

# Comparative Study of L2 Suprasegmental Development by the Effects of Immersion and L2 Learners' Groups\*

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**Kang, Seokhan. (2024). Comparative study of L2 suprasegmental development by the effects of immersion and L2 groups.** *The Linguistic Association of Korea Journal*, 32(3), 23-44. This study investigated the cross-directional development of L2 fluency in the production of suprasegmental features by the effect of immersion and the L2 learners' group. L2 learners of native English and Korean, with two different lengths of immersion, were compared and analyzed cross-linguistically. It was hypothesized that the longer-immersed groups of L2 learners would show suprasegmental features more similar to those of native speakers than the shorter-immersed learners. Both groups—English learners of Korean and Korean learners of English—with different immersion levels were examined to test the hypothesis. The results proved that the longer-immersed L2 groups produced acoustic signals similar to those of L1 native speakers, along with higher fluency scores than those of the short-immersed counterparts. However, some distinctive features can be found in that the longer-immersed groups have difficulty adjusting spectral cues. As a result, both groups exhibited acoustic characteristics with universal as well as individual acquisition patterns following the effects. The similar features are realized in the temporal cues such as speech rate and pause duration, while the particular features are found in the spectral cues. The results suggest that L2 development is influenced by both universal L2 development factors and distinctive groups of L2 learners.

**Key Words:** second language acquisition, immersion, prosody, phonetic cues, English, Korean, L2 experience

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# 1. Introduction

Prosody plays a crucial role in judging the L2 native-like fluency (Mennen, 2004; Trofimovich & Baker, 2006). Prosodic acoustic cues consist of temporal and spectral features which are connected with such phonological suprasegmental aspects as rhythm, stress, and intonation. Temporal aspects, dominant features of native-like fluent speech, have a direct connection to durational features including articulation rate, speech rate, pause duration, and frequency. In addition to temporal features, spectral cues such as pitch range, accent, and intonation also play a meaningful role in determining fluent L2 production. For example, inappropriate pitch contour, narrow pitch range, and misapplied tones may result in L1 natives perceiving a foreign-like, dysfluent pronunciation.

L2 development of prosody structure has been affected by the variables of age (Tahta, et al., 1981; Guion, et al., 2000), motivation (Conrad, 1991; Moyer, 1999), L2 experience (Guion et al., 2004; Mennen, 2004; Trofimovich & Baker, 2006; Kang, 2022), and the L1 background (Ueyama & Jun, 1997; Davis & Kelly, 1997; Guion, et al., 2004). Out of various effects, L2 immersion experience has been known to play an important role in acquiring L2 fluency (Aoyama et al., 2008; Kang, 2022). For example, Ueyama and Jun (1997) observed the production of rising and falling intonation patterns in English by native Koreans learning English. They suggest that less fluent speakers of an L2 strongly convey the prosody structure of the L1 when pronouncing a similar structure in the L2. In addition, with more immersion experience in the target language of English, a similar prosody structure is acquired quite well by more fluent L2 Korean speakers. Thus, they conclude that English prosody patterns might be a barrier for L2 adult Korean speakers to acquire correctly. Despite accumulating research in L2 acquisition, authentic understanding of L2 acquisition is quite challenging to achieve because most studies have focused on mono-directional L2 acquisition, which may lead to a biased understanding (e.g., Mennen, 2004). Reflecting the previous works, this study focuses on the cross-directional development of prosody (hereafter referred to as suprasegmentals<sup>1)</sup>) among different length immersed groups of L1 and L2.

The current study examines L2 suprasegmental developmental patterns over different lengths of immersion, comparing L1 with L2 of both languages: Korean and English. The

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1) Suprasegmentals include features like pitch, length, loudness, and timbre or phonatory quality of the voice, and thus could encompass a large amount of acoustic cues over segmental features. From the perspective of L2 acquisition, this paper adopts the norm of suprasegmentals instead of prosody, which is oriented towards phonology.

research is focused on exploring the different elements that affect the learning of L2 suprasegmental features, which are essential in establishing fluency in a second language. For the experiment, we analyzed the range of fundamental frequency (F0), speech rate, and the pause duration in whole sentences, as well as the syllable duration and mean F0 at the boundary of the sentences.

