



Parallel sound change between segmental and suprasegmental properties: An individual level observation*

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Abstract

The present study tested if individual speakers showing great sound change in segments (i.e., vowels and fricatives) also had innovative changing patterns in suprasegmental properties (i.e., lexical pitch accents) in Kyungsang Korean. The acoustic analysis at a group level first confirmed the presence of group level differences in distinguishing /i-/ and /s-s'/ both of which had different phonemic distinction from Seoul Korean. Younger speakers had more innovative segmental change than older speakers, and even within the younger generation, female speakers produced more innovative phonetic variants than male speakers. Regarding the individual observation within the younger group, the younger speakers with large acoustic distinction in vowels and fricatives also showed acoustically less distinct accent patterns, indicating the innovative sound change pattern consistent across segment and suprasegmental properties. The group and individual observations suggested that linguistic innovators introduced new phonetic variants with consistent degree of changing pattern between segment and suprasegmental properties.

Keywords: sound change, vowels, fricatives, lexical pitch accent, Kyungsang dialect, individual background

1. Introduction

The purpose of the present study is to examine if an individual language user show a consistency degree of sound change between segmental and suprasegmental properties in a sound change context. In other words, this study examined whether individuals who exhibited sound change in segments also showed change in suprasegmental features with a similar extent by testing whether a sound change in segments was correlated with a change in suprasegments. To compare the segmental and suprasegmental sound change, this study examined vowels/fricatives and lexical pitch accent of the Kyungsang dialect of Korean both of which have been reported to undergo sound change in a relation to language ideology and increased influence of standard Seoul Korean (Lee & Jongman, 2015, 2016; Lee, 2015, Lee *et al.*, 2016). Although the

sound change of Kyungsang Korean has been documented for each of the segmental and prosodic features, no attempt was made to examine if an individual have consistent degree of sound change between the two features. That is, we only know that a group of younger speakers produced each of vowels/fricatives and lexical pitch accent words differently from an older speaker group, whereas it is not clear if an individual contributes the segmental and suprasegmental sound change with a similar extent. Given the fact that segmental and suprasegmental features interact with each other (Hombert, 1978; Löfqvist *et al.*, 1989; Oglesbee, 2008), it is reasonable to expect that change in segments would also interplay with the change in suprasegments and vice versa. Therefore, by exploring the question, it is aimed to understand if an individual language user shows innovative phonetic variants selectively choosing one feature over the other, or if s/he has innovative speech

* This work was supported by Kyungnam University Foundation Grant, 2016.

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Received 31 October 2016; Revised 12 December 2016; Accepted 13 December 2016

patterns consistently between vowel/fricative and lexical pitch accent features. Addressing the question is important to demonstrate (1) whether there exists innovative language users who introduce new phonetic variants across segment and suprasegment and accordingly lead a sound change in a language community and (2) the qualitative nature of the speech by the linguistic innovators. If individual speakers within the same age group tend to show innovative pattern consistently between segmental and suprasegmental properties, it could be concluded that an innovative speaker plays a role in leading a sound change across multiple aspects of speech. This study examined the consistent sound change between segmental and suprasegmental properties in the South Kyungsang dialect of Korean.

