Training Korean speakers on English vowels and prosody: Individual differences in perception, production and vowel epenthesis

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Declaration

I, Dong-Jin Shin, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis. Portions of this thesis have been published in peer-reviewed journals and conference proceedings.

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“The fear of the Lord is the beginning of wisdom, and the knowledge of the Holy One is insight” (Proverbs 9:10)

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Abstract

The studies examined in this thesis analysed a range of speech production and perception abilities of Korean learners of English to observe how these abilities combine and relate and how they can be improved. The aim of the first study was to investigate whether individual differences in vowel epenthesis are more closely related to the perception and production of segments (vowels and consonants) and prosody or if they are relatively independent from these processes. Subjects completed a battery of production and perception tasks. They read sentences, identified vowels and consonants, read target words likely to have epenthetic vowels (e.g., *abduction*) and demonstrated stress recognition and epenthetic vowel perception. The results revealed that Korean second-language learners (L2) have problems with vowel epenthesis in production and perception, but production and perception abilities were not correlated with one another. Vowel epenthesis was strongly related to vowel production and perception, suggesting that problems with segments may combine with L1 phonotactics to produce epenthesis.

The second study gave Korean L2 speakers auditory training on vowel identification and prosody recognition (focus and lexical stress), to investigate the extent to which training improved general speech perception abilities or specific underlying processes. Vowel training was accomplished with a high-variability identification training technique (multiple talkers and words), and prosody training was accomplished using a category discrimination task in which respondents were asked to choose sentences based on focus or words based on syllable stress. The results revealed two main findings. First, focus/stress auditory training improved perception consistent with previous studies conducted using segments. Second, each type of training developed separate but overlapping abilities; vowel training had a greater effect on vowel recognition abilities, and focus-stress training had a greater effect on focus and stress recognition abilities. These findings suggest that training improves specific underlying

abilities rather than an overall ability relating to the training task or the stimulus variability. Therefore, different training approaches could be combined to achieve an overall greater improvement in speech recognition.

The third study analysed the recordings from the training study to examine the acoustic characteristics and contexts of epenthetic vowels produced by Korean L2 speakers. The acoustic characteristics of epenthetic vowels were measured in terms of F1, F2, F3, vowel duration and F0. The word and phoneme contexts of epenthesis were assessed. Extra phonological factors, such as English experience and orthography, were investigated to decipher whether these factors affected the amount of epenthesis. The results demonstrated that most epenthetic vowels had a high-central position in the vowel quadrilateral and that the frequency of epenthesis is affected by the consonants or voicing features primarily at word junctions.

Chapter 1: Introduction

Second-language learners typically have a wide range of difficulties with the phonetic and phonological systems of the L2 (e.g., segments and prosody). For example, several previous studies have investigated errors made by Korean L2 speakers, showing that the speakers had trouble learning English (Han, 1996; Koo & Oh, 2001; Kwak, 2003; Kabak & Idsardi, 2003, 2007; Kwak & Shin, 2005; White & Mattys, 2007; Kim et al., 2008; Lee, 2009; Jang, 2009; Hong, 2010; Lee & Lee, 2011). However, most previous studies have focused on quantifying the difficulties Korean speakers experience rather than finding the cause of the errors.

The Korean language has 19 consonants. The consonants are produced in five different places (bilabial, alveolar, alveo-palatal, velar and glottal) and in five manners (stop, fricative, affricate, nasal and liquid). The table of consonants is presented in Table 1.1. Korean has eight vowels, which are presented in Table 1.2.

		Bilabial	**Alveolar**	**Alveo-palatal**	**Velar**	**Glottal**
Stop (Plosives)	plain	p	t		k	
	aspirated	p^h	t^h		k^h	
	tense	p’	t’		k’	
Fricative	plain		s			h
	tense		s’			
Affricate	plain			č		
	aspirated			$č^h$		
	tense			č’		
Nasal		m	n		ŋ	
Lateral			l			

Table 1.1 Korean consonants

	Front		Back	
	Unrounded	Rounded	Unrounded	Rounded
High	i		ɨ	u
Mid	ɛ		ʌ	o
Low	æ		ɑ	

Table 1.2 Korean vowels (eight vowels)

Table 1.1 contains consonants that do not appear in standard IPA values but fit in with accepted conventions in Korean phonetics (Kang, 2002); they were used for typographic convenience. A consonant [č] is [tʃ] in IPA. The symbol [^{h}] means aspirated consonant and [’] means tensed consonant. For example, the symbol [č^h] means alveo-palatal affricate aspirated consonant, and [č’] means alveo-palatal affricate tensed consonant.

Korean has some phonotactic constraints. First, the language does not allow consonant clusters in either the onset or rhyme of syllables. Therefore, when we find adjacent consonants in Korean, the consonants belong to different syllables, making them consonant sequences rather than clusters. Korean speakers insert [ɨ] when speaking an English consonant cluster. These speakers do not have epenthesis when speaking Korean adjacent consonant sequences (Kang, 2002). Second, seven consonants, [p], [k], [t], [m], [n], [l] and [ŋ], can occur in coda position. Other consonants are neutralised or removed in production. When a CVC word is followed by C-initial one (consonant sequence), Korean speakers use different strategies, such as nasalizing (e. g., /tam-lon/ → [tamnon] ‘discourse’), geminating (e.g., /sil-lok/ → [sillok] ‘chronicle'’) and neutralizing, (e.g., /sus- ča/ → [sutč’a] ‘number’). English has a wide range of clusters and sequences - posing a challenge to Korean L2 learners - but vowel epenthesis is not a strategy normally used by native English speakers to simplify these. In terms of prosodic features, Korean does not have lexical stress or prosodic focus at sentence level, as we find in English, again posing a challenge to Korean L2 learners although intonation can be used to make meaning distinctions of other sorts; previous studies showed that intonation could change the meaning in a certain context (Lee et al., 2000).

The studies in this thesis examined a range of speech production and perception abilities to determine the relationship. The studies focused on vowel epenthesis because this is one of the most frequent errors made by Korean L2 speakers. Vowel epenthesis is the insertion of vowels within consonant clusters or at the end of a word, usually caused by L1 phonotactics. For example, Japanese speakers insert epenthetic vowels within consonant clusters. (e.g., *strike*/straɪk/ → [sutoraɪku]) (Dupoux et al., 1999). By conducting investigations using various approaches, previous studies have shown that Korean L2 speakers also produce vowel epenthesis (Han, 1999; Lee, 2000; Tak, 2000; Rhee & Choi, 2001; Kabak & Idsardi, 2003, 2007; Kang, 2003; Kim & Kochetov, 2011; Shin & Iverson, 2011; Ahn, 2012; de Jong & Park, 2012). However, the question remains of why epenthesis occurs. Previous studies have suggested that vowel epenthesis is caused by phonotactic constraints from a speaker's native language (Pitt, 1998; Dupoux et al., 1999, 2011; Kang, 2003; Kim & Kochetov, 2011; de Jong & Park, 2012). Although these studies have investigated the relationship between epenthesis and segmental abilities (Dupoux et al., 1999, 2011), the possibility of interaction between epenthesis and prosody has not been investigated.

The interaction between different kinds of speech production and perception abilities among L2 speakers is also not yet understood. Some previous works have revealed that production and perception are highly related (Bradlow et al., 1997; Rauber et al., 2005), but others have suggested that speech production and perception are separate (Goto, 1971; Shelton & Johnson, 1977; Sheldon & Strange, 1982; Borden et al., 1983; Gass, 1984; Flege & Eefting, 1987; Flege, 1993; Ramirez, 2006; Nasir & Ostry, 2009; Hattori & Iverson, submitted). This present thesis investigated the link between production and perception epenthesis to learn whether Korean L2 speakers' production and perception abilities are linked.

Previous studies have compared Korean L2 speakers with native English speakers in terms of prosody production, showing that Korean L2 speakers have difficulties (Park, 1980; Moon, 1991; Ryu, 1996; Yom, 2003, 2004; Chang & Kim, 2006; Lee, 2011). Some studies have tested prosody teaching methods (Ko, 1997; Han, 1999; Yoon et al., 2010a, 2010b; Yoon, 2011), but these studies have tended to focus on production training. The present thesis adapted the high-variability phonetic training approach that has been used with segments (Iverson & Evans, 2009) to improve the perception of word stress and sentence focus in Korean L2 speakers. Contrastive word stress (e.g., *COMpact* vs. *comPACT*) and sentence focus (e.g., *the CLOWN had a funny face* vs. *the clown had a funny FACE*) were both trained. The present study combined an identification task (e.g., *Was the stress on the first or second syllable?*) with a discrimination task (e.g., *hear three sentences and choose the one that has the different focus*). Furthermore, the present study used a vowel trainer from previous studies (Iverson & Evans, 2009) to improve English vowel production and prosody abilities. Through auditory training, the present study aimed for an overall improvement in speech perception and examined how these training methods affected a variety of abilities, such as reducing epenthesis and improving production.

Previous work has analysed the acoustic characteristics of epenthetic vowels (Kim, 2009; Kim & Kochetov, 2011), but the number of epenthetic vowels measured has been small. As part of this training study, 1505 epenthetic vowels from sentences read by 36 Korean L2 speakers were recorded. This allowed greater in-depth analyses. Acoustic measures, such as fundamental frequency (F0), F1, F2, F3 and vowel duration, were used to determine whether the epenthetic vowels provided by Korean L2 speakers were similar to a native Korean vowel. Furthermore, the present study examined the environment affecting vowel epenthesis.

Phonological analyses introduced in previous works helped elucidate the environment of vowel epenthesis (Kang, 2003). However, with a large corpus, the present study investigated various contexts of epenthetic vowels to observe when Korean L2 speakers produced them most. Past studies have also examined extra-phonological factors, including English experience or orthography (Vendelin & Peperkamp, 2006; Detey & Nespoulous, 2008; Lee, 2009). This present research further investigated these extra-phonological factors. A questionnaire was provided to each subject to gauge language background, such as the length of time spent learning English or living in an English-speaking country. Among the various orthographic effects, the present study focused on the English past-tense suffix '-ed' because studies have shown that second-language learners are influenced by the '-ed' ending (Bayraktaroğlu, 2008).

This work is not designed to test a specific theory of second-language learning. It is an exploratory work to investigate how the various underlying processes of L2 phonetic learning interrelate. This study also seeks to create a stress/focus training method that will have practical benefits for L2 learners.

The motivation for this work comes from the researcher's personal experience learning English as an L1 Korean speaker who was taught to produce some words incorrectly (e.g., *changed*) and believes these aspects of production could be improved with better training. The current study set an applied aim to improve the English abilities of Korean L2 speakers. In addition to this applied goal, the study seeks to understand the causes of L2 learning difficulties, particularly how different abilities combine.

Most researchers of vowel epenthesis have adopted a phonological approach (e.g., Funatsu et al., 2008; Shibuya & Erickson, 2010) and descriptive and qualitative analyses of production data. Previous epenthesis training methods have likewise focused on production.

Therefore, the current study is different in that its focus is on quantitative measures of epenthesis in terms of perception, and it investigates how epenthesis relates to other abilities. This study also takes a speech science approach rather than examining from the perspective of linguistic theory to analyse how training can affect these abilities.

The current study also stands out in that it does not focus on one issue but examines a range of L2 learning problems. Given the applied goal of improving L2 difficulties, it makes sense to try to improve many aspects rather than one difficulty at a time. By determining how different abilities interact, this study may discover how the language problems are related and make hypotheses about the underlying causes.

This dissertation consists of three studies. Chapter 2 presents an investigation of Korean L2 speakers to determine whether these learners had problems with vowel epenthesis in production and perception. The relationship between the amount of perception epenthesis and production epenthesis was examined to observe whether speech production and perception were related. The study analysed each Korean subject individually to find whether vowel epenthesis was more strongly linked to segment production and perception abilities (vowels and consonants) or prosody production. A battery of perception and production tasks was completed by 32 Korean L2 speakers. The learners were asked to read sentences, identify vowels and consonants, stress deafness and epenthetic vowel perception and read target words that were likely to have epenthetic vowels (e.g., *abduction*).

Chapter 3 examines the results of training Korean L2 speakers on English vowels and prosody to see whether perceptual training is effective for improvement. This study also compared vowel and prosody trainers to see whether they developed overall speech abilities or specific abilities. Production and perception tasks were completed by 36 Korean L2 speakers. These learners were asked to identify vowels, demonstrate focus and stress recognition, perceive epenthetic vowels, recognise speech in noise and read Bamford-Kowal-Bench (BKB) sentences (Bench et al., 1979). BKB sentences consist of simple, easy-to-read formatting designed for sentence recording. Most BKB sentences are subject-verb-object (SVO), making them easy for second-language learners to read. Half of the participants began with the focus-stress training, and the other half began with the vowel training.

Chapter 4 reports the acoustic analyses of epenthetic vowels produced by 36 Korean L2 speakers who participated in the training study. Although previous studies have tended to focus on phonological aspects (Kang, 2003), their analyses were performed at an abstract level. Furthermore, previous studies have conducted phonetic analyses (Kim, 2009; Kim & Kochetov, 2011) but with only up to 10 respondents. The data these studies provided do not appear sufficient to reveal the phonetic characteristics of Korean epenthetic vowels. When the sample size is too small, speaker variation may create biased results. For example, if there were 10 speakers, the entire statistical result set can be affected by one or two speakers' extreme results or different language backgrounds. Therefore, a greater sample sizes are needed to obtain sufficient data. The present study also compared epenthetic vowels to other native Korean vowels to determine which vowel was most similar to the epenthetic vowel. Extra-phonological factors were investigated to determine the relationship between those factors and the amount of epenthesis.

Chapter 2: Individual differences in vowel epenthesis among Korean L2 speakers

2.1 Introduction

Korean L2 speakers have many problems learning the pronunciation of English words. One of these problems is vowel epenthesis. Vowel epenthesis is the insertion of vowels into or between words, and Korean learners of English typically do this between successive consonants, either within clusters, or across syllables, word boundaries or following final coda consonants. This may occur because the Korean language does not have consonant clusters, so the insertion of epenthetic vowels breaks these clusters into CVCV sequences.

For the past several decades, most researchers of vowel epenthesis have adopted a phonological approach, focusing mostly on examples of epenthesis in production (e.g., Funatsu et al., 2008; Shibuya & Erickson, 2010). However, recent research has demonstrated that epenthesis has also been shown to have effects on perception (e.g., Dupoux et al., 1999; Van Donselaar et al., 1999; Chang et al., 2007; Parlato-Olibeira et al., 2010). For example, Dupoux and colleagues (1999) asked Japanese and French speakers to discriminate between non-words, such as [ebzo] (no epenthetic vowel within consonant sequences) and [ebuzo] (full epenthetic vowel within consonant sequences). The results showed that Japanese speakers were worse at discriminating between these differences; Japanese speakers perceptually inserted the [u] vowel into [ebzo] so that it sounded perceptually similar to the [ebuzo] syllable structure. Moreover, research using ERP recordings (e.g., Dehaene-Lambertz et al., 2000) demonstrated that Japanese participants did not show any mismatch negativity (MMN) response to the change from [ebzo] to [ebuzo]. However, the French participants exhibited the MMN response for the mismatch. These results demonstrated that vowel epenthesis affected perception at a low pre-attentive level. Native English speakers perceptually insert a vowel when they initially hear an illicit consonant cluster in English. Pitt (1998) showed that native English speakers hear the [ə] vowel when they hear illegal consonant clusters in English. Synthesised stimuli containing illegal consonant clusters, such as [tl] in an initial word, were given to native English speakers, and they were asked to determine whether the illegal consonant cluster contained an epenthetic vowel. The results revealed that the subjects had a perceptual epenthesis and concluded that native English speakers naturally inserted an epenthetic vowel.

Kabak and Idsardi (2003) claimed that vowel epenthesis in Korean was complicated because it can occur both due to consonant clusters and due to constraints in which consonants occur in coda position. Moreover, Korean speakers use multiple strategies to repair illicit consonants, including both vowel epenthesis and changing a consonant to one that is legal. Interestingly, Kabak and Idsardi (2003) claimed that Korean speakers use different types of repair strategies in speech production and perception. For example, if strident consonants, such as [s] and [č], are in the coda position, they are typically neutralised in production to an unreleased stop [t] (e.g., [nač] *daytime*, [nač^h] *face* and [nas] *sickle* are spoken as [nat]). Through perception tests, they suggested that listeners repair strident consonants in the coda position through epenthesis; Korean learners of English have difficulty detecting an [u] inserted into that environment. This possible disassociation of the strategies used in speech production and perception suggests that the underlying process of vowel epenthesis in speech production and perception may be different. That is, the perceptual epenthesis investigated by Dupoux and colleagues (1999) may be very different to the epenthesis production investigated in phonological research.

The link between speech production and perception among L2 learners has varying support. Some previous studies have suggested that production and perception are highly related to each other (Bradlow et al., 1997; Rauber et al., 2005). For example, Bradlow et al. (1997) trained Japanese L2 learners to identify the English consonants /r/ and /l/ perceptually. The results revealed that Japanese L2 learners showed an improvement in identifying the English consonants /r/ and /l/. Moreover, Japanese speakers became able to articulate these contrasting consonants more accurately, suggesting that improving speech perception affects speech production in L2 learners. Rauber et al. (2005) also investigated 16 Brazilian Portuguese speakers to see whether their English vowel production and perception were related. Their results showed that inaccurately produced vowels were also inaccurately perceived, supporting the idea that speech production and perception abilities are strongly related.

However, other previous studies have argued for the independent natures of speech production and perception (Goto, 1971; Shelton & Johnson, 1977; Sheldon & Strange, 1982; Borden et al., 1983; Gass, 1984; Flege & Eefting, 1987; Flege, 1993; Ramirez, 2006; Nasir & Ostry, 2009; Hattori & Iverson, submitted). For example, Borden et al. (1983) trained Korean L2 speakers in the production and perception of the /r/ and /l/ contrast in English and investigated the interaction between the speakers' production and perception abilities. Flege (1993) also showed that the relationship between speech production and perception was independent. English L2 learners, whose L1 was Chinese, were asked to speak minimal pairs, such as 'bat' versus 'bad'. They then performed a forced-choice identification task. The correlation results between vowel duration differences in the production and identification tests showed that the link between speech production and perception was not strong. Gass (1984) revealed that production and perception abilities were unrelated. Through several production and perception experiments, 11 Chinese English speakers were asked to pronounce and perceive target consonants, such as /p/ or /b/. The results showed that the subjects pronounced the target consonants in the same way native English speakers do.

