledge, no study has addressed the correlation between the laryngeal features and tones at the phrase-initial position in KFL learners. In this regard, this paper examines how the sensitivity to phrase-initial tone affects KFL learners' identification of the laryngeal features. This paper shows how KFL learners respond when the phrase-initial tones superimposed on minimal triplets with three different laryngeal features are manipulated. This paper also explores whether KFL students improve their laryngeal feature identification after some intonation training for a certain period of time.

2. Experiment design

2.1 Stimuli

Two female native speakers, who were linguistically naïve, were recorded by the author for the test stimuli. These native speakers read a script made up of twelve three-syllable words, which correspond to laryngeal triplets of four different places of articulation: labial (/p, p^h, p'/), alveolar (/t, t^h, t'/), post-alveolar (/c, c^h, c'/), and velar (/k, k^h, k'/). They read each word in a carrier sentence: *nato* _____ '_____ for me, too'. The average VOT of the recorded words was shortest for the tense series (23.84 ms), and longest for the aspirated series (108.96 ms). It was confirmed that VOT is not very different between the aspirated and plain series; the average VOT of the plain series was 101.65 ms. The average F0 at the midpoint of the first vowel was highest for the aspirated series (273.66 Hz), lowest for the plain (185.71 Hz), and in between for the tense (251.59 Hz) (see Appendix for the F0 values at the onset and offset of the first vowel).

With these 24 original recorded tokens, another 24 words were created by modifying the word-initial tone such that the original high F0 was lowered for the aspirated and tense series, while the original low F0 was raised for the plain series. F0 was modified manually on the Praat manipulation windows as displayed in <Figure 1>.

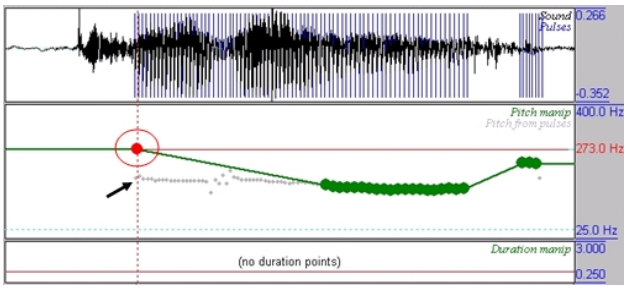

Figure 1. Word-initial F0 heightened for the word *palayo* 'I hope': original F0 indicated by the arrow and modified F0 indicated by the circle.

On the Praat manipulation window, all pitch pulses but the very first of the first syllable vowel and the very last of the second syllable vowel were removed and then the very first pitch pulse was either raised or lowered by 80-100 Hz, which roughly corresponds to the average F0 difference between plain and aspirated series. As the original pitch pulses were removed, the modified pitch contour was an interpolation between the very first pitch pulse and the last pitch pulse of the second vowel. These two pitch pulses were selected for the manipulation for two reasons: it was very difficult to pinpoint an F0 target for phrasal tones and the author wanted to maintain methodological consistency across tokens. One native speaker had a wider pitch range than the other, and the modified degree was 100 Hz for the former speaker's tokens and 80 Hz for the latter's. The degree of modification also slightly changed within 10 Hz in the cases where modified pitch sounded too exaggerated or awkward to the perception of the author. While the F0 value was modified, all the other acoustic cues such as VOT or intensity remained intact. A set of total 48 tokens (original plus modified) were repeated five times in the actual set of test stimuli; that is, total of 240 test tokens were included in the experiment stimulus set. By looking at how KFL learners respond to the words with the original tone and the modified tone, this experiment examines whether they are sensitive to the tone switch so that they respond differently to the stimuli with the identical segmental features.