1.1. Sound change of Kyungsang Korean

1.1.1. Sound change in segments: Vowels and fricatives

The South Kyungsang dialect of Korean has different vowel and consonant systems from the standard Seoul dialect of Korean. South Kyungsang Korean is known to have six vowels (/i, e, a, i-Λ, o, u/), whereas standard Seoul Korean has 7 or 8 vowels (/i, e-ε, a, i, Λ, o, u/). The varying number of vowels in Seoul Korean is due to the on-going merger of the two mid front vowels, /e-ε/ (Hong, 1991; Yang, 1996; Sohn, 1999; Lee & Ramsey, 2000; Lee & Ramsey, 2011). While older Seoul speakers distinguished /e/ from /ε/ based on the height difference, younger speakers did not, that is, the difference of the first formant frequency between /e/ and /ε/ were not significant (Lee & Jongman, 2016). In Kyungsang Korean the high central and the mid back vowels (i.e., /i, Λ/) have been merged long as well as the two mid front vowels (i.e., /e/ and /ε/) (Kuak, 2003), and accordingly the different vowel system between the two dialects of Korean was mainly due to the lack of distinction between /i/ and /Λ/ in Kyungsang Korean. However, Lee & Jongman (2016) examined vowels and fricatives of Kyungsang Korean based on generational (younger vs. older generation) and dialectal (Kyungsang vs. Seoul) comparisons, and demonstrated that the segmental properties of Kyungsang Korean have undergone a sound change, shifting similar to those of Seoul Korean. That is, the merged /i/ and /Λ/ vowels for older Kyungsang speakers were split for younger speakers. Specifically, both the first and second formant frequencies (F1, F2, henceforth) were not significantly different between /i/ and /Λ/ for older speakers, indicating that the two vowels were not distinct in both the height and advancement properties. But for younger Kyungsang speakers, /i/ and /Λ/ were significantly different in both F1 and F2, suggesting that the two merged vowels became split, and they has undergone a sound change. Lee & Jongman (2016) pointed out that as a result of this vowel split the vowel system of Kyungsang Korean became similar to that of the standard Seoul Korean by having seven vowels (/i, e-ε, a, i, Λ, o, u/).

The two-way fricative contrast (i.e., non-fortis /s/, fortis /s'/) of Kyungsang Korean was traditionally believed to be less or non-distinct compared to that of Seoul Korean. Lee & Jongman (2016) provided empirical evidence supporting for the traditional belief by showing that the acoustic distinction between /s/ and /s'/ was indeed less distinct for older Kyungsang speakers. But there was a generational difference such that younger speakers made the two-way fricative distinction in durational properties (frication, aspiration), center of gravity and H1-H2, whereas older speakers made it only in aspiration duration and H1-H2. Older speakers' production of the non-fortis /s/ showed greater center of gravity and

longer frication duration than /s/ produced by younger Kyungsang and Seoul speakers, indicating that older Kyungsang speakers' production of /s/ was similar to fortis /s'/ having a less aspirated property. The findings in Lee & Jongman (2016) suggested that Kyungsang speakers became to make the two-way fricative contrast similar to Seoul speakers under a sound change.

Overall, the recent findings in Lee & Jongman (2016) showed that the segments of Kyungsang Korean have undergone a sound change and the acoustic properties of the segments shifted toward those of Seoul Korean. Based on the similarity of the segments between the two dialects of Korean, Lee & Jongman (2016) claimed the influence of Seoul Korean in the diachronic sound change of the Kyungsang dialect.

1.1.2. Sound change in prosody: Lexical pitch accents

Sound change was also observed in the prosody of Kyungsang Korean as well as in the segmental property. Lexical pitch accents of Kyungsang Korean is a unique phonological feature of the regional dialect compared to the standard Seoul Korean, a non-tonal language. Kyungsang Korean distinguishes segmental homonyms using pitch differences. In disyllables, South Kyungsang Korean has HL (káci, 'type'), HH (káci, 'branch'), and LH (kací, 'eggplant') accent patterns, and two acoustic properties, namely F0 scaling (Hz) and F0 timing (ms), distinguish the contrastive accent words. For F0 scaling (Hz), the highest F0 value (peak) within a word is measured, being highest for HL words, intermediate for HH words, and lowest for LH words (Kenstowicz & Park, 2006). Regarding the F0 timing property, the duration between the pitch onset and peak point is measured, and it is longest for LH words, intermediate for HH words, and shortest for HL words (Lee, 2008).

