



Research Article

Acoustic evidence for diachronic sound change in Korean prosody: A comparative study of the Seoul and South Kyungsang dialects



Hyunjung Lee*, Allard Jongman

Department of Linguistics, University of Kansas, USA

ARTICLE INFO

Article history:

Received 23 January 2013

Received in revised form

25 November 2014

Accepted 8 January 2015

Keywords:

Korean

Diachronic sound change

Lexical pitch accent

Seoul

South Kyungsang

ABSTRACT

This paper examined the acoustic properties of the pitch accent of South Kyungsang Korean, focusing on generational differences. Kyungsang Korean has lexical pitch accents, whereas standard Seoul Korean does not. However, whether the pitch accents are maintained by younger Kyungsang speakers is questionable given the influence of Seoul Korean. Through comparisons between older and younger speakers and between Seoul and South Kyungsang speakers, this study tested if and how sound change occurs in the pitch accent system of the regional dialect, and if the prosody of Kyungsang Korean shifts towards that of non-tonal Seoul Korean. We examined F_0 scaling and alignment of pitch accents for the data collected from 40 female Korean speakers (10 younger and 10 older speakers each for Seoul and South Kyungsang dialects). Clear acoustic differences between generations provided evidence for diachronic sound change in the lexical pitch accent of South Kyungsang Korean. First, the differences in F_0 scaling and alignment across accent contrasts are less distinct for younger Kyungsang speakers than for older speakers. Second, the F_0 peak occurs later for younger Kyungsang speakers across all accent classes, resulting in a final rising accent pattern in disyllables similar to Seoul Korean. Third, despite the similarity with Seoul Korean, results from longer words revealed that Kyungsang Korean is still distinct from Seoul in terms of its maintenance of the lexical pitch accent. Based on these findings, we conclude that the sound change in lexical pitch accent is in progress by satisfying the prosodic properties of both Seoul and South Kyungsang Korean.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The purpose of this study was to investigate diachronic sound change in the prosody of South Kyungsang Korean, and to address how this dialect's prosodic properties shift toward those of standard Seoul Korean. The South and North Kyungsang dialects of Korean (spoken by approximately 13 million people in the southeastern part of Korea) have preserved lexical pitch accents from Middle Korean (15–16th centuries), whereas the standard Seoul dialect lost its lexical pitch accent around the 17th century (e.g., Ramsey, 1975; Lee & Ramsey, 2000; Kenstowicz, Cho, & Kim, 2008). In a pitch accent language, the location of pitch prominence in a word cues meaning differences. In disyllables, for example, Kyungsang dialects distinguish triplets using three contrastive pitch accent patterns as in *káci* (HL) 'type', *káci* (HH) 'branch', and *káci* (LH) 'eggplant', whereas these triplets are homonyms for Seoul Korean speakers who do not use pitch differences for lexical distinctions. However, whether these lexical pitch accent contrasts in Kyungsang Korean are maintained by younger speakers consistent with older generations is questionable due to an increase in contact with Seoul speakers (Lee, 2008) and the prevailing linguistic ideology that has lent Seoul Korean a strong normative bias (Silva, 2011).

Over the past several decades, Kyungsang speakers have had more exposure to the standard Seoul dialect through increased contact with Seoul speakers and media based in Seoul (Lee, 2008). According to the notion that "dialect differences are the result of isolation and the lack of communication" (Labov, 1974: 234), exposure to a different dialect may be an important factor in dialect change. In fact, several empirical studies have demonstrated that long-term exposure to a target dialect results in the acquisition of speech characteristics of that dialect (e.g., Munro, Derwing, & Flege, 1999; Evans & Iverson, 2007) in both production and

* Corresponding author. Current address: Department of English, Hankyong National University, 327 Jung-ang-ro, Ansong-si, Kyenggi-do 456-749, Republic of Korea. Tel.: +82 10 3325 5203.

E-mail address: hyunjunglee123@gmail.com (H. Lee).

perception. Importantly, the dialect acquisition observed in previous synchronic studies may be evidence to support diachronic sound change induced by language exposure or language contact. In their view of language change, [Trudgill \(1986\)](#) and [Auer and Hinskens \(1996\)](#) claimed that the face-to-face communication between speakers forms a short-term accommodation, and if the permanently occurring short-term accommodation becomes a long-term accommodation, this might affect the language community, leading to language change. In this sense, we can reasonably ask whether a diachronic change occurs in Kyungsang Korean because the regional variety has been increasingly in contact with the standard Seoul dialect over decades, which leads us to doubt the extent of linguistic homogeneity across older and younger generations.

Along with the exposure to Seoul Korean, the language ideology in Korean motivates us to question the homogeneity of Kyungsang Korean between older and younger speakers. In sociolinguistics, the prestige or stigma of language is considered an important social factor in language change (e.g., [Heffernan, Borden, Erath, & Yang, 2010](#); [Armstrong, 2012](#)). By defining ‘standard Korean’ as “the modern speech of Seoul widely used by the well-cultivated” (1977, National Institute of the Korean Language), the Korean government’s language policy has given Seoul Korean a strong normative bias ([Silva, 2011](#)). A survey by [Min \(1997\)](#) also noted that college students who speak regional dialects have a negative attitude toward their dialects, which is particularly true among females. This leads to the hypothesis that the Korean ideology might motivate younger Kyungsang speakers to imitate speech characteristics of prestigious Seoul Korean or to avoid marked properties in their Kyungsang speech. Accordingly, in addition to the exposure to Seoul Korean, the prevailing Korean ideology might play another critical role in increasing the phonetic and phonological similarity between Seoul and Kyungsang Korean in favor of Seoul Korean. In this sense, the increased exposure to Seoul Korean might provide an optimal linguistic setting for younger Kyungsang speakers who favorably imitate the phonetic properties of the standard Seoul dialect.

For example, [Lee \(2008\)](#) found generational differences for sentence intonation in North Kyungsang Korean. [Lee \(2008\)](#) showed that older Kyungsang speakers use falling intonation in marking yes/no and WH questions as well as statements, and pointed out the non-universal tendency of falling intonation for yes/no questions in Kyungsang Korean. [Lee \(2008\)](#) attributed the weak intonation distinctions in Kyungsang to sentence-final particles to mark sentence types, although this was not empirically supported in her data. In [Lee \(2008\)](#), contrary to the older generation, younger Kyungsang speakers did not preserve the final-falling intonation for yes/no questions and WH questions. Instead, the younger generation used final-rising intonation for both question types, similar to Seoul Korean. [Lee \(2008\)](#) suggested that this generational difference possibly indicates ongoing sound change that may be attributed to increased exposure to prestigious Seoul Korean.

Although the current sociolinguistic setting of Kyungsang Korean suggests a possibility of diachronic sound change, few studies have explored this topic. Therefore, the present study investigated sound change in Kyungsang Korean by focusing on lexical pitch accent. We tested the phonetic homogeneity of contrastive accents between older and younger speakers of South Kyungsang in an apparent-time investigation where the phonetics between two different age groups were observed at the same point in time. Apparent-time studies assume that the speech of each generation reflects the language that existed at the time when that generation learned the language ([Bailey, Wickle, Tillery, & Sand, 1991](#)). In addition to the generational comparison, we compared the prosodic properties of South Kyungsang with those of Seoul Korean to address whether and how the prosody of Kyungsang is re-formed to approximate standard Seoul Korean, which is not a pitch accent language. As a first sociophonetic study of Kyungsang Korean, the phonetic examination in this study will hopefully build a bridge between past research and future work that traces the process of diachronic sound change in South Kyungsang Korean.

1.1. Prosody of Seoul Korean

In her investigation of the phonetics and phonology of Seoul Korean prosody [Jun \(1993, 1998\)](#) suggested that surface phonetic forms of an utterance can be used to define prosodic units at different levels, and proposed a prosodic hierarchy of Seoul Korean based on phonetic patterns. [Jun \(1993, 1998\)](#) proposed the accentual phrase (AP) as the smallest unit, which establishes a tonal boundary in Seoul Korean. [Jun \(1993, 1998, 2000, 2006\)](#) indicated that most APs have a phrase-final rising pattern (LH) in Seoul Korean, and therefore the most common AP-final tone is a High tone; but, [Jun \(2000, 2006\)](#) also stated that when the following AP begins with a High tone, an AP-final tone is sometimes realized as a Low tone. According to Jun, the underlying tonal pattern of the AP in Seoul Korean is LHLH or HHLH, and the realization of either LHLH or HHLH depends on the laryngeal gesture of the phrase-initial segment; when the initial segment has [+stiff vocal cords] with aspirated or tense obstruents, the phrase-initial tone is High, otherwise it is Low. [Jun \(1998\)](#) states that all four tones in LHLH (or HHLH) are realized when an AP has four or more syllables; in her later study, [Jun \(2000\)](#) showed intonational variations in which the first tone is realized on the first syllable of the AP, but the second tone (i.e., H) is loosely associated with the second syllable or grouped together with the preceding tone or the following tone. When there are fewer than four syllables, the tone in the second or third syllables is undershot. For example, an AP with three syllables has either LLH (or HLH) or LHH (or HHH) depending on which syllable is undershot. Overall, it is noted that with the exception of [+stiff vocal cords] phrase-initial segments, the AP in Seoul Korean most commonly has a final rising tonal pattern (i.e., LH).

1.2. Lexical pitch accent in South Kyungsang Korean

The accent contrasts between the South and North Kyungsang dialects are alike in that the two dialects have monosyllabic High (H) and disyllabic HH, HL and LH accents. However, due to different historical development, while South Kyungsang has preserved the rising accent (R) from Middle Korean, in North Kyungsang the rising accent has merged with H(H) and the vowels in the accent

class have been lengthened (e.g., Kenstowicz et al., 2008). To avoid geographical variation, the current study focused on South Kyungsang Korean. Henceforth, the term Kyungsang Korean in this study refers to South Kyungsang, and whenever we refer to previous studies on North Kyungsang Korean we specifically indicate ‘North’. In what follows, we outline the descriptive accent patterns of South Kyungsang Korean, and introduce how the contrastive accents have been investigated in previous research in terms of F0 scaling and alignment properties. Examples in this paper are transcribed according to the Yale Romanization (Martin, 1992).

1.2.1. Descriptions of South Kyungsang pitch accents

The lexical pitch accents of Kyungsang Korean have been well documented in terms of both their phonetic and phonological characteristics (e.g., Ramsey, 1975; Kenstowicz & Sohn, 1997; Jun, Kim, Lee, & Jun, 2006; Kenstowicz & Park, 2006; Chang, 2007, 2008; Lee, 2008; Schuh & Kim, 2007; Kim & Jun, 2009; Lee & Davis, 2009; Lee & Zhang, 2014). Although there are disagreements across previous studies regarding the phonological analysis of pitch accent, the literature on South Kyungsang's accent system generally agrees on the descriptive data pattern and the categorization of words according to accent classes. For example, although the word *mál* ‘horse’ in South Kyungsang Korean is formally analyzed as a Middle tone (Chang, 2007, 2008), accented (Lee & Davis, 2009), or toneless (Lee & Zhang, 2014) word, there is no disagreement about the fact that the word *mál* differs from words like *mǎl* ‘speech’ or *múl* ‘water’ in terms of its accent classification.

When there is no suffix attached, South Kyungsang Korean shows High (H) and Rising (R) prosodic patterns in monosyllables, and HH, HL and LH in disyllables. Previous studies (e.g., Ramsey, 1975; Schuh & Kim, 2007; Chang, 2007, 2008; Lee & Davis, 2009; Lee & Zhang, 2014) noted that a phonological word consisting of fewer than three syllables should be expanded with suffixes in order to determine the underlying accent class. Tables 1 and 2 present examples of the accent patterns for monosyllabic and disyllabic nouns, respectively, when expanded with the suffix *-i* (nominative case marker) and *-pota* ‘than’. Throughout this paper, a word may refer to either a root only or a combination of a root and suffixes attached to the root.

For monosyllables (Table 1), the addition of suffixes reveals that there are two kinds of monosyllabic Hs. In order to indicate underlying distinct accent classes, we use the notation of H(H) and H which reflect the prosodic pattern when suffixed. Regarding the role of suffixation, although both *múl* ‘water’ and *mál* ‘horse’ are described as an H in isolation, when the suffix *-i* (nominative case marker) is added, the prosodic pattern for ‘water’ is *múl-i* (H-H), while that for ‘horse’ is *mál-i* (H-L). That is, the peak occurs across two initial syllables of the word *múl-i*, whereas the peak is only on the first syllable of *mál-i*. In addition, with the suffix *-pota*, while *múl-póta* (H-HL) shows the prosodic pattern consistent with *múl-i* (H-H) regarding the peak across the two initial syllables, *mal-póta* (L-HL, ‘than horses’) shows a different pattern from *mál-i* (H-L) in that the peak does not occur on the root, but on the first syllable of the suffix *-pota*. Finally, for the rising accent, the peak occurs at the right edge of a monosyllable and on the second and available third syllables, which is consistent between *-i* and *-pota*.