2.2 Subjects and procedures

Twenty KFL learners participated in the identification experiment. They were all registered students for the first- or second-year Korean courses at the University of Chicago. Seventeen of them were first-year students and the other three were second-year students. English was their only native language for most of them, but Chinese was also their native language for three students, and Serbo-Croatian was the only native language for one student. The number of the second-year students is much smaller than that of the first-year students, but the three students were all the students who were registered for the course at the time of the experiment. The first-year students were divided into two groups, nine Korean heritage and eight non-heritage students, and the second-year students were all non-heritage students. In this study, heritage students are defined as those who have one or both native Korean parents and use Korean when communicating with their Korean parent.[2)]

All the twenty students took the identification test twice: at the beginning (pre-test) and the end (post-test) of their autumn quarter

in 2009. In between the pre-test and post-test, all the students attended a weekly 15 minute long intonation training session as one of their course requirements. In this training session, an assistant gave some explicit instruction on the phrase-initial segment-tone correlation, i.e. H for aspirated and tense obstruents and fricatives and L for the others, as well as sentence-type intonation, i.e. statement and question intonation. After the explicit instruction, the students were made to listen to native intonation and practice producing intonation until their intonation approximated the native speaker's. Six different sentences were selected carefully from the students' Korean textbook each week such that those sentences reflected the segment-tone correlation and sentence-type intonation well. By comparing the students' identification patterns before and after they received the weekly training, this experiment aims to examine whether the explicit intonation training had any effect on the students' identification of laryngeal feature distinctions.

Seven native speakers also participated in the identification test. Their responses were collected for a reference in the results.

The experiment took place in the Phonology Laboratory at the University of Chicago. Each participant listened to the set of 240 stimuli in a random order by using a headset and picked what they thought they heard. For each stimulus, three choices were visually provided on the computer screen: the minimal triplets plain, tense, and aspirated in Korean. They were told to choose one answer by pressing a relevant button 1 through 3, as soon as they decided.

3. Experiment results

In this section, a term *matching identification ratio* is used for the discussion of the results. Matching identification ratio refers to the ratio of the actual number of matching responses over the total number of responses per participant and stimulus. "Matching" responses count when a participant's choice matches with the laryngeal feature of the original stimulus. For example, for the stimulus *palayo* 'I hope' with the plain initial stop, if one participant gave three *plain* responses and two *aspirated* responses from the five repetitions, the matching ratio is 3/5, i.e. 60%. This is also the case whether the stimulus is original or modified. For instance, if the participant responded with one *plain* and four *aspirated* choices to the stimulus *palayo* with a modified tone, i.e. High tone, the matching identification ratio is now 1/5, i.e. 20%.

3.1 Native speakers

As <Figure 2> shows, native speakers identified all three laryngeal categories almost 100% correctly when the word-initial tone was not changed. However, they did not identify the aspirated and plain series *correctly* when the word-initial tone was modified. In <Figure 2>, we can see that the aspirated obstruents were identified as aspirated only 21.8% of the time, and plain obstruents were identified as plain only around 1% of the time, when their initial tones were changed. In other words, the original aspirated obstruents had High initial tone, but when the tone was lowered, those aspirated obstruents were much less likely to sound aspirated to the native speakers' ears, despite the unchanged segmental features. Moreover, the original plain obstruents had Low initial tone, but when the tone was raised, those plain obstruents did not sound plain to the native speakers' ears. In contrast, the native speakers still identified tense series close to 100% correctly even when the tone was modified. In <Figure 2>, we see that the native speakers identified the tense series more than 95% of the time for both the original and modified tones. It is interesting that the tense series were independent of the initial tone change, which is probably attributable to the strong segmental cues, such as remarkably short VOT, that help tense obstruents clearly distinguishable from the other two laryngeal series.

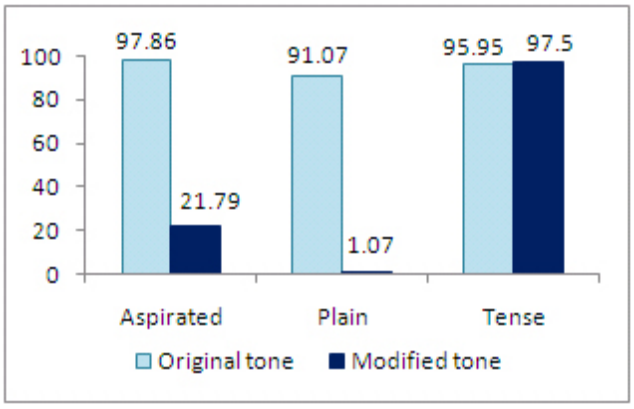

Figure 2. Mean matching ratios of native speakers' responses to the words with the original tone (light shade) and the modified tone (dark shade)