But there was a generational difference in F0 scaling and timing properties in distinguishing the contrastive accent patterns. Lee & Jongman (2015) compared the production of the lexical pitch accents between older and younger Kyungsang speakers and between Kyungsang and Seoul speakers. They found that while older Kyungsang speakers showed acoustic patterns consistent with the previous reports, younger speakers did not maintain the acoustic properties consistent with either the previous report or the production of older speakers. There were two primary changes observed for the accent production of younger speakers relative to older speakers. One was that younger Kyungsang speakers showed less distinct acoustic properties in both F0 scaling and timing dimensions; while older speakers exhibited the F0 peak pattern of 'LH < HH < HL', younger speakers did not make the peak difference across the accent contrasts (i.e., LH = HH = HL). The other primary change of younger speakers' production was a substantial peak delay. Specifically, for the accent production of older speakers, the peak occurred on the first syllable for HL, across the first and second syllables for HH, and on the second syllable for LH. But for younger speakers, the peak was constantly located on the second syllable for all contrastive accent words. As a follow-up study of Lee & Jongman (2015), Lee (2015) examined if there was a gender effect for the observed sound change of the lexical pitch accent. Lee (2015) found that while younger female speakers exhibited the most innovative change, younger male speakers did not change their accent production as much as younger female speakers did. Given that females were known to be more innovative than males (Labov, 2001) in the context of sound change, the finding in Lee (2015) could be expected. But what was noticeable

from the gender effect is that the fact that large individual variation could exist even within one generation, for which the gender difference could be one source of the variation.

1.2. Current study

Although Lee & Jongman (2015, 2016) and Lee (2015) demonstrated that both segmental and suprasegmental properties of Kyungsang Korean have undergone a sound change at a group level, what remained unanswered is if and how the changes between the segmental and suprasegmental features are correlated with each other. That is, it is not clear if an individual speaker has a similar innovative (or conservative) changing pattern between the segmental and suprasegmental features, or if a change in segmental properties is independent from prosodic change and vice versa. Therefore, the present study aimed to examine if an individual speaker who is undergoing a sound change exhibits consistent magnitude of sound change between segmental and suprasegmental properties by observing correlations of the sound change between the two phonological features. This study focused on the split of /i-/ and /s-s'/ and the peak delay and less distinct F0 scaling features of the lexical pitch accents, and several correlation tests examined the consistency in segmental and suprasegmental sound change at the individual level. This study specifically examined if individuals who exhibited great F1/F2 differences in /i/ and /ɿ/ and those who had a great center of gravity difference in /s/ and /s'/ also showed great peak delay and substantially non-distinct F0 scaling properties.

The vowel and fricative data including the production of younger male speakers were newly analyzed in the present study, and thus the result sections of this study first presented the gender effect for the vowel and fricative change (§3.1, §3.2). By including both the male and female production, it was intended to ensure large individual variation, that is, to have linguistic innovators and conservatives within and across generations. As an individual level observation, the consistent sound change between the segmental and suprasegmental changes was present in the following section (§3.3). The production data of the pitch accent were adapted by Lee & Jongman (2016) and Lee (2015).

2. Methods

2.1. Participants

The production data from ten older female and ten younger speakers (5 males, 5 females) were analyzed. The speakers were born and educated in the South Kyungsang region (i.e., Pusan, Ulsan cities). The mean age of the older speakers was 66 (SD = 5.3) and that of the younger speakers was 23 (SD = 1.8) at the time of recording. Data were adapted from Lee & Jongman (2016) and Lee (2015), and the vowels and fricatives produced by younger male speakers were newly added. The speakers participated for a nominal fee, and none of the speakers reported hearing and speaking problems.

2.2. Speech materials and procedure

For the segments, this study examined the two target vowels [i, ɿ (/—/, /ᄃ/)] recorded in both the non-word frame of *hVda* and real word contexts (i.e., /tik-i/ 'profit-nom.', /tak-i/ 'virtue-nom.') and the two-way fricative contrast, /s/ and /s'/ (/ᄃ/, /ᄃ/), in a minimal

pair (i.e., /sal-i/ 'flesh', /s'ak-i/ 'bud') [see Lee & Jongman (2016) for a detail about the recording procedure]. For the lexical pitch accents, this study examined the HL and LH accent words collected in Lee (2015) [HL: /maŋi/ 'head', /more/ 'sand'; LH: /papo/ 'a fool', /pobe/ 'treasure']. This study chose HL and LH accent classes because their acoustic patterns were more distinct than the other contrasts. The degree of the acoustic differences between HL and LH words would be an indicator for observing innovative or conservative prosodic change. The speech materials were written in the Korean orthography provided in an index card, and the participants produced each target words twice at a normal speech rate. A Marantz Digital Recorder (PMD 671) and a SHURE head-mounted microphone were used in the recording. The recording was made in a quiet places on campus, and digitized at a 22050 Hz sampling rate. A total of 320 tokens were analyzed in the current study [vowel: 160 = 2 items x 2 contexts x 2 repetitions x 20 speakers, fricative: 80 = 2 items x 2 repetitions x 20 speakers, pitch accent: 80 = 2 items x 2 repetitions x 20 speakers].