However, their perception abilities were not similar to those of native English speakers. Therefore, their findings could be interpreted to mean that production and perception abilities are independent. Nasir and Ostry (2009) investigated the relationship between the perceptual shift of the English words *had* and *head* and the amount of motor learning involved, and demonstrated that speech production and perception were weakly associated. Furthermore, Hattori and Iverson (submitted) trained Japanese L2 learners to speak the English consonants /r/ and /l/ correctly. The results revealed that Japanese L2 learners showed an improvement in speech production. However, they did not show an improvement in perception. These findings demonstrated that training individuals in production does not necessarily affect perception.

Furthermore, previous studies have not revealed how vowel epenthesis is related to other abilities. Phonological descriptions of vowel epenthesis have mostly been in terms of phonotactic constraints (Dupoux et al., 1999; Davidson, 2005, 2006, 2011). For example, Davidson (2011) investigated 42 English, 30 Catalan and 13 Russian speakers to determine how phonemic, phonetic and phonological factors were related to illicit consonant-cluster discrimination abilities. AX discrimination tests were conducted, and the subjects were asked to distinguish words from counterparts containing [ə]. Twenty-seven short and long stimuli were prepared according to four types of consonant clusters: fricative-fricative, fricative-nasal, sonorant-nasal and sonorant-fricative. The results showed that Russian listeners were the most accurate, regardless of conditions and variables, such as consonant combination or length of stimuli. Although other interpretations were suggested based on the results, it is plausible that perceptual epenthesis is highly related to the phonotactic of the first language. However, in terms of the ability of L2 learners, it is not clear whether vowel epenthesis is specifically linked to L2 phonotactics, the ability to learn segmentals (e.g., vowel category) or supra-segmentals (e.g., stress or rhythm). Finally, it is an empirical issue whether vowel epenthesis is related to broader measures, such as how well individuals recognise speech in noise or their overall degree of spoken accent.

The present study investigated Korean L2 speakers with varying degrees of English experience to see whether the frequency of epenthesis production was related to perceptual epenthesis. Moreover, this study used an individual-difference approach to examine whether vowel epenthesis was related more to the perception and production of segments (vowels and consonants) or prosody, or was relatively independent from these processes. Thirty-two subjects completed several perception and production tasks: read target words that are likely to have epenthetic vowels (e.g., *abduction*), read sentences, identify vowels and consonants, recognise word stress and perceive epenthetic vowels.

2.2. Method

2.2.1 Subjects

Thirty-two Korean learners of English completed the experiment. Their age range was 20–30 years (median = 24 years, 5 months). Through questionnaires, they reported they had learned English from the age of 7 to 17 years (median = 11 years, 5 months). Subjects reported that they had lived in English-speaking countries from 2 months to 6 years (median = 10 months). Both length of residence (LOR) and age of learning English (AOL) showed a wide range of variability. Thus, the current study is aware that there are potential problems involved in having participants with large ranges of LOR and AOL. None of the subjects reported having any hearing disorders. Twelve native English speakers also completed the stress deafness and the epenthetic vowel perception tests.

2.2.2 Stimuli and apparatus

A number of production and perception tasks were completed in a quiet recording room. Audio files for the production test were recorded with 16-bit 22,500 samples per second using the RODE - NT1A microphone and Speech Filing System (SFS) program. Headphones were given to subjects for perception tasks.

One female southern British native English speaker (SBE) recorded the following stimuli for the consonant identification test: *aba* /b/, *acha* /ʧ/, *ada* /d/, *aga* /g/, *afa* /f/, *aja* /dʒ/, *aka* /k/, *ala* /l/, *ara* /r/, *ama* /m/, *ana* /n/, *apa* /p/, *asa* /s/, *asha* /ʃ/, *ata* /t/, *ava* /v/ and *aza* /z/. Stimuli for the vowel identification test were taken from a previous study (Iverson & Evans, 2009); a female SBE recorded the following words: *beat* /i/, *bit* /ɪ/, *bet* /e/, *Burt* /ɜ/, *bat* /æ/, *Bart* /ɑ/, *bot* /ɒ/, *but* /ʌ/,*bought* /ɔ/, *boot* /u/, *bait* /eɪ/, *bite* /aɪ/, *bout* / aʊ / and *boat* /əʊ/. Stimuli for the stress deafness test were recorded by three different SBEs with different stress patterns: *contract* /'kɒntrækt/ - /kən'trækt/, *object* /'ɒbdʒekt / - /əb'dʒekt/, *permit* /'pɜmɪt/ - /pə'mɪt/, *rebel* /'rebl/ - /rɪ'bel/, *record* /'rekɔd/ - /rɪ'kɔd/ and *subject* /'sʌbdʒekt/ - /səb'dʒekt/. Stimuli for the epenthetic vowel test were created by extracting eight words (one single word and seven compound words) that had an epenthetic vowel from a pilot version of the production test (i.e., a real example of epenthesis from three Korean speakers): *abduction, egg timer, garage truck, package tour, pig tail*, *punch man, milk tea* and *ridge tile*. Edited versions were created without an epenthesis by removing the epenthetic vowel (e.g., *abduction* ‘ [æb'dʌkʃən]’ vs. *abduction* ‘[æbu'dʌkʃən]’).

2.2.3 Procedure

a) Production test

Thirty-three target words that were likely to have epenthetic vowels were prepared. These words were based on combinations that Kabak and Idsardi (2007) determined were possibly difficult for Korean learners of English. These words included mostly compound words, but a few were single words: *mil**k t**ea*, *co**nt**act lens*, *pun**ch m**an*, *blac**k m**ailbox*, *a**bd**uction*, *sandwi**ch m**aker*, *Wal**km**an*, *fa**ct**ory*, *ve**get**ables*, *wat**chm**aker*, *fi**lt**er*, *garba**ge t**ruck*, *fro**gm**an*, *Scot**chm**an*, *sa**lt***, *Fren**chm**an*, *loun**ge ch**air*, *bo**lt***, *packa**ge t**our*, *lun**cht**ime*, *sandwi**ch m**an*, *pi**g t**ail*, *e**gg t**imer*, *coa**chm**an*, *ma**gm**a*, *oran**ge m**an*, *Dut**chm**an*, *sto**ck m**arket*, *wa**ln**ut*, *ac**tr**esses*, *mil**km**an*, *emban**km**ent station and rid**ge t**ile*. The results of the pilot test showed that Korean learners of English rarely show epenthesis with onset clusters such as [pr-] or [spl-], whereas the coda cluster was a bit difficult for them to read. Thus, this production test designed as difficult consonant sequences and coda clusters was possible. Instead of displaying target words, pictures referring to the target words were presented to subjects to avoid their reading a compound word as two words (see Appendix 3). Before the experiment, a brief explanation of what the picture was referring to was given to the subjects in Korean. Thirty-one BKB sentences such as *A boy fell from the window, She used her spoon, The car hit a wall, The cat caught a mouse, The child drank some milk* were also prepared, and the subjects read the individual sentences on a computer monitor separately. The subjects could pause briefly, if desired, between recording target words and BKB sentences. All subjects repeated the entire procedure twice.

b) Identification of consonants and vowels

Each trial consisted of VCV sequences or CVC words (e.g., /aba/ or /but/). For the consonant identification test, 17 VCV words were repeated four times randomly. There were only three repetitions for the sequences /asa/ due to an error in one of the repetitions. The total number of trials was 67 (16 VCV sequences × 4 repetitions + 3 repetitions of /asa/). For the vowel identification test, 14 CVC words were randomly repeated four times. The total number of trials was 56 (14 words × 4 repetitions). In each trial, the subjects selected the word or sequences they had heard on the computer monitor. Each trial was conducted once, and no feedback was given to the subjects after testing.

c) Stress deafness

During each stress deafness trial, two of the three stimuli had the same stress pattern, and the third had a different stress pattern. The total number of trials was 36 (6 words × 6 repetitions with a different pattern). For each trial, oddity testing was performed in which the subjects were asked to pick the word that had a different stress pattern from the three successive words presented. For example, the word *contract* was spoken by three different speakers (e.g., *contract* /'kɒntrækt/ - *contract* /kən'trækt/- *contract* /'kɒntrækt/), and the subjects were instructed to click either the 'first', 'second' or 'third' button on a computer monitor that corresponded to the word with a different stress pattern. Before the experiment, the subjects completed a short practice. Each trial was conducted once, and no feedback was given to the subjects after testing.

d) Epenthetic vowel perception

During each epenthetic vowel perception trial, two of the three stimuli presented were the same words, and the third word was different (e.g., *abduction* /æb'dʌkʃən/ - *abduction* /æbu'dʌkʃən/ - *abduction* / æb'dʌkʃən/). The total number of trials was 78 (13 words had an epenthetic vowel × 6 repetitions with different patterns). For compound words, such as *egg timer*, *garbage truck*, *package tour* and *pig tail*, more than one Korean L2 speaker inserted an epenthetic vowel into the word; thus, these words were repeated more than the others. For example, only one Korean L2 speaker inserted an epenthetic vowel into the word *abduction*, but three Korean L2 speakers inserted an epenthetic vowel into the term *pig tail*. Consequently, the word *abduction* was repeated with six different patterns, but the term *pig tail* was repeated 18 times (3 speakers × 6 different patterns). For each trial, listeners heard the words and were instructed to click either the 'first', 'second' or 'third' button on a computer monitor, depending on which corresponded to the word that differed from the other two. Before the experiment, the subjects completed a short practice. Each trial was conducted once, and no feedback was given to the subjects after testing.

2.3 Results and discussion

2.3.1 Production and perception results

Figure 2.1 displays the frequency of epenthesis (i.e., amount of times Korean L2 speakers inserted or heard an epenthetic vowel) in production and perception. There was high variability in the frequency of epenthesis among Korean learners of English. Some learners produced epenthesis fewer than 5 times, but other learners produced it more than 20 times (median = 6 times); 33 words and 31 sentences were used for this test. The results of the epenthetic vowel perception test demonstrated that Korean learners of English were correct in 50% to 80% of the trials (median = 70%). Regarding the native English speakers, the percentage of correct responses was between 60% and 90% (median = 80%). The results of a paired *t*-test between native English speakers and Korean learners of English demonstrated that there was a significant difference (t = -2.7912, df = 16.062, $p < .05$), suggesting that Korean L2 speakers had more difficulty detecting an epenthetic vowel than native English speakers. However, despite a significant difference between the groups, there was substantial overlap, suggesting that not all native English speakers were better than the Korean L2 learners.

The results presented in Figure 2.2 show that the production and perception of epenthetic vowels are not linked. There was no significant correlation between production and perception of epenthetic vowels (r = -.280, p > .05), suggesting that production ability may not be linked to perception ability.

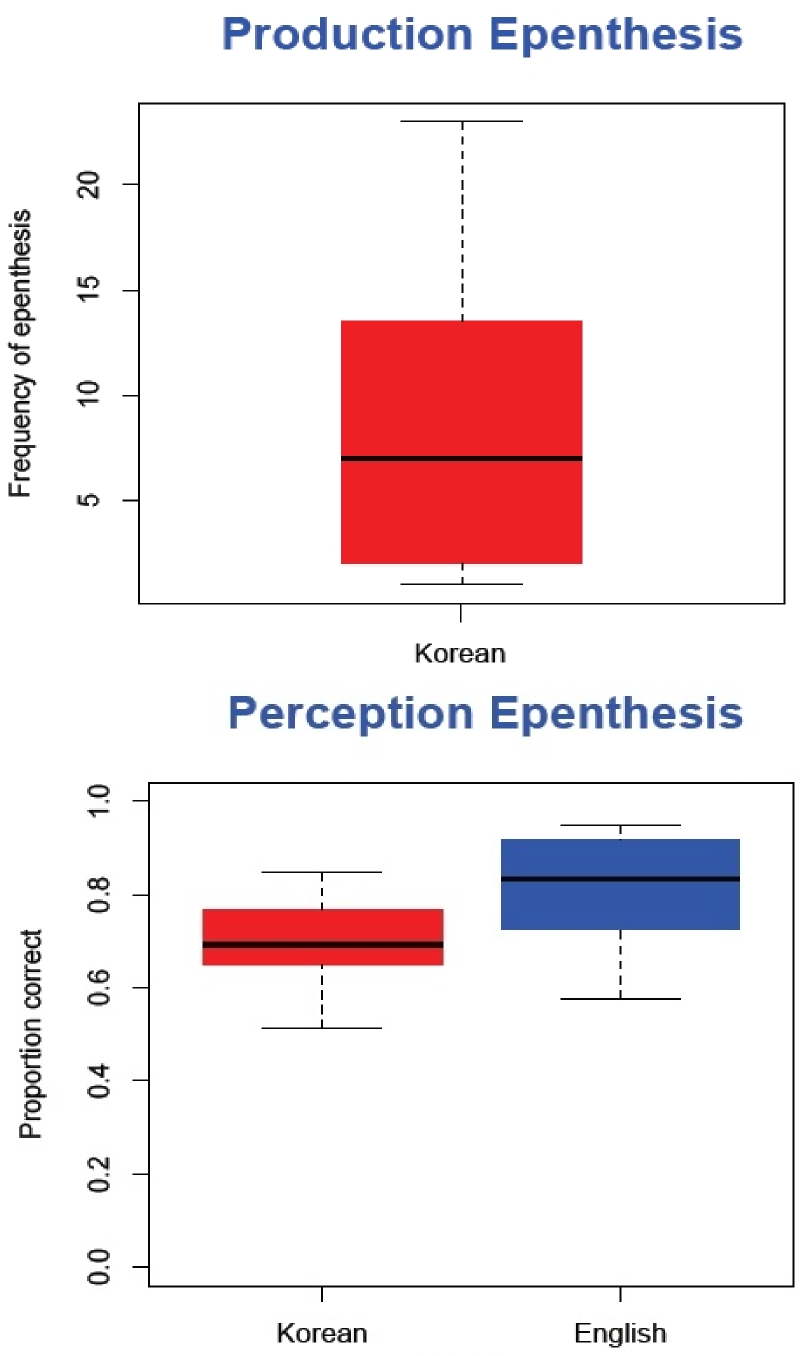


Figure 2.1 The first boxplot presents epenthetic vowel production among Korean L2 speakers, and the second boxplot shows the proportion of correct responses in the epenthetic vowel perception test from native English speakers and Korean learners of English.

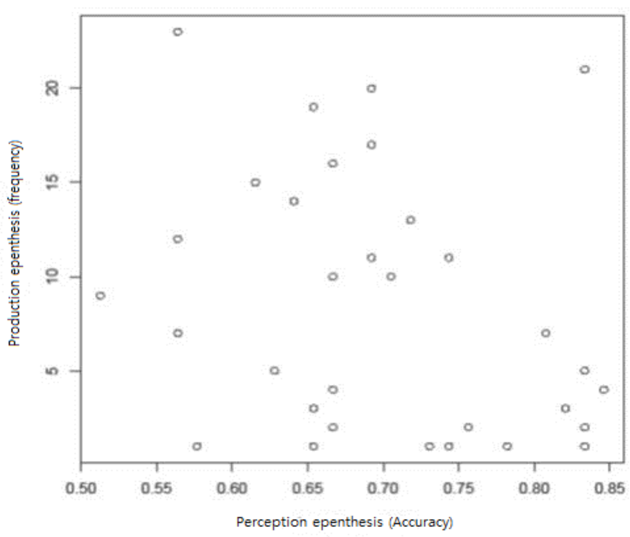


Figure 2.2 The scatter-plot presents the relationship between production and perceptual epenthesis. No significant correlation was found between the two factors.

Figure 2.3 displays the proportion of correct responses for three different perception tests: consonant identification, vowel identification and stress deafness. The results of the consonant identification test show that the proportion of correct responses was between 80% and 95% (median = 85%), suggesting that most of the Korean learners of English correctly identified the given English consonants. However, the results of the vowel identification test indicate that Korean learners of English were correct between 50% and 70% (median = 60%) of the time, demonstrating that this task was more difficult than consonant identification for Korean learners of English. Regarding the stress deafness test, the results show that Korean learners of English varied from 50% to 80% correct (median = 70%). However, the results for the native English speakers show that the percentage of correct responses was between 70% and 100% (median = 90%), suggesting that most of the native English speakers identified the given contrastive stress clearly. A paired *t*-test demonstrated that there was a significant difference between the results for Korean learners of English and those for native English speakers (t = -6.388, df = 27.647, $p < .01$), suggesting that native English speakers were much better than Korean learners of English at identifying contrastive stress.

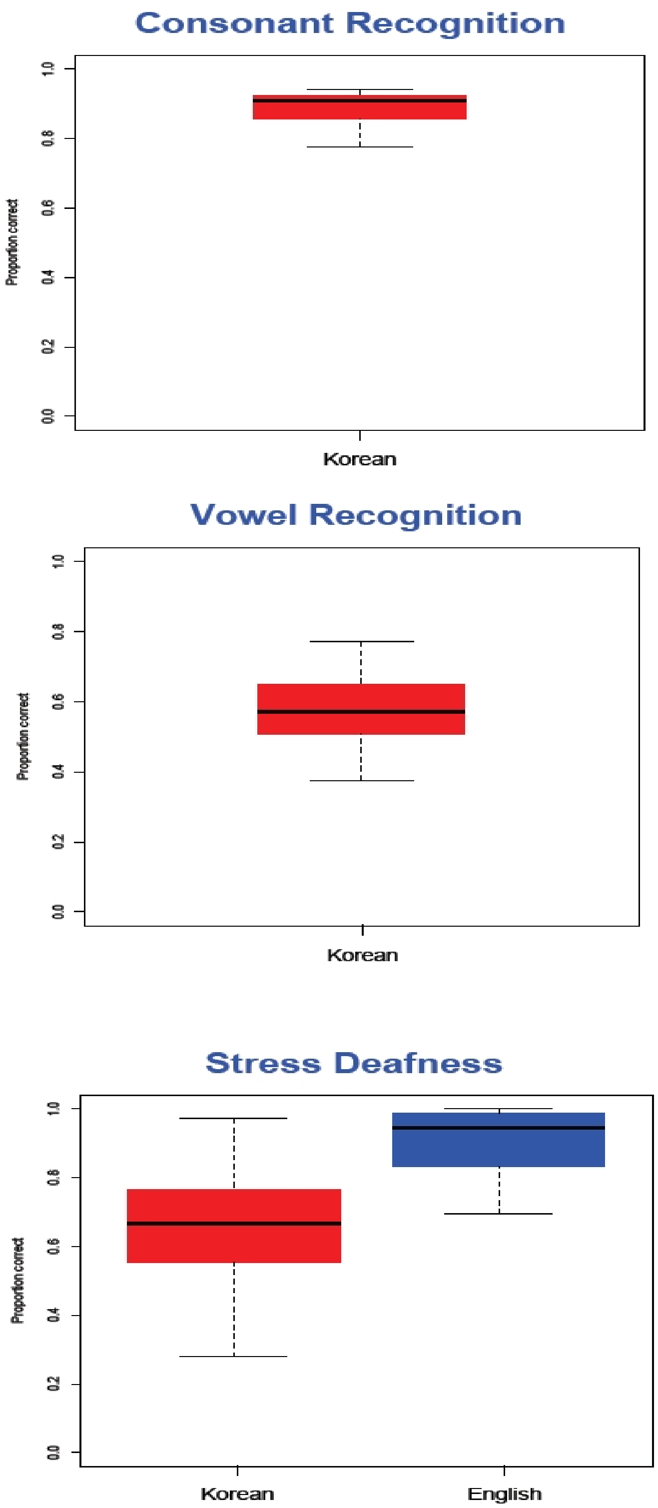
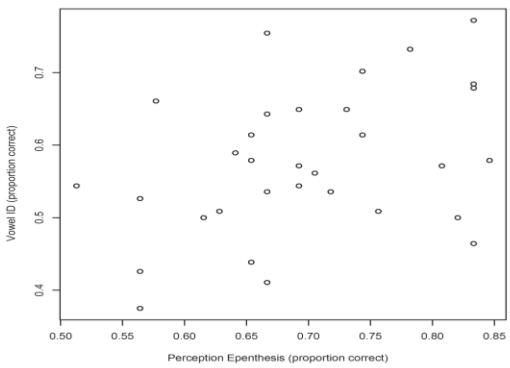


Figure 2.3 Each boxplot presents the results of the consonant recognition, vowel recognition and the recognition of contrastive stress tests, respectively.