Now the question is what responses the native speakers chose to the aspirated and plain stimuli when the word-initial tone was changed. <Figure 3> shows that the native speakers thought that the aspirated obstruents with Low tone were plain, more than 75% of the time, whereas they thought that the plain obstruents with High tone were aspirated, more than 95% of the time. That is, the native speakers showed a clear alternation between aspirated and plain in

their identification, depending on the phrase-initial tone. Noteworthy is that the identification of the aspirated series was affected by the tone shift slightly less than that of the plain series. This minor asymmetry may be attributable to more salient segmental cues that the aspirated obstruents had. M. R. Kim (2001) found that the low F0 was the most salient perceptual cue for the lax stops, whereas the perception of tense and aspirated stops depended on a combination of VOT, F0 and H1-H2 characteristics. That is, such segmental characteristics of the aspirated obstruents that are absent in the plain counterparts have made it slightly less likely for the native speakers to perceive aspirated obstruents as plain, when the initial tone changed.

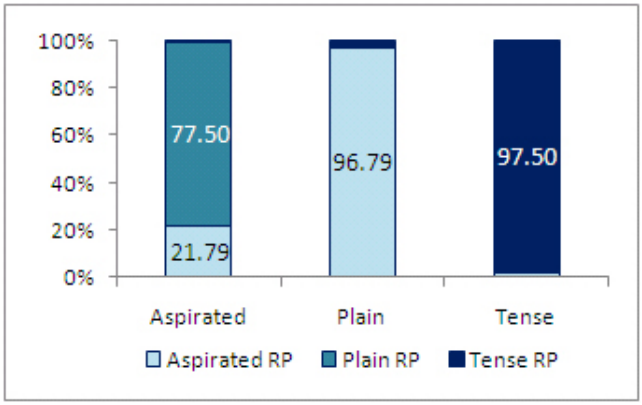

Figure 3. Mean response ratios of laryngeal features with modified tone: stimulus type on the X-axis and response ratios on the Y-axis with three response (RP) categories, Aspirated, Plain and Tense.

In contrast, the identification of the tense obstruents was not affected by the tone modification such that the tense obstruents with Low tone still sounded tense almost 100% of the time. These results suggest that phrase-initial tone is one of the most important perceptual cues for distinguishing between Korean aspirated and plain obstruents at the phrase-initial position, whereas tense series are independent of tone when it comes to the identification.

3.2 KFL learners

3.2.1 Tone sensitivity

Overall, KFL learners were not as good as native speakers in the laryngeal feature identification. The identification patterns were not homogeneous among the KFL learners. The KFL learners were classified into three KFL groups, first-year heritage, first-year non-heritage and second-year non-heritage, and these three groups showed slightly different identification patterns.

First, the first-year heritage students were not as good at identifying the aspirated consonants as the native speakers were, but their identification patterns with the original and modified stimuli were similar to those of the native speakers. When the word-initial tone was not changed (see the *Original tone* columns in the top panel of <Figure 4>), the matching identification ratios of the first-year heritage students were quite high with over 60% on the aspirated and plain series. In contrast, the matching identification ratios for the aspirated and plain series dropped by some 50%, when the word-initial tone was modified (see the *Modified tone* columns in the top panel of <Figure 4>). The difference in the matching ratios between the original and modified stimuli are statistically significant ($p<.001$). Moreover, the tone insensitivity in the tense series that was observed in the native speakers was found in the first-year heritage students as well. Unlike the aspirated and plain series, tense series were not really affected by the tone modification, as shown in the *Tense* columns on the top panel of <Figure 4>.

Second, the first-year non-heritage students showed a different identification pattern from the native speakers and first-year heritage students. They were less successful than the first-year heritage students in identifying the laryngeal features with the original tone, with the matching ratios only around 50% or less, and they were not so sensitive to the tone change, either. As the middle panel of <Figure 4> shows, the tone modification slightly lowered the matching ratio, but the extent is very small; an analysis of variance on aspirated and plain series together reveals that the tone change made a barely significant difference in their identification patterns ($p<.05$). However, the tense series did not display much difference between the original and modified stimuli, which is similar to those of the native speakers and first-year heritage students. The lack of significant difference in the tense series is statistically supported ($p>.05$).