2.3. Measurements

To measure acoustic properties for the newly added male data, this study followed the measurement criteria used in Lee & Jongman (2016). For vowels, this study measured F1 and F2 of the first vowel in *hVda* and /tik-i/ and /tak-i/. F1 and F2 were measured at the midpoint of the first vowel using an LPC analysis with a 25 ms window. They were first measured using a Praat script (Lennes, 2003), and additionally re-checked by hand. For fricatives, center of gravity (COG), which showed the most noticeable age differences among the other acoustic properties distinguishing the two-way fricative contrast, was measured from the onset of frication to the onset of the following vowel. COG was measured at every 25% point during the fricative production using a 20 ms window, and thus the COG values for five time windows were presented (i.e., 0%, 25%, 50%, 75%, 100%).

2.4. Statistical analysis

The first phase of the statistical analysis (§3.1, §3.2) examined if there was a gender difference in distinguishing /i/ from /ɿ/ and /s/ from /s'/. This study tested if male speakers showed the sound change pattern for the vowels and fricatives consistent with females, or if male speakers' segmental change was less innovative compared to female speakers' as seen for the lexical pitch change (Lee, 2015). We used mixed-effects regression models for analyzing both vowels and fricatives, and the *lmer* function in the *lme4* package (Bates *et al.*, 2013) in R was used. For the vowels, the F1/F2 difference between /i/ and /ɿ/ ($\Delta F1$ and $\Delta F2$, henceforth) was assessed as dependent variables. Each of the two dependent variables, $\Delta F1$ and $\Delta F2$, was assessed by two fixed variables: Group (older female, younger female, *younger male*) and Context (nonword, *word*). For the fricatives, mixed-effects regression models were constructed for evaluating COG for the fricative contrast. The COG difference between /s'/ and /s/ was entered as the dependent variable (ΔCOG), and it was assessed by two fixed variables: Group (older female, younger female, *younger male*) and Window (0%, 25%, 50%, 75%, 100%). The fixed variables were contrast-coded (as ± 1), and the italicized levels in the parentheses were the reference level. A log-likelihood test was used to test the

interaction effect, selecting the final model based on forward addition.

The second phase of the analysis (§3.3) examined correlations between segmental and suprasegmental changes. This study specifically tested if an acoustic difference between two segmental categories was correlated with an acoustic difference of suprasegmental contrast.

3. Results

3.1. Group results of vowel changes

Figures 1 and 2 show the results of individual formant measurements with scatter plots and those of averaged F1/F2 values with interquartile ranges, respectively. Visual inspection of Figures 1 and 2 indicates that while older female speakers do not make the F1 and F2 distinction between /i/ and /ɨ/, younger speakers, both females and males, distinguish the two vowels in F1 and F2 dimension. In terms of gender differences within the younger generation, the vowel production of the male speakers tends to show lower F1 than the female production for both /i/ and /ɨ/, indicating that the two vowels are produced in a higher position for males than for females. Regarding the context effect, it is seen that younger females exhibit larger individual variation than males in F2. Statistical assessments confirmed the visual inspection. Table 1 summarizes the parameter estimate of the fixed effects and interactions for the selected models based on log-likelihood tests.

For $\Delta F1$, significant effects were found for Group, but not for Context. The mixed-effects regression model showed that compared to $\Delta F1$ of the younger male group, $\Delta F1$ of the older females was significantly smaller, but that of younger females was greater. This indicated that the F1 distinction between /i/ and /ɨ/ is greatest for the younger female, intermediate for the younger male, and smallest for the older female group. Adding the two-way interaction of Group x Context did not improve the model based on a log-likelihood test [$\chi^2(2)=2.25, p=0.329$], indicating that the Group effect was not different between word and non-word contexts.

