

# Cross-directional Development of Prosody

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This study examined L2 cross-directional development on the production of prosody features such as fundamental frequency range, speech rate, duration in the boundary word, and declination tilt of intonation. L2 learners of native Korean and English speakers with different levels were compared and analyzed. It was expected that L2 learners would have suprasegmental features more similar to native L1 speakers by the effect of longer immersion, while the variation in L2 acquisition could be found by the effect of background language. Two experiments for Korean learners of English and English learners of Korean were carried out to check the hypothesis. In the first experiment for Korean learners of English, thirty subjects in three groups joined. Also, another experiment was designed for English learners of Korean, in which thirty subjects in three took part. The results showed that L2 longer-immersed groups exerted the similar features of L1 native speakers. As we expected, the direction of L2 development, however, was different. That is, Korean immersed group of English was more native-like by having a wider F0 range, and a comparatively longer duration for the final boundary word, as well as a steeper F0 declination tilt. On the contrary, English immersed group of Korean followed more Korean-like features: a narrower F0 range, and a comparatively longer duration for the final-sentence word, as well as a gentle F0 slope of declination tilt. As a result, both groups have features with similar and different patterns at the same time. The similar features are realized in fast speech rate and longer duration in sentence-final words, while the contrastive features are found in F0 range and declination tilt. The result suggests that L2 development is decided by both factors: L1 background language and universal L2 developmental features.

**Keywords:** second language acquisition, immersion, cross-direction, F0, speech rate, declination tilt, boundary cues, prosody, phonetics

## **1. Introduction**

Prosody plays a crucial role in L2 native-like speech (Kang et al. 2012). It consists of temporal and spectral features related with such phonological suprasegmental aspects as stress, rhythm, and intonation. These suprasegmental factors usually include information at levels higher than the prosodic word. This information, realized phonetically as fundamental frequency (Hz), duration (ms), intensity (dB), has been found to affect L2 speech.

L2 development of prosody has been influenced by the effect of the age (Guion et al. 2000, Tahta et al. 1981), language experience (Flege & Liu 2001, Mennen 2004, Trofimovich & Baker 2006, Kang, Guion-Anderson, Rhee, & Ahn 2012), the background of the native language (Archibald 1995, 1998, Davis & Kelly 1997, Guion et al. 2004), and motivation (Conrad 1991, Moyer 1999). Out of various effects, it is well-known that the effect of immersion experience has been suggested to play a key role in native-like prosodic production (Aoyama, Guion, Flege, Tsuneeo, & Akahane-Yamada 2008, Kang, Guion-Anderson, Rhee, & Ahn 2012). For example, Kang, Guion-Anderson, Rhee, & Ahn (2012) claimed that speakers tended to impose their native intonation patterns on their speaking of second language by the effect of immersion. In their study, immersed-Korean learners of English produced different intonational features from non-immersed Koreans in the English production in spite of almost equal English proficiency.

In spite of accumulating research in L2 acquisition which has focused on mono-directional development of prosody, authentic understanding on L2 acquisition is quite difficult because studies of mono-directional L2 acquisition may lead biased understanding (Mennen 2004). This study is based on the reflection that comparatively rare works have been researched in cross-directional development of prosody in both directions of L1 and L2. The study examines the comparison between English as L1 and L2 versus Korean as L1 and L2 with different immersion experience on L2 acquisition.

L2 development is greatly influenced by both L1 and L2 (Mennen 2006). Both Korean learners of English and English learners of Korean have been affected by mixed features of both languages. Korean has different prosody features from English. Korean has two prosodic units above the prosodic word: the intonational phrase (IP) and the accen-

tual phrase (AP) (Jun 2005). An IP is defined by phrase final lengthening as the form of a boundary tone and also is the highest prosodic unit defined by intonation. An IP boundary tone has a falling F0 pattern in declarative sentences. APs in Korean have some predictable pitch accents (e.g., LHLH, HHLL, etc) associated with stressed syllables in their domain and also lack the phrase accent which occurs at the end of the intermediate phrase of English.

English, unlike Korean, is a stress language in which one syllable is stressed within the prosodic unit. The stressed syllable tends to produce a greater duration, higher pitch, and more complicated contour of F0 than the unstressed syllables. English has three prosodic units above the prosodic foot: the intonation phrase (IP), the intermediate phrase (iP), and accentual group (AG) (Wells et al. 2004). An IP is the highest prosodic unit defined by intonation and may contain one or more iP. It has final lengthening with the final falling F0 in the case of statement sentences. An iP has to contain at least one pitch accent, in which each iP consists of one or more AGs, defined as the domain for a pitch accent configuration (Kang, Guion-Anderson, Rhee, & Ahn 2012).