## 2. Previous Studies

Fluent L2 speech is determined by the L1 native listeners' judgment, considering the various suprasegmental cues such as pause duration and frequency, fundamental frequency, speech rate, and boundary cues (Derwing & Munro, 2001; Kormos & Denes, 2006). Some researchers argue that L2 learners' background language influences the judging of the degree of fluency. For instance, Bongaerts, Mennen, and Slik (2000) examined the fluency levels by comparing Dutch-speaking learners of English and French; they suggested that the role of typological prosody distance between L1 and L2 is an important factor. Of the four most successful Dutch learners, three learners were native speakers of German with the last one being a native speaker of English. This finding suggests that, in the domain of pronunciation, the effect of the L1 background could be one of the crucial variables in determining L2 adult fluency.

A foreign-accented suprasegmental cues transferred from the learners' background languages cause L2 speakers' miscommunications with the L1 listeners. For example, errors that occur more often in the production of L2 English suprasegmentals exhibit certain unique characteristics: a narrow F0 range (Willems, 1982; Mennen, 2006), problems with the correct placement of stress (Guion, et al., 2004), slow speech rate (Munro & Derwing, 1996; Guion, Flege, and Loftin, 2000), incorrect pitch contour (Kang, Guion-Anderson, Rhee, & Ahn, 2012), longer pause structure (Riazantseva, 2001; Trofimovich & Baker, 2006), and foreign-like intonation structure (Willems, 1982; Cruttenden, 1997). These suprasegmental factors influenced the assessment of L2 fluency.

Along with L1 background, the experience of early immersion influences L2 suprasegmental acquisition. Some longitudinal studies report positive results in acquiring native-like fluency. Grover et al. (1987) reported that 10-year-old French immersion

children produced the French intonation more natively than 17 years students. Trofimovich and Baker (2007) examined L2 experience effects on Korean children's acquisition of L2 English suprasegmentals. They reported that the children with 11 years of residence in America produced all but one suprasegmental (speech rate) natively. It means that longer immersion could have a positive effect on the acquisition of L2 suprasegmentals.

The degree of L2 oral proficiency is evaluated based on fluency, comprehensibility, foreign-accentedness, and intelligibility (Munro & Derwing, 1996). Among these factors, fluency is a key indicator of L2 speakers' oral performance and forms the basis for L2 speaking tests such as OPIc and TOEFL speaking. Segalowitz (2010) proposed that fluency refers to the ability to express any idea in the L2 that one can also express in the L1, or to the ability to speak with little or no accent in the L2. Thus, fluency can serve as an indicator to evaluate the extent to which L2 learners acquire the suprasegmentals.

The current study investigates L2 suprasegmental acquisition by considering both the L2 learners' group and the length of immersion in the target language. The purpose of the study is to explore suprasegmental cues influencing the acquisition of L2 fluency. In the experiment, the L2 suprasegmental production and their mutual effects were acoustically examined. The research investigated whether the suprasegmental structure of second language (L2) learners could evolve during extended immersion, influenced by interactions with their native language (L1) and the target language (L2). More specifically, when adult learners experience extended immersion in a second language, they may benefit from specific suprasegmental cues triggered by the immersion process. These cues could enhance their suprasegmentals and contribute to more fluent language acquisition.

The study conducted an acoustic analysis of L2 suprasegmental production, specifically examining how acoustic cues change in response to both the influence of L2 learners' groups (of Korean learners of English and English learners of Korean) and the duration of immersion (between long-immersion and short-immersion groups). This investigation sheds light on the dynamic interplay between two factors for L2 fluency acquisition. Five suprasegmental cues—speech rate, pause duration, F0 range, and syllable duration and mean F0 at the boundary—which proved to be important cues to determine L2 fluency (e.g., Munro and Derwing, 1995; Mennen, 2006; Trofimovich and Baker, 2006), were investigated.

### 3. Methodology

#### 3.1. Participants

The data were accumulated from 35 adult participants for experiment. The study divided subjects into six groups, each consisting of two L2 learners' group and four immersion groups, along with two control groups. The rough information of participants in each group is presented in Table 1.

Table 1. Subjects' Information

Classification	*Group	***subject	Age	****LOR	****AOA
English learners of Korean	NK(con.**)	3m	34.1	—	
	LILEK	8m	23.6	3.7	19.3
	SILEK	7m	25.2	1.3	23.9
Korean learners of English	NE(con.**)	3m	36.2	—	
	LILKE	8m	24.1	4.8	20.1
	SILKE	6m	23.7	1.4	22.3

\* NK: Native Korean Speakers, NE: Native English Speakers, LILEK: Long Immersed Learners of English learning Korean; SILEK: Short-Immersed Learners of English learning Korea; LILKE: Long Immersed Learners of Korean learning English; SILKE: Short-Immersed Learners of Korean learning English.

\*\* con.:control group

\*\*\* subject: m; male

\*\*\*\* LOR: length of residence in L2 country(year).