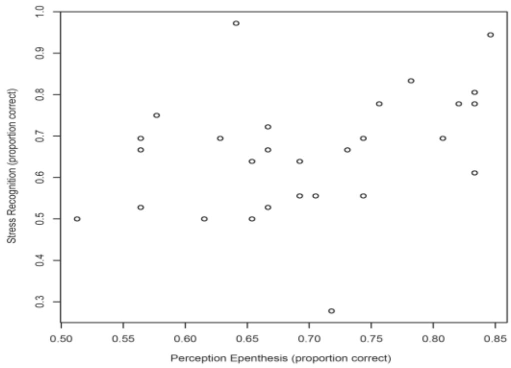
Figure 2.4 displays scatter-plots for selected measures and perception or epenthesis production. Pearson correlation tests were used to investigate the relationships between epenthetic vowel perception and three different measures (i.e., consonant recognition, vowel recognition and the identification of contrastive stress) among Korean individuals. The correlation results between epenthetic vowel perception and consonant recognition demonstrated that they were not significantly correlated with each other (r = .235, $p > .05$). However, epenthetic vowel perception and vowel recognition were significantly correlated, although the correlation was not high (r = .388, $p < .05$). Further, it appeared that epenthetic vowel perception was correlated with vowel recognition ability rather than consonant recognition ability. Moreover, the perception of epenthetic vowels and contrastive stress recognition were significantly correlated (r = .371, $p < .05$), suggesting that the perception of epenthetic vowels was related to contrastive stress perception.

The same correlation tests were conducted to investigate the relationship between epenthetic vowel production and the three measures (i.e., consonant recognition, vowel recognition and the identification of contrastive stress) among Korean individuals. The epenthetic vowel production and consonant recognition showed no significant correlation (r = -.094, $p > .05$). However, epenthetic vowel production and vowel recognition were significantly correlated (r = -.619, $p < .01$). Epenthetic vowel production and contrastive stress recognition had no significant correlation (r = -.312, $p > .05$). Thus, the results demonstrated that epenthetic vowel production was only linked to vowel recognition.

i)



ii)



iii)

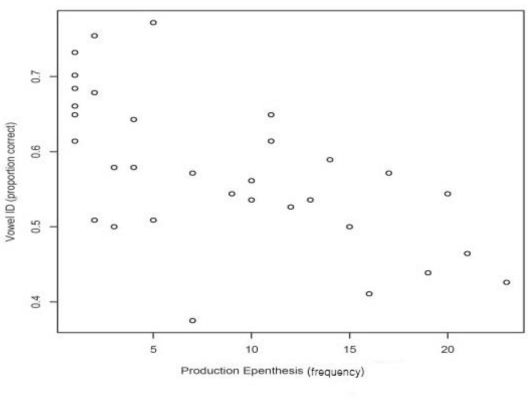


Figure 2.4 The scatter-plots present the relationship between i) vowel recognition and epenthetic vowel perception, ii) contrastive stress recognition and perception of an epenthetic vowel, and iii) vowel recognition and epenthesis production. Figure iii) shows a negative correlation.

2.3.2 Comparisons with spoken accent measures

The accents of Korean L2 speakers were assessed for the 31 spoken BKB sentences. The degree of accent was analysed by three different acoustical measures: speech rate, timing and vowel spectra. All Korean individuals' recordings were automatically annotated and manually corrected. Regarding speech rate, the duration of all consonant and vowel segments (i.e., excluding pauses) were measured from each Korean individual's recordings and summed to give an overall measure of speech rate.

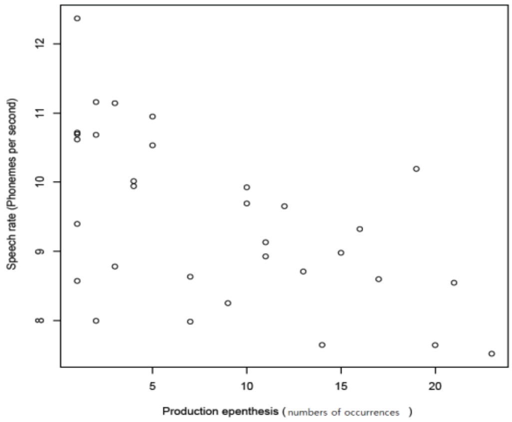
Regarding timing, the durations of consonant and vowel segments were measured from each Korean individual's recordings. Through a sentence-by-sentence comparison, the duration of each consonant and vowel segment was correlated with that of SBEs. This procedure assessed how the duration of each segment spoken by Korean learners of English was correlated with each segment spoken by the native English speakers. Finally, the median of the correlations from each sentence was calculated.

The Accent Characterisation by Comparison of Distances in the Inter-segment Similarity Table (ACCDIST) metric is based on a relative similarity of segment realization (Huckvale, 2004, 2007; Pinet et al., 2010). For example, the words 'after', 'father' and 'cat' were produced by different accents, which are Birmingham and Southeast British. The results show that the distance between 'after' and 'father' was 3.48 and the distance between 'after' and 'cat' was 2.14 in the Birmingham accent, while the distance between the same word pairs was 2.27 and 3.21, respectively, in the Southeast accent. The results can be interpreted that the vowel in 'after' was more similar to the vowel in 'cat' in the Birmingham accent, while the vowel in 'after' was more similar to the vowel in 'father' in the Southeast accent (Huckvale, 2004).

The recordings from Korean learners of English were automatically annotated and corrected manually. The vowel segments were extracted from recordings, and each of them was divided into two equal halves. The feature vectors, known as Mel-frequency cepstral coefficients (MFCCs), were computed, and each half of the vowel segment had 13 MFCC values. Next, the distance between each vowel from the other vowels was calculated, resulting in a large matrix of vowel distances. After completing the measurements, the correlation between the matrix of vowel distances from Korean L2 speakers and the vowel distance matrix from each native English speaker was calculated to discern any similarities.

Figure 2.5 displays the relationships between epenthesis production and three different acoustic measures: speech rate, timing and vowel spectra. The top figure shows the relationship between epenthetic vowel production and speech rate for Korean learners of English. The results demonstrate that speech rate was significantly correlated with epenthetic vowel production (r = -.566, $p < .01$), suggesting that slow speakers produced more epenthetic vowels. Despite significant correlations, some Korean speakers produced fewer epenthetic vowels, even if their speech rate was not fast. These results could be interpreted to mean that some Korean individuals' speech rates were slow because they read the target words and the BKB sentences carefully, rather than because they had low experience. The next figure shows the relationship between epenthetic vowel production and segment duration. The results show no significant correlation between these factors (r = .159, $p > .05$). The bottom figure shows the relationship between epenthetic vowel production and vowel spectra. These factors were significantly correlated (r = -.508, $p < .01$), suggesting that Korean L2 speakers who produced fewer epenthetic vowels had similar vowel spectra to native English speakers.

i)



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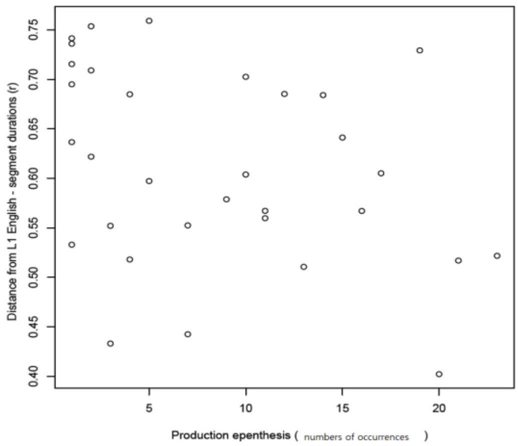


iii)

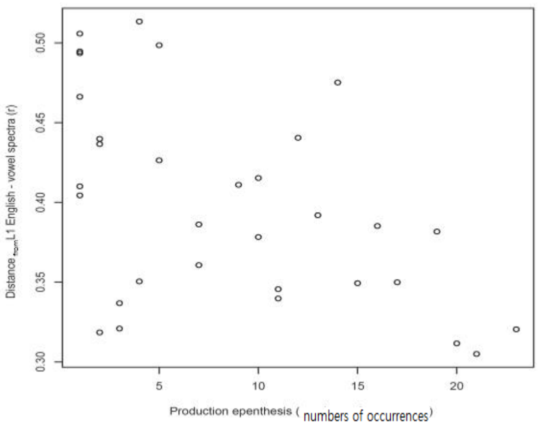


Figure 2.5 The scatter-plots present the correlation results among epenthetic vowel production and three different acoustical factors: i) speech rate, ii) timing and iii) vowel spectra, respectively. Figure iii) shows a negative correlation.

The three acoustic factors of speech rate, timing and vowel spectra were also compared with epenthetic vowel perception. Perceptual epenthesis and speech rate had no significant correlation (r = .186, p > .05). Perceptual epenthesis and syllable timing were also not significantly correlated (r = .159, p > .05). The correlation results found between epenthesis perception and vowel spectra also had no significant correlation (r = .193 p > .05). These results demonstrate that none of the acoustical measures was significantly related to perceptual epenthesis.

2.4 Discussion

The results demonstrate three main findings. First, the results confirm the previous studies' findings that Korean learners of English have problems with vowel epenthesis, with native English speakers being more accurate than Korean L2 speakers. Second, epenthesis in production and perception are not significantly correlated within Korean individuals. These individuals show a large variability in vowel epenthesis in both production and perception, and production and perception abilities were unrelated. Finally, compared with other measures, vowel epenthesis correlates only with vowel production and perception. However, the results show that the amount of epenthesis is related to vowel production and perception abilities, suggesting that vowel recognition abilities affect production and perceptual epenthesis.

The lack of correlation between epenthetic vowel production and perception is surprising. If epenthesis arises from abstract levels, such as in Dupoux et al.'s (1999) study, vowel epenthesis would be heavily related to phonotactic constraints. However, the present study shows that vowel epenthesis is related to the vowel segmental ability rather than phonotactic ability. This distinction could be explained by Kabak and Idsardi's (2003) claim that difficulties with phonotactic constraints are realised and repaired by L2 speakers differently during speech production and perception. Although the present study investigated vowel epenthesis only, it was, nonetheless, expected that people differ in the types of perceptual and production repairs they make, and this finding could interfere with this correlation. Therefore, Korean individuals have problems with phonotactic constraints, but each Korean individual might have a different means for repairing either epenthetic vowel production or perception, which distorts the correlation between speech production and perception.

In general, previous research has frequently revealed that speech production and perception are not always related to each other (e.g., Goto, 1971; Shelton & Johnson, 1977; Sheldon & Strange, 1982; Borden et al., 1983; Flege & Eefting, 1987; Flege, 1993; Nasir & Ostry, 2009; Hattori & Iverson, submitted). For example, Hattori and Iverson (submitted) reported that an improvement of speech production did not affect speech perception among L2 speakers. Nasir and Ostry (2009) demonstrated that speech production and perception were weakly associated. Sheldon and Strange (1982) revealed evidence that speech production could precede speech perception and suggested that speech production and perception were not closely linked. Furthermore, regarding individual differences, they showed that abilities in speech production and perception were different. The present study supported the view that speech production and perception were generally independent processes.

The present results show that vowel epenthesis is most strongly correlated with vowel production and perception. It could be argued that, although vowel epenthesis is moderately related to supra-segmental factors, such as contrastive stress recognition and speech rate, vowel epenthesis is highly related to vowel segment abilities rather than other supra-segmental abilities. Therefore, it could further be argued that vowel epenthesis occurs because of a lack of development in vowel systems.

Although it has been suggested that vowel epenthesis is related to vowel systems, it is plausible that some correlations arise because they are linked to overall English experience. For example, according to the results of the consonant identification test, most of the Korean individuals correctly identified the given English consonants. This signifies that this task was too easy for them and, thus, is not a proper indicator for the examination of overall English experience. However, the results of the vowel recognition test show a significant variability among Korean individuals; thus, it could be argued that vowel ability might be a better indicator for overall English experience. Therefore, the correlations between vowel epenthesis and vowel recognition could be interpreted to mean that vowel epenthesis is highly related to overall English experience. Furthermore, some correlations between vowel epenthesis and certain supra-segmental factors could be explained because contrastive stress recognition ability and speech rate may measure overall English experience.

If vowel epenthesis is related to overall English abilities, the claim that vowel epenthesis is caused by phonotactics could be explained. That is, phonotactic problems could play a greater role when overall experience is low. L1 phonotactics may indeed cause epenthesis, but it only causes a problem when individuals are having trouble with other aspects of speech perception and production.

Some previous research has claimed that there are environmental factors involved in the learning process (i.e., length of time learning English and length of time living in an English-speaking country), and these factors might have affected the present results. Specifically, these factors might affect overall English experience or the relationship between production and perception. For example, Sheldon (1985) reanalysed the results of Borden et al. (1983) and revealed that the link between speech production and perception was related to the length of time living in the United States. It would be worth investigating these environmental factors in further research for precise measurements.

The present results suggest some directions for further research. First, the causal links underlying the correlations could be investigated. Specifically, because the link between vowel recognition and epenthetic vowel production was strong, this result could be used to test whether training vowel recognition affects epenthetic vowel production and perception. For example, Korean L2 speakers could be divided into two groups, and each Korean individual in group one would be trained only on the perception of English vowels to determine how training vowel recognition affects epenthetic vowel production and perception. Then, the Korean individuals in the second group could be trained with other linked abilities, such as contrastive stress recognition or speech rate, to determine how these factors affect epenthetic vowel production and perception. If these abilities are linked to each other, then a major improvement might be seen. For example, because vowel recognition is highly linked with epenthetic vowel production, it could be expected that training vowel-recognition ability would lead to less epenthetic vowel production.

Second, environmental factors that affect vowel epenthesis could be investigated. For example, the relationship between length of time living in an English-speaking country with vowel recognition, contrastive stress recognition and speech rate could be investigated. Because the present study revealed that vowel recognition was linked to overall English experience, the accuracy of vowel recognition would be different according to the length of time living in an English-speaking country. Moreover, other supra-segmental factors, such as contrastive stress recognition or speech rate, could also vary in terms of the length of time living in an English-speaking country.

In summary, this study investigated whether Korean L2 speakers exhibited problems with vowel epenthesis. Through an individual approach using different segmental and supra-segmental measures, it was shown that Korean individuals have problems with vowel epenthesis, and it was related to vowel production and perception. The surprising finding was that speech production and perception were unrelated, which confirmed previous results suggesting a lack of association between speech production and perception in L2 speakers.

Chapter 3: Training Korean L2 speakers on English vowels and prosody

3.1 Introduction

Adult second-language speakers face many problems learning English segments and prosody. For example, Korean L2 speakers have difficulties with learning the English vowel system. They have to learn additional vowel categories for English (e.g., Han, 1999) because Korean only has eight vowels. Korean language learners also have problems with the English tense - lax vowel distinction (Lee, 2009; Lee & Lee, 2011; Cho & Jeong, 2013). Korean learners of English sometimes produce an epenthetic vowel when producing or perceiving English consonant clusters (e.g., Kabak & Idsardi, 2003) or illegal consonants in coda position in Korean (Kang, 2003). Furthermore, their rhythm and stress patterns differ from those of native English speakers (e.g., Jang, 2009). Thus, they sometimes have a more monotonous F0 pattern (Hong, 2010) and lack vowel reduction in unstressed syllables (Han, 1999).

Korean L2 speakers also have problems when perceiving and producing English prosody because the Korean language does not have contrastive stress or focus patterns. Previous studies have investigated the cause of these difficulties in prosody and demonstrated that it may stem from a dearth of variable word-stress or fixed-stress patterns in the L2 speakers' first language (Dupoux et al., 2001, 2008; Peperkamp et al., 2010). For example, Dupoux et al. (2001) found that French speakers showed difficulty in identifying contrastive stress. They studied L2 Spanish and French speakers to see whether they had difficulties in stress recognition. For stimuli, they created two types of minimal pairs: segmental contrast (e.g., 'tu**k**u /'tuku/' vs. 'tu**p**u /'tupu/') and contrastive stress patterns (e.g., 'p**i**ki /'piki/' vs.

‘piki /pi'ki/’). All minimal pairs were nonsense words in both French and Spanish. The results showed that French speakers had more problems than the Spanish with stress.

Previous studies have shown that segmental perception of a second language was improved by auditory training when using high-variability designs. Participants were exposed to phonetic contrasts produced by multiple talkers and in multiple word contexts (e.g., Logan et al., 1991; Lively et al., 1993). The auditory training improved their perception of English consonants (e.g., Logan et al., 1991; Lively et al., 1993; Bradlow et al., 1997; Iverson et al., 2005). For example, Bradlow et al. (1997) examined 11 Japanese L2 speakers to see whether perceptual training on /r/ and /l/ affects /r/ and /l/ production abilities. The subjects completed 45 sessions, identifying 68 English /r/ and /l/ contrast minimal pairs. The results of the perception test showed that significant improvement was found with training, suggesting that their perceptual /r/ and /l/ identification abilities were improved. The results of the production test also showed that trained subjects performed better than untrained subjects. They demonstrated that the Japanese subjects improved in both their production and perception abilities after training, suggesting that auditory training impacted production improvement.

High-variability training designs have also been effective in terms of training vowel categories (e.g., Hirata, 2004; Lambacher et al., 2005; Nishi & Kewley-Port, 2007; Iverson & Evans, 2009; Iverson et al., 2011) and tone contrasts (e.g., Wang et al., 1999). For example, Lambacher (2005) trained Japanese L2 speakers on low and mid vowels in American English and found that the Japanese speakers improved both their production and perception of English vowels. Iverson & Evans (2009) found similar results concerning auditory training and improved vowel identification abilities in a study using Spanish and German speakers. Seventeen Spanish and 16 German speakers completed five sessions of high-variability phonetic training in vowel identification over 225 trials. The results showed that both groups improved, although the Spanish speakers showed relatively modest improvement, whereas the German speakers improved significantly. The researchers concluded that a larger vowel inventory facilitated the learning of new vowel categories.