For disyllables (Table 2), the words in the HL and HH accents have distinct prosodic patterns regardless of the suffix *-i* or *-pota*. For HL, the peak occurs only on the first syllable of *kéwul*, and for HH the peak is across two initial syllables of *kúlím* with and without the addition of *-i* or *-pota*. Similar to the monosyllables, disyllabic words in LH also show the role of suffixation; the tonal notation of LH (H) and LH marks the two distinct accent classes. Specifically, when the suffix *-i* is added to *salám* ‘person’ and *palám* ‘wind’, both of which have LH in isolation, ‘person’ patterns as *salám-i* (LH-H), while ‘wind’ patterns as *palám-i* (LH-L). In other words, the comparable pitch prominence is across the second and the available third syllables in *salám-i*, whereas the peak is only on the second syllable in *palám-i*. In addition, while the accent patterns of *salám* are comparable regardless of suffix types, those of *palám* are not; while the peak is only on the second syllable of the root with *-i*, the peak occurs across the second syllable of the root and the first syllable of the suffix *-pota*. The descriptive prosodic pattern of South Kyungsang Korean indicates that (1) the neutralized monosyllabic H and disyllabic LH accents in isolation actually belong to two different underlying accent classes, namely H(H) and H, and LH(H) and LH, respectively, and (2) the H and LH classes have tonal variation by suffix type.

In their formal analysis of the pitch accent system of South Kyungsang Korean, Lee and Zhang (2014) noted some parallels of accent patterns between monosyllabic and disyllabic nouns under suffixation: (1) HL – a peak on the penultimate syllable; (2) H(H)/

Table 1
Accent patterns for monosyllabic noun roots when isolated and suffixed with *-i* (nom.) and *-pota* ‘than’.

H(H)		H		R	
<i>múl</i> ‘water’	H	<i>mál</i> ‘horse’	H	<i>mǎl</i> ‘speech’	R
<i>múl-i</i>	H-H	<i>mál-i</i>	H-L	<i>mal-i</i>	L-H
<i>múl-póta</i>	H-HL	<i>mal-póta</i>	L-HL	<i>mal-póta</i>	L-HH

Table 2
Accent patterns for disyllabic noun roots when isolated and suffixed with *-i* (nom.) and *-pota* ‘than’.

HL		HH		LH(H)		LH	
<i>kéwul</i> ‘mirror’	HL	<i>kúlím</i> ‘painting’	HH	<i>salám</i> ‘person’	LH	<i>palám</i> ‘wind’	LH
<i>kéwul-i</i>	HL-L	<i>kúlím-i</i>	HH-L	<i>salám-i</i>	LH-H	<i>palám-i</i>	LH-L
<i>kéwul-pota</i>	HL-LL	<i>kúlím-pota</i>	HH-LL	<i>salám-póta</i>	LH-HL	<i>palám-póta</i>	LH-HL

HH – peaks across the first and second syllables; (3) R/LH(H) – peaks across the second and third syllables; (4) H/LH – tonal variation depending on suffix type. Based on these prosodic parallels, Lee and Zhang (2014) proposed a formal analysis according to which nouns of South Kyungsang Korean fall into one of four underlying accent classes, namely, penult-H (HL), initial-H⁺ (H(H)/HH), pen-initial-H⁺ (R/LH(H)), and toneless (H/LH). As for the penult-H (HL) analysis, Lee and Zhang (2014) suggested that since monosyllabic roots do not have a penult syllable, the analysis explains the absence of monosyllabic nouns in this accent class. The diacritic⁺ in the initial-H⁺ and pen-initial-H⁺ classes in Lee and Zhang (2014) marked the rightward spreading property of their underlying accent. Lee and Zhang (2014) argued that the prosodic patterns of the penult-H, initial-H⁺, and pen-initial-H⁺ words are predetermined by the underlying accent type, whereas those in the toneless class surface by constraint interactions and suffixal accent types.

1.2.2. F0 scaling and alignment of pitch accents

When phonetic properties of contrastive accents are investigated, accent or tone distinctions have been explored in terms of two acoustic dimensions, namely the horizontal and vertical dimensions of fundamental frequency (F0). The horizontal dimension is temporal and indicates turning point location of F0 (=F0 alignment); the vertical dimension is frequency and relates to F0 values (=F0 scaling) (e.g., Bruce, 1977; Xu, 1993; Prieto, van Santen, & Hirschberg, 1995; Arvaniti, Ladd, & Mennen, 1998).

Previous phonetic studies of Kyungsang's accents (e.g., Chang, 2007, 2008; Lee, 2008) showed that its contrastive lexical accents are also characterized in terms of F0 alignment and scaling (Fig. 1). The temporal distance from the onset of a target word to the maximum F0 point is defined as the timing of maximum F0 ((a) in Fig. 1), and the distance from the onset of a target word to pre-accentual F0 minimum point is defined as the timing of minimum F0 (b); F0 is measured at the peak F0 value (c) and at the minimum F0 value (d), for F0 maximum and minimum values, respectively.

Chang (2007, 2008) has explored the F0 scaling and alignment properties for H(H), H and Rising accents of monosyllables in South Kyungsang Korean, primarily focusing on clarifying inconsistent tonal descriptions among studies. In her production study, Chang (2007, 2008) measured F0 minimum and maximum values, timing of F0 (F0 peak and fall delay) and syllable duration for words in isolation and with various suffixes. Chang (2007, 2008) compared these acoustic properties between Rising and H, and between H(H) and H classes (Fig. 2).

First, regarding the Rising and H comparison, Chang (2007, 2008) reported that both the timing of the F0 peak (from first syllable onset to F0 peak onset) and F0 fall (from first syllable onset to F0 peak offset) came later for words of the Rising accent class than words of the H class for both unsuffixed and suffixed words. In addition, the syllable is longer for Rising class than H class words. As for F0 scaling, Chang (2007, 2008) showed that while peak F0 was not significantly different between Rising and H class words, low F0 values were lower for Rising class words than H class words. Second, for the H(H) and H comparison, Chang (2007, 2008) reported that in the suffixed condition, the F0 peak and fall occurred significantly later for H(H) than H class words. For words in isolation, however, the timing of F0 was not different between the two accent classes. The difference between unsuffixed and suffixed words was due to the fact that the F0 peak is spread to the next syllable (suffix) in H(H) class but not in H class words. This difference in the spreading feature in H(H) and H accent classes was also reflected by a longer peak plateau for H(H) accent words than H

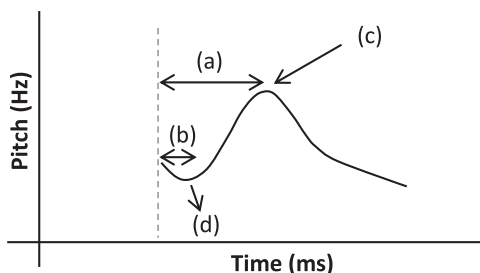


Fig. 1. Example of F0 alignment and scaling measures: (a)=timing of maximum F0 (ms), (b)=timing of minimum F0 (ms), (c)=peak F0 value (Hz), (d)=minimum F0 value (Hz). The dotted line represents the onset of the target word (adapted from Lee (2008): 42).

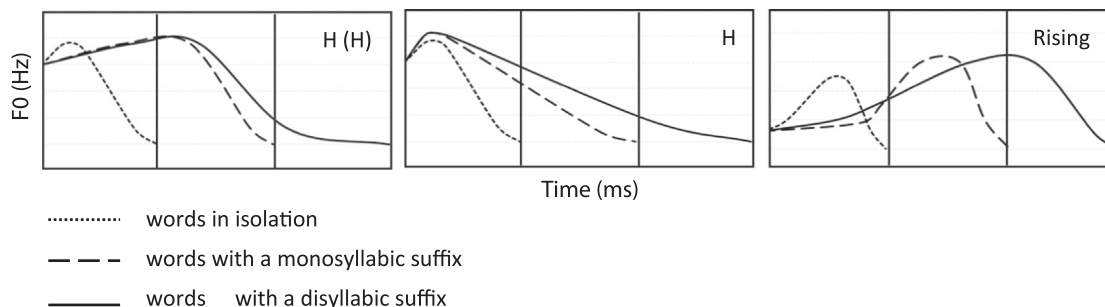


Fig. 2. Schematic pitch contours of monosyllabic H(H), H and Rising accents in South Kyungsang Korean under suffixation. The vertical lines in each panel indicate the syllable boundaries (adapted from Chang (2007): 28, 87).

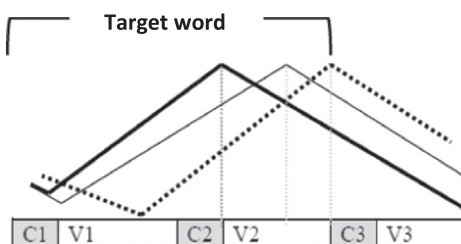


Fig. 3. Schematic pitch contours for disyllabic words in HL (thick solid), HH (thin solid) and LH (dotted) accents. (adapted from Lee (2008): 49).

words. In addition, Chang (2007, 2008) showed that peak F_0 in unsuffixed words is slightly higher for H(H) than H class words.

Lee (2008) investigated the phonetic realizations of HL, HH and LH accents of disyllabic nouns in North Kyungsang Korean by examining F_0 scaling and alignment properties for data collected from five females in their early twenties to thirties. Fig. 3 presents a schematic illustration of Lee's findings. The target words in Lee (2008) were followed by a quotation suffix *-ila* or *-lako* that was altered by the structure of the preceding syllable (i.e., *-ila* after a word with a coda, *-lako* after a word without a coda), and, accordingly, C3 and V3 in Fig. 3 indicate the consonant and vowel of the suffix.

Lee (2008) reported that the timing of the F_0 maximum is the shortest for HL, intermediate for HH, and the longest for LH, but the timing of the F_0 minimum for HH overlaps with that of HL and LH. For the timing of the F_0 minimum, Lee (2008) reported that the F_0 minimum is reached later for LH than HL and HH. For the scaling of F_0 , Lee (2008) reported that while the F_0 minimum value is lower for LH than the other two accent classes, the F_0 maximum value is not significantly different across HL, HH and LH, as seen in Fig. 3.

To summarize, in South Kyungsang Korean, the pitch accent patterns of monosyllabic words are High and Rising, and those of disyllabic words are HH, HL and LH in isolation. Importantly, suffixation plays a role in revealing that there are three accent classes for monosyllabic words (H(H), H, and Rising) and four accent classes for disyllabic words (HL, HH, LH(H) and LH). Phonetically, the contrastive accents in South Kyungsang Korean may be characterized in terms of the scaling properties of F_0 (F_0 maximum and minimum values (Hz)) and the alignment properties of F_0 (F_0 maximum and minimum turning point duration (ms)).

Broadly, the current study aimed to address whether diachronic sound change occurs in the lexical pitch accent of South Kyungsang Korean. The goal of this paper is threefold. First, we aimed to capture fine-grained phonetic details of the lexical pitch accent of South Kyungsang Korean for older and younger generations and thereby address if and how the two generations of Kyungsang speakers phonetically maintain the accent contrast. For this purpose, we measured F_0 minimum and maximum values (F_0 scaling) and F_0 minimum and maximum distance (F_0 alignment) for the monosyllabic H(H), H and Rising, and disyllabic HL, HH, LH(H) and LH accent contrasts in isolation. Statistical comparisons assessed if younger and older Kyungsang speakers use F_0 scaling and alignment in a similar way to distinguish the accent contrasts in isolation.

Second, the current study examined if and how the observed phonetic properties of the pitch accent in isolation are reflected in longer words. We examined the F_0 contours of monosyllabic and disyllabic roots when suffixed with the nominative case marker *-i* that has been reported as a toneless suffix (Chang 2007, 2008; Lee & Zhang, 2014). Adding the toneless suffix to roots allowed us to examine if and how the alignment F_0 properties are realized differently between the two generations of Kyungsang speakers. The monosyllabic suffix *-i* has allomorphs, and the allomorphy is determined by the last segment of the noun root: a consonant-final noun takes the vowel-initial suffix allomorph (i.e., *-i*); a vowel-final noun takes the consonant-initial suffix allomorph (i.e., *-ka*).

Third, for a cross-dialectal comparison, the same acoustic measures were collected for the data from older and younger Seoul speakers. Through this dialectal comparison, we also tested whether the prosody of South Kyungsang Korean becomes similar to that of Seoul Korean.