The current study examines L2 developmental patterns of immersion on the acquisition of L2 suprasegmentals, comparing L1 with L2 of both languages: English and Korean. The goal of the study is to extend our understanding of L1 factors influencing the acquisition of suprasegmentals, which affects native-like L2 speech. Because the longer-immersed group received massive exposure to L2 speaking, we predicted that their suprasegmental factors would be more native-like than the shorter-immersed group who studied L2 (English or Korean). For this investigation, we analyzed fundamental frequency (F0) range, speech rate, duration in the final word as well as intonational slope.

## 2. Methodology

### 2.1. Participants

The data were collected from 60 adult participants for two experiments. None reported being diagnosed with a language or speech disorder. In the first experiment, the participants for L2 English were

divided into three groups of 10 each: LISK-E (Long Immersed Speakers of Koreans learning English) SISK-E (Short-Immersed Speakers of Koreans learning English) and N-E (Native English Speakers). For the second experiment, the participants for L2 Korean were divided into three groups of 10 each: LISE-K (Long Immersed Speakers of English natives learning Korean) SISE-K (Short-Immersed Speakers of English natives learning Korean) and N-K (Native Korean Speakers).

The characteristics of participants in the six groups are presented in Table 1. Most of the L2 English participants were students from a state university in the United State, in which native English subjects were university students. Korean LISK-Es were students majoring in the same disciplines at the same universities as Korean SISK-Es. The students in both groups had begun learning English in their home country, South Korea, starting from 3<sup>rd</sup> grade of the public elementary schools. Most of them studied English about six hours a week in both schools and private institutions in which native Korean speakers served as English teachers.

On the contrary, L2 Korean learners were visiting-students from a national university in Seoul who joined Korean Language program in the Language Center. Most of all were from North America to learn Korean for business, military, or personal matters (e.g., marriage). The LISE-K subjects were selected based on years of immersion experience over 3 years (mean 4.9 years), while SISE-K participants were less than 3 years (mean 1.4 years). Native Koreans were all university students in Korea who were majoring in English, or international studies and related fields at the same university. Table 1 presents participants' information including age, the number of years they had studied L2 (English or Korean), and the number of years they spent in L2 speaking countries.

**Table 1.** Subjects' Information.

Classification	Group	Age	LOR	LOL2	Education
Korean learners of English	N-E	21.3	–	–	14.5
	LISK-E	21.1	4.7	10.3	14.2
	SISK-E	21.3	1.3	10.5	14.5
English learners of Korean	N-K	21.1	–	–	14.2
	LISE-K	22.1	4.9	4.9	14.3
	SISE-K	23.2	1.4	1.6	13.8

LOR: length of residence in L2 country. LOL2: L2 study duration

## 2.2. Materials and Procedures

All participants were recorded reading 15 declarative sentences written by English or Korean. In this experiment, F0 range, speech rate, and duration in the final word were examined in both English and Korean with equivalent meaning.

### (1) English sentences

1. My friend is coming on Saturday.
2. Jennifer wanted to be a policeman.
3. Children like candy very much.
4. The students are going to the zoo.
5. I believe the class begins at ten.
6. The cats should have eaten the meat.
7. The police took the cab to the town.
8. The players sent the message to Susan.
9. Jane can't remember the scene vividly.
10. The people built the beautiful castle.
11. I have friends who are just like me.
12. Miss Smith drank a cup of coffee.
13. They suspect that the suspect killed Ted.
14. I closed the door and waited for the man.
15. John walked home from school in the rain.

### (2) 한국어 문장

1. 나의 친구가 토요일에 올 것이다.
2. 제니퍼는 경찰관이 되기를 원했다.
3. 어린이들은 사탕을 대단히 좋아한다.
4. 학생들은 공원에 갈 예정이다.
5. 나는 수업이 10시에 시작한다고 생각한다.
6. 이 고양이가 고기를 먹었음에 틀림 없어.
7. 경찰이 택시를 시내로 압송했다.
8. 선수들은 메시지를 수잔에게 전달했다.
9. 제인은 그 장면을 생생하게 기억할 수 없었다.
10. 사람들은 아름다운 성을 건설했다.
11. 나는 나와 닮은 친구가 있다.
12. 스미스양은 한잔의 커피를 마셨다

13. 그들은 그 피의자가 테드를 살해했다고 의심했다.
14. 나는 문을 닫고 그 남자를 기다렸다.
15. 좁은 비를 맞으며 학교에서 돌아왔다.