L2 prosody training tends to focus on improving production rather than perception. For example, subjects receive feedback from native English speakers, as well as visual displays of their pitch (e.g., de Bot, 1983; Hardison, 2004, 2005) to improve their production. Furthermore, previous studies on Korean L2 speakers were inclined to reveal the differences between their production abilities and those of native English speakers (Park, 1980; Moon, 1991; Ryu, 1996; Yom, 2003, 2004; Chang & Kim, 2006; Lee & Lee, 2011). For example, Lee and Lee (2011) compared the acoustic characteristics of Korean L2 speakers with the characteristics of native English speakers and found that Korean learners of English produced lower F0, intensity and shorter duration than native English speakers. Beyond these production teaching methods (Ko, 1997; Han, 1999; Yoon et al., 2010a, 2010b, Yoon, 2011), high-variability phonetic training has not been examined sufficiently for prosody.

The present study used the high-variability phonetic training approach to improve the perception of sentence focus and lexical stress in Korean L2 speakers. Disyllabic words with stress patterns that determine whether they were verbs or nouns (e.g., *PREsent* vs. *preSENT*) were selected for training. Sentences with an analogous contrast between emphasis on a word near the beginning versus near the end of a sentence were also used for the training (e.g., *CHILDREN like strawberries* vs. *children like STRAWBERRIES*). Typically, high-variability phonetic training involves only identification with feedback. However, the present study combined an identification task (e.g., *was the stress on the first or second syllable?*) with a discrimination task (e.g., *listen to three sentences and choose the one that has a different focus*) because even native (L1) speakers have difficulty with explicit judgements of stress or focus. Thus, the present study aimed to comprehensively improve the ability of the listeners to hear the differences between sound patterns that relate to stress and focus, rather than only training explicit identification.

Additionally, the present study explored how focus-stress training could be combined with high-variability training for English vowels. Combining training techniques is particularly important because English learners have problems with various aspects of their L2. The combination is also important for evaluating the specificity of training effects. So far, an amazing degree of uniformity with high-variability phonetic training has been shown, with similar amounts of improvement found with different stimuli (e.g., Iverson et al., 2005) and training modality (Hazan et al., 2005). Examining whether two types of high-variability training enhanced different aspects of speech perception was done to determine whether these tasks provided an overall improvement in each subject, related to the task on overall abilities to cope with naturally variable speech, or whether each training method improved a more specific set of abilities.

A comparison of before and after test results revealed how the different aspects of speech perception and production are linked. For example, Korean learners of English often perceive epenthesis, hearing vowels within consonant clusters, even when little evidence exists in the acoustic signal for a vowel, at least to L1 listeners (e.g., Dupoux et al., 1999, 2011). Vowel epenthesis production and perception is a common problem for Korean L2 speakers (e.g., Han, 1999; Lee, 2000; Tak, 2000; Kang, 2003; Kim & Kochetov, 2011; Ahn, 2012), with native English speakers being more accurate than Korean L2 speakers in detecting epenthetic vowels (Ahn, 2012). Chapter 2 demonstrated that vowel epenthesis was related to segmental and supra-segmental abilities. The present study extended this investigation, examining whether production and perception epenthesis were affected by vowel and focus-stress training. This examination helped to reveal whether vowel epenthesis was purely a result of phonotactics (i.e., unaffected by training on vowels or segments) or affected by the processing of L2 segments or prosody.

Thirty-six Korean L2 speakers completed several production and perception tasks: focus and stress recognition, vowel identification, epenthetic vowel perception, speech-in-noise recognition and sentence production. All Korean subjects completed both vowel and focus-stress training, with the first half starting with focus-stress training and the other half beginning with vowel training. The goals of this study are to examine whether this approach to focus-stress training was effective, how it could be combined with vowel training, and how the two types of training might modulate the results of various pre- and post-tests.

3.2. Method

3.2.1 Subjects

Thirty-six Korean learners of English completed the experiment. Their ages ranged from 20 to 41 years (median = 25.5 years). Subjects reported that they had lived in an English-speaking country for 2 months to more than 10 years (median = 10 months). They reported that they started learning English from the age of 11 to 30 years old (median = 15 years old). None of the subjects reported any hearing disorders. Half of the subjects started with the focus-stress training, and the other half began with the vowel training. The subjects, who come from different Korean dialect backgrounds, have a wide range of English fluency. Five subjects who took part in Study 1 participated in this study.

3.2.2 Stimuli

a) Focus-stress training and pre/post-test

Three female and four male SBEs recorded stimuli for both focus-stress training and tests. For the stress recognition test and training, 68 pairs of English disyllabic words were used that could be spoken with contrastive stress patterns. Fifty-eight word pairs were selected from the English dictionary, and 10 pairs of words with phonemically contrastive stress were chosen from Cutler (1986): *DIScount/disCOUNT*, *FORbear/forBEAR*, *FOREarm/foreARM*, *GOATy/goatEE*, *IMpress/imPRESS*, *INsight/inCITE*, *RElay/reLAY*, *REtail/reTAIL*, *TRUSty/trustEE and UNderground/ underGROUND*. Although the list include some low-frequency words, the word pairs show stress shift without vowel reduction to confuse the nature of the contrast but are semantically unrelated to each other. Additionally, the study needed as many words as possible that were distinguished by their stress pattern. However, the familiarity with the test items (lexical bias) could affect the results. For example, words such as *FORbear/forBEAR* are not commonly used in a conversation, whereas words like *DIScount/disCOUNT* are frequently used. So, lexical bias could produce the realisation of stress. Fifty-eight word pairs having the same orthography in verb and noun (i.e., contract, permit) were chosen from the English dictionary. Speakers were asked to stress the syllables according to the grammatical form (verb or noun) of the given words. For example, speakers were asked to stress the first syllable if the target word was a noun and the second syllable if the word was a verb (e.g., *compact* /ˈkɒmpækt/ vs. *compact* /kəmˈpækt/). Next, a trained phonetician manually checked each word and selected the most clear and unambiguous words for the lexical stress test and training. Each target word was randomly displayed on a computer monitor separately to avoid list intonation. Subjects could move to the next word by pressing a button on the keyboard. All subjects recorded the target words twice.

Sixty-one BKB sentences (see Appendix 2) were used to create the stimuli for the focus recognition test and training. Each BKB sentence had a question designed to elicit stress on the initial and final words of the target sentence. For example, BKB sentences such as, 'The house had nine rooms' had two questions such as, 'What has nine rooms?', intending to highlight the word *house* and 'What did the house have?', with a focus on the last word *rooms*. The questions and answers were randomly displayed on the computer monitor, and SBE speakers were only asked to read the answer in relation to the question. After the recording sessions, a trained phonetician will check each sentence and manually picked the best BKB sentences that expressed the most distinctive and clear patterns for the focus-stress test and training. Of the seven SBE speakers, recordings from one female and one male speaker were used for the focus-stress recognition test, and recordings from the five other speakers were used for the focus-stress training.

Stimuli for the stress recognition test were composed of 952 words (68 pairs * 2 type of pattern * 7 speakers) and 854 sentences (61 BKB sentences * 2 type of pattern * 7 speakers), and were crafted for focus recognition test and training. A hundred and eight stimuli were used for focus- stress recognition test and the rest of the stimuli were used for training.

b) Epenthetic vowel perception pre-/post-test

The stimuli for the epenthetic vowel perception test were four nonsense words that had an epenthetic vowel within a consonant sequence: [patʃ(i)ma], [patʃ(i)ta], [paʤ(i)ta] and [paʤ(i)ma]. These nonsense words were selected from the Kabak and Idsardi's (2007) study, which had no meaning in both Korean and English. The stimuli were recorded by a phonetically trained native Korean speaker. After repeating the words several times, each word was auditorily checked by a phonetically trained Korean listener, and the most suitable words were chosen. Edited versions were created by removing the epenthetic vowel (e.g., 'pacma – [patʃ(i)ma]' vs. 'pacma – [patʃ(i)ma]').

c) Vowel identification training and pre-/post-test

The stimuli for training were taken from a previous study (Iverson & Evans, 2009). The stimuli for the trainer were recorded by two male and three female SBEs, who had been asked to record 14 British English vowels divided into four groups: /ɛ/, /ɑ/, /æ/ and /ʌ/ (e.g., pet, part, pat and putt); /i/, /ɪ/, /aɪ/ and /eɪ/ (e.g., feel, fill, file and fail); /ɒ/, /əʊ/ and /ɔ/ (e.g., was, woes and wars); and /u/, /aʊ/ /ɜ/ (e.g., shoot, shout and shirt). The stimuli for the test were recorded by one female SBE: *beat* /i/, *bit* /ɪ/, *bet* /ɛ/, *Burt* /ɜ/, *bat* /æ/, *Bart* /ɑ/, *bot* /ɒ/, *but* /ʌ/,*bought* /ɔ/, *boot* /u/, *bait* /eɪ/, *bite* /aɪ/, *bout* /aʊ/ and *boat* /əʊ/.

d) Speech-in-noise recognition pre-/post-test

The stimuli for the speech-in-noise recognition test were taken from a previous study (Pinet et al., 2010). One male and one female SBE and one male and one female Korean L2 speakers recorded 56 BKB sentences. The recordings were embedded in speech-shaped noise, which was created for each speaker based on the smoothed long-term average spectrum of their recordings, with SNRs of -9, -6, -3, 0 and +3 dB. There were six noise blocks of 56 stimuli.

3.2.3 Apparatus

The pre-, mid- and final tests were conducted in a quiet recording room. All the Korean subjects completed a test before they were trained, and all the stimuli were played over the headphones. The audio files for the production test were recorded at 16-bit 22,500 samples/s using a RODE – NT1A microphone and SFS program. The stimuli for speech-in-noise recognition were recorded at a 44,100 sampling rate. All the training was conducted on each subject's laptop which they were requested to bring when they came for the pre-test.

The vowel and focus-stress trainings were installed on the laptops. Both training programs were protected by a password so that the trainee could not access the log file or the control panel.

3.2.4 Tasks for the pre-, mid- and final tests

a) Production

Sixty-one BKB sentences with different types of questions were prepared, and the subjects were asked to read the sentences in relation to the given question. Each question and BKB sentence was displayed on the computer monitor separately. Before the experiment, all the subjects were briefed on what to expect and were given the opportunity to clarify on any issue. They could pause for a short while any time they want during the test, and there were no time limits. All the subjects completed the entire procedure in their first attempt.

b) Vowel identification

For each trial, /b/-V -/t/ words were played over headphones, and 14 CVC words were randomly repeated four times. The total number of trials was 56 (14 words × 4 repetitions). The subjects were instructed to choose the word they heard from options displayed on the computer monitor. They were asked to complete the procedure once, and no feedback was given. The mid-test was conducted a week after pre-test, and the final test was done a week after the mid –test (7 days interval).

c) Epenthetic vowel perception

Each epenthetic vowel perception test consisted of nonwords with an epenthetic vowel (e.g., [patʃima], [patʃita], [padʒita] and [padʒima]) and edited versions with the epenthesis removed. For each trial, subjects heard three speech recordings and had to choose the one that sounded different. For example, if they heard the following three stimuli in a row, [patʃma] – [patʃima] – [patʃma], the correct response would be the middle word because it still contains the epenthesis. There were 24 experimental trials (four nonwords, three orders, and either the presence or absence of epenthesis investigated which stimulus was different).

All trials were conducted once, and no feedback was given. The mid-test was conducted a week after pre-test and the final test was done a week after the mid –test (7 days interval).

d) Speech-in-noise recognition

The subjects heard recordings with different levels of noise and were asked to verbally repeat what they heard. The experimenter logged the number of content words that were correctly identified by clicking numbers on the computer monitor. Each stimulus was randomly presented once, and no feedback was given. There were two blocks in this test series (Southern British English Native speakers and Korean L2 speakers) and each block consisted of 56 experiment trials. The mid test was conducted a week after the pre-test and the final test was done a week after the mid –test (7 days interval).

3.2.5 Procedure for training

a) Focus-stress training

The training in each session encompassed 50 oddity test trials and 40 identification test trials for both stress and focus. For the oddity tests, the subjects heard three recordings each and had to pick the recording with a different focus or stress pattern. If they chose the right answer, a cash register sound was played and the next recording was presented. If the answer is wrong, the right answer was automatically repeated once and the next recording was presented. For the identification tests, the subjects listened to a stimulus and chose between images labelled '1' or '2' on the screen, depending on the focus or stress patterns. For example, if a subject heard '*compact* - /ˈkɒmpækt/', they had to click the '1' displayed on the screen. There were five sessions of training composed of 180 trials. The subjects were asked to complete no more than one session per day. The focus-stress training took approximately one hour, and as most of the subjects completed the five sessions within a week, the training interval was 1 to 2 days.

b) Vowel training

The same vowel training used in Iverson and Evans' (2009) study was used in the present study. Two male and three female SBEs recorded English words that contained 14 British English vowels divided into four groups: /ɛ/, /ɑ/, /a/ and /ʌ/ (e.g., pet, part, pat and putt); /i/, /ɪ/, /aɪ/ and /eɪ/ (e.g., feel, fill, file and fail); /ɒ/, /əʊ/ and /ɔ/ (e.g., was, woes and wars); and /u/, /aʊ/ /ɜ/ (e.g., shoot, shout and shirt). There were five sessions composed of 225 trials. The subjects listened to a real English recording and were then required to choose the word they heard on a computer monitor. If they chose the right answer, a cash register sound was played. If not, the trainer automatically repeated the right answer, and the next recording was presented. The vowel training took approximately 90 minutes, and as most of the subjects completed the five sessions within a week, the training interval was 1 to 2 days.

3.3 Results

3.3.1 Perception tests

A logistic mixed-model analysis examined each acoustic measure with block (pre-, mid-, or final) and the trainer order as fixed factors. The subjects and trials were random factors. Each analysis was evaluated by using the ANOVA function of the Companion to Applied Regression package in R.

The results showed that focus-stress training was more effective than vowel training in terms of improving focus and stress recognition. Figure 3.1 shows the results of the focus recognition test. After the focus-stress training, the subjects showed a greater improvement compared to the subjects after the vowel training. The statistical analyses showed that there was a main effect of block ($c^2[2] = 47.17$, $p < .001$), suggesting that subjects improved after training. A significant interaction was found with order ($c^2[2] = 8.12$, $p = .017$), suggesting that the focus-stress and vowel trainings worked in different ways. Post-hoc tests showed that the focus-stress training improved focus recognition ability significantly, but vowel training did not ($p > .05$).

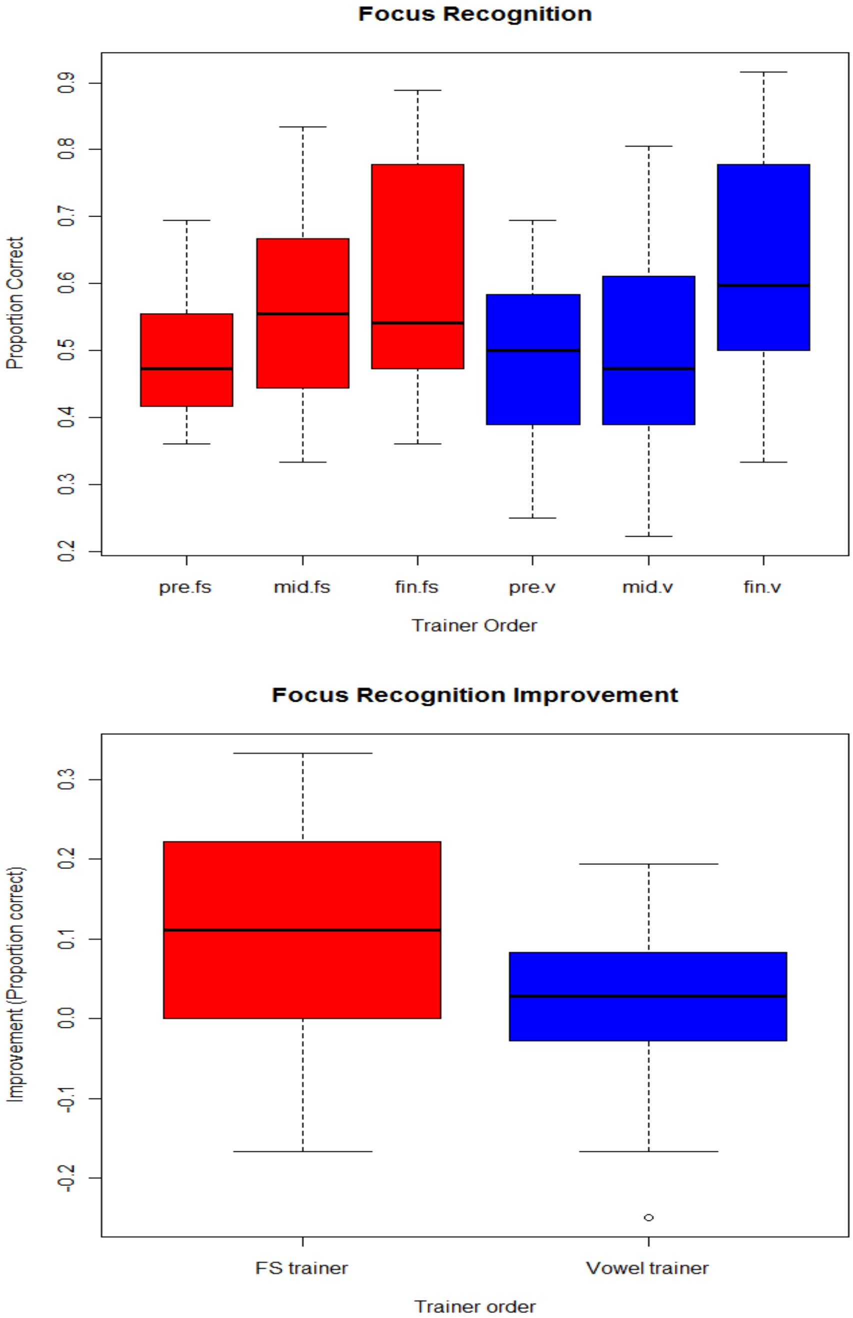


Figure 3.1 Proportion of correct of focus identification and improvement of focus recognition abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with a circle.