2. Methods

2.1. Participants

Forty Korean speakers participated (10 younger and 10 older speakers each for the Kyungsang and Seoul dialects). To avoid any potential variation due to gender differences, we only analyzed female speakers.¹ Participants born after 1985 were grouped as younger speakers; their age ranged from 20 to 23 (mean=21 years old; s.d.=1.2) and from 18 to 26 (mean=20.7 years old; s.d.=2.6) for the younger Kyungsang and Seoul groups, respectively. Participants born before 1952 were grouped as older speakers; their age ranged from 59 to 75 (mean=66.4 years old; s.d.=5.9) and from 61 to 71 (mean=65.8 years old; s.d.=3.8) for the older Kyungsang and Seoul groups, respectively. All participants were born and had lived in the target dialect region with parents who spoke the same target dialect. These participants had not lived in other dialect regions for more than 1 year, except for two older Kyungsang speakers who were born in Japan and had lived there for 10 years.² For the Kyungsang group, older Kyungsang participants were recruited in the Youngdo Senior Welfare Centre in Pusan city, South Kyungsang; all younger participants were students of Pusan National University. For the Seoul dialect group, older and younger participants were recruited through the

¹ In our pilot study where we analyzed the production of five male speakers, we did not find gender-related differences in the realization of the pitch accents.

² We found no phonetic differences between these two older Kyungsang speakers and the other eight speakers. Accordingly, these two speakers were included in the data analysis.

Table 3
Monosyllabic and disyllabic test words in the present study.

H(H)		R		H	
mul nwun	'water' 'eye'	mal nwun	'speech' 'snow'	mal mun	'horse' 'door'
HL		HH		LH(H)	
meli molay	'head' 'sand'	moki moley	'mosquito' 'day after tomorrow'	papo popay	'fool' 'treasure'
				tali namu	'bridge' 'tree'

experimenter's personal network in Seoul and Kyunggi regions where standard Korean is spoken, and most younger Seoul participants were students of Hankyong National University in Ansong city, Kyunggi. Demographic information for the 40 participants including the highest level of schooling and annual income per household is presented in the [Appendix](#). None of the speakers of either dialect reported any speech or hearing disorders, and all of the speakers were literate in Korean.

2.2. Speech materials

Two noun roots were selected from each of the three monosyllabic (H(H), R and H) and four disyllabic (HL, HH, LH(H) and LH) underlying accents, as listed in [Table 3](#). The monosyllabic and disyllabic noun roots were recorded in isolation and with the suffix *-i(ka)*. Since the present study compares the prosodic structure of a word across Kyungsang and Seoul Korean, all stimuli were categorized according to tonal Kyungsang Korean rather than non-tonal Seoul Korean. For example, the stimulus *mólay* 'sand', which belongs to the HL accent class in Kyungsang Korean, is also treated as HL for Seoul Korean.

For the selection of the word stimuli, phonetic factors that might affect *F0* scaling and alignment were controlled as much as possible. Specifically, the stimuli were mostly sonorant, and tense or aspirated consonants were avoided. Syllable structure was also controlled with CVC and CV.CV structures for all monosyllabic and disyllabic words, respectively.

2.3. Procedure

Speakers produced two repetitions of each target word embedded in the sentential frame *ice ____ cohta* 'Now, (I) like ____'. Each target word was written in Korean orthography and provided on an index card. To help the subjects distinguish segmental homonyms (e.g., *mál* (H) 'horse' vs. *mǎl* (R) 'speech'), a corresponding picture was provided next to each stimulus. Since the first author of the current study is a speaker of Seoul Korean, a female Kyungsang language consultant assisted in the Kyungsang recording session to prevent any phonetic accommodation between the two dialects of Korean. Subjects were instructed to read each word as naturally as possible at a normal speaking rate, and practiced before the actual recording.

In total, 2240 tokens were obtained: 960 tokens for the monosyllabic words (2 words * 3 underlying accents * 2 contexts (isolation, suffixed) * 2 repetitions * 40 speakers) and 1280 tokens for the disyllabic words (2 words * 4 underlying accents * 2 contexts * 2 repetitions * 40 speakers). Subjects were recorded in various quiet locations, such as the subject's campus, home, or village community center using a Marantz Digital Recorder (PMD 671) and a SHURE head-mounted microphone. The stimuli were recorded at a sampling rate of 22,050 Hz and analyzed using the software package Praat ([Boersma & Weenink, 2011](#)).

2.4. Measurements

For the test words recorded in isolation, scaling (Hz) and alignment (ms) properties of *F0* were examined. *F0* was measured in Praat using the autocorrelation function with a window size of 40 ms and a step size of 10 ms. Measurements included (1) *F0* minimum value (Hz), (2) *F0* maximum value (Hz), (3) *F0* minimum distance (ms), and (4) *F0* maximum distance (ms). [Fig. 4](#) presents an example of these measurements.

After annotating a target word (= 1st tier in [Fig. 4](#)), Local was defined as the interval from the onset of the first vowel to the offset of the target word, which includes VC for monosyllabic nouns and V.CV for disyllabic nouns. By excluding the initial consonants for each target word Local allowed consistent measurements and observation across stimuli. Specifically, the word-initial consonants in the present study differ in sonority; while the nasal onset carries pitch, the stop onset does not. This inconsistency would result in variation for the acoustic measures, which could confound the data interpretation.

Within the defined Local, *F0* minimum and maximum values (Hz) were measured at the point of the lowest *F0* occurring before the *F0* maximum point (dotted arrows in [Fig. 4](#)) and at the point of the highest *F0* (solid arrows in [Fig. 4](#)), respectively.

The temporal location of the *F0* minimum and maximum (ms) was also measured. Within Local, the *F0* minimum and maximum distance was measured from Local onset to the point of the *F0* minimum value (= 3rd tier in [Fig. 4](#)) and from Local onset to the point of the *F0* maximum value (= 4th tier in [Fig. 4](#)), respectively. *F0* minimum and maximum distance was first measured in milliseconds, and then converted to a ratio to control for differences in word duration. For example, the ratio of *F0* maximum distance was obtained by dividing *F0* maximum distance by Local duration, expressing the point where *F0* maximum occurs as a percentage of the Local duration.

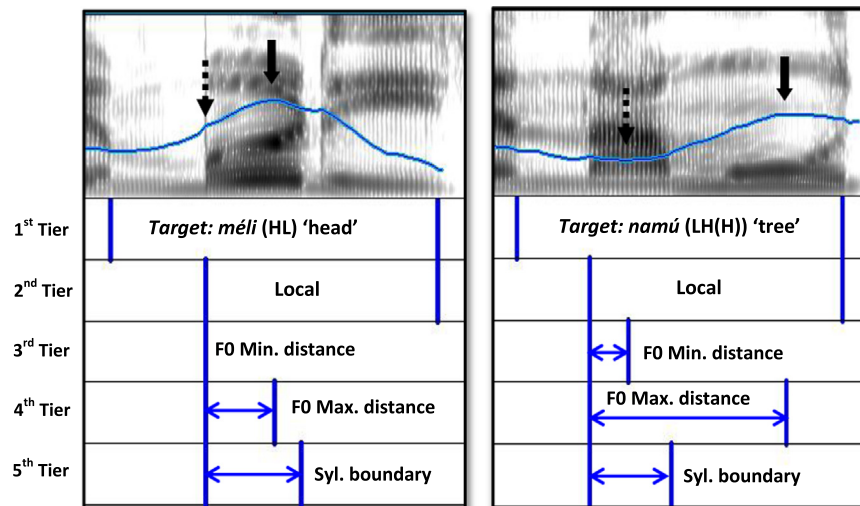


Fig. 4. Example of F_0 scaling and alignment measurements for disyllabic nouns *méli* (HL) 'head' vs. *namú* (LH(H)) 'tree' (see the text for more detail).

In addition to these four measures, onset and offset F_0 values of Local were measured in order to draw schematized pitch contours; syllable boundaries were marked at the offset of the first vowel for disyllabic word stimuli, annotated as 'Syl. boundary' (5th tier in Fig. 4).

We also examined F_0 contours for the test words recorded with the suffix. Using a Praat script by Xu (2006), F_0 was measured every 10% within each of the two or three syllables (i.e., rime) and as such the duration of each syllable was normalized. The F_0 contours were averaged across stimuli within the same accent class and across speakers in each of the four dialect and age groups.

2.5. Analysis

Measurements were averaged across the two repetitions and two test stimuli recorded in isolation within an accent class for each speaker. The data recorded in isolation were evaluated based on repeated measures General Linear Model (GLM) Analyses of Variance (ANOVAs).³ Repeated measures ANOVAs were conducted for each of the four dependent variables: (1) F_0 minimum value, (2) F_0 maximum value, (3) F_0 minimum distance, and (4) F_0 maximum distance. Three-way ANOVAs included the within-subjects factor of Accent Class and between-subjects factors of Dialect (Kyungsang, Seoul) and Age (Older, Younger). The statistical evaluation was made separately for monosyllabic (Section 3.1) and disyllabic (Section 3.2) nouns due to the different number of levels for the Accent Class factor: three levels for monosyllabic nouns (H(H), H and Rising) and four levels for disyllabic nouns (HL, HH, LH(H) and LH). After conducting Mauchly's test of sphericity, Huynh–Feldt corrected degrees of freedom were used to report F ratio and p value for those cases when the sphericity assumption was violated. If there were interaction effects between factors, paired-samples t -tests with Bonferroni adjustment further evaluated the Accent Class factor separately for each of the age and dialect groups. For the F_0 scaling property, we additionally analyzed F_0 range, namely the difference between F_0 maximum and minimum values (ΔF_0), and examined if ΔF_0 as a function of Accent Class exhibits comparable results to the analysis of F_0 minimum and maximum values. To minimize variability in speakers' pitch ranges, we converted F_0 values measured in Hertz into semitones (Patel, 2006), and then calculated ΔF_0 . Paired-samples t -tests were conducted to examine ΔF_0 for each of the four dialectal and age groups.

3. Results

3.1. Monosyllabic nouns

Fig. 5 presents the schematized pitch contours of monosyllabic accents, for each of the age and dialect groups. The pitch contours were drawn according to mean F_0 measured at the onset (0%, onset of the vowel) and offset (100%, offset of the target word) of the pitch contour along with the mean F_0 scaling and alignment measures.

Fig. 5 illustrates age and dialectal differences in the prosodic patterns of monosyllables. First, the words in the three accent classes are more distinct from each other for the older Kyungsang speakers than for the younger Kyungsang speakers. Second, for the Seoul speakers the words categorized according to Kyungsang's accents do not differ in their prosodic patterns. The following sections present statistical assessments of the measures of F_0 scaling and alignment for the monosyllabic nouns.

³ The statistical analysis in this paper did not include the suffixed words because it would not add information beyond what is already known from the pattern between the monosyllabic and disyllabic nouns without a suffix.

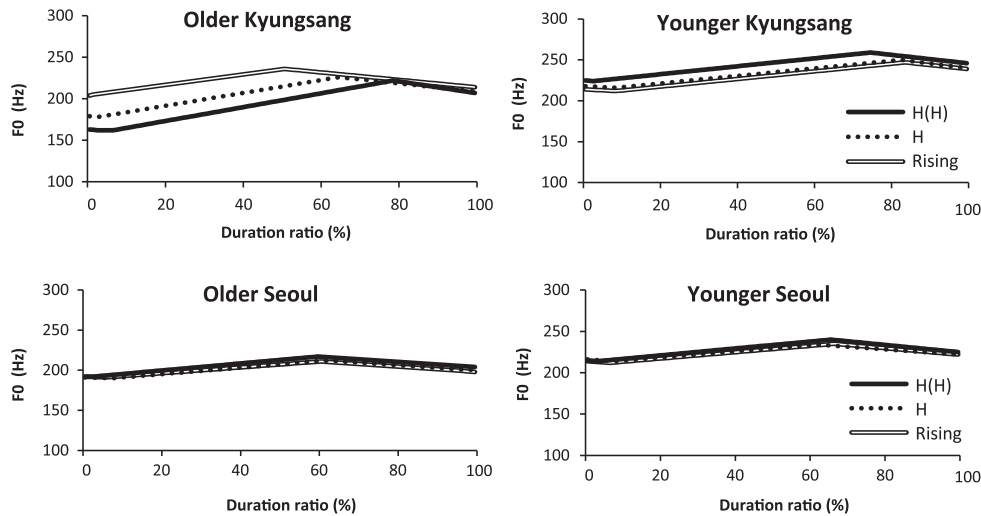


Fig. 5. Schematized pitch contours of the monosyllabic accent classes (H(H), H and R) averaged across all participants in each of the older and younger and Kyungsang and Seoul groups.