Third, the second-year non-heritage students were not so successful in discriminating the three laryngeal features, either. However, they did show some sensitivity to the tone switch. As the bottom panel of <Figure 4> shows, the second-year non-heritage students were quite bad at identifying the aspirated (35.83%) and plain (31.67%) with the original tones. They were slightly better identifying the tense series (57.5%), but still not comparable to the native speakers. When the phrase-initial tone was changed, the identification ratio either increased (aspirated series) or decreased (plain and tense series). The changes in the identification ratios were statistically significant only for the plain ($p<.05$) and tense series ($p<.001$). The significantly lower matching ratios of the *Modified tone* stimuli in the tense series are unique to the second-year non-heritage students. Unlike all the other subject groups, who were not affected by the tone modification in the tense identification, the second-year non-heritage students were significantly affected by it.[3)]

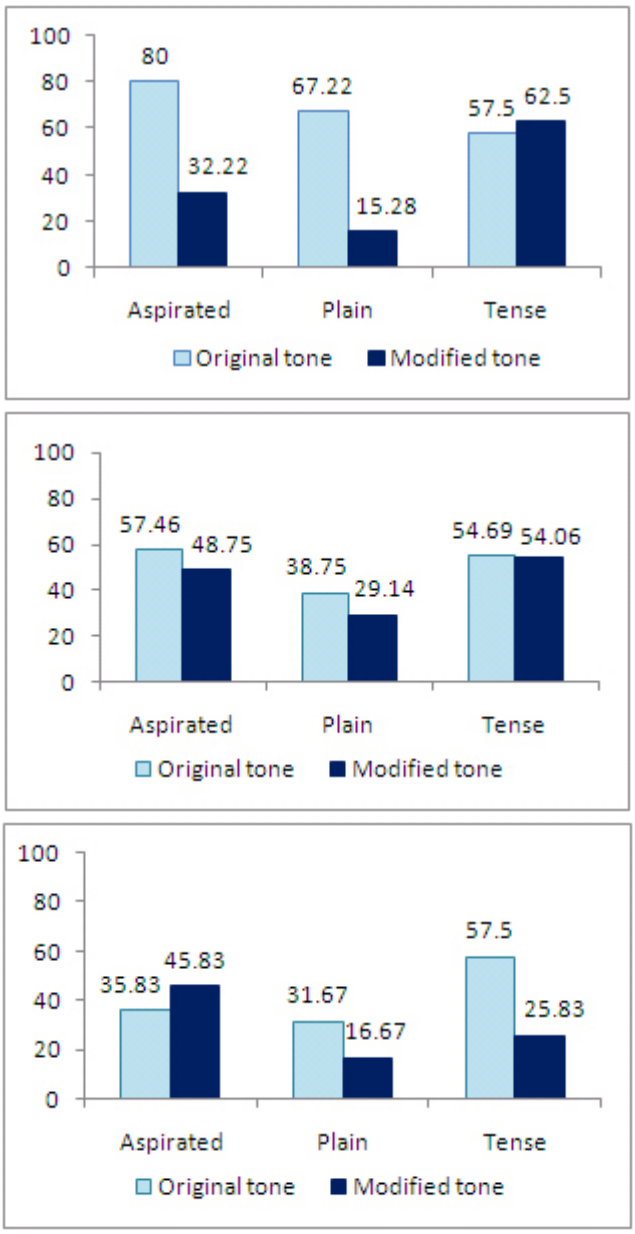

Figure 4. KFL learners' mean matching ratios (%) for the stimuli with original (light shade) and modified tones (dark shade): first year heritage (top), first-year non-heritage (middle) and second-year (bottom).

It is interesting to note that the second-year students did not show much advantage in tone sensitivity when it comes to the identification of aspirated obstruents, even though they already took a Korean course for a year. I think this is because implicit exposure to Korean intonation did not help them improve their tone sensitivity for identifying laryngeal features. That is, their weak sensitivity to phrasal tones in Korean speaks for the importance of explicit learning of intonation.