Focus-stress training was also effective in terms of improving stress recognition abilities, but there was an overlap between the two training techniques. Figure 3.2 displays the results of the stress recognition test. There was a large improvement after the focus-stress training. However, the subjects after the vowel training exhibited less than 10% improvement. The statistical analyses showed that there was a main effect of block ($c^2[2] = 131.27$, $p < .001$), suggesting an overall training effect. A significant interaction was found with trainer order ($c^2[2] = 6.60$, $p = 0.037$). Post-hoc tests showed that both training methods significantly improved stress recognition ($p < .05$), although the focus-stress training was slightly better than the vowel training.

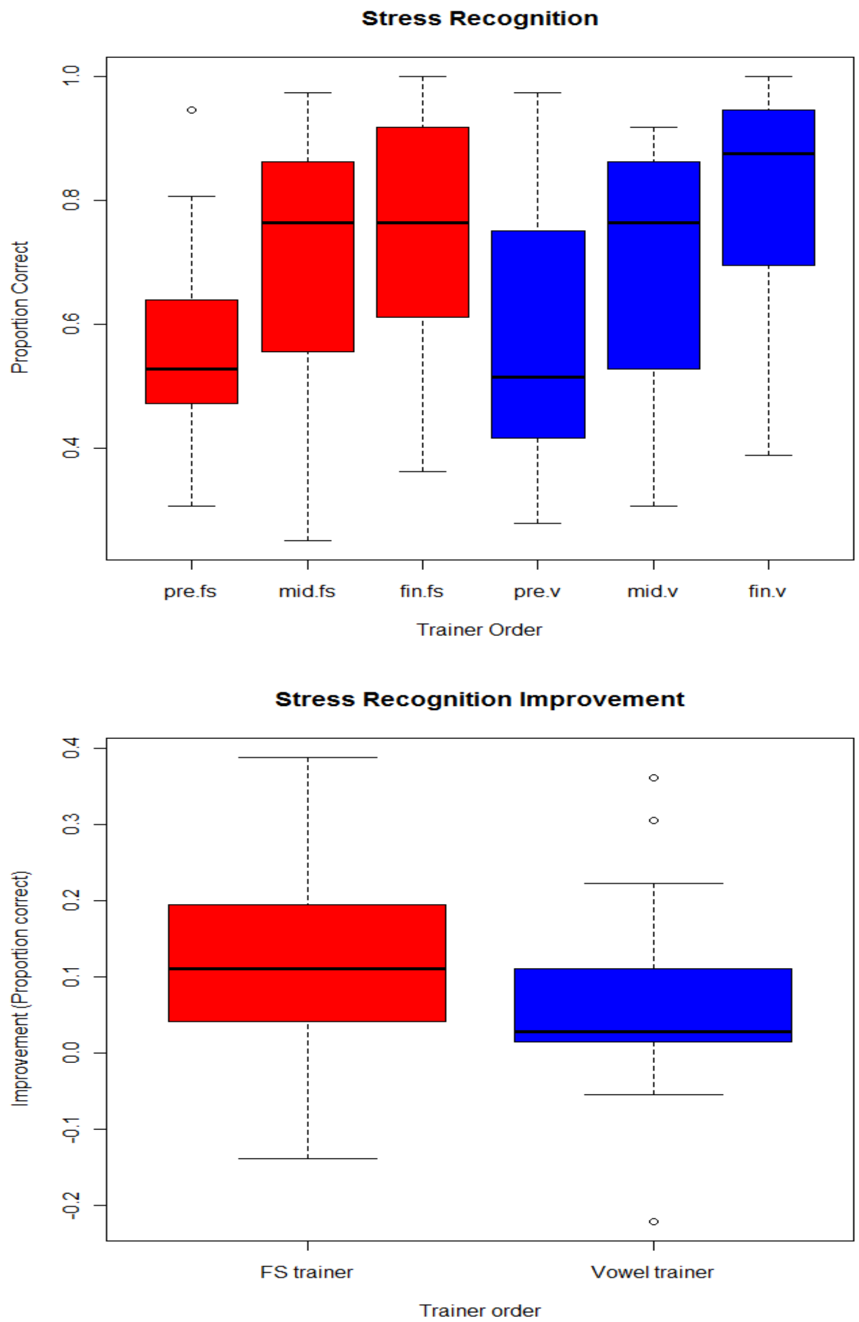


Figure 3.2 Proportion of correct stress recognition and improvement of stress recognition abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with a circle.

Although focus-stress training was effective in terms of prosody improvement, the vowel training was more effective with respect to vowel abilities. Figure 3.3 shows the results of the vowel identification test for perception. The subjects after the vowel training showed a greater improvement compared to the subjects after focus-stress training, showing about 20% improvement. The statistical tests showed that there was a main effect of block ($c^2[2] = 117.87$, $p < .001$). A significant interaction was found with trainer order ($c^2[2] = 16.10$, $p < .001$). Post-hoc tests showed that the vowel training produced significant improvements, but the same result was not seen with the focus-stress training ($p > .05$), suggesting that vowel training worked better than focus-stress training in improving vowel identification abilities.

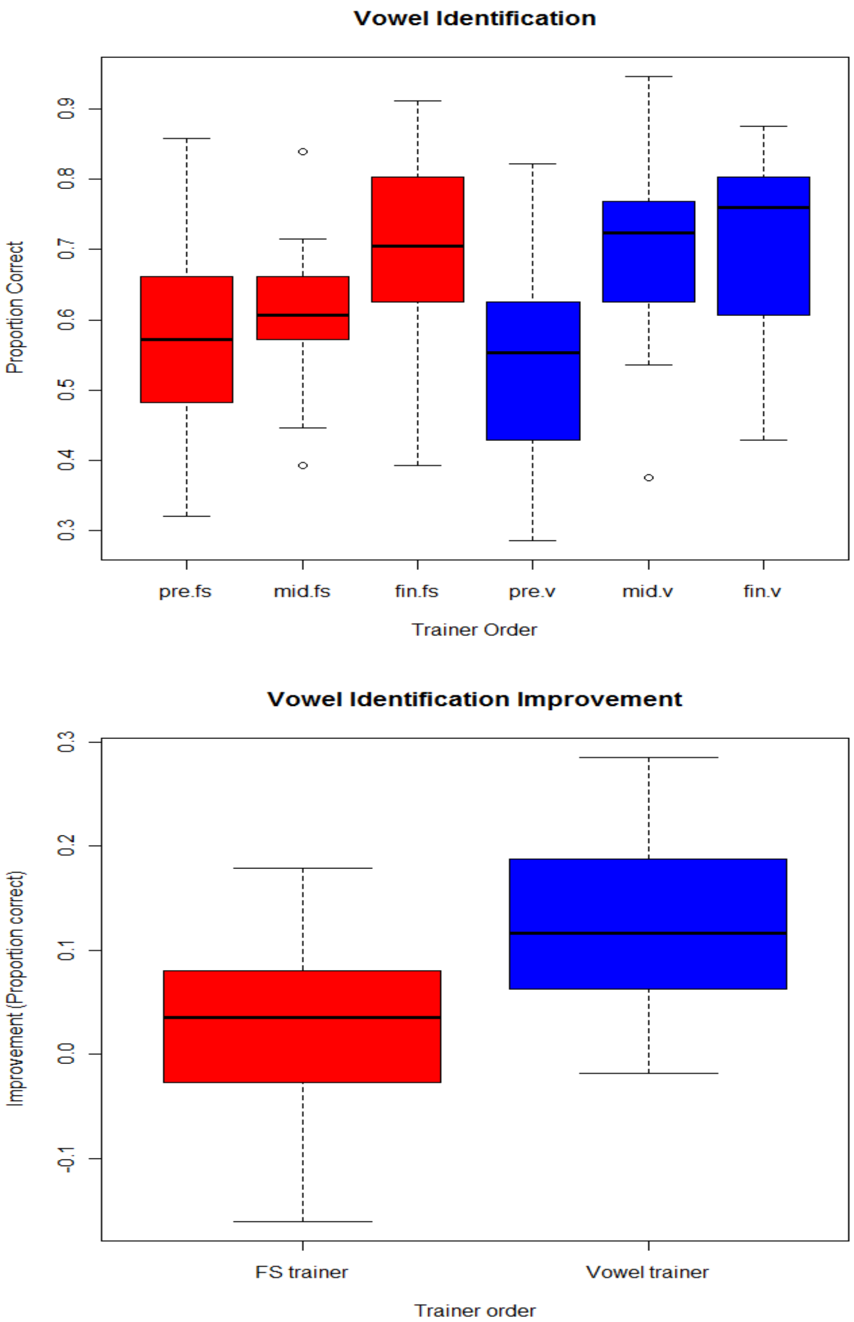


Figure 3.3 Proportion of correct vowel identification and improvement of vowel identification abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

The results of the focus, stress and vowel recognition tests showed that the training seemed to have different effects, despite some overlaps. However, the results of the epenthesis training showed that both training methods were effective in reducing errors in the perception of vowel epenthesis. Figure 3.4 displays the proportion of correct vowel epenthesis during the perception test. Both the subjects who started with the focus-stress training and those who had vowel training exhibited similar improvements. The statistical tests showed that there was a main effect of block ($c^2[2] = 49.28$, $p < .001$), suggesting that the subjects improved after training. However, no significant interaction was found with order ($p > .05$), suggesting there was no difference between the training methods. Thus, it is plausible that perception of epenthesis is related to both segmental and supra-segmental abilities.

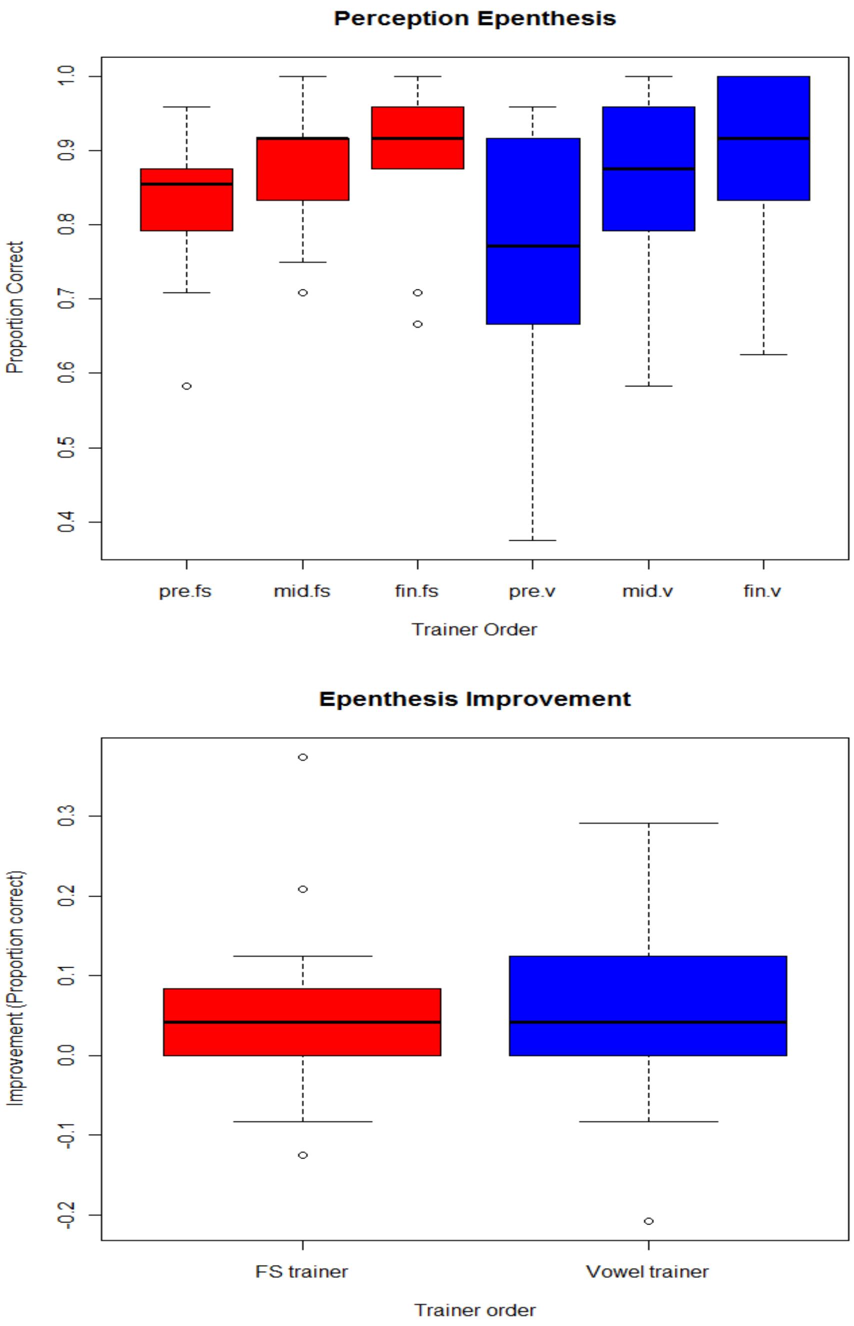


Figure 3.4 Proportion of correct perception epenthesis and improvement of epenthesis perception abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

Although the training methods improved the overall segmental and prosody perception, the speech perception in noise did not seem to improve. Figure 3.5 displays the results of the noise recognition test spoken by the SBEs and Korean speakers. After the focus-stress training, the subjects seemed to show more improvement than the subjects after the vowel training. However, the statistical tests showed that there was no significant main effect of block or training order ($p > .05$), suggesting that these trainings did not improve general speech recognition abilities. Although the present study was designed with the idea that the combination of the two trainings would improve speech-in-noise recognition, little improvement was obtained in the present study. This result is likely because there are many factors involved in sentence recognition (e.g., lexical, syntactic and semantic processing).

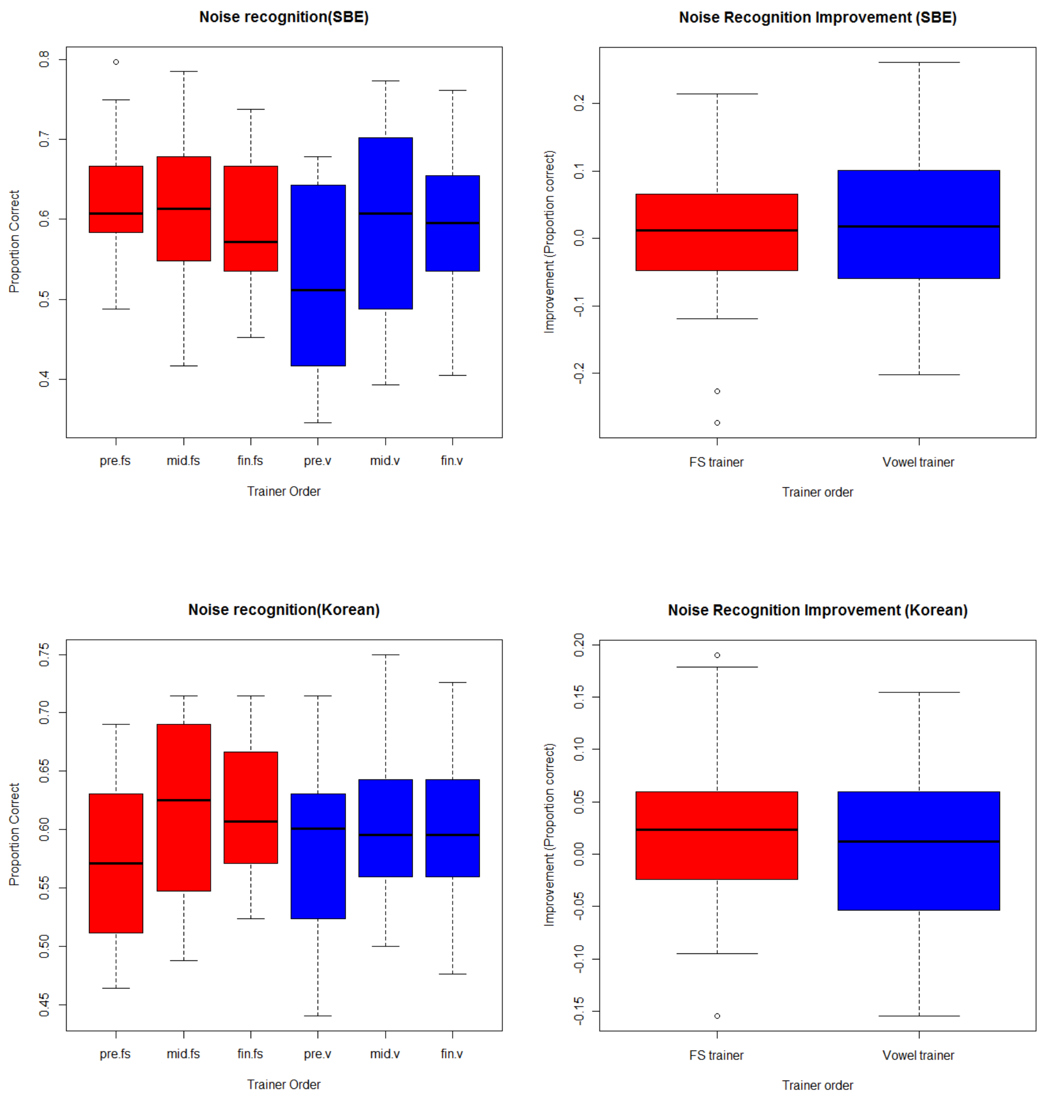


Figure 3.5 Proportion of correct speech recognition from the SBEs and the Korean L2 speakers in noise and improvement recognition abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

3.3.2 Production

Various acoustic measures (e.g., F0, segment duration, vowel quality and phoneme rate), including the number of epenthetic vowels, were analysed to see whether the Korean L2 speakers improved in their production abilities. The intonation of the F0 patterns was measured by correlating the mean F0 for each vowel in each sentence between each Korean L2 speaker and each L1 English speaker. To measure segment length, the duration of each syllable was measured from each Korean L2 speaker's recording, and was correlated with the corresponding SBE recording. This procedure showed how the relative duration of each syllable spoken by the Korean L2 speakers correlated with the corresponding syllable recorded by native English speakers.

The ACCDIST (Huckvale, 2004, 2007; Pinet et al., 2010) metrics were used to measure vowel distance. Each vowel segment was extracted from spoken BKB sentences and divided into two equal halves. MFCCs (Mel Frequency Cepstral Coefficient) were computed, making 13 MFCC values in each half of the vowel segment. Next, the distance between each vowel from the other vowels was calculated, resulting in a large matrix of vowel distances. After completing the measurements, the correlation between the matrix of vowel distances from the Korean L2 speakers and the vowel distance matrix from each SBE was calculated. To measure phoneme rate, the duration of all vowels and consonants (excluding pauses), were measured from each Korean L2 speaker's BKB recordings and summarised.

Perceptual judgements of the sentences produced by the Korean speakers were done by 20 native English speakers. Each listener judged the focus position (i.e., beginning or end) and the goodness of accent (5-point scale). For this evaluation, a subset of twenty recordings for each Korean L2 speaker was chosen from the production test, to reduce the total number of ratings required. Ten recordings were untrained sentences and the other ten were trained.