Each experiment was conducted separately. Each participant was asked to read each L2 (English or Korean) sentences two times. Before they produced the sentences, it was confirmed that they knew what the sentences meant, and that they knew how to pronounce them. The sounds were recorded with a SONY DAT recorder (TASCAM DA 20AMK II) and Marantz PMD 650 using a Shure SM 10A microphone, digitalized at 44.05 kHz and 16 bit resolution.

### 2.3. Measurements

Fifteen sentences were used to evaluate the suprasegmentals of each group. Several acoustic measurements of fundamental frequency (in Hertz) and duration (in milliseconds) were made. Duration and fundamental frequency were measured using a waveform display with a time-locked wideband spectrogram with the software Praat (5.3.04). All acoustic cues were measured from the initial acoustic signal in both the waveform and the spectrogram to the final acoustic cues of the boundary such as burst (Kent and Read 2003, Ladefoged 2001). Variables of F0 range, speech rate, duration in the final word and intonational tilt were calculated. Details of each specific measurement are outlined in the following sections:

*F0 range:* The range was measured from the highest point to the lowest point of the fundamental frequency in three areas: overall range of F0 across the sentence F0 range in the maximum point of F0 mostly occurred in the initial part of the sentence and F0 range at the final part of the sentence. We used the F0 tracing generated by Praat to determine peaks and troughs.

*Speech rate:* The speech rate is operationalized as duration measured from the initial acoustic signal of the sentence in both the waveform and the spectrograms to the final acoustic or spectral cues of the sentence boundary. The speech rate was measured by dividing the numbers of uttered syllables by their total duration in English sentences.

*Declination tilt (relationship between X and Y axes):* The F0 was measured at the onset of the sentence, the absolute maximum point of the first F0 peak, the local maximum point of the final F0 peak, and the F0 at sentence offset. The declination tilt  $\gamma$  was computed as follows.

$$\gamma = \frac{\Delta f}{\Delta t}$$

where  $\Delta f$  is the range difference of f0 declination over durational time.

Based on the formula, the intonation contours for the upper-line and lower-line were determined in a fashion similar to those in Cruttenden (1997), whose method provides information to compare the size of F0 slope and duration across the three groups. The upper-line connects the first maximum peak of F0 appearing in the initial part of the sentence to the final peak F0 of the utterance, while the lower-line connects the initial minimum point of F0 to the final valley point of F0 in the sentences. The formulas were as follows:

$$\text{Upper-line} = \frac{\text{the initial peak of F0} - \text{the boundary peak of F0}}{\text{duration} * 100}$$

$$\text{Lower-line} = \frac{\text{the initial valley of F0} - \text{the boundary valley of F0}}{\text{duration} * 100}$$

If the slope approximates 0, a level intonation between the two measured points of F0 is indicated. If the slope has a negative value approaching -1, it means that the initial peak point of F0 is larger than the final peak point of F0. On the contrary, in the case of a positive value approaching +1, it means that the final peak point of F0 is higher than the initial peak point of F0.

*Duration of boundary word:* This study measured the duration in the sentence-final word because the final lengthening is a meaningful linguistic mark. In this study, most final word consist of cross-syllables which are considered as foot which begins with lexically stressed vowel and includes the unstressed vowel.

These measures were analyzed with One Way ANOVAs for each

experiment which was conducted for statistical evaluation of the groups with the following dependent variables: fundamental frequency, speech rate, duration in the final word, and intonational tilt were examined by the factor Group (three levels). The statistical measurements were carried out separately for Korean learners of English and English learners of Korean.

### 3. Results

The sentences were analyzed to investigate differences among the leveled groups for both Korean learners of English and English learners of Korean. The variables of the F0 range (overall, initial, and final), speech rate, duration of the final word, and the intonational tilt were measured.