\*\*\*\* AOA: age of arrival(year).

The Korean learners of English who joined the project were either visiting students or enrolled at universities in the northeastern part of North America at the time of the experiment. The long-immersed Korean subjects learning English were selected based on their immersion experience in America, which was over 2 years (with a mean length of 4.8 years), while the immersion experience of short-immersed Korean participants was less than 2 years (with a mean length of 1.4 years). The daily use of English for both immersed groups averages around 6.8 hours, which includes classes, mass media, personal communication, and part-time jobs. On the other hand, the English-native participants in

the study, who were learning Korean, were either visiting students or office workers studying Korean at the university's language center in Seoul. Most of the English learners of Korean were from North America and were learning Korean for study, business, or personal matters (e.g., marriage). The long-immersed English subjects learning Korean were selected based on their immersion experience, which was over 2 years (with a mean length of 3.7 years), while the short-immersed counterparts were less than 2 years (with a mean length of 1.3 years). The daily use of Korean for both groups averages around 6.2 hours, which includes classes, mass media, personal communication, and part-time or full-time jobs.

### 3.2. Materials and Procedures

Before the experiment, three pictures were presented to subjects. Then, they were asked to explain them. They wore a headset using a laptop computer for the interview (see Appendix 1). Each participant was asked to describe each picture in the target language one time. Each interview consists of four to six sentences. The analyses were based on 315 sentences. All audio recordings were made using a TASCAM DA 20AMK II and a Shure SM 20 microphone, and were digitized at a resolution of 44.1 kHz and 16-bit audio.

Subjects' speech of each language (English and Korean) was used to analyze the suprasegmental acoustic cues. The indicators for fundamental frequency (measured in Hertz) and duration (measured in seconds or milliseconds) were gauged using a waveform display with a wideband spectrogram in the software Praat (5.4.05). The check points were set from the initial acoustic signals in the sentences to the final acoustic cues at the boundary. Variables of speech rate, pause duration, F0 range, and mean F0 and syllable duration in the sentence-final syllables were calculated.

The measures were analyzed with two-way ANOVAs, which were conducted to statistically evaluate differences among groups based on the dependent cues: speech rate, pause duration, the range of fundamental frequency (F0), and syllable duration and mean F0 at the boundary. These were examined based on both factors: the L2 learners' group and the length of immersion.

## 4. Fluency Analysis

### 4.1. Data

The 315 samples were randomized and presented to the native Korean and English raters using a headset. Six evaluators, ranging in age from 29 to 41 years (average age 35.1 years, standard deviation 6.7 years), were enlisted to evaluate fluency of the L2 subjects using a 6-point Likert scale (1=totally dysfluent speech, 2=dysfluent speech, 3=understandable fluent speech, 4=moderately good fluent speech, 5=good fluent speech, 6=native-like fluent speech).

For the assessment, the evaluators reviewed a selection of sample sentences before rating the sentences. All of the raters (3 native Korean, 3 native English) were professors holding master's or doctoral degrees in Linguistics or related majors. They already understood the purpose of the project. To emphasize the suprasegmental aspects when rating the subjects' fluency, some papers (e.g., Derwing & Munro, 1997, 2008) were presented to the raters before they participated in the workshop.

### 4.2. Fluency ratings

The primary objective of the research was to examine the hypothesis that long-immersed learners tend to produce L2 suprasegmentals more fluently, and that the effect of the L2 learners' group could be involved in acquiring L2 fluency. In this study, a correlation analysis was conducted to determine if the majority of evaluators maintained consistent results in the data. The variable of interest was the average scores of the fluency evaluations. The intra-class correlation coefficient was used to quantify the degree of agreement among the evaluators in their assessments of the subjects' speech. The correlation coefficient for the raters was high, with  $r(3) = 0.92$ ,  $p < 0.001$  for Korean raters, and  $r(3) = 0.89$ ,  $p < 0.001$  for English raters. The outcome demonstrates a significant consensus in the evaluations provided by the raters.

The mean fluency scores for the L2 learners' group and immersion levels are quite distinctive, ranging from 1 to 6. The mean difference in fluency scores across the L2 learners' group was not significant (English learners of Korean = 3.12, SD: 0.9; Korean learners of English = 2.97, SD: 1.1;  $p > 0.05$ ). As for the immersion effect, the mean scores of the long-term immersed L2 learners (mean = 3.82, SD: 1.2) were higher than those obtained for the short-term immersed learners (scores = 2.12, SD: 1.9;  $p < 0.001$ ).

However, the scores of the L2 learners' groups were significantly lower than those of the native speakers (Korean 5.14, SD: 1.2; English 4.92, SD: 1.3).