3.1.1. *F0* scaling: *F0* minimum/maximum values and $\Delta F0$

Figs. 6 and 7 present the distribution of the *F0* minimum and *F0* maximum values for the three monosyllabic accents for each dialectal and age group. In Figs. 6 and 7, the box shows the 25th and 75th percentile (the lower and upper quartiles, respectively), and the line in the middle of the box is the 50th percentile (the median). The ends of the whiskers represent the maximum and minimum value of the data, excluding outliers that are greater or less than 1.5 times the upper and lower quartiles. This interpretation of the boxplot is maintained throughout the paper.

Since the outcome of Mauchly's test for Accent Class was significant ($p < 0.05$) for *F0* minimum value, indicating a violation of the assumption of sphericity, Huynh–Feldt corrected values are reported here. For *F0* minimum value, a three-way repeated measures ANOVA (Accent Class by Age by Dialect) reported significant main effects of Accent Class ($F(1.754, 63.131) = 30.876, p < 0.001$) and Age ($F(1, 36) = 25.920, p < 0.001$), but no effect of Dialect ($F(1, 36) = 0.178, p = 0.676$). Bonferroni *post hoc* comparisons showed that across Age and Dialect *F0* minimum value is lower for Rising/H than for H(H) ($p < 0.01$), and it tends to be higher for H than Rising ($p = 0.078$); across Accent Class and Dialect, *F0* minimum value is lower for older speakers than younger speakers. Notably, there were significant interactions of Accent Class by Dialect ($F(1.754, 63.131) = 25.104, p < 0.001$), Accent Class by Age ($F(1.754, 63.131) = 8.283, p = 0.001$), and Accent Class by Dialect by Age ($F(1.754, 63.131) = 9.676, p < 0.001$), indicating the group differences. In order to closely examine the generational and dialectal differences, paired-samples *t*-tests further assessed *F0* minimum value as a function of Accent Class separately for each of the four groups. For older Kyungsang speakers, *F0* minimum value is significantly lower for Rising/H than for H(H); for younger Kyungsang speakers, *F0* minimum value is significantly different across the three accent classes, showing Rising < H < H(H). Finally, in Seoul Korean, *F0* minimum values are not different across the three monosyllabic accents for any comparisons in either age group.

Comparable results were reported for *F0* maximum value. The ANOVA (Accent Class by Age by Dialect) showed significant effects of Accent Class ($F(2, 72) = 20.925, p < 0.001$) and Age ($F(1, 36) = 6.115, p = 0.018$), but no effect of Dialect ($F(1, 36) = 2.642, p = 0.113$). *F0* maximum value is lower for Rising/H than for H(H), whereas the difference between Rising and H is not significant; *F0* maximum value is lower for older speakers than younger speakers. A significant interaction was found for Accent Class by Dialect ($F(2, 72) = 3.309, p = 0.042$), but not for Accent Class by Age ($F(2, 72) = 0.064, p = 0.938$) or Accent Class by Age by Dialect ($F(2, 72) = 0.039, p = 0.962$). Paired-samples *t*-tests showed that older Kyungsang speakers have a significantly lower *F0* maximum value for Rising than H(H)/H, but for younger Kyungsang speakers it is lower for Rising/H than H(H). In Seoul Korean, all the comparisons on *F0* maximum value were not significant across the three monosyllabic accents, except that younger Seoul speakers had a higher *F0* maximum value for H(H) than H.

As an additional confirmation of the age and dialect variation in the *F0* scaling property, this paper analyzed *F0* range, the difference between *F0* maximum and minimum value ($\Delta F0$). The analysis of $\Delta F0$ allowed us to see to what extent the monosyllabic accent contrasts are distinct across the age and dialect groups. The $\Delta F0$ data are presented in Table 4. Paired-samples *t*-tests revealed that older Kyungsang speakers have a significantly smaller $\Delta F0$ for H(H) than H and Rising ($p = 0.053$ and $p < 0.01$, respectively), but no difference between H and Rising ($p = 0.16$). For the other three groups, none of the comparisons were significant (p -value ranges from 0.32 to 0.95).

3.1.2. *F0* alignment: *F0* minimum/maximum distance

Figs. 8 and 9 show the distribution of the *F0* minimum and *F0* maximum distance for the three monosyllabic accents for each dialectal and age group.

For *F0* minimum distance, a three-way repeated measures ANOVA (Accent Class by Age by Dialect) reported significant effects of Accent Class ($F(2, 72) = 25.966, p < 0.01$) and Age ($F(1, 36) = 6.631, p = 0.014$), but no effect of Dialect ($F(1, 36) = 0.232, p = 0.633$).

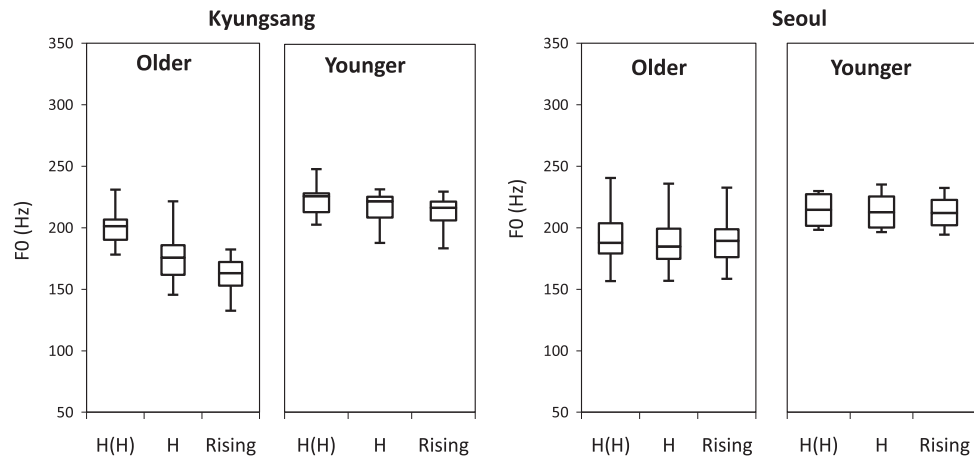


Fig. 6. Distribution of F_0 minimum values (Hz) for monosyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

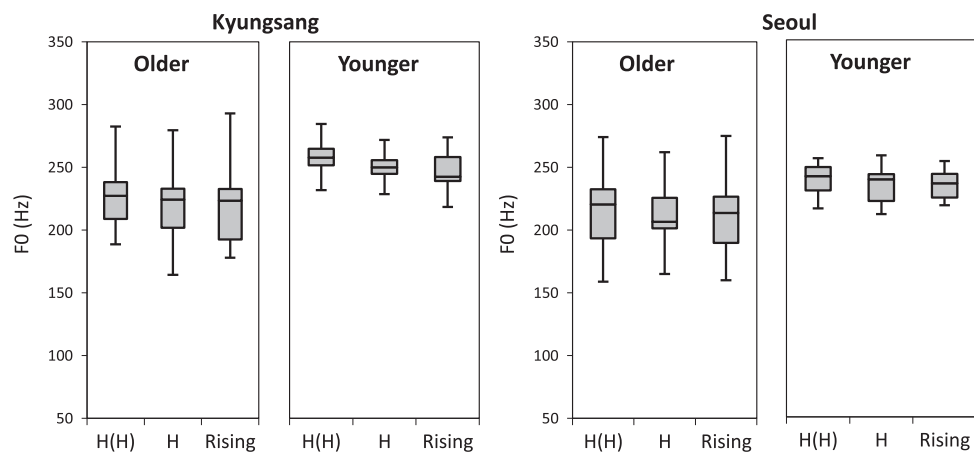


Fig. 7. Distribution of F_0 maximum values (Hz) for monosyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

Table 4

ΔF_0 (semitones) of the monosyllabic accent classes (H(H), H and R) averaged across all participants in each of the older and younger and Kyungsang and Seoul groups (standard deviation in parentheses).

	Kyungsang		Seoul	
	Older	Younger	Older	Younger
H(H)	2.29 (1.5)	2.47 (0.9)	2.04 (1.6)	1.93 (0.8)
H	4.07 (2.4)	2.49 (0.9)	1.90 (1.2)	1.58 (0.9)
R	5.32 (2.9)	2.68 (0.9)	1.70 (1.2)	1.74 (1.1)

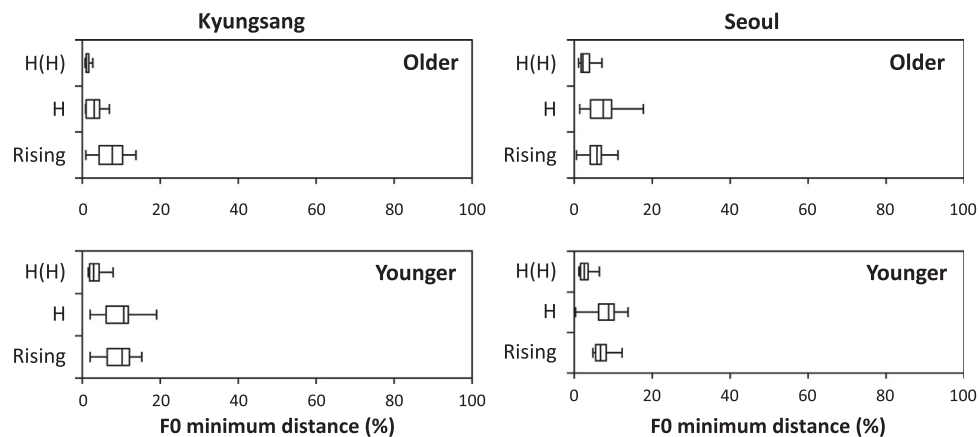


Fig. 8. Distribution of F_0 minimum distance (%) for monosyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

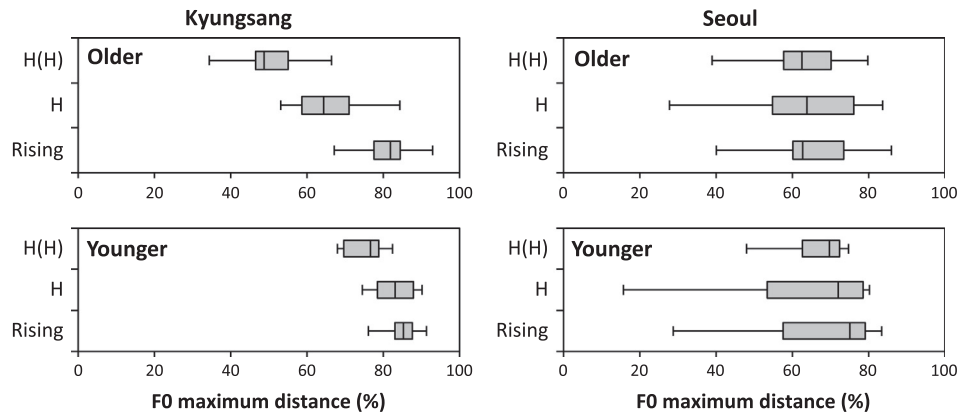


Fig. 9. Distribution of F_0 maximum distance (%) for monosyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

Bonferroni *post hoc* comparisons showed that across Age and Dialect F_0 minimum distance is shorter for H(H) than H/Rising ($p < 0.01$), but comparable between H and Rising; across Accent Class and Dialect it is shorter for older than younger speakers. A significant interaction was found for Accent Class by Dialect ($F(2, 72) = 3.787$, $p = 0.027$), but not for Accent Class by Age ($F(2, 72) = 1.384$, $p = 0.257$) or Accent Class by Dialect by Age ($F(2, 72) = 2.022$, $p = 0.140$). A further paired-samples *t*-tests showed that for older Kyungsang speakers F_0 minimum distance is shorter for H(H)/H than Rising, whereas for younger Kyungsang speakers it was shorter for H(H) than H/Rising. For Seoul Korean, F_0 minimum distance was not different across the three monosyllabic accents, except that older Seoul speakers had a shorter F_0 minimum distance for H(H) than H.

For F_0 maximum distance, there were significant effects of Accent Class ($F(2, 72) = 17.901$, $p < 0.001$), Age ($F(1, 36) = 5.697$, $p = 0.022$) and Dialect ($F(1, 36) = 6.124$, $p = 0.018$). F_0 maximum distance is shorter for H(H) than H/Rising, but comparable between H and Rising; it is shorter for older than younger speakers, and shorter for Seoul than Kyungsang speakers. Notably, there were significant interactions of Accent Class by Dialect ($F(2, 72) = 13.469$, $p < 0.001$), Accent Class by Age ($F(2, 72) = 4.492$, $p = 0.015$) and Accent Class by Age by Dialect ($F(2, 72) = 5.637$, $p = 0.005$). F_0 maximum distance was the shortest for H(H), intermediate for H and the longest for Rising for older Kyungsang speakers; for younger Kyungsang speakers, however, only the comparison between H(H) and H/Rising was significant, showing 'H(H) < H/Rising'. No comparisons in Seoul Korean reported significant differences.