#### 3.1. Korean Learners of English

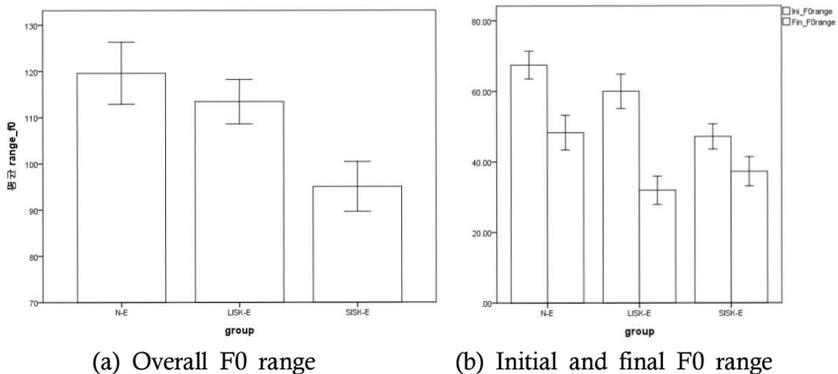
##### 3.1.1. F0 Range

For L2 English learners, the one way analysis of variance confirmed that there was a significant effect of group on Overall F0 range,  $F(2,769) = 21.767, p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the F0 range was smaller for the SISK-E group than both the N-E and LISK-E groups. Figure 1(a) presents the F0 range produced by the three groups. The results showed that members of the LISK-E group produced differences in the F0 range similar to the native speakers. However, members of the SISK-E group showed a comparatively smaller range in F0. This result supports the proposal that more fluent learners of English as a second language have a wider F0 range when speaking English than less fluent learners (e.g., Bradlow et al. 1996, Mennen 2006, Kang et al. 2012).

Recently, the debate has been occurred on whether a variant F0 range could be evidence of the influence of the native language (Scherer 2000, van Benzooijen 1995), or reflect a lack of proficiency in the second language (Backman 1979, Willems, 1982). Some research argues that the variation of F0 range is known to be an indicator of English proficiency (e.g., Backman 1979, Kang & Ahn 2010), while the range is highly influenced by the native language (Aoyama et al. 2008).

Kang & Ahn (2010) reported that a lower proficiency with English as a second language is related to a narrower F0 range for Koreans, while a lower proficiency with Korean as a second language is tied with a wider range for native English speakers. It is noteworthy that the F0 range of Korean spoken by native Koreans is only 70% of English F0 range produced by native English speakers. The F0 range for the longer immersed groups for English or Korean as an L2 language closely approximated the range of the native speakers, perhaps showing less L1 interference than the shorter immersed groups.

An interesting observation about the F0 range is that, although all groups have a wider range in the initial part of the sentence and a narrower range in the final word of the sentence, the degree is different (see Figure 1(b)). Both initial and final range for N-Es is almost one and a half times larger than that of the SISK-Es which is almost level between the two measured areas for F0 range leading to a relatively more monotonous intonation. LISK-Es follow the patterns of N-Es in the initial range of F0 and of SISK-Es in the final range of F0: wider range of the F0 in the initial part and narrower range of the F0 in the final part.



**Figure 1.** Mean values with standard errors for two acoustic parameters [(a) overall F0 range; (b) initial and final F0 range of sentences] by three groups (N-E, LISK-E, SISK-E).

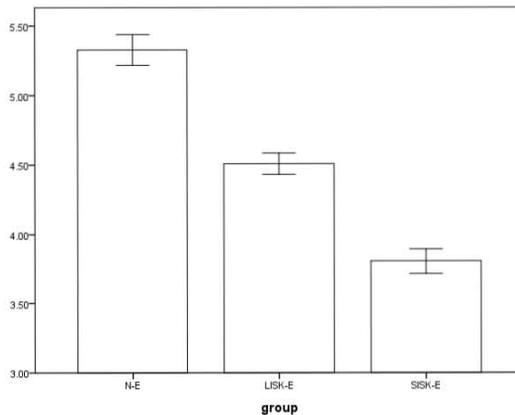
### 3.1.2. Speech Rate

For Korean learners of English, the results confirmed a significant effect of group on speech rate,  $F(2,769) = 244.859, p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the speech rate was larger for the N-E group

(5.36 syllables per second), intermediate for LISK-E (4.48 syllables per second), and shorter for SISK-E (3.87 syllables per second). Figure 2 presents the mean value of speech rate for the three groups.