The rating data were submitted to a two-way ANOVA with the L2 learners' group and L2 immersion levels as between-group and within-group factors, respectively. This analysis indicated a insignificant effect of the L2 learners' group, [ $F(1, 315) = 0.754, p > 0.05$ ], but a significant effect of immersion level, [ $F(2, 315) = 297.535, p < 0.001$ ]. The interaction of proficiency levels and the L2 learners' group was not significant as [ $F(2, 315) = 6.637, p > 0.05$ ].

The follow-up Bonferroni test revealed that the effect of the L2 learners' group generally has an insignificant impact on judging L2 speaking fluency ( $p > 0.05$ ). On the contrary, the groups immersed for a long time show higher scores than the ones immersed for a short time ( $p < 0.001$ ). Note that native speakers achieve a mean score of 5.03 out of 6<sup>2</sup>).

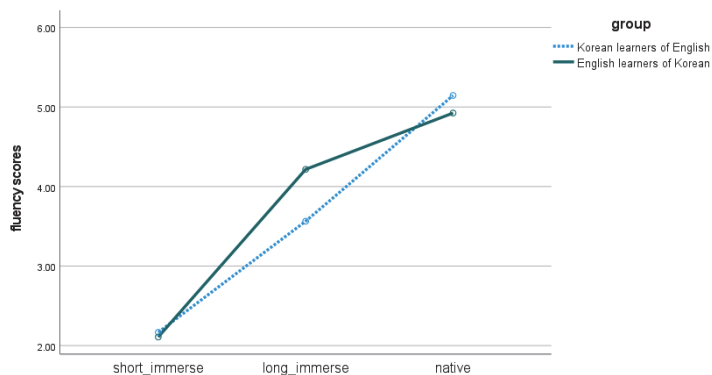


Figure 1. Means of fluency scores by both effects.

The analysis indicates that L2 immersion determines the degree of L2 fluency improvement. In this study, the long-term immersion learners show comparatively better fluency than the short-term ones, regardless of their L2 learners' group.

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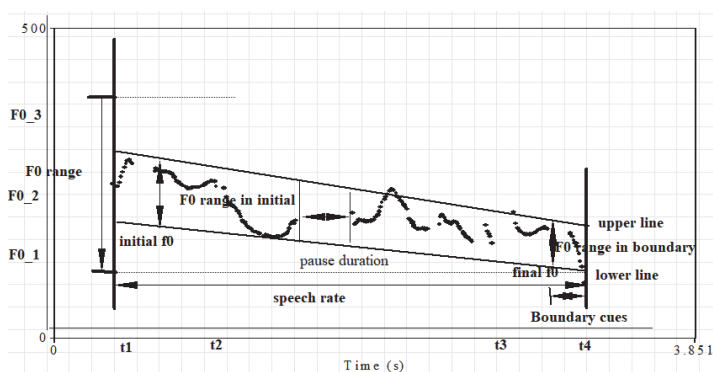
2) It appears to be difficult for native speakers to achieve full scores due to the picture-based description test method.



## 5. Acoustic Analysis

The primary objective of the analysis was to explore which particular suprasegmental cues influenced the fluency scores in the speech of the L2 learners and to determine the degree of their impact. Five specific suprasegmental cues that could have contributed to the fluency judgment were analyzed: F0 range, speech rate, pause duration, and F0 and duration at the boundary. The phonetic cues that were measured are potential elements influencing the judgement of fluency in L2 (Mennen, 2006; Trofimovich and Baker, 2006).

The speeches of the subjects were utilized to assess the suprasegmental acoustic indicators of each group. Several phonetic evaluations were conducted, focusing on the fundamental frequency in Hertz and the duration in seconds or milliseconds. A waveform with a time-locked wideband spectrogram was generated using the software Praat (version 5.4.05). The specific measurement methods are presented in Picture 1.



Picture 1. The measured cues of sampling speech.

The subsequent parameters outline the calculating method of measurement utilized in the study.