The results of $\Delta F2$ were similar to those of $\Delta F1$. For $\Delta F2$, significant effects were found for both Group and Context. Compared to $\Delta F2$ of the younger male group, the estimated mean $\Delta F2$ of the older female group was significantly smaller, but that of the younger females was greater. That is, older and younger female speakers have the smallest F2 and the greatest F2 difference between /i/ and /ɨ/, respectively. Regarding the Context effect, $\Delta F2$ was greater in the word context than in the non-word context. But given the absence of the interaction of Group x Context revealed by a log-likelihood test [$\chi^2(2)=2.75, p=0.25$], the Group effect did not pattern differently across the three groups.

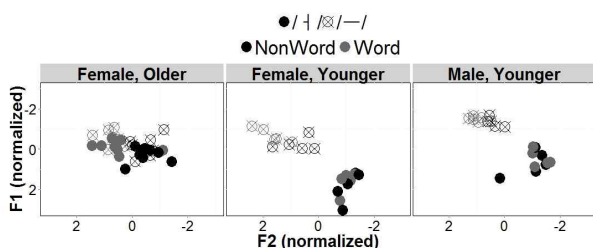


Figure 1. Formant scatter plots of /ɨ/ and /i/ for older and younger Kyungsang speakers in Non-word and Word.

To sum up, the results replicated Lee & Jongman (2016) where the acoustic differences between /i/ and /ɨ/ were more distinct for younger speakers than for older speakers, confirming the vowel split. Importantly, the present study newly revealed the gender difference of the /i/ and /ɨ/ vowel distinction, showing that younger females were more innovative than younger male speakers and the degree of the sound change varied even within one generation.

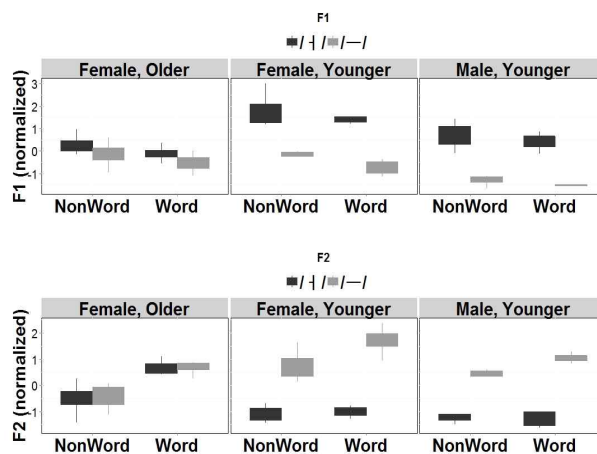


Figure 2. Interquartile ranges of normalized F1 and F2 of /ɨ/ and /i/ for older and younger Kyungsang speakers in Non-word and Word.

Table 1. Estimates for predictors of the mixed-effects models in the analysis of F1 and F2 differences between /i/ and /ɨ/ by Group and Context. Bold type indicates the significant effect based on t-statistic exceeding |2|.

	$\Delta F1$ of /i/ and /ɨ/		
	Coef. β	SE(β)	t value
(Intercept)	1.58	15.43	12.02
GROUP _{oldFemale}	-1.18	20.41	-6.79
GROUP _{youngFemale}	0.76	22.13	4.07
CONTEXT _{nonWord}	-0.04	7.21	-0.76
GROUP _{oldFemale} :CONTEXT _{nonWord}	0.04	9.33	0.59
GROUP _{youngFemale} :CONTEXT _{nonWord}	0.13	10.81	-1.46
	$\Delta F2$ of /i/ and /ɨ/		
	Coef. β	SE(β)	t value
(Intercept)	1.39	47.90	10.88
GROUP _{oldFemale}	-1.29	62.86	-7.68
GROUP _{youngFemale}	0.84	69.81	4.53
CONTEXT _{nonWord}	-0.33	42.07	-2.96
GROUP _{oldFemale} :CONTEXT _{nonWord}	0.22	54.95	1.55
GROUP _{youngFemale} :CONTEXT _{nonWord}	-0.08	61.87	-0.53

3.2. Group results of fricative changes

Figure 3 presents the measured COG between /s/ and /s'/, indicating age and gender differences mostly at the 50% and 75% time windows. Regarding the age difference, while older female speakers exhibited similar COG values between /s/ and /s'/ at 50%, the interquartile range at the same position were well separated for both younger females and males. The gender difference was less clear than the age effect; younger females tended to have large individual variation than males mostly at 50% and 75%. Table 2 summarizes

the parameter estimate of the fixed effects and interactions for the selected models based on log-likelihood tests.