Figure 3.6 shows the results of the accent ratings by native English speakers. The results showed that the Korean L2 speakers improved their accents after training. They showed a large variability before the training. A linear mixed-model analysis (block and order as fixed factors, and the English native raters and the Korean L2 speakers as the random factors) was conducted to see whether there was an improvement and interaction between trainings. There was a main effect of block ($c^2[2] = 17.95$, $p < .001$), suggesting that the Korean subjects improved after the trainings. However, no significant effects of training order or interaction between trainings were found ($p > .05$), suggesting that the training programs had similar effects.

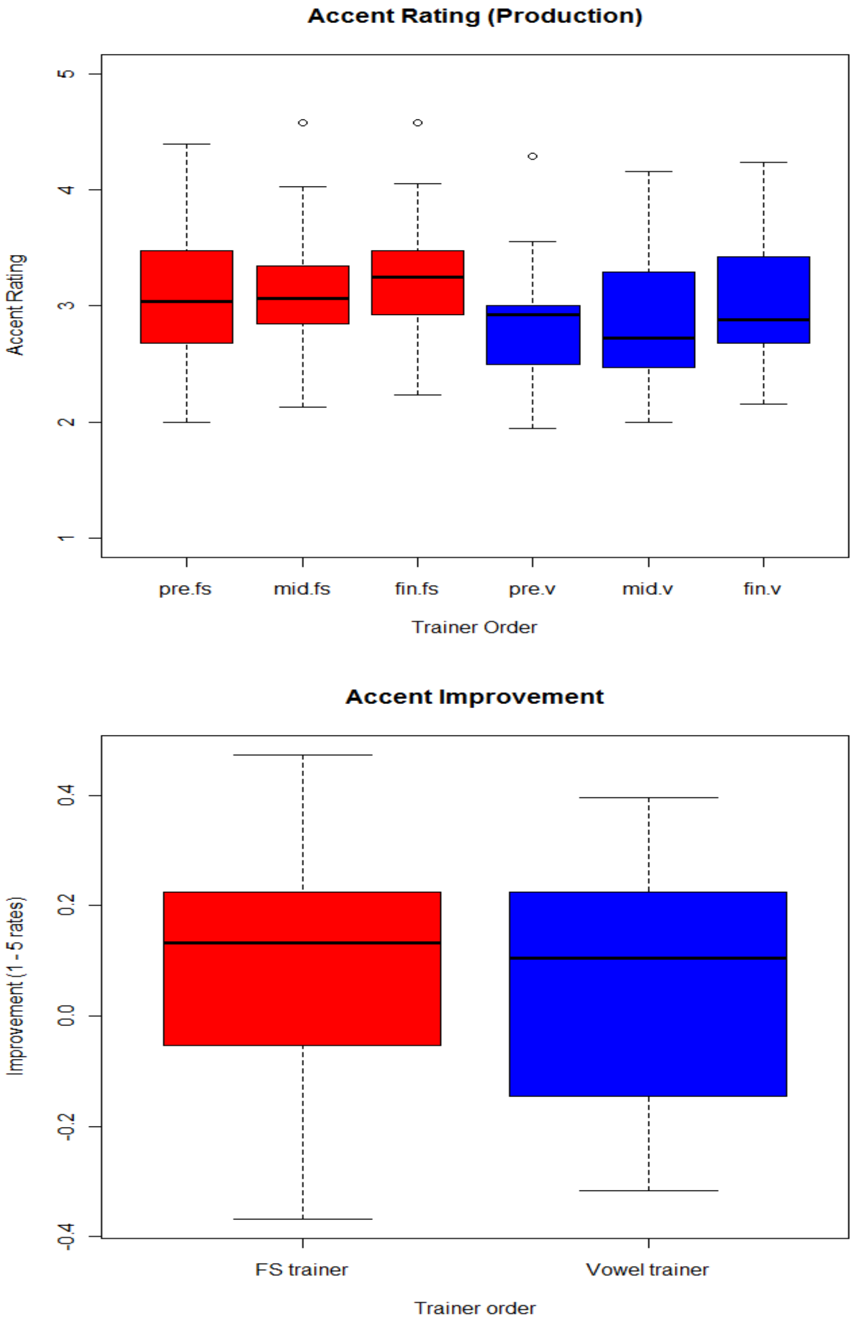
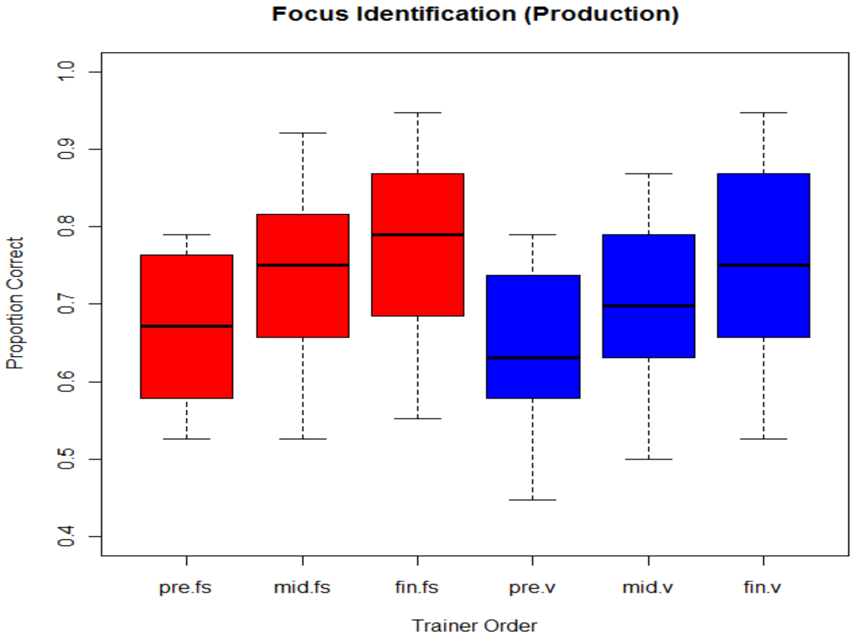


Figure 3.6 The results of accent rating by native English speakers. Subjects who began with the focus-stress training remained the same after the training. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

A similar result was discovered regarding focus identification. Figure 3.7 displays the results of focus identification evaluations by native English speakers. The results showed that the Korean L2 speakers had an overall improvement after the training. For the subjects who started with the focus-stress training, accuracy developed after the training, suggesting that the Korean L2 speakers properly highlighted the initial or final words after the focus-stress training. Overlapping results were also seen, in which the subjects improved after they were trained with the vowel training. Results showed that the subjects improved after the vowel training. A logistic mixed-model analysis was conducted with block and order as the fixed factors, and speaker and raters as the random factors. There was a main effect of block (c^2[2] = 43.49, $p < .001$), suggesting the trainings improved focus identification abilities. However, the interaction between training techniques was not significant ($p > .05$). The results were similar when only untrained sentences were selected.



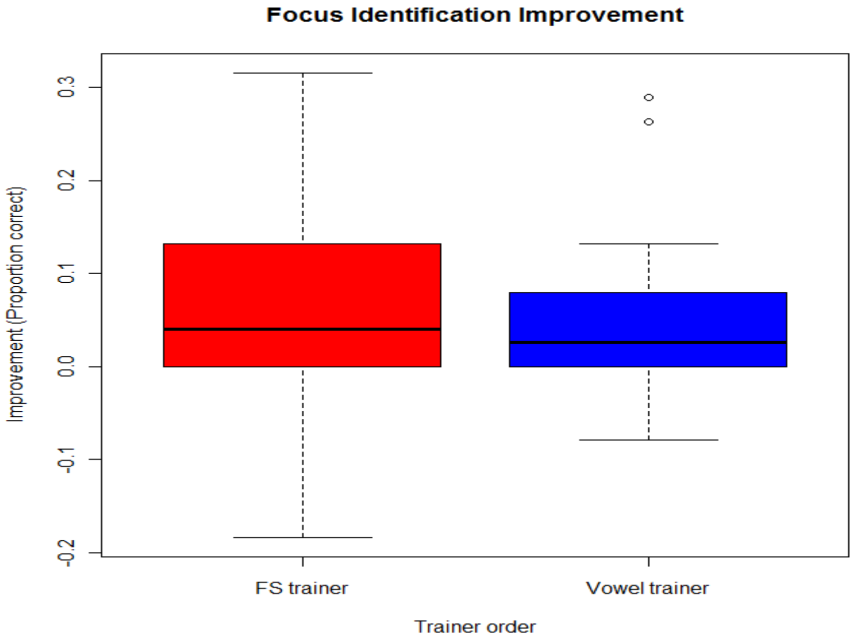


Figure 3.7 The results of focus identification by SBEs. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

The acoustic analyses suggest that focus-stress training was more effective than vowel training in terms of improving production. Figure 3.8 displays F0 correlations between the Korean L2 speakers and SBEs. If the correlation was high, it signified that the pitch contour of the Korean L2 speakers was close to that of the SBEs. As shown in Figure 5, both training methods improved prosody production, but the focus-stress training seemed to be more effective than the vowel training. For the subjects who started with the focus-stress training, overall correlations seemed to be improved after focus-stress training but remained the same after the vowel training. The subjects who started with the vowel training seemed to improve after both focus-stress and vowel training. There was a significant difference among blocks ($c^2[2] = 143.89$, $p < .001$). Training order also significantly interacted ($c^2[2] = 44.96$, $p < .001$). There was an improvement in F0 patterns after training, but this improvement was small and only emerged after two training blocks (i.e., there was little improvement after one block, regardless of whether it was focus-stress or vowel training).

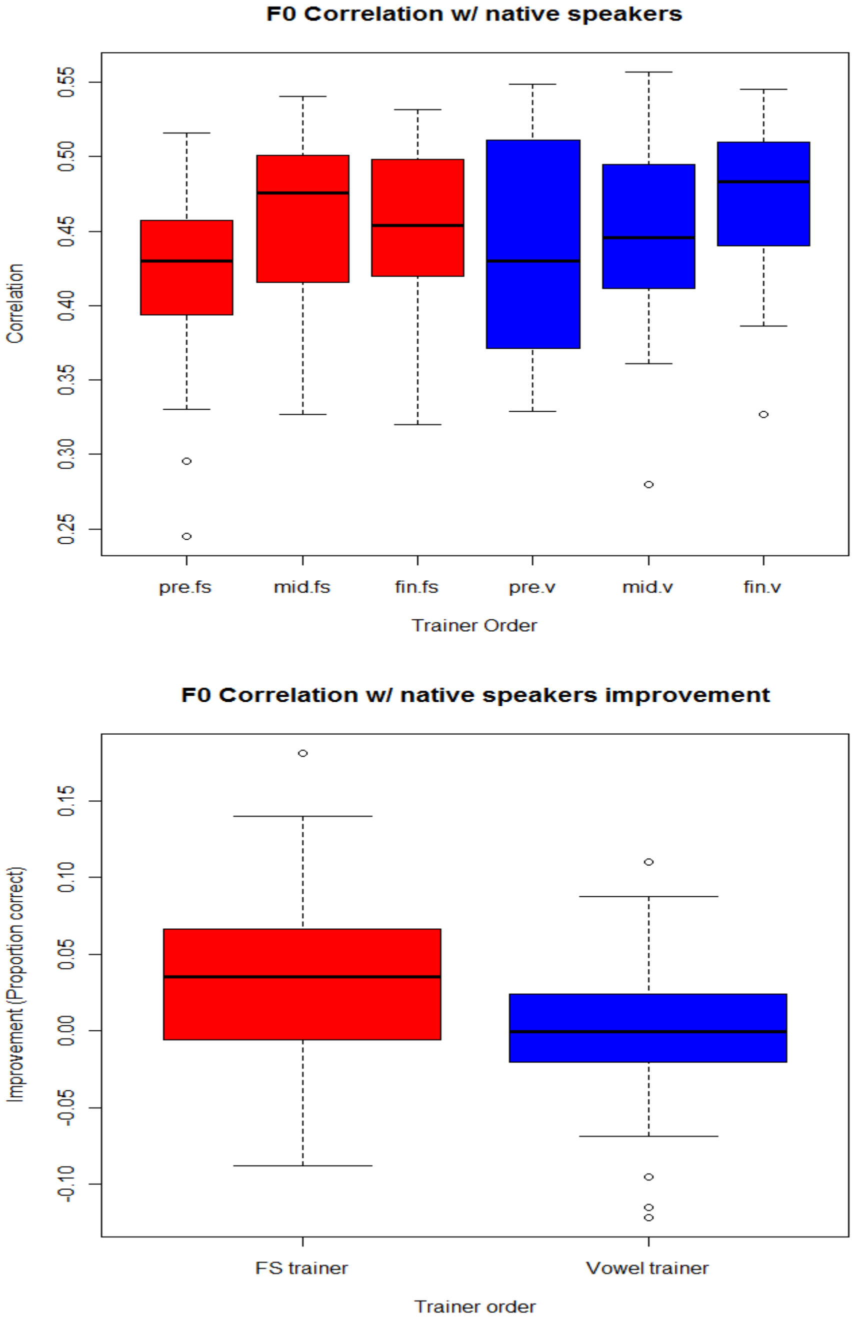
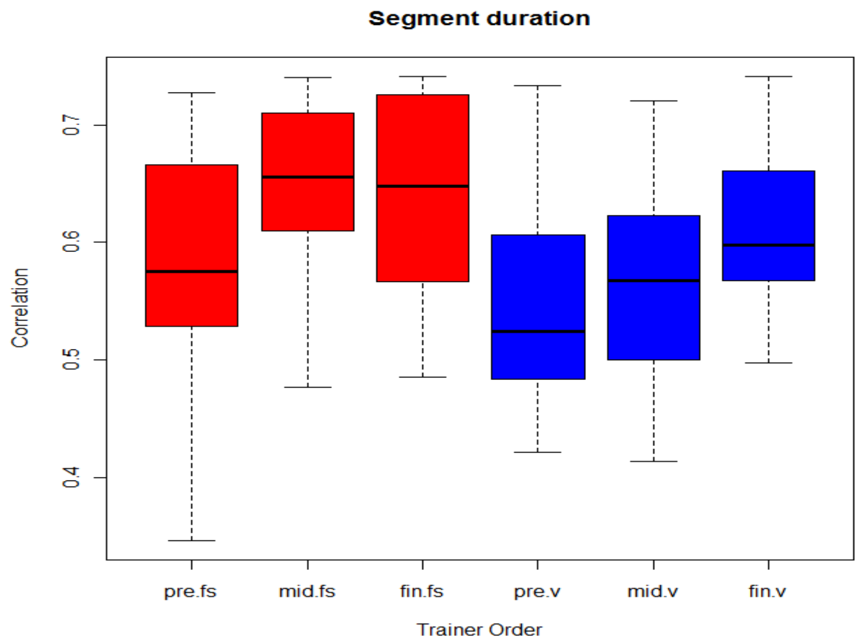


Figure 3.8 The results of F0 correlation with SBEs and the improvement of F0 production abilities. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

The segment duration results also showed that the focus-stress training was more effective than vowel training. Figure 3.9 shows the correlation of segment duration with

SBEs. For the subjects who started with the focus-stress training, the results suggested that the focus-stress training helped the Korean L2 speakers to speak more like native English speakers. However, there was no improvement after vowel training. For the subjects who started with the vowel training, the results may signify that the vowel training helped Korean subjects improve their timing correlation. A bit of enhancement was seen after the focus-stress training, which indicated that the focus-stress training improved the timing measure. There was a significant difference among blocks ($c^2[2] = 1697.77$, $p < .001$) and training order ($c^2[2] = 275.04$, $p < .001$). Post-hoc tests demonstrated that both training methods significantly improved segment duration, but the focus-stress training was significantly more successful than the vowel training ($p < .05$).



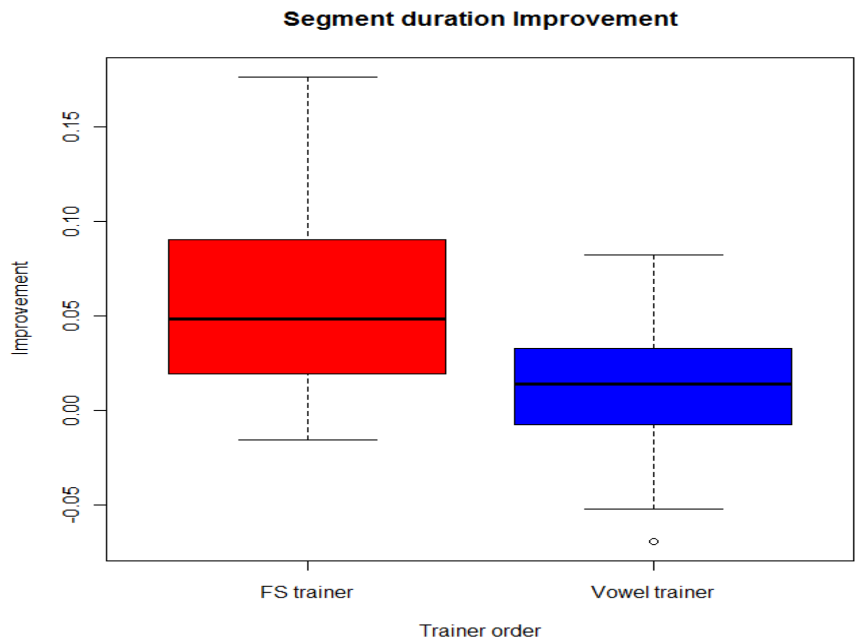


Figure 3.9 The correlation results of segment duration between the Korean L2 speakers and SBEs. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots represent the ranges of correlations and display the medians and the lowest and highest values. The box plots also show the quartile ranges of scores, and outliers are marked with circles.

Phoneme rates increase at a greater rate after focus-stress training compared to vowel training. Figure 3.10 displays the results of the phoneme rate test by the Korean L2 speakers. For the subjects who started with the focus-stress training, the results indicated that the focus-stress training helped the Korean L2 speakers to say the given sentences faster. However, the phoneme rate was not improved after vowel training in this group as some Korean subjects reduced their phoneme rates after the training. For the subjects who started with vowel training, the phoneme rate was slightly improved after the vowel training. However, after the focus-stress training, the phoneme rate was also improved. There was a significant difference among blocks ($c^2[2] = 298.29$, $p < .001$) and between training techniques ($c^2[2] = 151.37$, $p < .001$). Post-hoc tests revealed that the Korean L2 speakers spoke significantly faster after the focus-stress training and slightly, but significantly, slower after the vowel training ($p < .05$). Thus, the focus-stress training was more impactful in facilitating the speakers to be more fluent in English.