- a. F0 range(Hz):  $(\text{the initial F0 range (A)} + \text{the final F0 range (B)})/2$  for whole sentences (Wennerstrom, 1994).
- b. Speech rate(s): whole duration of the target sentence - pause duration (Segalowitz, 2010)
- c. Pause duration(ms): pause duration within a sentence (Riazantsva, 2001)
- d. F0 and duration at boundary: mean F0(Hz) and duration(ms) of the sentence-final syllable (Mennen, 2006)

## 5.1. Speech rate

The two-way analysis of variance (two-way ANOVA) revealed a statistically significant effect in terms of the L2 learners' group [ $F(1, 315) = 5.115, p < .05$ ] and the length of immersion [ $F(2, 315) = 27.378, p < .001$ ]. The interaction of both variables lacks a meaningful effect [ $F(2, 515) = 1.103, p > 0.05$ ]. Tukey tests ( $p < .05$ ) further reveal the following speech rate patterns: 1.94 seconds per sentence for the short immersion group and 1.33 seconds for the long immersion group of Korean learners of English, while 2.46 seconds for the short immersion group and 1.57 seconds for English learners of Korean.

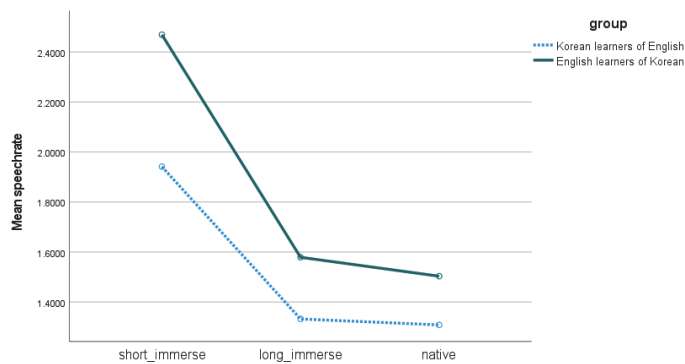


Figure 2. Means of speech rate by both effects.

These results agree with previous works in that more fluent pronunciation was produced with a faster speech rate for learners with longer immersion, regardless of the learners' background language (Lennon, 1990; Munro & Derwing, 1995; Kang, Guion-Anderson, Rhee, & Ahn, 2012; Kang, 2022). In this experiment, the group with longer immersion produced a faster speech rate, indicating that immersion has a significant influence on speech rate.

The reason why both shorter-immersed groups produced slower speech rates is closely connected with universal patterns in learning L2. This implies that less immersed L2 learners inherently face fluency problems: improper pronunciation, failure to properly position stress, longer pause duration, and frequent pauses (Kang et al., 2012; Kang, 2022). On the other hand, the longer-immersed L2 groups tend to approach the speech rate of native speakers. This is achieved through precise pronunciation, appropriate stress patterns, and shorter pause durations, resulting in faster speech rates.

## 5.2. Pause duration

It is well-known that the structure of pauses, including aspects like duration and frequency, influences how L1 natives rate the fluency of L2 speech (Munro and Derwing, 2006; Rossiter, 2009). Pauses might indicate the L2 speaker's difficulty in performing the task due to memory processing or constraints unique to L2 speech (Schachter, Christenfeld, Ravina, and Bilous, 1991; Riazantseva, 2001). Thus, in the assessment of L2 fluency, some studies suggest that the structure of pauses is a cross-linguistic factor that is independent of the L1 background (Grosjean and Deschamps, 1975; Riazantseva, 2001). The durations of pauses were submitted to a two-way ANOVA. The result lacked the statistical effect of the L2 learners' group,  $[F(1, 315) = 0.112, p > 0.05]$ , while its analysis indicated the significant effect of L2 immersion,  $[F(2, 315) = 34.813, p < 0.001]$ . The interaction of L2 immersion and L2 learners' group was not significant, as  $[F(2, 315) = 0.219, p > 0.05]$ .

Post-hoc Bonferroni tests indicated that the pause duration of all L2 learners' groups lacked any statistical difference ( $p > 0.05$ ). On the other hand, the tests revealed that the pause duration for the short immersion groups was significantly longer than those of the long immersion group and natives ( $p < 0.001$ ), which showed a meaningful difference between the two groups ( $p < 0.05$ ). The findings are consistent with prior studies that have shown a strong correlation between the length of pauses and the degree of immersion, but not to the L2 learners' group. The results are summarized in Fig. 3.

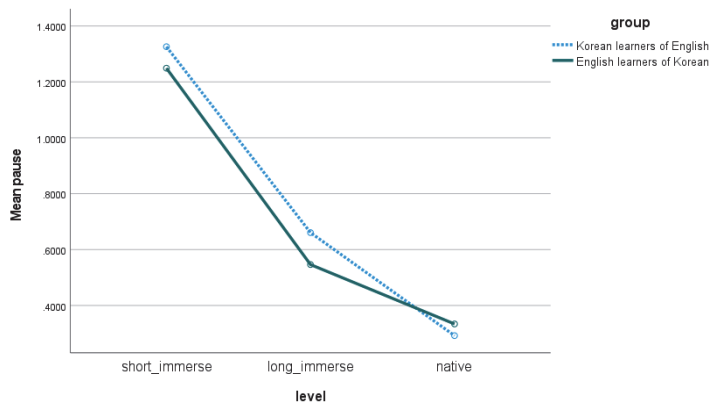


Figure 3. Means of pause duration by both effects.