3.1.3. Monosyllabic nouns suffixed with *-i(ka)*

In Fig. 10, the current study also examined F_0 contours of the monosyllabic accents expanded with the suffix *-i(ka)* to see if there is a generational and dialectal difference in longer words as well as in the monosyllabic noun roots.

In Fig. 10, dialectal and generational differences are clearly seen for the monosyllabic accent classes in suffixed condition. The generational difference is seen for Kyungsang but not for Seoul speakers. For the Seoul group, both older and younger speakers show the final rising pattern, forming L-H, regardless of words categorized according to Kyungsang's monosyllabic accent classes.

For the Kyungsang group, while the older speakers have different pitch patterns across the three monosyllabic accent categories, younger speakers show the identical pattern. Specifically, the accent patterns for the older speakers are consistent with the previous reports in the literature. When suffixed with *-i(ka)*, forming a two-syllable word, the monosyllabic H(H) class shows comparable high pitch across both syllables (H-H), the words in the H class show a peak only on the first syllable (H-L) (on the root), and the rising accent shows high pitch on the second syllable (L-H) (on the suffix). Notably, the distinction between H(H) and H is clearly seen when the suffix is added, showing H-H and H-L. On the other hand, the younger speakers show a peak on the second syllable (L-H) for all three monosyllabic accent classes.

3.2. Disyllabic nouns

Fig. 11 presents the schematized pitch contours of disyllabic accents, for each of the age and dialect groups. For the disyllabic accents, syllable boundaries are indicated in the pitch contours in the shaded portion; in general the syllable boundary is located later for HL words (*méli* 'head', *mólay* 'sand') than for LH(H) words (*papó* 'fool', *popáy* 'treasure'), which results in the variation in syllable boundaries. Because the differences of the F_0 scaling and alignment properties across accent classes were not significant for either older or younger Seoul speakers, the pitch contours often overlap.

Similar observations to the monosyllabic nouns can be made for the disyllabic nouns, regarding acoustically less distinct pitch accent contrasts for the younger Kyungsang speakers compared to the older speakers and no prosodic differences across disyllabic words in Seoul Korea. The following sections present statistical assessments of the measures of F_0 scaling and alignment for the disyllabic nouns.

3.2.1. F_0 scaling: F_0 minimum/maximum values and ΔF_0

Figs. 12 and 13 show the distribution of the F_0 minimum and F_0 maximum values for the four disyllabic accent classes for each dialectal and age group.

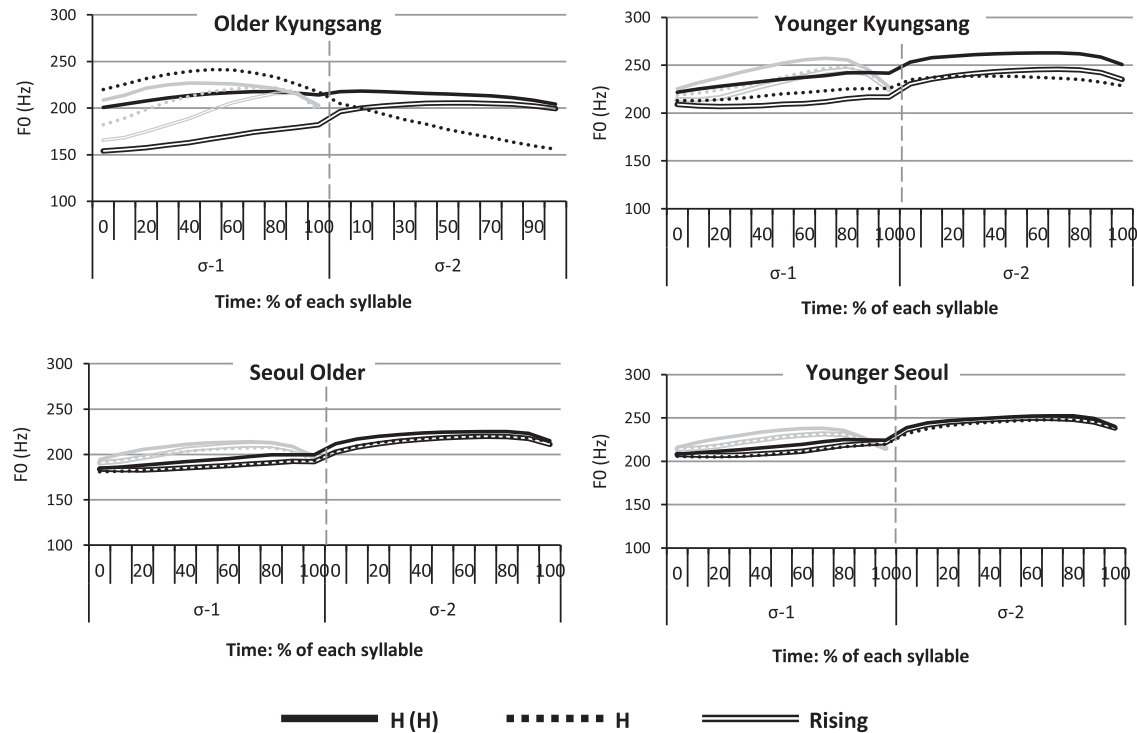


Fig. 10. F_0 contours of monosyllabic noun roots without $-i(ka)$ (gray color) and with $-i(ka)$ (black color) averaged across all participants in each of the dialect and age groups. The vertical dotted lines in the middle indicate the morpheme boundary.

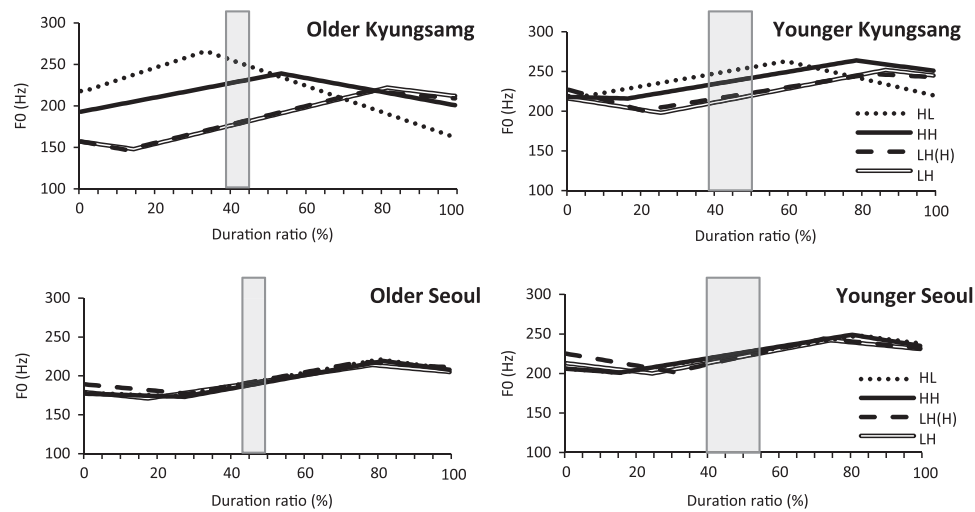


Fig. 11. Schematized pitch contours of disyllabic accent classes (HL, HH, LH(H) and LH) averaged across all participants in each of the older and younger and Kyungsang and Seoul groups. The shaded portion in the middle of each graph indicates the temporal range of the location of the syllable boundary across disyllabic words.

Since the outcome of Mauchly's test for Accent Class was significant ($p < 0.05$) for both F_0 minimum and maximum values, Huynh–Feldt corrected values are reported here. For F_0 minimum, a three-way repeated measures ANOVA (Accent Class by Age by Dialect) reported significant main effects of Accent Class ($F(2.427, 87.386) = 79.060, p < 0.01$) and Age ($F(1, 36) = 26.566, p < 0.01$), but there was no main effect of Dialect ($F(1, 36) = 0.812, p = 0.374$). Bonferroni *post hoc* comparisons showed that F_0 minimum value is the lowest for LH(H)/LH, intermediate for HH and the highest for HL ($p < 0.01$), whereas the comparison between LH(H) and LH was not significant; it was also lower for older than younger speakers. Importantly, there were significant interactions of Accent Class by Age ($F(2.427, 87.386) = 24.696, p < 0.01$), Accent Class by Dialect ($F(2.427, 87.386) = 79.822, p < 0.01$), and Accent Class by Dialect by Age ($F(2.427, 87.386) = 24.834, p < 0.01$), indicating generational and dialectal differences for the F_0 scaling properties. Further paired-samples *t*-tests reported that for older Kyungsang speakers F_0 minimum value is significantly different across HL, HH and LH(H)/LH accent classes, showing LH(H)/LH < HH < HL. For younger Kyungsang speakers, on the other hand, F_0 minimum value is significantly different only between HH/HL and LH(H)/LH, being higher for HH/HL than LH(H)/LH. In Seoul Korean, F_0 minimum value is not different across the accent classes categorized according to Kyungsang Korean in either age group.

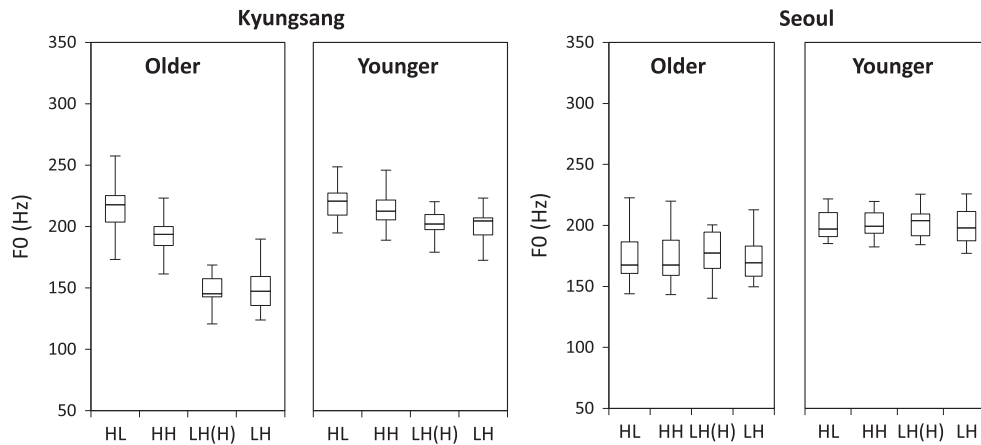


Fig. 12. Distribution of F_0 minimum value (Hz) for disyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

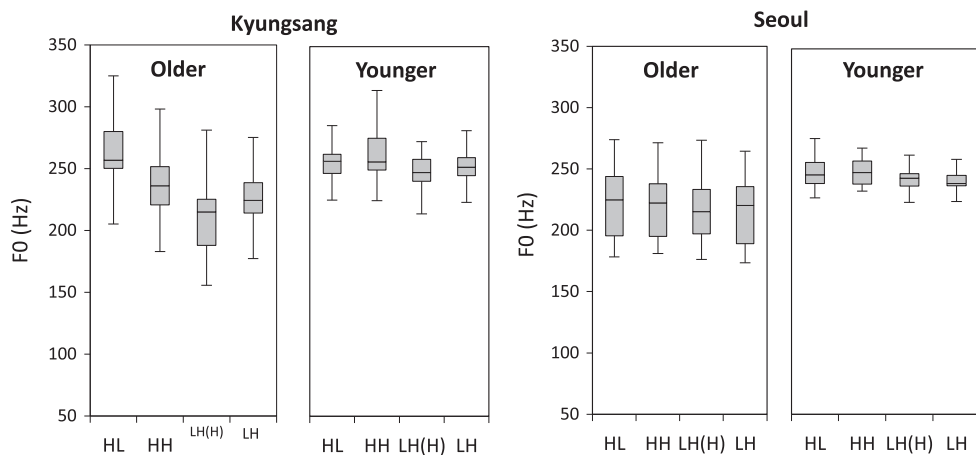


Fig. 13. Distribution of F_0 maximum value (Hz) for disyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

Results of F_0 maximum value were comparable to those of F_0 minimum value. There were significant main effects of Accent Class ($F(2.833, 101.978)=41.000, p<0.001$) and Age ($F(1, 36)=6.250, p=0.017$), but no effect of Dialect ($F(1, 36)=2.349, p=0.134$). Consistent with F_0 minimum value, Bonferroni *post hoc* comparisons showed F_0 maximum value patterning as $LH(H)/LH<HH<HL$ ($p<0.01$) and lower values for older than younger speakers. All the interactions were significant: Accent Class by Age ($F(2.833, 101.978)=9.095, p<0.001$), Accent Class by Dialect ($F(2.833, 101.978)=19.816, p<0.001$), and Accent Class by Age by Dialect ($F(2.833, 101.978)=8.885, p<0.001$). Paired-samples *t*-tests reported that while the pattern of F_0 maximum value was $LH(H)/LH<HH<HL$ for older Kyungsang speakers ($p<0.01$), F_0 maximum value was not significantly different across the four disyllabic accent classes for younger Kyungsang speakers. In Seoul Korean, none of the comparisons was significantly different, except that older Seoul speakers showed a higher F_0 maximum value for HL than LH.