<Figure 5> shows what responses the KFL learners chose to the stimuli with the modified phrase-initial tone. On the top panel of <Figure 5>, we can see that the majority (60%) of the first-year heritage students' responses to the modified plain series was *Aspirated* and the majority (69.72%) of their responses to the modified aspirated series was *Plain*. This result shows that the first-year heritage students have a similar plain-aspirated alternation pattern as the native speakers, although the alternation between aspirated and plain along with the tone change is not as drastic as that of the native speakers.

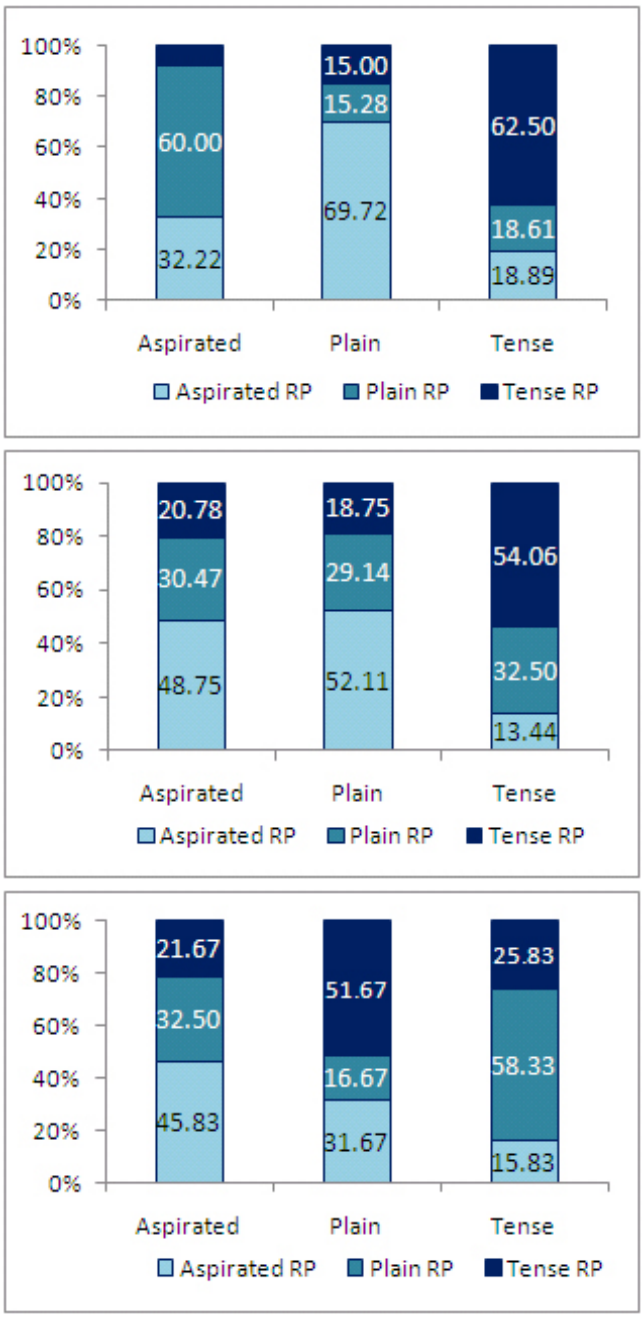

Figure 5. KFL learners' response (RP) ratios (%) for the three laryngeal stimuli with modified tone: first-year heritage (top), first-year non-heritage (middle) and second-year non-heritage (bottom) students.

The first-year non-heritage students and second-year non-heritage students did not show the plain-aspirated alternation with the phrase-initial tone change. In the middle panel of <Figure 5>, the response patterns of the first-year non-heritage students are similar across the aspirated and plain stimuli; that is, the first-year non-heritage students thought that both aspirated and plain stimuli with modified tones were aspirated around 50% of the time and plain around 30% of the time. With or without the tone change, they preferred the aspirated responses to the plain in both laryngeal types. This confirms that they are not sensitive to tone when it comes to the laryngeal feature identification. Moreover, the fact that they have a similar identification pattern between the aspirated and plain series suggests that they are probably tuned more to the segmental cues such as VOT, for the aspirated and plain series are neutralized in VOT phrase-initially.