### 5.3. F0 range

The two-way analysis of variance (two-way ANOVA) revealed a statistically insignificant effect on the L2 learners' group, [ $F(1,315) = 2.830, p > 0.05$ ], but a moderate effect on the length of immersion, [ $F(2,315) = 5.115, p < 0.05$ ]. The interaction of two factors—the L2 learners' group and the length of immersion—yielded a insignificant effect, as indicated by the statistical analysis ( $p > .05$ ). Tukey's tests for L2 immersion ( $p < .05$ ) further revealed specific trends: long immersion groups showed a wider range than the short immersion ones.

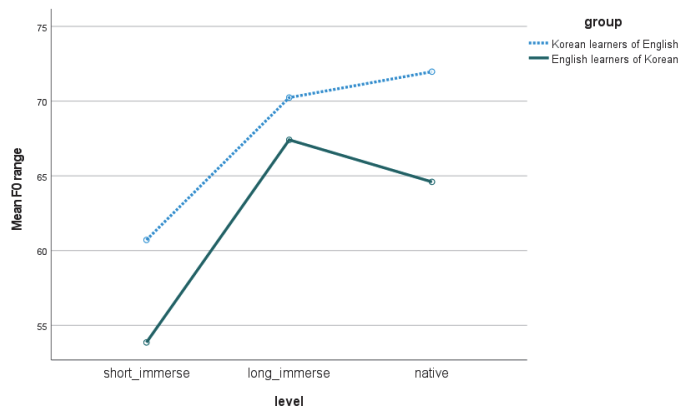


Figure 4. Means of F0 range by both effects.

Figure 4 presents how the F0 range changes over immersion duration for both Korean learners of English (60 Hz and 70 Hz for Korean learners of English; 72 Hz for English natives) and English learners of Korean (53 Hz and 67 Hz for English learners of Korean; 64 Hz for Korean natives). As immersion lengthens, both groups tend to approach the F0 range of native speakers. This finding highlights the dynamic interaction between both factors.

This result supports the proposal that F0 range of the long immersed learners follows the native speakers' patterns; more fluent learners of English as a second language have a comparatively wider F0 range when speaking English (Bradlow et al., 1996; Mennen, 2006), while more fluent Korean learners exert similar F0 range as Korean natives.

#### 5.4. Duration and Mean F0 of Phrase-final Syllable

Boundary cues are prominently realized at the end of sentences in the form of a distinctive pitch contour and longer duration (Wightman et al., 1992; Mennen, 2006). The analysis of variance revealed a significant effect of the L2 learners' group on syllable duration at sentence-final syllables [ $F(1, 315) = 27.231, p < 0.001$ ]. However, there was a insignificant effect on the length of immersion [ $F(2, 315) = 4.884, p > 0.05$ ]. Also, the interaction of both effects lacks the statistical distinction: [ $F(2, 315) = 3.413, p < 0.05$ ]. Tukey's tests further reveal that Korean learners of English exhibit longer duration than English learners of Korean.

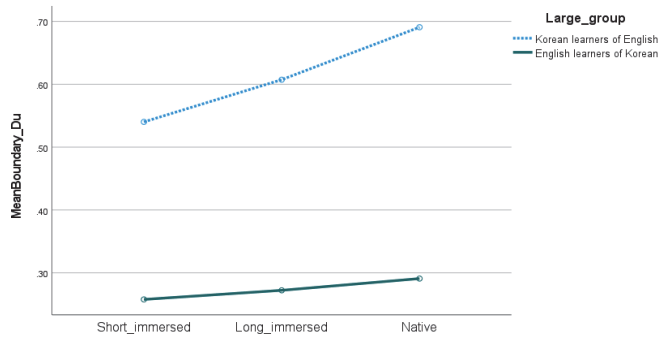


Figure 5. Means of syllable duration at boundary by both effects.

The differences at a sentence boundary among the groups provide valuable information. Although final lengthening results in a longer duration, it appears that final lengthening plays a meaningless role for the effect of L2 immersion ( $p > 0.05$ ). The durational difference between two groups of L2 learners ( $p < 0.05$ ), however, stems from syllable duration, in which the syllables of Korean, a syllable-timed language, maintain a comparatively longer duration than English, which is a stress-timed language.