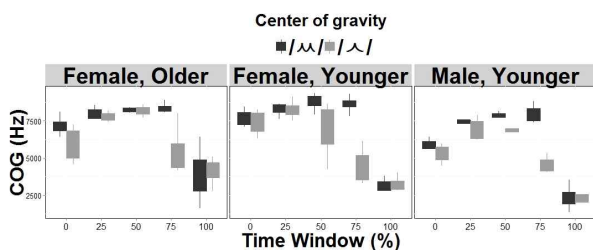


Figure 3. Interquartile ranges of center of gravity between /s/ and /s'/ for older and younger Kyungsang speakers in Non-word and Word.

Table 2. Estimates for predictors of the mixed-effects models in the analysis of center of gravity differences between /s/ and /s'/ by Group and Window. Bold type indicates the significant effect based on t-statistic exceeding |2|.

	ΔCOG of /s'/ and /s/		
	Coef. β	SE(β)	t value
(Intercept)	892	151	5.88
GROUP _{oldFemale}	-355	211	-1.68
GROUP _{youngFemale}	333	211	1.58
WINDOW _{0%}	-321	252	-1.27
WINDOW _{25%}	-772	252	-3.06
WINDOW _{50%}	24	252	0.09
WINDOW _{75%}	2241	252	8.89
GROUP _{oldFemale} ·WINDOW _{0%}	789	350	2.25
GROUP _{youngFemale} ·WINDOW _{0%}	-582	350	-1.65
GROUP _{oldFemale} ·WINDOW _{25%}	358	350	1.02
GROUP _{youngFemale} ·WINDOW _{25%}	-455	350	-1.29
GROUP _{oldFemale} ·WINDOW _{50%}	-578	350	-1.64
GROUP _{youngFemale} ·WINDOW _{50%}	646	350	1.84
GROUP _{oldFemale} ·WINDOW _{75%}	-755	350	-2.15
GROUP _{youngFemale} ·WINDOW _{75%}	594	350	1.69

The mixed-effects regression model revealed significant effects for Window, but not for Group. ΔCOG at the 100% of the time window was greater than that at 75%, but smaller than that at 25%. Notably, adding the two-way interactions of Group x Window improved the model based on a log-likelihood test [$\chi^2(8)=15.13, p=0.05$], indicating that the Window effects were different across the groups. ΔCOG at 75% was smaller for older females than for younger males; as seen in Figure 3, the COG value of the non-fortis /s/ was greater for older females compared to the two younger speaker groups, suggesting that /s/ produced by older females was less aspirated than that produced by younger groups. Overall, the results of the fricative analysis indicated that the COG distinction between /s/ and /s'/ was smaller for older females than for younger female and male speakers, and the age effect was mostly observed at the 75% point of Window where the aspirated feature of the non-fortis fricative was present.

3.3. Parallel sound change between segments and lexical pitch accents at the individual level

This section directly examined whether an individual exhibits consistent sound change between segmental and suprasegmental properties by using correlation tests. The acoustic differences (i.e., $\Delta F1, \Delta F2, \Delta \text{COG}_{75\%}$) between /i/ and /ɨ/ and between /s/ and /s'/ were set as variables for the segmental sound change; the duration and peak value differences (i.e., $\Delta \text{PeakDuration}, \Delta \text{PeakScaling}$) between LH and HL accent words were set as the other variables for the prosodic sound change. Given that this study already confirmed the age effect at a group level, the correlation tests were conducted within an age group.

First, each panel of Figure 4 shows that the data points of older speakers are in the upper left corner, whereas those of younger speakers are mostly in the lower right corner. This first confirmed the group observation that older speakers produced the HL and LH accent words with great acoustic differences than younger speakers, but the older produced /i/ and /ɨ/ with less F1/F2 distinction.