These results agree with previous work in which more native-like speech was produced with a faster speech rate regardless of language effects (Adams & Munro 1978, Guion et al. 2000, Lennon 1990, Munro & Derwing 1995, Kang et al. 2012). In this experiment, the long-immersed group produced sentences with intermediate speech rate between the SISK-E and N-E groups, indicating that immersion has an influence on speech rate.

The reason why SISK-Es produced the slower speech rate is closely tied with universal proficiency of L2. It means that the poor L2 learner inherently meets a fluency problem: failure to control various components of an utterance, including content versus function words, stressed versus unstressed syllables, and focused versus unfocused words (Kang et al. 2012). For example, L2 learners tended to produce function words and unstressed syllables with higher pitch and longer duration than the native groups (Guion et al. 2000). On the contrary, the advanced L2 group approached the patterns of native English rate, controlling stress/unstressed syllables, strengthening content words, weakening the functional words, and lengthening the pitch contour on focused words, leading to the fast speech rate.

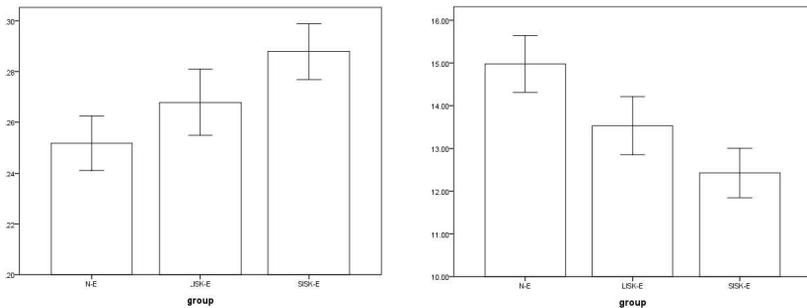


**Figure 2.** Mean values with error bars for Speech Rate by three groups for Learning English (N-E, LISK-E, SISK-E). It represents pronounced syllables per second.

### 3.1.3. Duration of Phrase-final Word

Boundary cues are realized in prosodic units at the end of the sentences as the form of longer duration (Beckman & Edwards 1991, de Pijper & Sanderman 1994, Wightman et al. 1992). For L2 Korean learners, the analysis of variance revealed that there was a significant effect of group on the duration of the sentence-final word,  $F(2,769) = 39.657$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the duration was longer for the SISK-E group than the LISK-E and N-E groups.

In spite of a clear result on the final duration, we couldn't agree with the result that SISK-E group exhibited the longest final lengthening in its production, while the N-E group produced the shortest duration. In fact, if the ratio of the final duration divided by their total duration of sentences is calculated, its durational ratio is the longest for N-E speakers (16%), then the LISK-E group (13.5%), and the least for the SISK-E group (12.2%). This implies that final lengthening could be the crucial variable in deciding L2 proficiency.



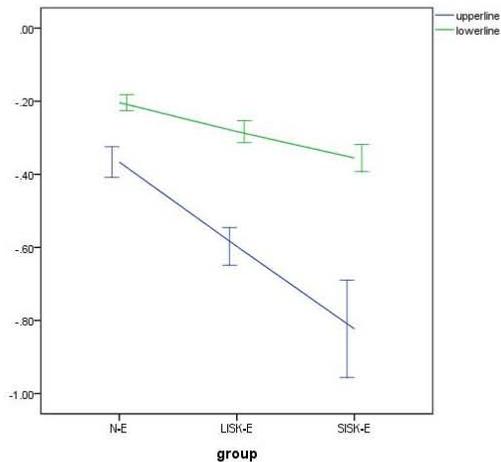
(a) Duration of sentence-final word (S) (b) Percentage of final word duration by whole sentences

**Figure 3.** Mean values with standard errors for duration of the sentence-final words and ratio of final duration by whole sentences by three groups (N-E, LISK-E, SISK-E).

### 3.1.4. Declination Tilt

For the intonational slope, the correlation between upper- and lower-line was significant for the three subject groups pooled,  $r = 0.423$  ( $p < .01$ ). This tilt implied that the two lines were significantly related. However, as can be seen in Figure 4, the groups diverged most in terms of both lines the N-E group had the steepest slope, followed by the LISK-E and then the SISK-E groups.

The ANOVA confirmed that there was a significant effect of group for upper-lines,  $F(2,769) = 26.417$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the mean value for the slope of the upper-lines was the steepest for the N-E group, intermediate for LISK-E, and the least steep for the SISK-E group. Results of the statistical analysis of variance returned significant effects for the lower-lines as well,  $F(2,769) = 23.711$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the mean value for the slope of the lower-lines is steeper for the N-E group, intermediate for LISK-E, and the least steep for the SISK-E group. The results are summarized in Figure 4.