On the other hand, final strengthening is closely related to the fundamental frequency (F0). The following are the results of the mean F0 at the boundary.

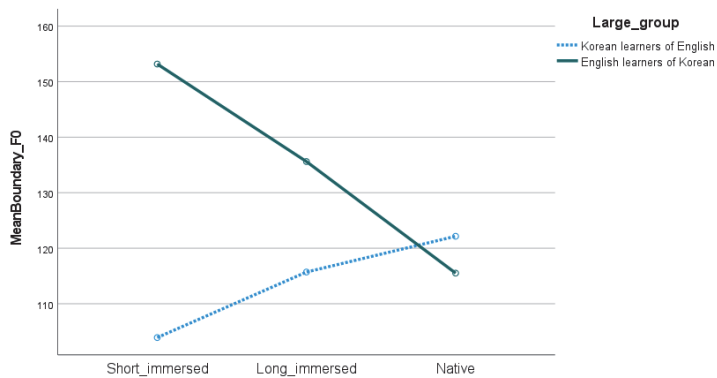


Figure 6. Means of F0 at boundary by both effects.

Boundary strengthening is realized at the end of sentences in the form of prominent F0 values (Wightman et al., 1992; de Pijper & Sanderman, 1994; Kang, 2022). The significant effects were observed as  $[F(1, 315) = 1768.800, p < .001]$  for the L2 learners' group, and as  $[F(2, 315) = 6242.725, p < .001]$  for immersion levels. This highlights the intricate interplay between the L2 learners' group and immersion experience in shaping suprasegmental features. The significant interaction effect  $[F(2, 315) = 3642.723, p < .001]$  underscores the complex interplay between both effects. Tukey's tests further reveal that English native speakers exhibit higher F0 values compared to both shorter and longer immersion groups, in the case of Korean learners of English. On the other hand, it shows that Korean native speakers exhibit lower F0 values compared to both shorter and longer immersion groups, in the case of English learners of Korean. Notably, longer-immersed learners tend to approach the natives' suprasegmental features.

## 6. Relationship between suprasegmental cues and effects

Indeed, the suprasegmental analysis for both the adult L2 learners' group and immersion level highlights their approach to the native speakers. Understanding the interplay among these factors affecting L2 fluency judgment is crucial in second language acquisition. An intriguing question arises: to what extent do the suprasegmental cues correlate with both of L2 learners' group and immersion experience?

To answer the question, both effects and their corresponding dependent values were

submitted to correlation analyses. Specifically, zero-order correlations were computed between the suprasegmental features and these effects. The analysis reveals that most of the acoustic values measured in this study have varying correlations with both effects (as shown in Table 2), implying that temporal indicators like speech rate and pause duration have a strong correlation with the duration of immersion. The findings suggest that these temporal cues can improve over the course of immersion, regardless of the L2 learners' group.

Table 2. Summary of Pearson correlation analyses between both effects and acoustic measurement

	Acoustic measurement				
	F0 range	Speech rate	Pause duration	Duration at boundary	F0 at boundary
Length of immersion	0.191**	-0.491**	-0.370**	0.109	0.343**
L2 learners' group	-0.113	0.091	-0.027	-0.728**	0.366**

\*\* $p < 0.001$ , \* $p < 0.05$

The table suggests that native-like fluent L2 speech is influenced by the length of immersion, while the impact of the L2 learners' group on the acquisition of L2 fluency is less. This means that both groups of Korean learners of English and English learners of Korean exhibit similar patterns in the acquisition of L2 suprasegmentals.

The distinctive features, however, could be found at the boundary cues. In general, acoustic cues are enhanced at the edges of prosodic domains cross-linguistically. The enhancements occur in the forms of longer duration, strengthening, overlap with adjacent segments, and distinctive pitch contour. These enhancements presumably have some influence on both effects. However, in this study, we can't find the clear evidence that the long-immersed learners produce a strong enhancement at the boundary.

The following analysis shows how these suprasemental cues affect L2 fluency decision. Table 3 shows that each of the five phonetic indicators significantly forecasted the proportion of fluency assessment; the variable of speech rate explained 36.5% of the variance, and the pause duration explained 18.2%. Recall that the temporal cues (speech rate and pause duration) are more important than the spectral cues (F0 range) in fluency judgment.