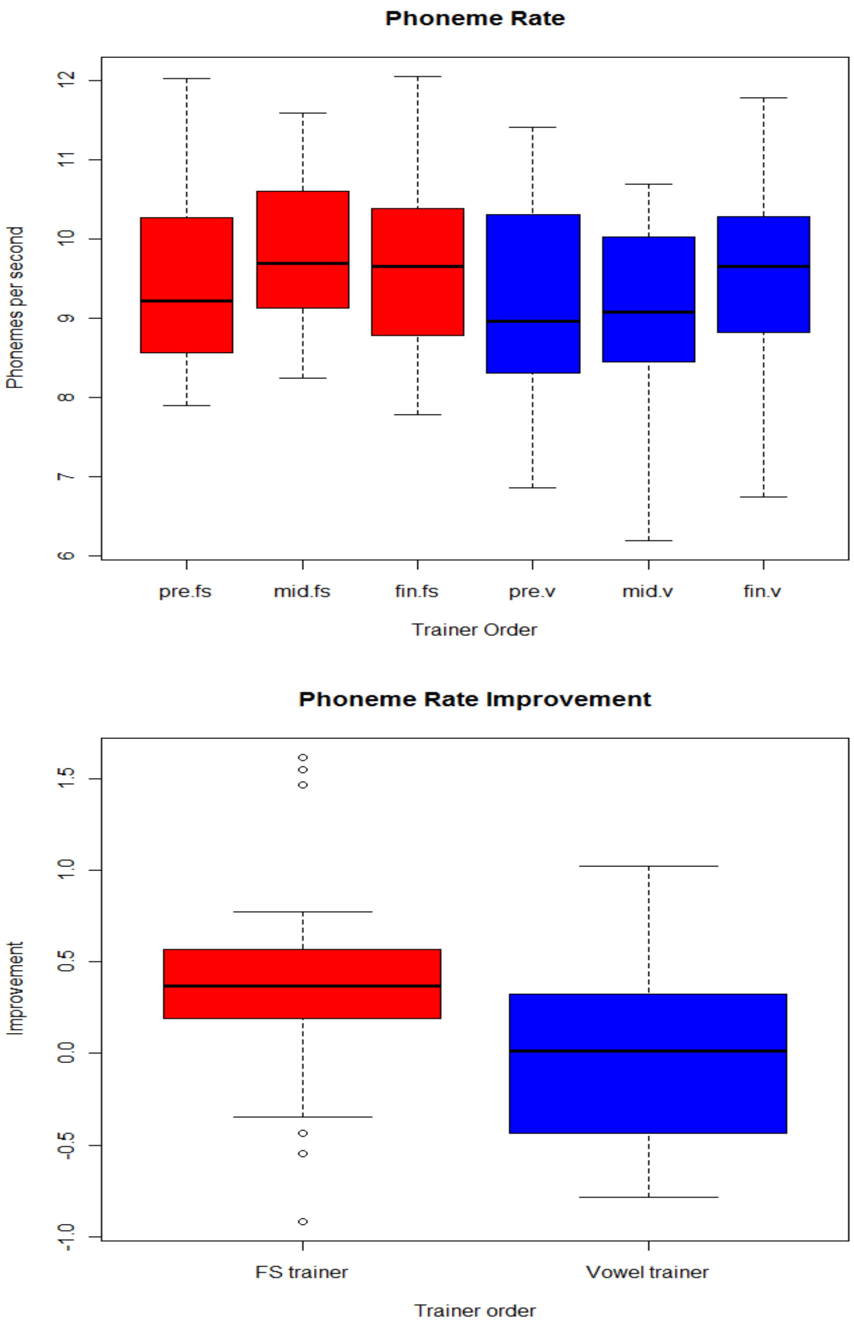


Figure 3.10 The phoneme rate spoken by the Korean L2 speakers. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre, mid and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

Focus-stress training may also have been slightly more effective than vowel training in terms of vowel quality. Figure 3.11 shows the results of vowel correlations between the Korean L2 speakers and native English speakers. There was a significant difference among blocks ($c^2[2] = 25.15$, $p < .001$). The interaction between order blocks was also significant ($c^2[2] = 7.40$, $p = .025$). The results showed a small overall change in the vowels. However, an anomalous improvement was seen by the end of the second block of training for the subjects who started with the focus-stress training.

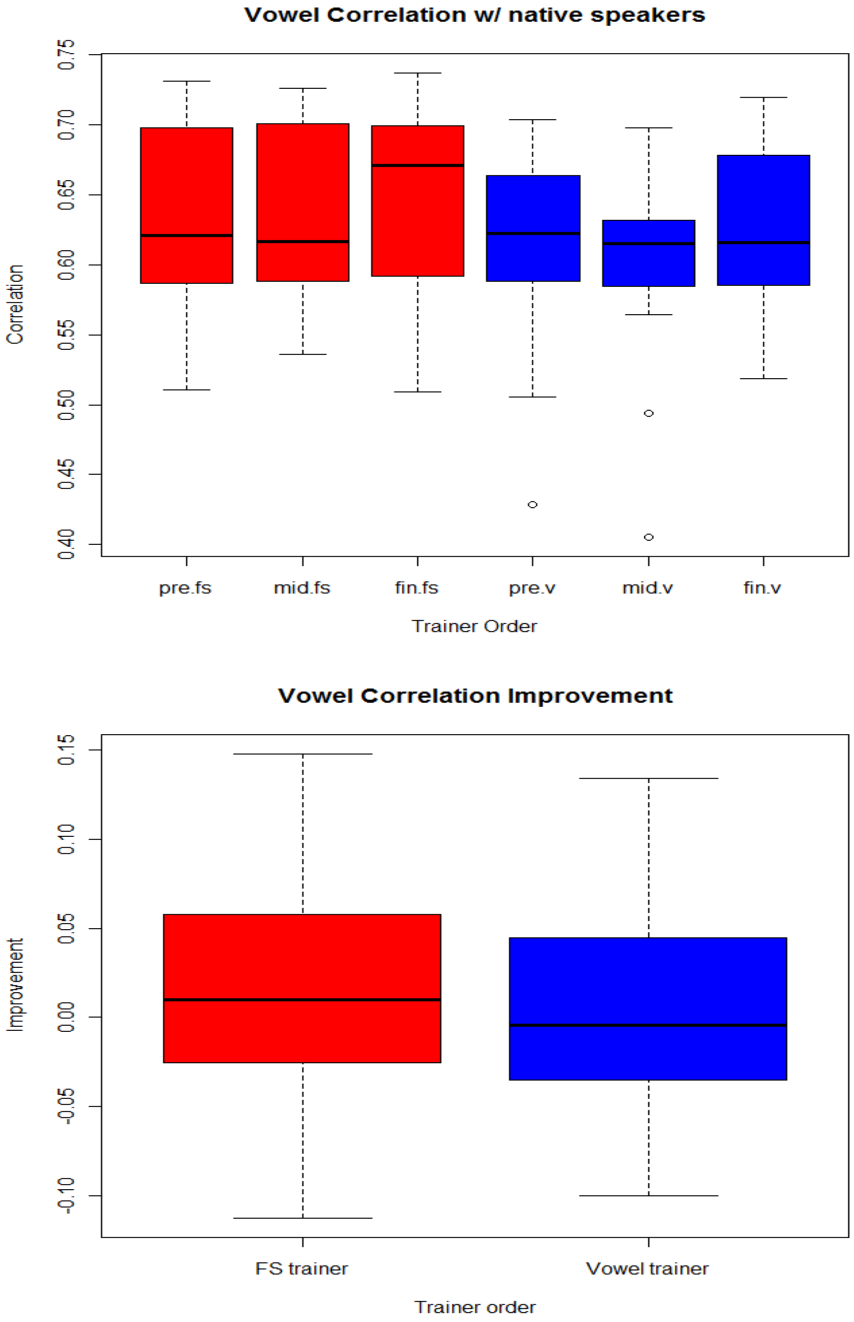


Figure 3.11 The results of vowel correlations of the Korean L2 speakers with SBEs. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

Production epenthesis showed similar patterns signifying that focus-stress training worked better than vowel training. The current study did not count the number of times epenthesis occurred. The study used the measure that Peperkamp et al. (2010) had utilised. It is the sum of duration multiplied by the intensity of epenthesis. Figure 3.12 displays the frequency of epenthetic vowel production among the Korean L2 speakers. Interestingly, several outliers were found in both groups, suggesting that some of the Korean L2 speakers produced many epenthetic vowels. There was a significant difference among blocks ($c^2[2] = 27.18$, $p < .001$). Training order was also a significant factor ($c^2[2] = 13.13$, $p = .001$). Post-hoc tests revealed that the production epenthesis was significantly reduced only after the focus-stress training ($p < .05$).

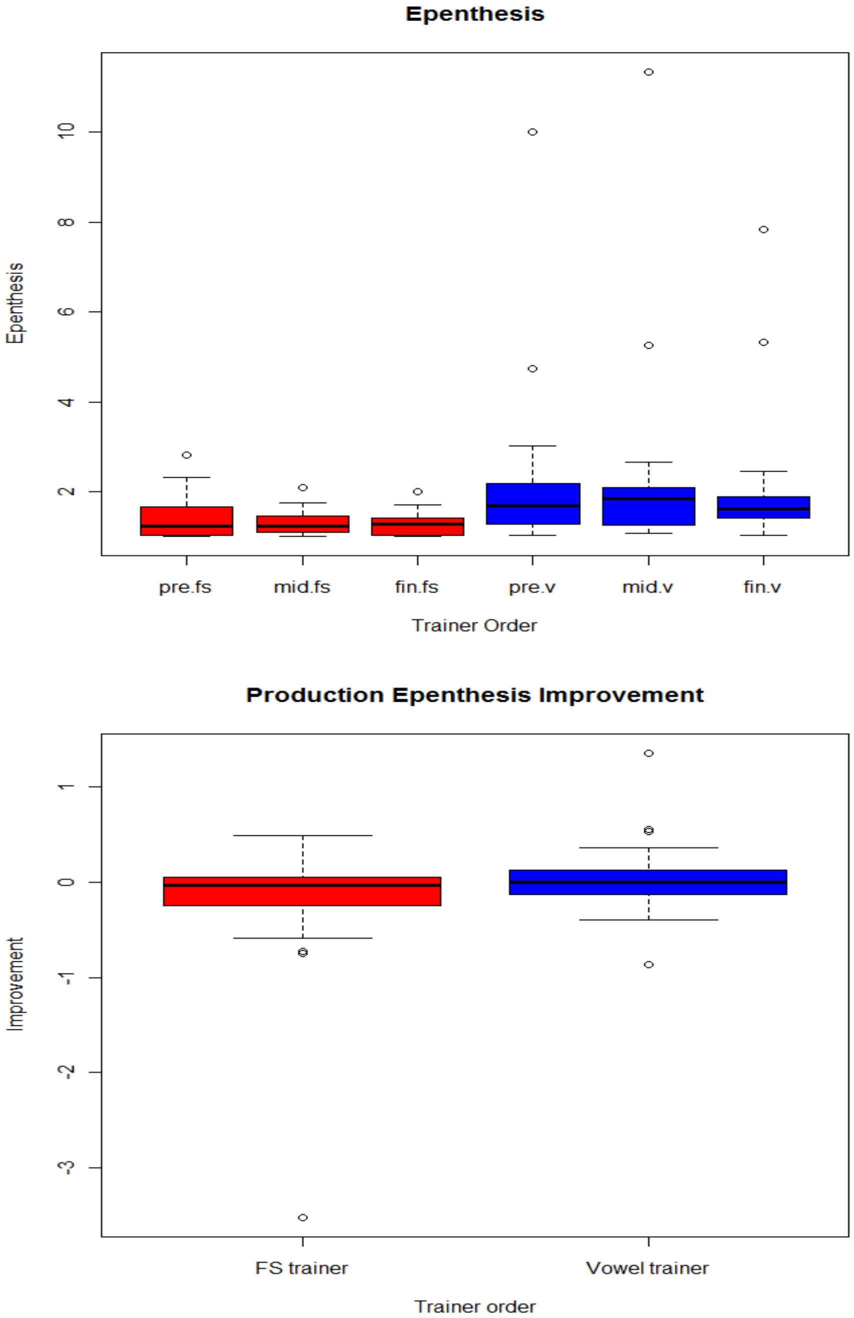


Figure 3.12 The amount of epenthesis spoken by the Korean L2 speakers. 'pre.fs','mid.fs' and 'fin.fs' indicate the results of pre-, mid- and final test of subjects who began with focus-stress training, and 'pre.v','mid.v' and 'fin.v' indicate the results of pre-, mid- and final test of subjects who began with vowel training. Box plots show the quartile ranges of scores, and outliers are marked with circles.

3.4 Discussion

The main findings of the present study are as follows. First, focus-stress training can improve perception in the same way that it did for segments as shown by previous studies. This is particularly important because previous work on prosody training has concentrated on production and required a personal interaction with an instructor (e.g., de Bot, 1983). However, the present study reveals that computer-based training is effective, which is useful because of the lower cost and self-paced nature of the training. Second, the present study demonstrated that each type of training works on independent abilities. The results show that vowel training had a greater effect on vowel recognition abilities, while focus-stress training had a greater effect on focus and stress recognition abilities, suggesting that training improves specific underlying abilities rather than the general ability of performing or coping with multi-talker variability. Therefore, it seems plausible that different training approaches can be combined to have an overall larger impact on speech recognition, although the speech-in-noise test, which was the most real-world test, was not improved.

The present study illustrated that auditory training also improves speech production abilities. The results show that both the focus-stress and vowel trainings improve accent ratings and focus identification. However, it was demonstrated that acoustic prosodic measures of the productions, such as F0 and segment durations, were the most improved, and the focus-stress training had a larger overall effect on productions than the vowel training. Previous work on segments indicated that production and perception were not strongly linked (Goto, 1971; Shelton & Johnson, 1977; Sheldon & Strange, 1982; Borden et al., 1983; Gass, 1984; Flege & Eefting, 1987; Flege, 1993; Ramirez, 2006; Nasir & Ostry, 2009; Hattori & Iverson, submitted; de Jong & Park, 2012). However, the results from the present study suggest that the link between production and perception might be stronger for prosody.

Why might prosody affect production differently? One possible answer is that prosody is more geared towards the demands of conversation. Conversations are usually composed of turn-taking, which are related to prosody and timing, whereas segments are more related to comprehension, rather than conversation timing. Another explanation is that prosody measures were improved because people were getting more confident. While subjects were trained by focus-stress trainer, they heard a lot of English sentences. They became used to perceiving English sentences and felt more comfortable when they were asked to read the given sentences, even though the sentences in the production test were not the same as the ones they heard in training.

The present study revealed that the amount of epenthesis was reduced after training, regardless of training type. The lack of interaction between training methods, in terms of perception epenthesis, supported the findings from previous studies, which suggested that vowel epenthesis is related to segmental and supra-segmental abilities.

The study also revealed that English abilities could be related to phonotactic constraints, causing vowel epenthesis. The results showed that the Korean L2 speakers improved after training. This means that L1 phonotactics cannot affect epenthesis when their English perception abilities improved as phonotactic constraints seemed to significantly influence epenthesis when English perception abilities were low.

Despite these findings, the present study has its limitations. First, the subjects repeated the same BKB sentences at the pre-, mid-, and final tests. This repetition could have made them familiar with the tests. However, they did not receive any feedback until they completed the final test; thus, they could not have known the correct answers. Furthermore, none of the sentences utilised in the test were used in the training. Second, the fact that there was no control group may weaken the claim that training is effective. Even if the two different training groups can legitimately act as controls for each other, it is possible to say that an untrained group might have also shown some improvement.

In summary, the present study trained 36 Korean L2 speakers on English vowels and prosody to examine whether the training improved their vowel and focus-stress recognition abilities. After completing the vowel and prosody training, the results revealed improvement in the Korean L2 speakers' abilities. The results also show that vowel training is better for vowel recognition abilities and focus-stress training is better for focus and stress recognition abilities, suggesting that training improves specific underlying abilities rather than overall speech abilities. Therefore, Korean L2 speakers can develop their overall speech abilities by combining the training methods. .

Chapter 4: Phonetic investigation of epenthetic vowels produced by Korean learners of English

4.1 Introduction

This chapter investigates the acoustic characteristics of epenthetic vowels and the environment of epenthesis production. During the training described in Chapter 3, a large body of spoken BKB sentence data by Korean learners of English was created with a wide range of variability. Thus, this data allowed for the analysis of epenthetic vowels

The present study measured F1, F2, F3, vowel duration and F0 of epenthetic vowels. Although previous studies have examined epenthetic vowels, their data were relatively sparse. For example, Kim and Kochetov (2011) presented the acoustic characteristics of an epenthetic vowel produced by six Korean learners of English. They conducted an acoustic analysis of the epenthetic vowel in the final-position word among English loanwords, spoken in four conditions (labial, alveolar, palatal and velar). For acoustic analysis, they measured the duration of the epenthetic vowel and the formant value of F1 and F2 at the middle of the epenthetic vowel. Six Korean native speakers using a Seoul dialect were recorded. The results showed that all epenthetic vowels, regardless of the conditions, were high vowels, with a low value for F1 and no large variation (females had approximately 400 Hz and males had approximately 300 Hz). Interestingly, the F2 value had large variability from approximately 750 to 2,750 Hz (females) and approximately 750 to 2,400 Hz (males), suggesting that the F2 formant value of epenthetic vowels in this study completely covered the F2 range of back and front vowels. However, results from six Korean speakers seem to be insufficient. The present study analysed 1,505 epenthetic vowels spoken by 36 Korean learners of English.

The present study examined the acoustic characteristics of epenthetic vowels to see whether an epenthetic vowel is closest to the shortest Korean full vowel, as previous studies have shown. Previous studies have shown that the shortest vowel is chosen for epenthesis (Pitt, 1998; Monahan et al., 2008; Dupoux et al., 2011). For example, Japanese speakers tended to insert the shortest or lightest vowel among their native vowels, which is /u/. Monahan et al. (2008) investigated 16 Japanese speakers to see whether they perceptually insert equal epenthetic vowels or change the epenthetic vowels in terms of circumstance. They prepared the target words with a coronal consonant (e.g., /e**t**oma/, /e**t**uma/ and /etma/), velar consonant (/e**k**oma/, /e**k**uma/ and /e**k**ma/) and bilabial nasal consonant (e.g., /e**m**oma/, /e**m**uma/and /e**m**ma/). After playing two stimuli, subjects were asked to identify whether the first and second stimuli were identical. The results showed that Japanese speakers did not perceptually insert the /o/ vowel in any condition, suggesting that /o/ cannot be an epenthetic vowel for Japanese speakers. However, they perceptually inserted the /u/ and /i/ vowel, demonstrating that the short vowels, which are a high vowel in Japanese, were used for the epenthetic vowel. This result is likely because high vowels in Japanese are easily devoiced, suggesting that those vowels are easily affected by the circumstance, whereas the /o/ vowel is not devoiced.