The second-year students showed more deviated patterns from those of the native speakers. In the bottom panel of <Figure 5>, we can see that more than a half of their responses (51.67%) to the modified plain series were *Tense*, whereas more than a half of their responses (58.33%) to the modified tense series were *Plain*. In other words, the second-year non-heritage students had a plain-tense alternation, instead of the plain-aspirated alternation as in the native speakers and first-year heritage students. Together with the tone sensitivity in the identification of tense series as shown in <Figure 4>, this unique alternation pattern in the second-year non-heritage students needs to be explained in a further study.[4)]

3.2.2 Effect of intonation training

As introduced in the experiment design, all the three student groups had a weekly intonation training for 6 weeks. This section explores whether the intonation training had any positive effect on the students' performance. It turns out that the first-year students, both heritage and non-heritage, did not show a significant improvement in their performance ($p>.05$), either on the correct identification of laryngeal features with the original tone or on the tone sensitivity.

However, the second-year students did show a significant improvement. <Figure 6> displays the matching ratios of the second-year students from the post-test conducted after the intonation training. In this figure, we see that the matching ratios of the second-year students for the original stimuli in all three laryngeal series got higher (compare with the bottom panel of <Figure 4>). Moreover, they learned not to pick Aspirated for low-toned stimuli and not to pick Plain for high-toned stimuli; they picked aspirated only 30% of the time for the low-toned aspirated stimuli, and picked plain only 8.33% of the time for the high-toned plain stimuli, which are both lower than those from the pre-test. An interesting finding is that their sensitivity to the tone change when it comes to the tense identification got even better; they picked tense only 15.83% of the time for the low-toned tense stimuli. An analysis of variance test run on all three laryngeal series together reveals that the identification ratio is significantly different between the original and modified tones ($p<.001$). Besides, the difference in the identification ratio between the pre-test and post-test is statistically significant for both the original ($p<.005$) and modified stimuli ($p<.001$).

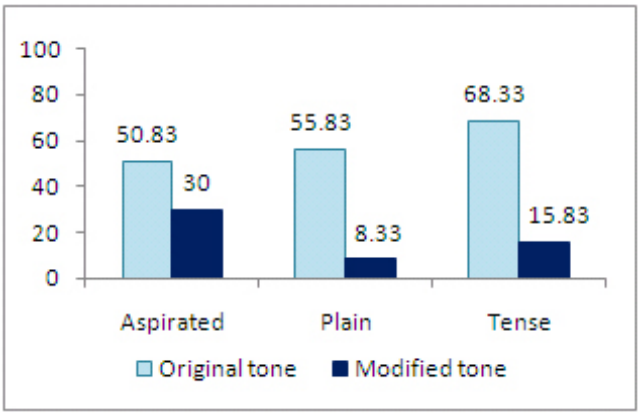

Figure 6. Second-year students' mean matching ratios for the stimuli with original (light shade) and modified tones (dark shade): the post-test.

4. Discussion

4.1 Tone sensitivity

It is confirmed in the present experiment that the phrase-initial tone is critical for the distinction between aspirated and plain series. The native speakers have a clear alternation between these two types of laryngeal series. The tense series, however, is opaque to the tone change, which is probably attributable to the salient segmental cues.

Tone sensitivity among KFL learners varied depending on whether they were heritage or non-heritage and whether they were in their first year or second year. The first-year non-heritage students were not sensitive to the tone change so that they responded similarly to both aspirated and plain series, regardless of their initial tones. In contrast, the first-year heritage students showed a similar identification pattern as the native speakers; they had the aspirated-plain alternation according to the tone change, and they were not affected by the tone change for the

tense series. Obviously, their exposure to native Korean prosody through their parents was helpful for them to acquire implicit knowledge about the tone-consonant correlation. However, they were not as successful in identifying correct laryngeal features as the native speakers, and their aspirated-plain alternation was not as sharp as the native speakers', either. The second-year non-heritage students had peculiar identification patterns at the pre-test, but they showed an aspirated-plain alternation with the tone change at their post-test. Interestingly, however, they were sensitive to the tone change in tense series as well, in contrast to the native speakers'.