**Figure 4.** Mean values with error bars for upper- and lower lines of intonation by three groups (N-E, LISK-E, SISK-E).

To summarize, N-E group had a greater F0 range, faster speech rate, and longer duration of the sentence-final word, and steep declination tilt. The LISK-E group was in between N-E and SISK-E on these measures.

## 3.2. English Learners of Korean

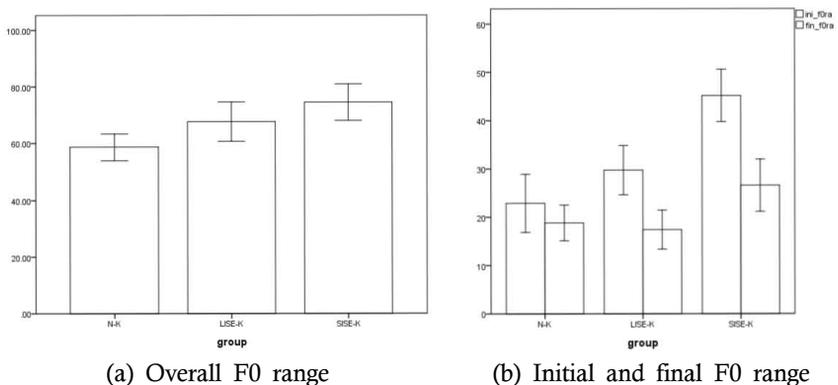
### 3.2.1. F0 Range

For L2-Korean English learners, the one way analysis of variance confirmed that there was a significant effect of group on Overall F0 range,  $F(2,769) = 24.276$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed

that the F0 range was smaller for the N-K group than both the LISE-K and SISE-K groups. Figure 5(a) presents the F0 range produced by the three groups. The results showed that members of the LISE-K group produced the F0 range similar to the native Korean speakers. However, members of the SISE-K group showed a comparatively wider range in F0. This result supports the proposal that more fluent learners of Korean as a second language have a narrower F0 range when speaking Korean than less fluent learners (e.g., Kang & Rhee 2011).

From the result, it is safe to say that a lower proficiency with Korean as a second language is related to a wider F0 range for English learners of Korean. It seems that a variant F0 range is affected by both effects of background language (Scherer 2000, van Benzooijen 1995) and poor proficiency in the second language (Backman 1979, Willems 1982) because beginning English learners of Korean keep strong L1 intervention. However, it is clear that the F0 range for the longer immersed groups closely approximates the range of the native speakers.

An interesting observation about the F0 range is that, although all groups have a wider range in the initial part of the sentence and a narrower range in the final word of the sentence, the degree is different (see Figure 5(b)). SISE-Ks' initial range is larger than the final range, but the N-Ks' range is almost leveled between the two measured areas for F0 range, which produces a relatively more monoto-



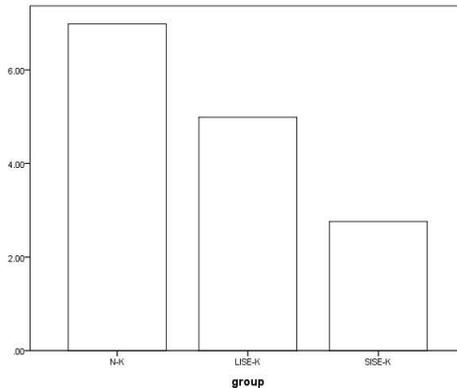
**Figure 5.** Mean values with standard errors for acoustic parameters [(a) overall F0 range; (b) initial and final F0 range of sentences] by three groups for Learning Koreans (N-K, LISE-K, SISE-K).

nous intonation. LISE-Ks' range is in the mid position.

### 3.2.2. Speech Rate

For English learners of Korean, the results confirmed a significant effect of group on speech rate,  $F(2,769) = 232.675$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the speech rate was faster for the N-K group (6.98 syllables per second), intermediate for LISE-K (4.98 syllables per second), and slower for SISE-K (2.76 syllables per second). Figure 6 presents the mean value of speech rate for the three groups.