Table 3. The regression analyses

		B	SE B	B	R <sup>2</sup>	t
Speech rate	Const.	0.530	0.024			22.445**
		-0.062	0.006	-0.607	0.365	-10.728**
F0 range	Const.	1.007	0.015			65.262**
		.016	0.001	1.033	-0.004	-1.119
Pause Duration	Const.	1.717	0.162			10.609**
		-0.265	0.039	-0.432	0.182	-6.718**
Duration at boundary	Const.	1.307	0.015			21.262**
		-1.098	0.081	-0.103	0.052	-3.218**
F0 at boundary	Const.	1.017	0.018			2.245*
		.013	0.002	1.237	-0.002	-0.092

\*\* :  $p < 0.001$ , \* :  $p < 0.05$

In this table, some spectral cues such as F0 range and mean F0 at the boundary are less influential in determining L2 fluency, explaining less than 1%. Indeed, a hierarchical order between the temporal and spectral cues can be established.

## 7. Discussion and Conclusion

The immersion experience significantly influenced the acquisition of L2 suprasegmentals, including speech rate, F0 range, pause duration, and mean F0 and duration at the boundary. Here are the key findings: one is that the acoustical suprasegmental patterns of the long immersion group closely resembled those of native speakers. The other is that the speech rate is one of the most important cues in determining L2 fluency, but the spectral cues such as the fundamental frequency (F0) are not.

Both immersion groups show some common features as well as some distinctive characteristics at the same time, presumably affected by two factors: universal L2 development and the distinctive L2 learners' group. The length of immersion is closely associated with both durational cues of speech rate and pause duration, which play a key role in determining L2 fluency. On the contrary, the effect of the L2 learners' group strongly is related with the spectral cues such as the fundamental frequency. Considering that the spectral cues are closely related to the L1 background, it appears that the L1



native language still interferes with the acquisition of L2 suprasegmental cues.

In this study, both factors manifest differently in cross-directional development between learners of Korean (L1) transitioning to English (L2) and those of English (L1) transitioning to Korean (L2). The longer-immersed English learners of Korean show a higher F0 at the boundary, while longer-immersed Korean learners of English exhibit a comparatively lower F0 at the same position. Note that the mean F0 at the boundary in Korean is much lower than that of English.

Also, both advanced groups share a common feature: a faster speech rate and a shorter pause duration. This suggests that these both durational cues are not tied to the L2 learners' group but rather to the length of immersion. Interestingly, these cues are revealed to be the most crucial cues in determining L2 fluency.

It is intriguing to examine the boundary cues in terms of mean F0 (pitch) and syllable duration. Notably, the immersed English learners of Korean transit from a higher to a lower pitch at these boundaries, while Korean learners of English do from a lower to a higher pitch at these boundaries. To date, final lengthening/strengthening in an intonational phrase (IP) has been recognized as a characteristic realized cross-linguistically (Wightman et al., 1992; de Pijper & Sanderman, 1994; Jun, 2006). From the phonological viewpoint, the final lengthening/strengthening could play an important role as a phonological marker representing a breakdown between IPs cross-linguistically, leading to the determination of L2 fluency. However, in this study, we can infer that L1 background could serve more influence than phonological enhancement at the boundary.

In this study, the issue of immersion supports the hypothesis that longer immersion in an L2 environment accelerates the acquisition of crucially important suprasegmental cues such as speech rate and pause duration. Thus, longer exposure to the immersion leads to a fluent decision by the natives. Although learners' age of initial exposure to the L2 has been known as the critical factor in achieving native-like fluency (Trofimovich & Baker, 2006), the results of this study support the hypothesis that immersion could be another variable that contributes to the acquisition of second language fluency, even to the adult learners.

The cross-directional study between two language learner groups reveals that suprasegmental features are not acquired equally. In the context of L2 language learning, L2 immersion could have a more important effect than the L2 learners' group. However, several years of immersion duration does not guarantee a native-like fluent production of suprasegmentals. In this study, even after several years of immersion, they still have difficulty in some spectral cues such as the F0.

In conclusion, the longer-immersed L2 groups exhibit more native-like suprasegmentals compared to the short-immersed group. From this result, we can infer that the facilitative effect of immersion clearly leads to easier acquisition of L2 suprasegmentals, even for adult learners. The effects, however, were manifested differently; L2 immersion has a positive effect on fast speech rate and short pause duration, while the effect of the L2 learners' group exerts somewhat meaningless influence on the spectral cues.

Also, in some local boundary cues, we can draw the conclusion that some cues at the boundary are hard to change easily despite intensive immersion in an L2 environment. The immersed group still retains some suprasegmental characteristics stemming from their mother tongue, even though the L2 learners are exposed to an L2 speaking environment with longer immersion. Further research is needed to study why some cues are comparatively hard to acquire and how these features contribute to diminished fluency ratings.

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## Appendix 1. Test pictures.

Please explain following pictures.



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