As a second phase of the F_0 scaling analysis, we analyzed ΔF_0 (Table 5). Paired-samples *t*-tests showed that the older Kyungsang speakers have a significantly smaller ΔF_0 for HL/H(H) than LH(H)/LH ($p<0.01$), whereas the comparisons between HL and H(H) and between LH(H) and LH were not significant ($p=0.72$ and $p=0.5$, respectively). For the younger Kyungsang speakers, none of the comparisons were significant except that ΔF_0 is smaller for HL than LH2 ($p=0.026$). For Seoul speakers, none of the comparisons was significant (p -value ranges from 0.28 to 0.91).

3.2.2. F_0 alignment: F_0 minimum/maximum distance

Figs. 14 and 15 show the distribution of the F_0 minimum and F_0 maximum distance for the four disyllabic accent classes for each dialectal and age group.

Since the outcome of Mauchly's test for Accent Class was significant ($p<0.05$) for both F_0 minimum and maximum distance, Huynh–Feldt corrected values are reported here. For F_0 minimum distance, a three-way repeated measures ANOVA (Accent Class by Age by Dialect) reported significant main effects of Accent Class ($F(2.830, 101.880)=29.773, p<0.01$) and Dialect ($F(1, 36)=12.045, p<0.01$), and a near-significant effect of Age ($F(1, 36)=3.816, p=0.059$). Bonferroni *post hoc* comparisons showed that F_0 minimum distance is the shortest for HH/HL, intermediate for LH, and the longest for LH(H) ($p<0.05$), and it is shorter for older than younger speakers and shorter for Kyungsang Korean than Seoul. In addition to these main effects, there were significant interactions of Accent Class by Age ($F(2.830, 101.880)=5.639, p=0.002$) and Accent Class by Dialect ($F(2.830, 101.880)=11.005, p<0.01$),

Table 5

ΔF_0 (semitones) of the disyllabic accent classes (HL, HH, LH(H) and LH) averaged across all participants in each of the older and younger and Kyungsang and Seoul groups (standard deviation in parentheses).

	Kyungsang		Seoul	
	Older	Younger	Older	Younger
HL	3.29 (1.7)	3.13 (1.4)	4.12 (1.5)	3.66 (1.1)
HH	3.59 (1.4)	3.48 (1.1)	4.03 (1.4)	3.70 (1.0)
LH(H)	6.59 (2.7)	3.56 (1.6)	3.63 (1.7)	3.23 (1.3)
LH	6.91 (2.2)	4.18 (1.2)	3.86 (1.8)	3.32 (1.7)

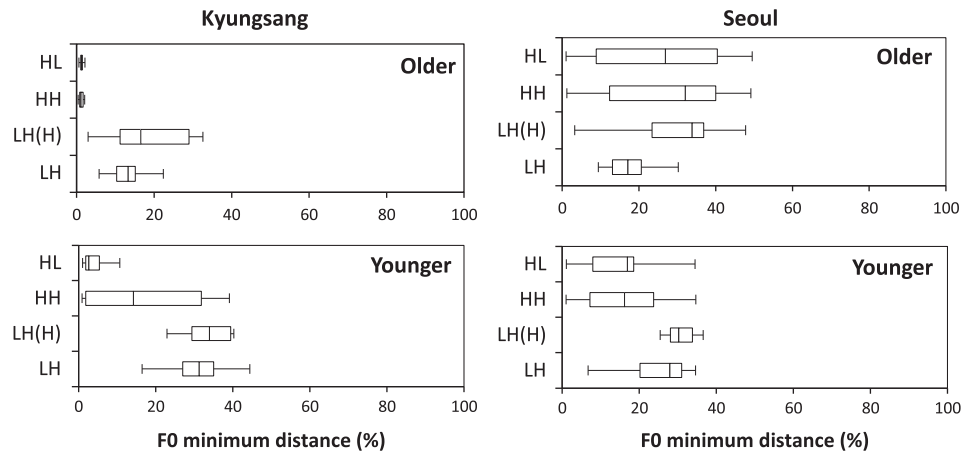


Fig. 14. Distribution of F_0 minimum duration (%) for disyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

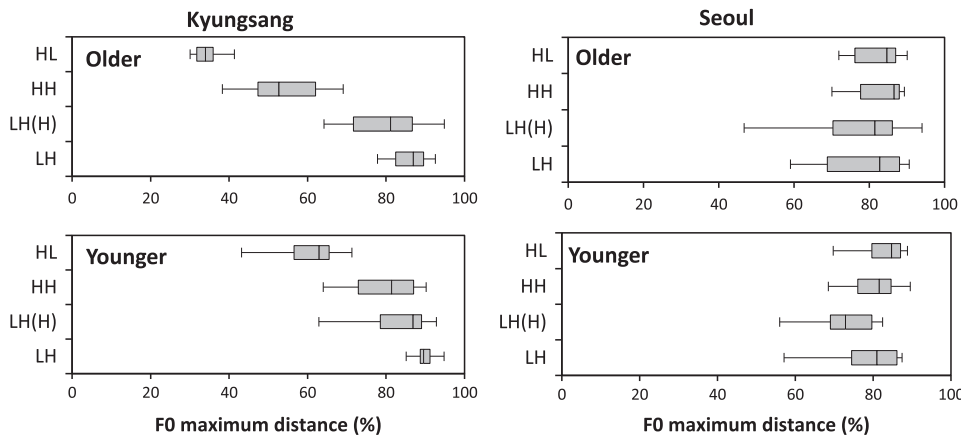


Fig. 15. Distribution of F_0 maximum duration (%) for disyllabic accents between older and younger speakers in Kyungsang and Seoul Korean.

but the three-way interaction of Accent Class by Age by Dialect failed to reach statistical significance ($F(2.830, 101.880) = 2.291$, $p = 0.089$). A further paired-samples t -tests reported that for older Kyungsang speakers, F_0 minimum distance is significantly longer for LH(H)/LH than HH/HL, while the other comparisons were not significant; for younger Kyungsang speakers, while F_0 minimum distance was significantly longer for LH(H)/LH than HL, the other comparisons with HH were not significant. In Seoul Korean, none of the comparisons was significantly different.

For F_0 maximum distance, ANOVAs reported significant main effects of Accent Class ($F(2.969, 106.901) = 32.414$, $p < 0.001$), Age ($F(1, 36) = 7.751$, $p = 0.009$), and Dialect ($F(1, 36) = 14.681$, $p < 0.001$). F_0 maximum distance is the shortest for HL, intermediate for HH/LH(H), and the longest for LH ($p < 0.05$), and it is shorter for older than younger speakers and shorter for Kyungsang Korean than Seoul. All the interactions were significant: Accent Class by Age ($F(2.969, 106.901) = 7.962$, $p < 0.001$), Accent Class by Dialect ($F(2.969, 106.901) = 66.549$, $p < 0.001$), and Accent Class by Age by Dialect ($F(2.969, 106.901) = 4.198$, $p = 0.008$). For older Kyungsang speakers, paired-samples t -tests showed that the F_0 maximum distance was significantly different across HH, HL and LH(H)/LH, being the shortest for HL, intermediate for HH and the longest for LH(H)/LH. For younger Kyungsang speakers, on the other hand, the F_0 maximum distance was significantly shorter for HL than HH/LH(H)/LH, and shorter for HH than LH, while the other comparisons were not significant. In Seoul Korean, paired-samples t -tests showed that F_0 maximum distance are not different across the four disyllabic accents for most cases, except that younger Seoul speakers showed a longer distance for LH(H) than HL/HH.

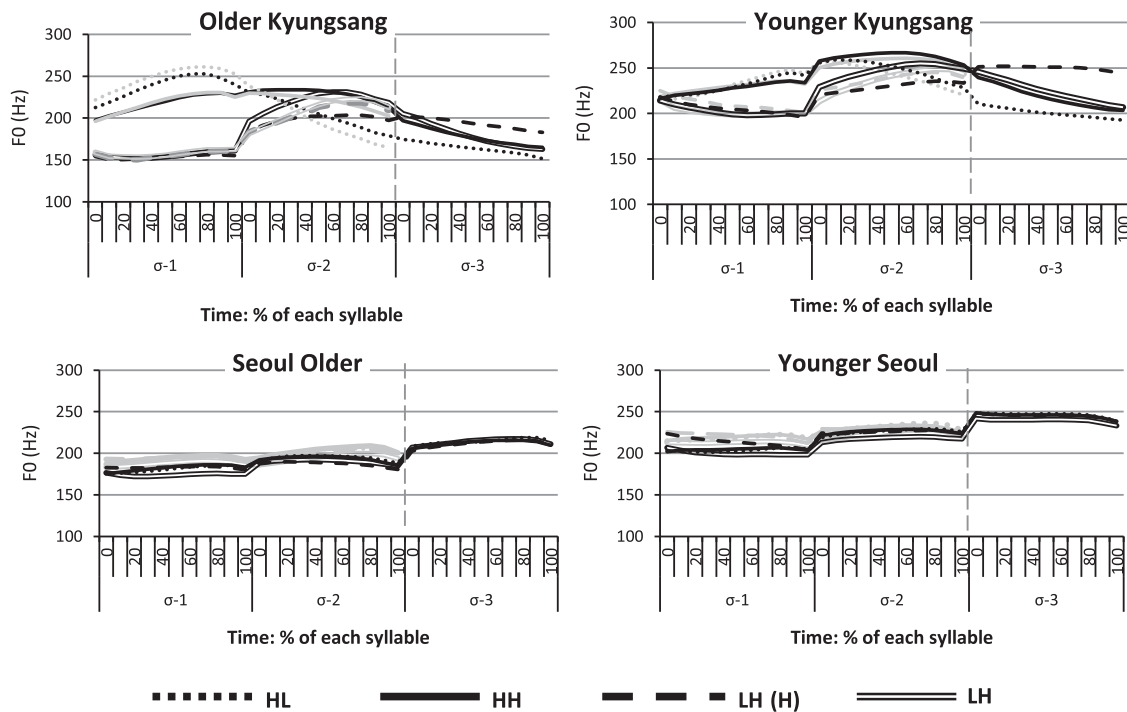


Fig. 16. *F0* contours of disyllabic noun roots without *-i(ka)* (gray color) and with *-i(ka)* (black color) averaged across all participants in each of the dialect and age groups. The vertical dotted lines in the middle indicate the morpheme boundary.

3.2.3. Disyllabic nouns suffixed with *-i(ka)*

In Fig. 16, *F0* contours of the disyllabic accent classes expanded with the suffix *-i(ka)* show how the observed age differences in *F0* scaling and alignment are reflected in longer words.

Fig. 16 indicates that the two generations of Kyungsang speakers pattern differently in producing the four disyllabic accent classes suffixed with *-i(ka)*. While the older speakers show the clear four-way accent distinction, it is not clear if the younger speakers maintain the four-way accent distinction. Consistent with the literature, for the older speakers, the HL class has a peak on the first syllable (HL-L), HH shows comparable high pitch across the first two syllables (HH-L), LH(H) shows high pitch on the second and third syllables (LH-H), and the LH class has a peak on the second syllable (LH-L). Similar to the monosyllabic H(H) and H classes, the LH(H) and LH classes are also clearly distinct under suffixation, showing LH-H and LH-L. Contrary to the older speakers, however, the younger Kyungsang speakers locate *F0* peak on the second syllable for HL, HH and LH accents (LH-L), although the phonetic properties of the peak on the second syllables are different across HL, HH and LH; while the peak occurs at the left edge of the second syllable for HL, it occurs at the right edge for LH, and the HH accent forms a peak plateau on the second syllable. For the LH(H) accent, the peak occurs on the third syllable (LL-H). In other words, the older Kyungsang speakers have four distinct accent patterns where the different locations of a peak across syllable boundaries distinguish the four accent classes. On the other hand, if we consider the syllable location where a peak occurs, younger speakers only have two, namely HL/HH/LH and LH(H). In addition, it is noted that the way younger Kyungsang speakers make the tonal distinction is different from older speakers; the initial *F0* peak for HL/HH is realized as the second syllable high pitch by the younger speakers, and the second and third syllable high pitch for LH(H) is realized only on the third syllable. That is, compared to the tonal pattern for the older speakers, *F0* peak is realized one syllable later.

Finally, contrary to Kyungsang speakers, both older and younger Seoul speakers have a consistent LL-H pattern across all three-syllable words, which is in line with Jun (1993, 1998, 2000, 2006). This indicates no use of pitch in distinguishing words for Seoul speakers as well as no generational difference in the prosody of Seoul Korean.