As argued in Silva (2006) and Wright (2007), it is confirmed that the sensitivity to the phrase-initial tone is very important for the laryngeal feature distinction in Korean. Without knowing that the phrase-initial tone is one of the most important perceptual cues to distinguish between aspirated and plain consonants, it would be very challenging for KFL learners to acquire the three-way laryngeal contrasts. However, to my knowledge, the importance of the word-initial tone has been neglected in the KFL curricula. The tone-consonant correlation is context-dependent, but if properly instructed in the KFL curricula, this additional cue in specific contexts may help KFL learners acquire the three-way laryngeal contrasts in Korean with more ease.

4.2 Effect of explicit instruction

The present experiment has shown that a significant effect of the intonation training was observed only in the second-year students. After the training, the second-year students picked up the aspirated-plain alternation with the tone change, and they improved significantly in identifying laryngeal features with the right tone. Their raised awareness about the tone-consonant correlation made them sharpen their sensitivity to tone for the perception of tense series as well; they chose tense responses to the low-toned tense stimuli, only around 15% of the time. In any case, it is clear that the intonation training raised their awareness about the tone-consonant correlation and improved their tone-sensitivity significantly.[5)]

Now why didn't the intonation training have the same positive effect on the first-year students? One possible reason is that the intonation training might have been too short. The weekly training was conducted for only six weeks and for 15 minutes every week. Although the students were exposed to the native Korean instructor's input during their regular classes, total explicit intonation training was only 90 minutes long. Moreover, the explicit training might have confused the first-year students. The training was conducted when they were in their very first Korean course, as opposed to the second-year students who had already taken Korean courses for one year. The second-year students have already had explicit instructions in class on the segmental cues of the three-way laryngeal contrast and a lot more chances to enhance such explicit knowledge on the distinction. In contrast, the first-year students did not have such opportunities. That is, the weekly training alone might not be sufficient for them to pick up the suprasegmental cues to distinguish the laryngeal features along with the segmental cues, and the learning load for the first-year students to acquire both segmental and suprasegmental cues for the laryngeal contrast may have been too much.

The current experiment has shown that the first-year heritage students performed better in the laryngeal identification and tone sensitivity at the pre-test than the second-year, which may entail that the former group had more potential to improve their performance after the intonation training. However, this expectation was not borne out at the post-test. The first-year heritage students' better performance is probably attributable to their implicit knowledge about intonation and laryngeal features that they acquired through their parents. It is possible that the new explicit information on intonation and laryngeal feature did not restructure their interlanguage effectively by the time the post-test was performed. Heritage students typically display both native and non-native characteristics in second language learning, and there is some evidence showing that heritage learners come in with stabilized interlanguage (see H. S. Kim, 2005). With the stabilized or even fossilized (Selinker, 1972) interlanguage, heritage learners may take longer to restructure their interlanguage due to their incomplete knowledge of the target language (Korean) and the dominance of their first language (e.g. English). The first-year heritage students in this study may have had the same issue such that their stabilized incomplete knowledge of Korean intonation and laryngeal features prevented them from improving their performance.

Although the intonation training in this study turned out effective only for the second-year students, it does not undermine the importance of intonation training for all levels in the KFL curriculum. As Mennen (2007) argued, "Just as poor pronunciation can make a foreign language learner very difficult to understand, poor prosodic and intonational skills can have an equally devastating effect on communication and can make conversation frustrating and unpleasant for both learners and their listeners "(p.53), prosody should be an important part of second language learning. Missaglia (2007) also argued, "[t]hus in Second Language Acquisition (SLA)

correct prosody is to be considered primary with respect to segments also because prosodic deviations have a more negative influence on the communicative effect of speech acts than segmental mistakes" (p.240). Intonation, or prosody in a broader term, is important not only for natural-sounding accent, but also for semantic differences in Korean. A well-known example is indefinite pronoun. In example (1), for instance, WH word *mwe* is ambiguous until it has proper prosody superimposed on it; it means 'what' if the word attracts focus, whereas it means 'something' if the immediately following word attracts focus. For the interpretation of (1a), the WH word *mwe* either has longer duration and High pitch, or has its default Low tone enhanced such that the Low tone becomes even lower. For the interpretation of (1b), *mwe* does not have semantic weight anymore, so the following verb *mek-* attracts focus, which enhances the default Low tone that *mek-* carries; i.e. the F0 of *mek-* becomes even lower.

mwe mek-eyo? (1)
a. what eat-Polite?
'What do you eat?'
b. something eat-polite?
'Do you eat anything?'