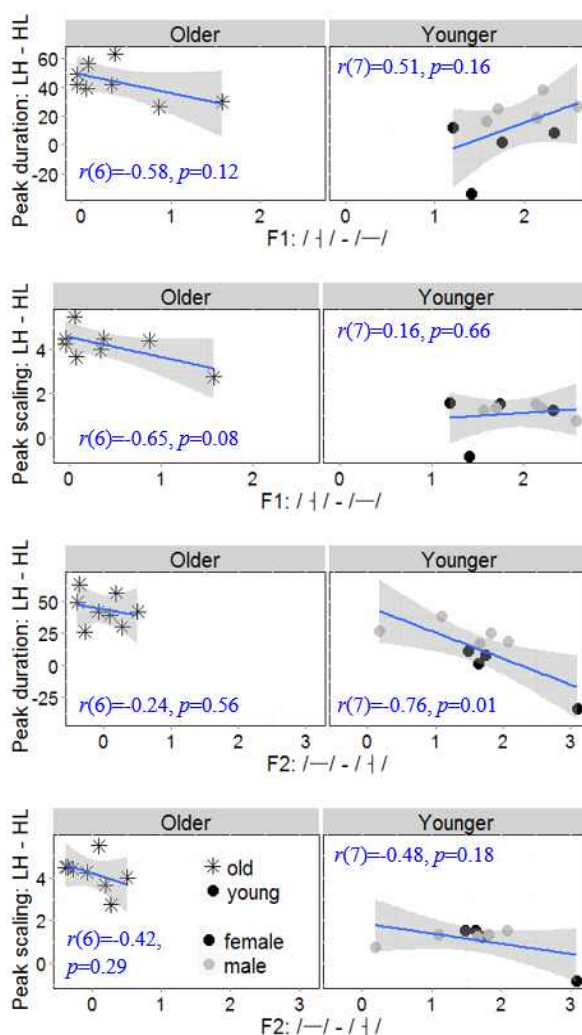


Figure 4. Correlations between vowel and pitch accent changes within each age group.

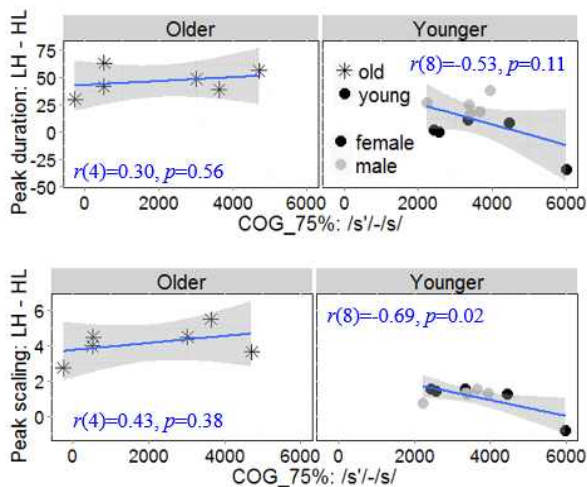


Figure 5. Correlations between fricative and pitch accent changes within each age group.

Regarding the consistency between vowel and pitch accent changes within an age group, a significant correlation was reported between $\Delta F2$ and $\Delta \text{PeakDuration}$ within the younger group [$r(7) = 0.76, p = 0.01$]. This indicated that younger speakers who made greater height distinction in the /i-/ɛ/ contrast had smaller peak value distinction in the HL-LH contrast, suggesting that younger individuals who innovatively change the pitch accent also showed an innovative vowel split pattern. Contrary to the younger group, the older speaker group did not report significant correlations for any comparisons.

Second, each panel of Figure 5 also indicates clearly separated data points between older and younger groups, confirming the group pattern that older speakers produced the HL and LH accent words with great acoustic differences than younger speakers but produced /s/ and /sʰ/ with the less COG distinction. Regarding the consistent sound change at the individual level, a significant correlation was reported between ΔCOG and $\Delta \text{PeakScaling}$ within the younger group [$r(8) = 0.69, p = 0.02$]. This indicated that younger individuals who made greater COG distinction in /s/ and /sʰ/ had smaller peak value distinction in HL and LH words, suggesting that individuals with an innovative accent change pattern also had an innovative fricative change. But such correlation effects were not observed within the older speaker group.