4. Summary and general discussion

4.1. Summary of results

The current study examined the scaling and alignment *F0* properties of the accent contrasts between older and younger Kyungsang generations to determine if the pitch accent of Kyungsang Korean is undergoing a sound change. Acoustic comparisons were also made between Kyungsang and Seoul Korean to see if Kyungsang is shifting from a pitch accent language to become more like Seoul Korean, which does not have pitch accent.

Pooled across Age and Dialect, the pattern of *F0* minimum was H(H)<H=Rising, and that of *F0* maximum was LH(H)/LH<HH<HL. The *F0* values were lower for older than younger speakers, which is in line with the notion that older speakers generally produce lower pitch and larger pitch ranges than younger speakers (Benjamin, 1981). For *F0* alignment properties, *F0* minimum and

maximum distance was always shorter for H(H) than H/Rising, and shorter for HL than LH(H)/LH. The distance was longer for younger than older speakers, indicating that younger speakers locate F_0 valley and peak later within a word than older speakers. Finally, the distance was longer for Seoul than Kyungsang speakers, which might be due to the fact that while Seoul Korean has a phrase-final rising pattern (LH) that locates F_0 peak to the right edge within an AP regardless of lexical items, the location of the F_0 peak varies by lexical items in Kyungsang Korean.

Importantly, the ANOVAs reported significant interactions among factors, indicating age and dialectal differences for the scaling and alignment F_0 properties, and follow-up paired-samples t -tests for each group confirmed the age and dialectal variations.

4.2. Generational differences in F_0 scaling and alignment of pitch accent

The results in the present study suggest three major points: (1) Seoul and Kyungsang speakers differ in their prosodic properties, (2) F_0 scaling and alignment properties of lexical accent contrasts differ between older and younger Kyungsang speakers, while they are consistent for the two generations of Seoul speakers, (3) the two important generational differences in Kyungsang are a reduced acoustic distinction for accent contrasts and a more delayed F_0 peak among the younger Kyungsang speakers.

First, Seoul and Kyungsang Korean differ in their prosodic properties. The measures of F_0 scaling and alignment are systematically distinct among the monosyllabic and disyllabic accents in Kyungsang Korean, but not in Seoul, which is not surprising given the fact that the two dialects differ in their tonal systems. Across the two generations of Kyungsang speakers, for example, the lowest and peak F_0 values are lower for LH than HL/HH, and lower for Rising than H(H); the distance between the lowest and peak F_0 is shorter for HL than LH, and shorter for H(H) than Rising. These acoustic properties are in line with Chang (2007). On the other hand, for Seoul Korean, the F_0 scaling and alignment properties are highly similar among all words that were categorized according to Kyungsang's accents. Although some comparisons showed differences in their measures, the two acoustic properties do not pattern in any systematic way. Figs. 5 and 11 showed that the F_0 contour of disyllabic and monosyllabic words shows a final rising pattern (i.e., LH) for both generations of Seoul speakers, consistent with Jun (1993, 1998, 2000, 2006). Overall, the observed dialectal variation verifies that while the tonal pattern of Kyungsang Korean is different depending on the lexically determined accent classes, that of Seoul Korean is identical across all words, showing the final rising pattern (LH).

Second, there were age differences in the scaling and alignment F_0 properties that characterize the contrastive accents of Kyungsang Korean. The differences in the F_0 scaling and alignment measures across contrastive accents are less distinct for younger than older Kyungsang speakers, suggesting that the acoustic distinction for pitch accents is reduced.

Figs. 5 and 11 clearly illustrate the reduced acoustic distinction among younger Kyungsang speakers compared to older speakers, showing more overlap in F_0 scaling and alignment measures across accent contrasts. For the monosyllabic nouns in isolation, three-way interactions of Accent Class by Dialect by Age were reported for F_0 minimum value and F_0 maximum distance, indicating that the accent distinction is not comparable between the two generations of Kyungsang speakers or between the two dialectal groups. Specifically, the difference in F_0 minimum value between H(H) and Rising is 43 Hz and 12 Hz for older and younger Kyungsang speakers,⁴ respectively; the ratio difference in F_0 maximum distance between H(H) and Rising is 29% and 9% for older and younger Kyungsang speakers, respectively. In fact, the ΔF_0 analysis indicated a significant difference between H(H) and Rising only for the older Kyungsang speakers, but not for the younger speakers, suggesting that the monosyllabic accent contrast might be perceptually more distinct for the older speakers than the younger speakers. Similarly, the acoustic correlates of the pitch accent distinction are substantially reduced in disyllabic words for the younger speakers compared to older Kyungsang speakers. The F_0 minimum and maximum values are significantly different across disyllabic accents for older Kyungsang speakers, patterning LH(H)/LH<HH<HL, but not for younger Kyungsang speakers. In addition, although some accents (e.g., LH(H)<HL) are statistically distinct in F_0 minimum values for younger Kyungsang speakers, the extent of F_0 differences is smaller compared to older speakers; the difference in F_0 minimum value between HL and LH(H) is 72 Hz and 18 Hz for older and younger Kyungsang speakers, respectively,⁵ which might be in line with the ΔF_0 analysis where the significant difference between HL and LH(H) was only observed for the older Kyungsang speakers. Likewise, F_0 maximum distance is significantly different across disyllabic accents for older Kyungsang speakers, patterning HL<HH<LH(H)/LH, but not for younger Kyungsang speakers; in addition, for the HL and LH(H) comparison that was statistically significant, the ratio difference in the F_0 maximum distance between the two accents is 45% and 22% for older and younger Kyungsang speakers, respectively. Overall, while the accent contrasts are clearly distinguished in the scaling and alignment F_0 properties among older Kyungsang speakers, younger Kyungsang speakers do not use the acoustic properties as much as older speakers do.

Third, along with the reduced acoustic distinctions, Figs. 5 and 11 indicate noticeable differences between age groups with respect to the location of F_0 peaks that are placed further to the right for younger than for older Kyungsang speakers. In a similar vein, Figs. 9 and 15 also showed that F_0 maximum distance is always longer for the younger than for the older speakers for monosyllabic and disyllabic accents. In other words, the point at which F_0 reaches its maximum value occurs later for younger than older Kyungsang speakers, indicating that F_0 peak is more delayed for the younger speakers. For the monosyllabic accents in isolation, F_0 maximum distance was always longer for younger than older speakers across the three monosyllabic accents, showing the delayed

⁴ In semitones, the difference in F_0 minimum value between H(H) and Rising is 4 and 1 for older and younger Kyungsang speakers, respectively. Paired-samples t -tests indicated consistent results for the analyses between Hertz and semitones, reporting Rising<H(H) ($p<0.01$) for both age groups.

⁵ In semitones, the difference of F_0 minimum value between HL and LH(H) is 6.9 and 1.4 for older and younger Kyungsang speakers, respectively. Paired-samples t -tests indicated consistent results for the analyses between Hertz and semitones, reporting LH(H)<HL ($p<0.01$) for both age groups.

F_0 peak within a monosyllable (Fig. 5). The peak delay is more clearly observed for the disyllabic nouns in isolation (Fig. 11); the peak always occurs after the syllable boundary, that is, on the second syllable, for all the disyllabic accent classes including HL. In other words, the more delayed F_0 peak for the younger speakers occurs even across syllable boundaries, resulting in the loss of the initial peak for the HL disyllabic accent class.

Importantly, Figs. 10 and 16 indicated that younger speakers' peak delay occurs across morpheme boundaries as well as syllable boundaries. In Figs. 10 and 16, the F_0 peak for younger Kyungsang speakers tends to occur one syllable later compared to that of older speakers. Therefore, in terms of which syllable the peak occurs on, older speakers' H-H (H(H)) and H-L (H) are realized as L-H by younger speakers for the monosyllabic root with *-i(ka)*; for the disyllabic accents HL-L (HL), HH-L (HH) and LH-H (LH(H)) are realized as LH-L (HL/HH) and LL-H (LH(H)) by younger speakers. This might suggest the possibility that the reduction of lexical pitch accent contrasts is in progress and the accent system of Kyungsang is becoming simpler. That is, younger speakers' strong peak delay across syllable and morpheme boundaries presumably affects the peak location that occurs one syllable later within a word, and the potential reduction of accent contrasts and the different way of maintaining the contrasts for the younger speakers may also be attributable to this peak delay. Overall, the observation from monosyllables up to three-syllable words suggests that younger Kyungsang speakers' substantial peak delay is not only generational variation in the surface phonetic form of the pitch accent, but it might also be related to the phonological category of the pitch accent.

Since the younger speakers in this study are generally more educated than the older speakers (see the demographic information in the Appendix), a potential alternative explanation might be that the observed generational change is due to the different education levels between the two generations of Kyungsang speakers rather than the age difference per se. To investigate this alternative possibility, we compared the accent pattern of the more educated older Kyungsang speakers (4 high school graduates) to that of the less educated older Kyungsang speakers (3 elementary school graduates). This comparison revealed no differences in accent pattern between more and less educated older Kyungsang speakers. Specifically, two-way repeated measures ANOVAs (Accent Class by Education) were conducted for each of the 4 dependent variables in both monosyllabic and disyllabic nouns: F_0 minimum and F_0 maximum values, and F_0 minimum and F_0 maximum distances. For the sake of brevity, we do not report the full statistics here. The key finding is that none of the 8 possible interaction effects between Accent Class and Education for the F_0 scaling and alignment properties in either monosyllabic or disyllabic accents was significant (p values ranging from 0.13 to 1.0). In addition, the two older speaker groups differing in education levels showed comparable accent patterns in the nouns expanded with *-i(ka)*. Moreover, additional analyses showed that the four more educated older speakers whose education level is comparable to that of the 10 younger Kyungsang speakers do not pattern similarly to the younger speakers. Two-way ANOVAs (Accent Class by Age) revealed significant interaction effects between Accent Class and Age for the monosyllabic and disyllabic accent contrasts for 6 of the 8 comparisons, as well as a trend ($p=0.09$) for F_0 minimum distance in monosyllabic words. There was only one parameter, F_0 maximum in monosyllabic words, that did not differ between the 4 older and 10 younger Kyungsang speakers, indicating that the age difference is still present despite similar education levels. Taken together, this strongly suggests that our observed age difference indeed reflects the generational change, not the effect of education.

4.3. Converging evidence for sound change in the pitch accent of South Kyungsang Korean

So far, we have provided and discussed acoustic evidence for sound change in the lexical pitch accents of Kyungsang Korean. This sound change in progress raises the question whether and how the acoustic properties of the pitch accent in Kyungsang Korean are kept distinct from non-tonal Seoul Korean. Fig. 17 compares the schematized pitch contours of the disyllabic accents for the (a) older Kyungsang, (b) younger Kyungsang, and (c) younger Seoul groups.

The comparison between Fig. 17(b) and (c) shows how similar and different the prosodic patterns are between younger Kyungsang and Seoul speakers. The prosodic pattern of younger Kyungsang speakers is similar to that of Seoul speakers in terms of the small acoustic difference and the location of the F_0 peaks. Specifically, F_0 minimum and maximum values across disyllabic

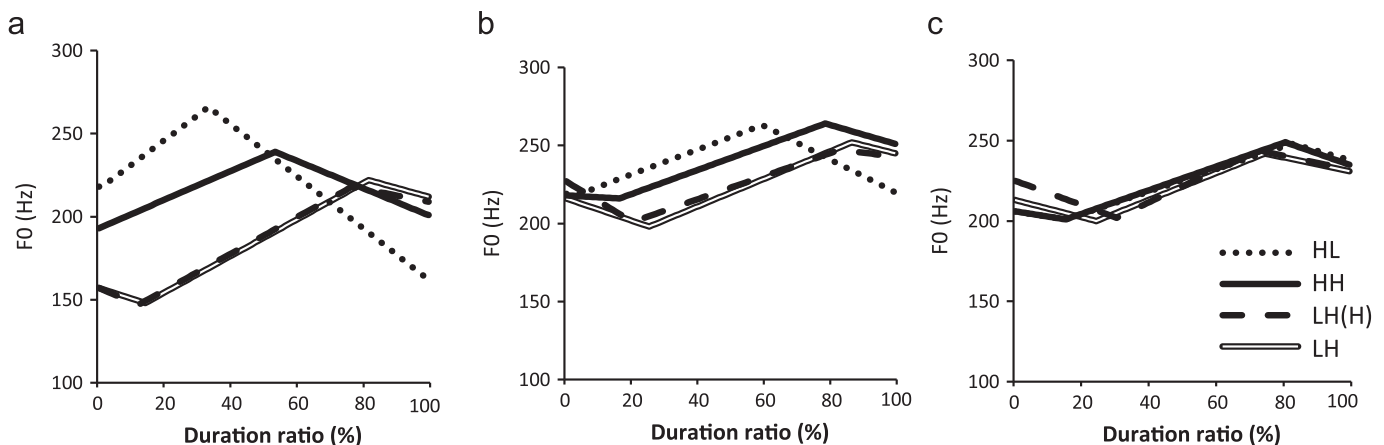


Fig. 17. Schematic pitch contours of disyllabic HL, HH, LH(H) and LH accents in isolation for (a) older Kyungsang, (b) younger Kyungsang, and (c) younger Seoul speakers.

accents are less distinct for younger Kyungsang speakers compared to older speakers, which results in an accent structure similar to Seoul Korean with comparable F_0 minimum and maximum values for all accents. The location of F_0 maximum points for younger Kyungsang speakers also makes the accent pattern similar to Seoul Korean. As observed in Fig. 16, F_0 peak never occurs on the first syllable for younger Kyungsang speakers due to their peak delay. In other words, F_0 of the first syllable is likely lower than that of the second syllable for younger Kyungsang speakers, forming the final-rising pattern for all disyllabic accents as in Seoul Korean. In sum, the reduced acoustic distinction for contrastive accents and the peak delay make the accent structure of younger Kyungsang speech similar to that of Seoul Korean, but different from that of older Kyungsang.