The result follows the cases of Korean learners of English. It confirmed that more native-like speech was produced with a faster speech rate. The results showed that the longer immersed group produced sentences with intermediate speech rate between the SISE-K and N-K groups, indicating that immersion has an influence on speech rate. It is safe to say that L2 learners' speech rate is not closely tied with the effect of background language.

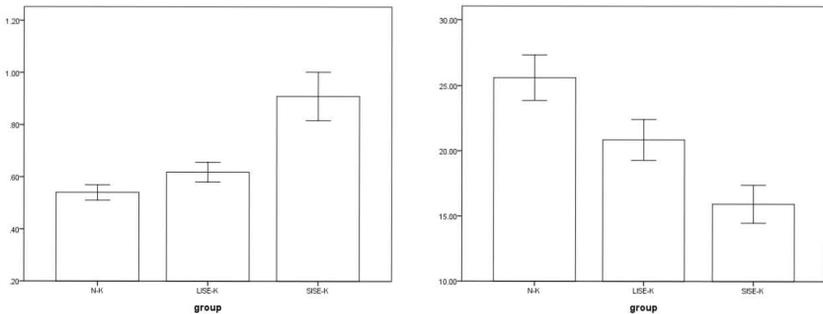


**Figure 6.** Mean values with standard errors for Speech Rate by three groups for Learning Korean (N-K, LISE-K, SISE-K). It represents pronounced syllables per second.

### 3.2.3. Duration of Phrase-final Word

For L2 Korean learners, the analysis of variance revealed that there was a significant effect of group on the duration of the sentence-final word,  $F(2,769) = 36.278$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the duration was longer for the SISE-K group (0.90 s) than the LISK-E (0.61 s) and N-E groups (0.54 s).

Just like the case of Korean learners of English, we can't say that SISE-K group, the shorter immersed group, exhibited the longest final lengthening in its production. In fact, its duration was the longest for N-K speakers (25.2% of the whole sentences), than the LISE-K group (20.2%), and the least for the SISE-K group (15.2%). This implies that phonological final lengthening could be the crucial factor to decide the L2 proficiency, regardless of the background language.



**Figure 7.** Mean values with standard errors for duration and ratio of sentence-final word by three groups (N-K, LISE-K, SISE-K).

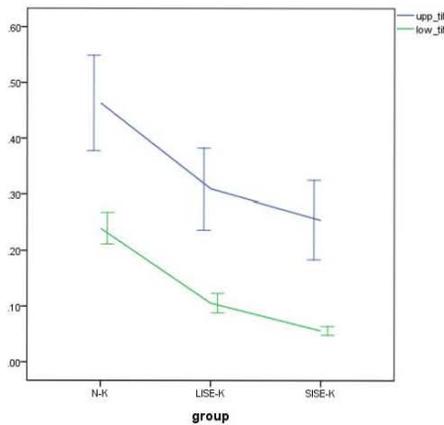
#### 3.2.4. Declination Tilt

For the intonational slope, the correlation between upper-line and lower-line was significant for the three subject groups pooled,  $r = 0.517$  ( $p < .01$ ). This tilt implied that the two lines were closely related. However, as can be seen in Figure 8, the groups diverged most in terms of the upper-line and the lower-line the N-K group had the steepest slope, followed by the LISE-K and then the SISE-K groups.

The ANOVA confirmed that there was a significant effect of group for upper-lines,  $F(2,769) = 48.422$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the mean value for the slope of the upper-lines was the steepest for the N-K group, intermediate for LISE-K, and the least steep for the SISE-K group. Results of the statistical analysis of variance returned significant effects for the lower-lines as well,  $F(2,769) = 24.623$ ,  $p < .001$ . Tukey's tests ( $p < .05$ ) revealed that the mean value for the slope of the lower-lines is steeper for the N-K group, intermediate for LISE-K, and the least steep for the SISE-K group. The results are summarized in Figure 8.

It is interesting observation that the degree of declination tilt is sepa-

rated from the features of background language, against well-known suggestion that the slope degree mainly results from the effect of background language (e.g., van Bezooijen 1995). Rather than the background language, it is clear that L2 proficiency determines features of intonational tilt because a one-side axe composed of the slope is closely tied with speech rate. Again, speech rate of an X-axe have more influence than F0 range of a Y-axe, in determining the intonational tilt. It means that the steep declination tilt for native Korean speakers results from the fast speech rate, not from narrow F0 range.



**Figure 8.** Mean values with error bars for declination tilt of upper- and lower lines by three groups (N-K, LISE-K, SISE-K).