Hakkyo-ey ka-n cwul al-ass-e. (2)
school-Loc go-Past Head know-Past-Decl.
a. 'I thought that you went to school (but I was wrong).'
b. 'I knew that you went to school (and it is true).'

Example (2) shows another semantically ambiguous sentence. In this case, too, the proper interpretation depends on the right intonation. In order to get the interpretation of (2a), the matrix verb *al-* 'to know' cannot make its own phonological phrase and its phrasal tone gets depressed. For the interpretation of (2b), on the other hand, the verb *al-* must have its own phonological phrase and its intonation should be enhanced.

In the KFL classroom, prosody is instructed only when it is needed and for a short period of time. For instance, the intonational distinction between the WH word and indefinite pronoun as exemplified in (1) is one of the major grammar points in Lesson 7 in the textbook *Integrated Korean: Intermediate 1* (Cho, et al., 2000), but little intonational notion appears before Lesson 7. Accordingly, it is very difficult for learners to acquire the distinction which is solely dependent on intonational features, because they had very little knowledge or awareness about the basic intonation features of Korean. From the author's experience in class, students acquired intonational distinctions between indefinite pronouns and WH pronouns much faster and more easily when they received instruction and training on basic intonation patterns from one quarter before. Since these students were aware of the basic intonation patterns from the training, all they had to do for the intonational distinction between indefinite and WH pronouns was understand which word was focused and enhance the basic intonation pattern of the focused word. Thus, it would be more effective and easier for KFL learners to pick up semantic differences triggered by intonation as well as to familiarize themselves with natural-sounding intonation of Korean, if an explicit instruction and/or training on basic intonation patterns is included in the KFL curriculum early on.

This study has shown that a 15-minute long weekly intonation training might not be sufficient for some students to acquire the segment-tone correlation in 6 weeks, and suggested that teaching both segmental and suprasegmental cues for the laryngeal distinction may confuse students or slow down their learning. It warrants more studies to determine whether intonation training for a longer period of time, e.g. 6 months or a year, will have a clearer positive effect on tone sensitivity of KFL learners at all levels, and exactly when it would be ideal to begin explicit intonation instruction for KFL learners.

5. Conclusion

Based on an identification experiment with original and manipulated stimuli, this paper shows that the phrase-initial tone plays a critical role in the correct identification of the laryngeal features in consonants. It is especially true for the aspirated-plain contrast at the phrase-initial position. Tone sensitivity varied among different student groups. The first-year non-heritage students did not have sensitivity to tone-consonant correlation, whereas the first-year heritage students did have some sensitivity to tone-consonant correlation such that their identification pattern on the aspirated and plain series was similar to the native speakers'. Moreover, the short period of intonation training was partially effective in improving KFL students' sensitivity to phrase-initial tones. The second-year non-heritage students showed a significant improvement in their identification and tone sensitivity. Since the importance of phrase-initial tone has been confirmed when it comes to the phrase-initial laryngeal feature identification, it is suggested that some explicit prosody training be included in the KFL curriculum to help KFL learners improve their perceptual distinction of the three-way laryngeal contrasts.

Acknowledgements

I owe many thanks to Hi-Sun H. Kim and Alan Yu at the University of Chicago for their help on the recruitment of experiment participants and the creation and implementation of the experiment. I am also very thankful to anonymous reviewers for their valuable comments on this paper.

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Appendix

A. The list of words used as stimuli in the experiment.

	Plain	Tense	Aspirated
Labial	바라요	빨아요	팔아요
	palayo	p'alayo	p^halayo
Alveolar	달이요	딸이요	탈이요
	taliyo	t'aliyo	t^haliyo
Post-alveolar	자라고	짜라고	차라고
	calako	c'alako	c^halako
Velar	갈이요	깔이요	칼이요
	kaliyo	k'aliyo	k^haliyo

B. Mean VOT and F0 values of the word-initial syllable of the original test stimuli

	Plain	Tense	Aspirated
VOT (ms)	101.65	23.84	108.96
F0 at vowel onset (Hz)	192.50	252.91	268.95
F0 at vowel midpoint (Hz)	185.71	251.59	273.66
F0 at vowel offset (Hz)	182.39	254.94	280.85

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