Despite the similarities with Seoul Korean, the prosodic pattern is not identical between younger Kyungsang and Seoul Korean speakers. While the phonetic realization across all disyllabic roots is the same for Seoul Korean in terms of F_0 scaling and alignment properties, some F_0 differences for contrastive accents still exist among younger Kyungsang speakers, though they are small. According to the paired-samples t -tests, the F_0 minimum and maximum values are lower for LH than HL/HH for younger Kyungsang speakers; the F_0 maximum point for HL also occurs earlier than for HH/LH. In other words, the small but existing phonetic differences for some contrastive accents among younger Kyungsang speakers indicate a dialectal difference in their prosodic properties between (younger) Kyungsang and Seoul Korean, suggesting the maintenance of lexical pitch accent by younger Kyungsang speakers.

The younger Kyungsang speakers' maintenance of the lexical pitch accent is more clearly seen in longer words. In Fig. 16, presenting F_0 contours of the three-syllable words, both older and younger Seoul speakers showed LL-H patterns for all disyllabic roots with $-i(ka)$. On the other hand, in terms of which syllable the peak occurs on, younger Kyungsang speakers had at least two different accent patterns between LH-L and LL-H; in addition, a closer observation of the contour movement within syllables indicated that the location of the peak might be different across accent classes. That is, older Kyungsang speakers maintain the accent contrasts with distinct peak locations across syllable boundaries, whereas the way that younger speakers maintain the contrasts is subtle in that the accent distinction is observed only within syllables. This dialectal difference suggests that despite the similarities in accent pattern with Seoul Korean, the lexically determined pitch accent pattern is maintained by younger Kyungsang speakers, and the tonal system between (younger) Kyungsang and Seoul Korean is distinct.

5. Conclusions

The current study hypothesized that South Kyungsang Korean is undergoing sound change under the influence of Seoul Korean. We explored whether the acoustic properties of the lexical pitch accent in South Kyungsang Korean are maintained by younger speakers, and tested whether Kyungsang Korean is shifting from a pitch accent language to become more like Seoul Korean, which is not a pitch accent language. This study provided concrete evidence for sound change in progress in the lexical pitch accent of Kyungsang Korean, reporting clear generational differences. The reduced acoustic distinction and the substantial peak delay across accent contrasts make the accent structure similar to that of Seoul Korean, which suggests that high-prestige Seoul Korean might be an influence in the re-formation of the regional dialect. However, although the accent structure of younger Kyungsang speakers is becoming similar to that of Seoul Korean, the comparison in longer words still showed dialectal differences between (younger) Kyungsang and Seoul Korean. This indicated that South Kyungsang Korean is still distinct from Seoul Korean regarding its maintenance of the lexical pitch accent. Therefore, we conclude that the sound change in the lexical pitch accent is on-going by satisfying the prosodic properties of both Seoul and Kyungsang Korean.

Acknowledgments

We would like to thank Joan Sereno and Jie Zhang for insightful comments and feedback. Our thanks also go to Professors Byunggon Yang and Soonbok Kwon at Pusan National University, Professors Kyungae Kim, Yeonmi Park and Hoyoel Ryu at Hankyong National University and the staff at Youngdo Senior Welfare Center for their help in recruiting participants in Korea. Portions of this study were conducted as part of the first author's dissertation at the University of Kansas.

Appendix

Subject	Dialect	YOB	Education	Occupation	Income
1	Kyungsang	1945	Elementary	Housewife	Low
2	Kyungsang	1942	Elementary	Personal business	Mid
3	Kyungsang	1936	Middle	Personal business	Mid
4	Kyungsang	1950	Middle	Housewife	Mid
5	Kyungsang	1940	High	Housewife	Mid
6	Kyungsang	1946	High	Housewife	Mid
7	Kyungsang	1952	Elementary	Housewife	Low
8	Kyungsang	1952	High	Housewife	Mid
9	Kyungsang	1947	High	Private tutor	Mid
10	Kyungsang	1936	Middle	Housewife	Low

11	Kyungsang	1989	High	College student	
12	Kyungsang	1991	High	College student	
13	Kyungsang	1991	High	College student	
14	Kyungsang	1990	High	College student	
15	Kyungsang	1991	High	College student	
16	Kyungsang	1989	High	College student	
17	Kyungsang	1988	High	College student	
18	Kyungsang	1991	High	College student	
19	Kyungsang	1991	High	College student	
20	Kyungsang	1989	High	College student	
21	Seoul	1950	Middle	Housewife	Low
22	Seoul	1949	Middle	Housewife	Mid
23	Seoul	1949	Middle	Housewife	Mid
24	Seoul	1943	High	Housewife	Mid
25	Seoul	1940	High	Housewife	Mid
26	Seoul	1949	Middle	Housewife	Mid
27	Seoul	1946	College	Housewife	Mid
28	Seoul	1942	College	Private tutor	Mid
29	Seoul	1942	High	Housewife	Mid
30	Seoul	1942	Middle	Housewife	Low
31	Seoul	1985	College	Office-worker	Mid
32	Seoul	1992	High	College student	
33	Seoul	1991	High	College student	
34	Seoul	1993	High	College student	
35	Seoul	1992	High	College student	
36	Seoul	1990	High	College student	
37	Seoul	1992	High	College student	
38	Seoul	1987	High	College student	
39	Seoul	1989	High	College student	
40	Seoul	1992	High	College student	

Income level index: (1) Low=less than \$20,000, (2) Mid=\$20,000–40,000, and (3) High=over \$40,000.

All the younger participants except one were college students, and did not have any income.

References

- Armstrong, T. (2012). Establishing new norms of language use: The circulation of linguistic ideology in three new Irish-language communities. *Language Policy*, 11, 145–168.
- Arvaniti, A., Ladd, D. R., & Mennen, I. (1998). Stability of tonal alignment: The case of Greek prenuclear accents. *Journal of Phonetics*, 26, 3–25.
- Auer, P., & Hinskens, F. (1996). *Dialect change: Convergence and divergence in European languages*. Cambridge University Press.
- Bailey, G., Wikle, T., Tillery, J., & Sand, L. (1991). The apparent time construct. *Language Variation and Change*, 3, 241–264.
- Benjamin, B. (1981). Frequency variability in the aged voice. *Journal of Gerontology*, 36, 722–726.
- Boersma, P., & Weenink, D. (2011). Praat: Doing phonetics by computer [Computer software]. Available from <http://www.Praat.org/>.
- Bruce, G. (1977). *Swedish word accents in sentence perspective*. Lund: Gleerup.
- Chang, S.-E. (2007). *The phonetics and phonology of South Kyungsang Korean tones* (Ph.D. Dissertation). Austin: University of Texas.
- Chang, S.-E. (2008). Tone alternations in South Kyungsang Korean. *Paper presented at the 82nd annual meeting of the Linguistic Society of America (LSA)*. Chicago, IL.
- Evans, B. G., & Iverson, P. (2007). Plasticity in vowel perception and production: A study of accent change in young adults. *Journal of the Acoustical Society of America*, 121, 3814–3826.
- Heffernan, K., Borden, A., Erath, A., & Yang, J. (2010). Preserving Canada's 'honour' ideology and diachronic change in Canadian spelling variants. *Witten Language & Literacy*, 13, 1–23.
- Jun, J., Kim, J., Lee, H., & Jun, S. (2006). The prosodic structure and pitch accent in Northern Kyungsang Korean. *Journal of East Asian Linguistics*, 15, 289–317.
- Jun, S.-A. (1993). *The phonetics and phonology of Korean prosody* (Ph.D. Dissertation). Ohio State University.
- Jun, S.-A. (1998). The accentual phrase in the Korean prosodic hierarchy. *Phonology*, 15, 189–226.
- Jun, S.-A. (2000). *K-ToBI (Korean ToBI) labelling conventions (Ver. 3.1)*. UCLA working papers in phonetics. (pp. 149–173, Vol. 99). URL (<http://www.linguistics.ucla.edu/people/jun/ktobi/k-tobi.html>).
- Jun, S.-A. (2006). Intonational phonology of Seoul Korean revisited (URL). *Japanese-Korean Linguistics*, 14 (pp.15-26). Stanford: CSLI. (<http://www.humnet.ucla.edu/humnet/linguistics/people/jun/JUN-JKL14-FINAL.pdf>).
- Kenstowicz, M., Cho, H., & Kim, J. (2008). *A note on contrasts, mergers and acquisitions in Kyungsang accents*. Toronto working papers in linguistics, (pp. 107–122, Vol. 28).
- Kenstowicz, M., & Park, C. (2006). Laryngeal features and tone in Kyungsang Korean: A phonetic study. *Studies in Phonetics, Phonology and Morphology*, 12, 247–264.
- Kenstowicz, M., & Sohn, H. (1997). *Phrasing and focus in Northern Kyungsang Korean*. MIT Working papers in linguistics . (pp. 25–47, Vol. 30).
- Kim, J., & Jun, S. (2009). Prosodic structure and focus prosody in South Kyungsang Korean. *Language Research*, 45, 43–66.
- Labov, W. (1974). Linguistic change as a form of communication. In A. Silverstein (Ed.), *Human communication: Theoretical explorations* (pp. 221–256). Hillsdale, NJ: Erlbaum.
- Lee, D., & Davis, S. (2009). On the pitch-accent system of South Kyungsang Korean: A phonological perspective. *Language Research*, 45, 3–22.
- Lee, H., & Zhang, J. (2014). The nominal pitch accent system of South Kyungsang Korean. *Journal of East Asian Linguistics*, 23, 71–111.
- Lee, H.-S. (2008). *Pitch accent and its interaction with intonation: Experimental studies of North Kyeongsang Korean* (Ph.D. Dissertation). Cornell University.
- Lee, I., & Ramsey, S. R. (2000). *The Korean language*. Albany: State University of New York Press.
- Martin, S. E. (1992). *A reference grammar of Korean* (1st ed.). Rutland and Tokyo: Tuttle Publishing.
- Min, H. (1997). A study on the sociolinguistic features of men's and women's language in Korean. *The Sociolinguistic Journal of Korea*, 5, 529–587.
- Munro, M. J., Derwing, T. M., & Flege, J. E. (1999). Canadians in Alabama: A perceptual study of dialect acquisition in adults. *Journal of Phonetics*, 27, 385–403.
- Patel, A. D. (2006). An empirical method for comparing pitch patterns in spoken and musical melodies: A comments on J.G.S. Pearl's "Eavesdropping with a master: Leos Janáček and the music of speech". *Empirical Musicology Review*, 3, 166–169.
- Prieto, P., van Santen, J., & Hirschberg, J. (1995). Tonal alignment patterns in Spanish. *Journal of Phonetics*, 23, 429–451.
- Ramsey, S. R. (1975). *Accent and morphology in Korean dialects: A descriptive and historical study* (Ph.D. Dissertation). Yale University.
- Schuh, R., & Kim, J. (2007). *South Kyungsang tones and pitch accent*. UCLA.

- Silva, D. (2011). Out of one, many: The emergence of world Korean(s). In James For more than 6 authors, list the names of first 6 authors, then use 'et al.' as required by journal style.Hye-Suk Yoon (Ed.), *Inquiries into Korean Linguistics IV* (pp. 9–37). Seoul: Taehaksa.
- Trudgill, P. (1986). *Dialect in contact*. Oxford: Blackwell.
- Xu, Y. (1993). *Contextual tonal variation in Mandarin Chinese* (Ph.D. Dissertation). University of Connecticut.
- Xu, Y. (2006). Time Normalize F0 [Praat script], Version 2.4.3.