To summarize, N-K group had a narrower F0 range, faster speech rate, shorter duration of the sentence-final word, and steep declination tilt. The LISE-K group was in between N-K and SISE-K on these measures.

#### 4. Discussion

Immersion experience was found to have some influence on the production of L2 suprasegmentals in terms of F0 range, speech rate, duration in the sentence-final word, and declination slope. Long-immersed Korean learners of English (LISK-E) exhibited patterns more similar to those of native English speakers than the short-immersed Korean learners of English (SISK-E) as a whole. Along with this result, long-im-

mersed English learners of Korean English (LISE-K) approached to those patterns of native Korean speakers.

Both immersed groups have some shared features as well as some contrastive characteristics at the same time, influenced by two factors: L1 interference and universal L2 development. L1 interference is closely tied with F0 range and declination tilt of intonation (as a Y-axis), in which acoustical features from mother tongue strongly influences on L2 acquisition. On the contrary, universal L2 development strengthens the speech rate (as an X-axis of intonational slope) and final lengthening duration. These cues are not related with L2 learners' background language.

In this study, the factors of L1 interference realize differently in both directions of Korean to English and English to Korean: wider F0 range and steep tilt of declination for advanced Korean learners of English versus narrower F0 range and gentle tilt of declination for advanced English learners of Korean. However, both advanced groups hold common characteristics: faster speech rate and final lengthening.

The study implies the result that L1 interference mainly realizes in F0 related cues: F0 range and declination tilt of intonation. Advanced Korean learners of English moves from narrower F0 range which known as characteristics of Korean pitch to wider F0 range as those of English pitch. On the contrary, advanced English learners of Korean change their wider F0 range to narrower F0 range. Naturally the F0 movement directly influences on declination tilt of intonation because F0 range forms an X-axis.

Again, the speech rate and final lengthening are not related with L1 background. Both advanced groups produce the fast speech rate and longer final lengthening. Regardless of L1 background, L2 fluency speakers speak fast rather than beginning speakers, along with longer duration in the sentence-final words. Until now, final lengthening has been known as characteristics realized in some languages (Beckman & Edwards 1991, de Pijper & Sanderman 1994, Wightman et al. 1992). It is certain that final lengthening plays the role of mark representing breakdown between two sentences cross-linguistically. Between two sentences (or phrases), the special features which realized as final lengthening, lower mean of F0, and longer duration of pause are not confined to English, but could be applied to Korean.

The issue of immersion in this study supports the hypothesis that in-

tensive exposure to L2 environment accelerates the acquisition of intelligible suprasegmentals. In this study, a high exposure to opportunities to learn English or Korean under the immersion environment leads better suprasegmental acquisition skills than learning in a less experienced L2 learners. Although subjects' age of first exposure to the L2 has been considered as critical factor to decide the native-like pronunciation (Flege & Liu 2001, Trofimovich & Baker 2006), this study supports the hypothesis that immersion may become a critical variable.

The comparison study between two language learners implies that suprasegmental features are not acquired equally. That is, L1 interference features such as F0 range are harder to acquire than universal L2 factors such as speech rate and final lengthening. For example, initial and final ranges of F0 for advanced L2 learners are close to those of beginning L2 group, rather than native L1 speakers. Thus, several years of extensive immersion does not guarantee a native-like production of suprasegmentals. This means that some speech fluency aspects are native-like, while others are not. More specifically, several years of immersion appear to improve fluency as shown in speech rate and phrase final lengthening. On the other hand, more local F0 patterns such as F0 range in the overall and final part of sentences are found to be less native-like.

## **5. Conclusion**

The long-immersed L2 groups are reported to have more native-like suprasegmentals than a short-immersed group. From this result we can infer a facilitative effect of immersion on the production of suprasegmentals in a second language acquisition: L1 interference and L2 developmental patterns. It means that L1 interference closely influences on F0 range and declination tilt of intonation, while L2 developmental patterns have a positive effect on speech rate and final lengthening.

However, some F0-related signals in L2 tend to be hard to change in spite of intensive immersion in L2 environment. The immersed group still reserves some intonational characteristics which most likely stem from the first language, even though they are exposed to an L2 speaking environment for a significant period. Further research is

needed to study why some F0-related cues are comparatively hard to acquire and how these characteristics contribute to diminished intelligibility or to the detection of a non-native accent.

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