4. Discussion and Conclusion

The present study examined if an individual speaker showed the sound change with a similar extent between segmental and suprasegmental sound changes by testing the correlation between vowel/fricative and lexical pitch accent changes in South Kyungsang Korean. We first observed the age and gender effects in the segmental change (i.e., /i-/ɛ/ and /s-/sʰ/) at a group level, and found the age and gender effects for /i-/ɛ/ and the age effect for /s-/sʰ/. In addition to Lee (2015) in which younger males were conservative in changing the lexical pitch accent than younger females, the findings provided an additional support for the gender effect with the vowel change showing that younger males lagged behind in the split of /i-/ɛ/ compared to younger females.

As a second phase of the analysis, this study conducted several correlation tests between segmental and suprasegmental variables.

For the segmental and prosodic change, there were significant correlations between $\Delta F2$ and $\Delta \text{PeakDuration}$ and between ΔCOG and $\Delta \text{PeakScaling}$ within the younger speaker group. But there were no such correlations within the older speaker group. The findings indicated several implications.

First, not only across generations but also within one generation there were linguistic innovators and conservatives. In other words, although the younger group of this study could be considered homogeneous based on similar dialectal background and age range, individual language users exhibited systematic variations in the use of acoustic properties. Presence of such individual variations might not be surprising in the context of sound change, given that the sounds undergoing a change are more likely to have phonetic variants (e.g., Harrington & Stevens, 2014). The larger individual variation limited to the present younger speakers who are undergoing sound change might support the notion regarding the relationship between individual variation and sound change.

Second, what was also notable in the present findings was that the variation was not limited to prosodic properties, but it patterned parallel with segmental properties and vice versa. That is, when a sound change occurs in a language, phonetic variants are present in both segmental and suprasegmental features. Importantly, if an individual language user has an innovative phonetic variant in segments, s/he also tended to have an innovative variant in prosody, suggesting that the sound change patterns together between segment and suprasegment. The consistent sound change between the two phonological aspects suggests that even within a homogeneous sample some language users are more innovative than others with every aspect of a language, leading us to conclude the presence of linguistic innovators who introduce a new phonetic variant and lead a sound change in a language community. Therefore, figuring out the factors explaining the linguistic innovators including both individuals' social and cognitive factors would shed light on understanding the mechanism of a sound change (Lee & Kong, 2016, Yu *et al.*, 2013).

Considering the interaction between segmental and suprasegmental features, one could expect the correlation observed in the present study. For example, the lexical pitch accent is a unique phonological feature of Kyungsang Korean compared to Seoul Korean, which would presumably compromise the lack of /i-/ɛ/ and /s-/sʰ/ contrasts in the regional dialect. Accordingly, losing a pitch accent could mean the loss of the compromising factor for the less distinct segment, and this might result in the need for the segmental distinction. Conversely, having /i-/ɛ/ and /s-/sʰ/ contrast could also mean that younger Kyungsang speakers would not need the pitch accent distinction as much as older speakers would. Therefore, it will be interesting to explore whether the loss of the lexical pitch accent or the obtainment of the segment contrast triggers the sound change occurring consistently between segment and suprasegment.

What remains unclear in the present study is the absence of significant correlations between other segmental and suprasegmental variables (i.e., $\Delta F1$ and $\Delta \text{PeakDur} / \Delta \text{PeakScaling}$, $\Delta F2$ and $\Delta \text{PeakScaling}$, ΔCOG and $\Delta \text{PeakDuration}$). It seems highly possible that the lack of data points might result in the non-significant effects for the correlations between these variables. In both Figures 4 and 5, although it failed to reach the significance level at 0.05, the segmental and suprasegmental variables generally tended to negatively correlate with each other both for the younger

and older speakers. Therefore, testing the consistent sound change with ample data would be able to confirm the present findings not only for younger group, but also across generations, and enable further understanding the mechanism of sound change.

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