Previous studies have shown that the /ɨ/ vowel is the shortest vowel among Korean full vowels (Koo, 1998), and epenthetic vowels spoken by Korean L2 speakers were closest to the /ɨ/ vowel (Kim & Kochetov, 2011). For example, Koo (1998) recorded three Korean females speaking eight Korean vowels in a carrier sentence: /i/, /ɨ/, /u/, /ɛ/, /ʌ/, /o/, /ɑ/ and/æ/. The results showed that the /ɨ/ vowel was the shortest.

The present study compared epenthetic vowels to three English full vowels, /i/, /u/ and /ɑ/, to determine where epenthetic vowels are made in the vowel chart. All vowels were normalised to remove anatomical and physiological variations. If the epenthetic vowels were made between two high vowels, such as /i/ and /u/, it could be interpreted that epenthetic vowels by Korean L2 speakers are close to the /ɨ/ vowel, supporting previous studies that the shortest vowel is chosen for epenthesis (Kim & Kochetov, 2011).

Previous studies have shown that vowel epenthesis can be different in terms of context, such as preceding or following consonants (Kang, 2003; Kim, 2009; Kim & Kochetov, 2011; Ahn, 2012). For example, Kang (2003) phonologically revealed that the likelihood of epenthetic vowel placement varies due to the tenseness of a non-adjacent preceding vowel, as well as place and voicing of the preceding consonants. After completing a phonological analysis, the results suggested that the frequency of vowel epenthesis was different, showing that only 28% of epenthetic vowels were found after lax vowels, whereas 89% occurred after tense vowels. The frequency was also different in accordance with the placement of the articulation. Epenthetic vowels were likely to occur after coronal stops (72%), dorsal stops (34%) and labial stops (21%). Compared with voiceless stops (29%), vowel epenthesis more frequently occurred after the voiced stops (88%). The study concluded that vowel epenthesis occurs to enhance ‘perceptual similarity’ between Korean and English.

The present study investigated the context of epenthesis to see if it was affected by its environment, such as preceding or following consonants. By analysing the corpus, it was possible to examine various contexts of vowel epenthesis, such as between words (e.g., *The lorry **carried fruit***), within words (e.g., bru**shed** / brʌʃt /) or coda position (e.g., be**d** / bedɨ /). The analyses facilitated understanding whether Korean L2 speakers produced epenthetic vowels within consonant clusters, as previous studies have shown (Kabak & Idsardi, 2007), or in other contexts such as coda position or between words.

The present study investigated English experience because it might be related to vowel epenthesis, as previous studies have shown (Lee, 2009; Masuda & Arai, 2010). For example, Lee (2009) investigated Korean L2 speakers with varying degrees of English experience to see whether it affected vowel epenthesis. The subjects were divided according to their English experience level into three groups based on these criteria: 35 advanced speakers, 32 intermediate speakers and 26 beginner speakers. The subjects in each group heard three stimuli (e.g., pelm - pelm - pelɨm) and were asked to identify whether the first stimulus was identical to the second or third stimulus. The results showed that advanced learners were better at detecting epenthetic vowels than the other two groups, with their accuracy reaching 85.7% (advanced group) compared to 80.2% (intermediate group) and 77.6% (beginner group).

Masuda and Arai (2010) also revealed that English experience was related to vowel epenthesis. They investigated 39 Japanese learners of English to see whether English experience affected epenthesis production and perception. Japanese subjects were divided into two groups, the advanced-level learners and the beginner-to-intermediate-level learners, and completed several production and perception tasks. For the perception tasks, they presented stimuli consisting of VCCV (e.g., /ebzo/) and VCuCV (e.g., ebuzo) constructions and asked the Japanese learners to identify if the second stimulus was identical to the first or third stimulus (e.g., /ebzo/ - /ebuzo/ - /ebuzo/). The results showed that most of subjects in the advanced group produced fewer errors (less than five) than the subjects in the beginner-intermediate group (up to 35 errors). For the production tasks, all subjects were asked to read the target words. The type of epenthesis was categorised into three groups: full epenthesis, partial epenthesis and no epenthesis. The results of acoustic analyses showed that the beginner-intermediate group produced more full and partial epenthesis than the advanced group. The advanced group only produced 1.3% full epenthesis, whereas the beginner-intermediate group produced 54.5% full epenthesis.

The present study investigated the relationship between the amount of epenthesis and English experience, such as the length of time learning English and living in an English-speaking country, through questionnaires to see whether those factors affected epenthesis production. All subjects who participated in the second study completed the questionnaire. The present study did not consider the scores of an English proficiency test because most tests tend to focus on measuring English grammar or reading comprehension.

The present study also examined orthography. Previous studies have shown that orthography can affect speech perception (Grainger et al., 2001) and vowel epenthesis (Vendelin & Peperkamp, 2006; Detey & Nespoulous, 2008). For example, Vendelin and Peperkamp (2006) investigated French-English bilinguals to see whether orthography affected loanword adaptation. They presented 24 CVC target words (e.g., /fVp/, /mVb/ and /pVd/) with eight English monophthongs. Seventeen of the 24 target words were nonwords in both English and French. Among 12 late French-English bilingual subjects, half heard the stimuli without orthography. The other half heard the stimuli with orthography. The results showed that French-English bilingual speakers were more accurate when perceiving stimuli with orthography than without it. Additionally, Detey and Nespoulous (2008) examined Japanese native speakers learning French, demonstrating that orthography affected syllable segmentation among second-language learners and produced epenthesis. They created nonword stimuli containing consonant clusters in the initial-, medial- and final-word positions. Sixty Japanese native speakers learning French were asked to count the number of syllables in a given word in auditory, visual and audio-visual conditions. The results showed that the visual condition had the highest epenthesis rate (77.05%). The audio-visual condition and auditory condition followed with 66.5% and 58.5% epenthesis, respectively. They explained that the participants were able to perceive the ‘phonetic syllable’ in the auditory condition, whereas their ‘phonological representations’ were activated in the visual condition.

When investigating orthography effects, the present study focused on investigating the English ‘-ed’ because previous studies have shown that L2 speakers are affected by this past-tense suffix (Delatorrer & Koerich, 2006). Similar to Brazilian L2 speakers, it is possible that Korean L2 speakers are also affected by orthography because they were asked to read English sentences. When speaking the given BKB sentences, Korean L2 speakers might intentionally insert an epenthetic vowel when reading English past-tense words (e.g., *brushed* in *She brushed her hair*) because the past-tense suffix ‘-ed’ orthographically contains the letter < e >. To measure this effect, the frequency of epenthesis related to ‘-ed’ was counted, and the proportion of this epenthesis was calculated.

In summary, the present study aimed to investigate the acoustic characteristics and contexts of epenthetic vowels produced by 36 Korean L2 speakers by analysing the data developed during the training study (see Chapter 3). First, the present study examined the acoustic characteristics of epenthetic vowels, measuring F1, F2, F3, vowel duration and F0. The contexts of epenthesis were analysed to examine which condition affected epenthesis the most. Extra phonological factors such as English experience and orthography were investigated to decipher whether these factors affected the amount of epenthesis. The aspects of length of time learning English and living in an English-speaking country were correlated with the amount of epenthesis.

4.2 Method

4.2.1 Subjects

The subjects for this study were the same subjects described in Chapter 3.

4.2.2 Procedure

Korean L2 speakers read BKB sentences during the pre, mid and final test described in Chapter 3. Sixty-one BKB sentences with different types of context questions were prepared, and the subjects were asked to read the sentences in terms of the given questions. Each question and BKB sentence was displayed on a computer monitor one at a time. Before the experiment, the subjects were able to ask for assistance if they found any ambiguous or unclear sentences. The subjects could take a break if they wanted, and there was no time limit for test completion. All subjects completed the entire procedure once. Each speaker read 366 sentences (61 sentences × 2 feeder questions × 3 sessions), and all recordings of Korean subjects were automatically segmented and manually realigned. Next, the acoustic measures of each recording were calculated. Three samples of /i/, /u/ and /ɑ/ were extracted from each speaker for normalisation, removing inter-speaker variation caused by different lengths of vocal tract.

4.3 Results

4.3.1 Phonetic analysis

Table 4.3 and Figure 4.1 show the mean values of the first three formants, duration and F0 from epenthetic vowels. The range of F1 varied, but most F1 values were between 300 and 500 Hz, suggesting that epenthetic vowels were created as high vowels. The mean F1 value was 400 Hz (median = 403 Hz, *SD* = 52.96 Hz). There was more variability in F2 values, ranging from less than 1,400 Hz to more than 2,200 Hz. The mean F2 value was 1,811 Hz (median = 1,864 Hz, *SD* = 213.67 Hz). The range of F3 values was from 2,400 Hz to more than 3,200 Hz. The mean F3 value was 2,878 Hz (median = 2,896, *SD* = 223.17 Hz). The variability of vowel duration was significant, ranging from 51 ms to more than 167 ms. The mean duration was 85 ms (median = 77 ms, *SD* = 26.95 ms). F0 values also showed large variability due to mixed gender. The mean F0 value was 186 Hz (median = 203 Hz, *SD* = 50.78 Hz). Table 4.3 shows the mean values for each measure.

Subject	**F1 (Hz)**	**F2 (Hz)**	**F3 (Hz)**	**Duration (ms)**	**F0 (Hz)**
k001	315	1,562	2,680	74	108
k002	309	1,702	2,410	94	111
k003	364	1,664	2,536	73	113
k004	406	1,331	3,316	103	187
k005	333	1,557	2,599	60	104
k006	402	1,585	2,485	58	96
k007	417	1,602	2,605	62	154
k008	421	1,831	2,942	75	213
k009	350	1,571	2,605	137	125
k010	376	1,790	2,629	99	125
k012	412	1,436	2,587	133	130
k013	361	2,126	3,067	61	181
k014	347	1,513	2,668	76	112
k015	370	1,864	3,072	61	210
k016	430	2,077	3,094	51	210
k017	411	1,771	3,110	74	228
k018	477	1,747	3,105	68	231
k019	428	1,899	3,130	94	286
k020	448	1,657	2,871	85	199
k021	416	1,874	3,147	99	222
k022	346	1,660	2,959	94	228
k023	522	2,094	2,989	142	185
k025	384	1,907	2,896	92	203
k026	386	1,951	3,028	76	212
k027	431	1,952	2,879	108	220
k029	475	1,968	3,071	80	234
k030	487	1,902	3,097	60	129
k031	373	1,990	2,830	77	182
k032	403	1,875	2,874	95	217
k033	351	1,710	2,888	67	193

k034	396	1,881	2,777	58	231
k035	521	2,087	3,002	167	234
k036	407	1,995	2,821	52	243
k037	411	2,222	2,906	94	241
k039	335	2,036	3,051	80	209

Table 4.1 Mean value of first, second and third formant, duration and pitch.

Figure 4.1 shows the mean F1 and F2 values for the average epenthetic vowel productions of 36 Korean L2 speakers. The overall results showed that epenthetic vowels were more often produced as high medial vowels. Furthermore, most of the epenthetic vowels were inserted near the high-vowel position

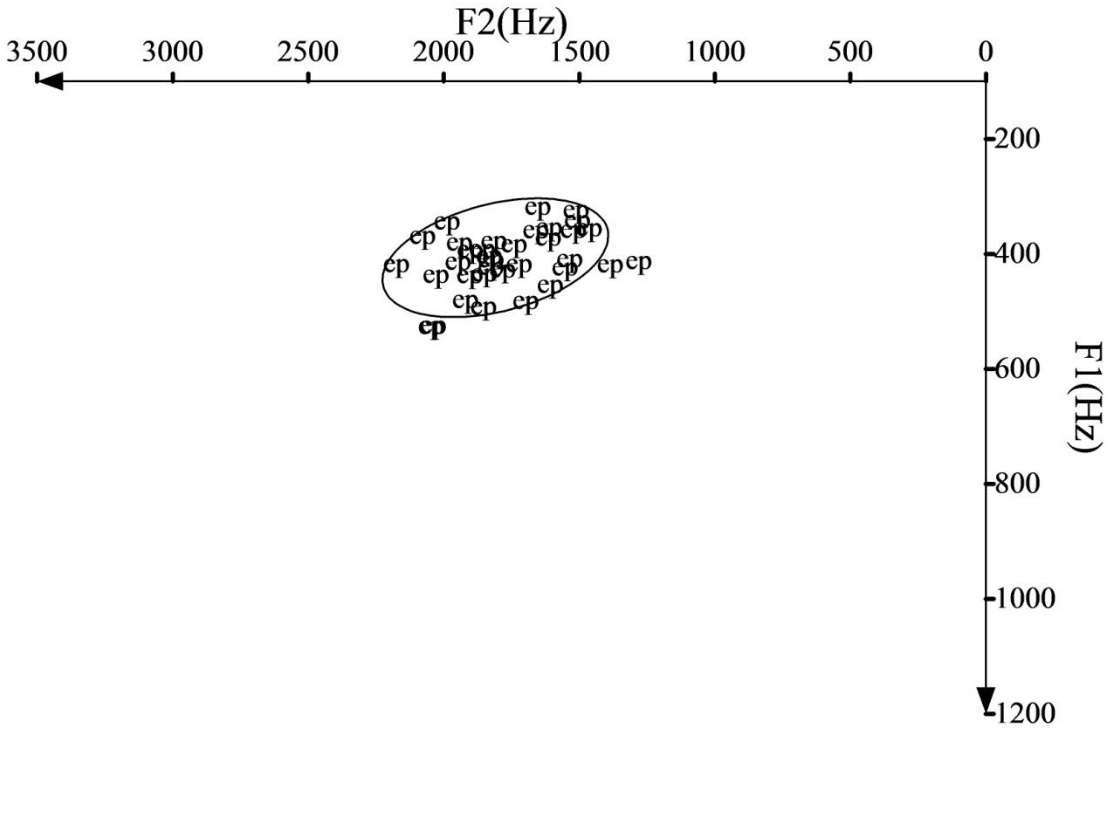


Figure 4.1 Scatter-plot of epenthetic vowels produced by Korean L2 speakers.

Although Figure 4.1 seems to show a tight clustering of values in the high central area, each plotted value is the mean value for one speaker. Therefore, to ascertain whether these values reflect what is really going on, the individual tokens need to be investigated. Figure

4.2 displays the F1 and F2 values of four Korean male L2 speakers, suggesting that there is a genuine clustering in the high central area, despite quite wide variability in F2. Although each speaker showed a different amount of epenthesis, the overall results showed that the F1 values for this group ranged between 200 Hz and 600 Hz, suggesting that most epenthetic vowels seemed to be close to high vowels. All the Korean L2 speakers showed similar ranges of F2 values, as well, between 1,000 Hz and 2,200 Hz.

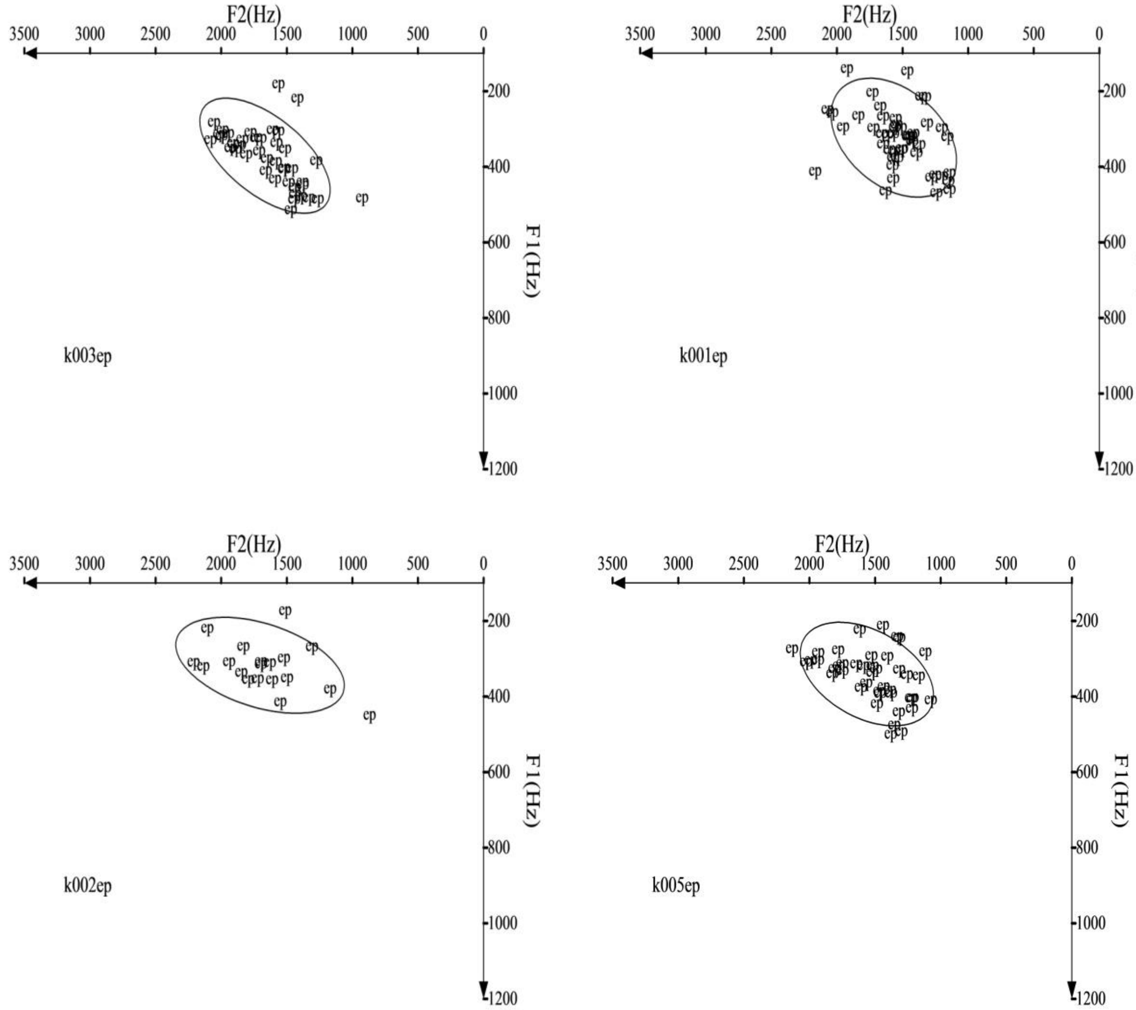


Figure 4.2 Scatter-plot of F1 and F2 values of 4 Korean male L2 speakers.

Figure 4.3 shows the F1 and F2 values of three female speakers. These Korean L2 speakers showed different patterns of epenthesis because of an environment where epenthetic vowels were created both as high-front and high-medial vowels. For example, k008 and k034 had epenthetic vowels that were not only close to high-medial vowels, but were also close to the high-front vowel /i/.

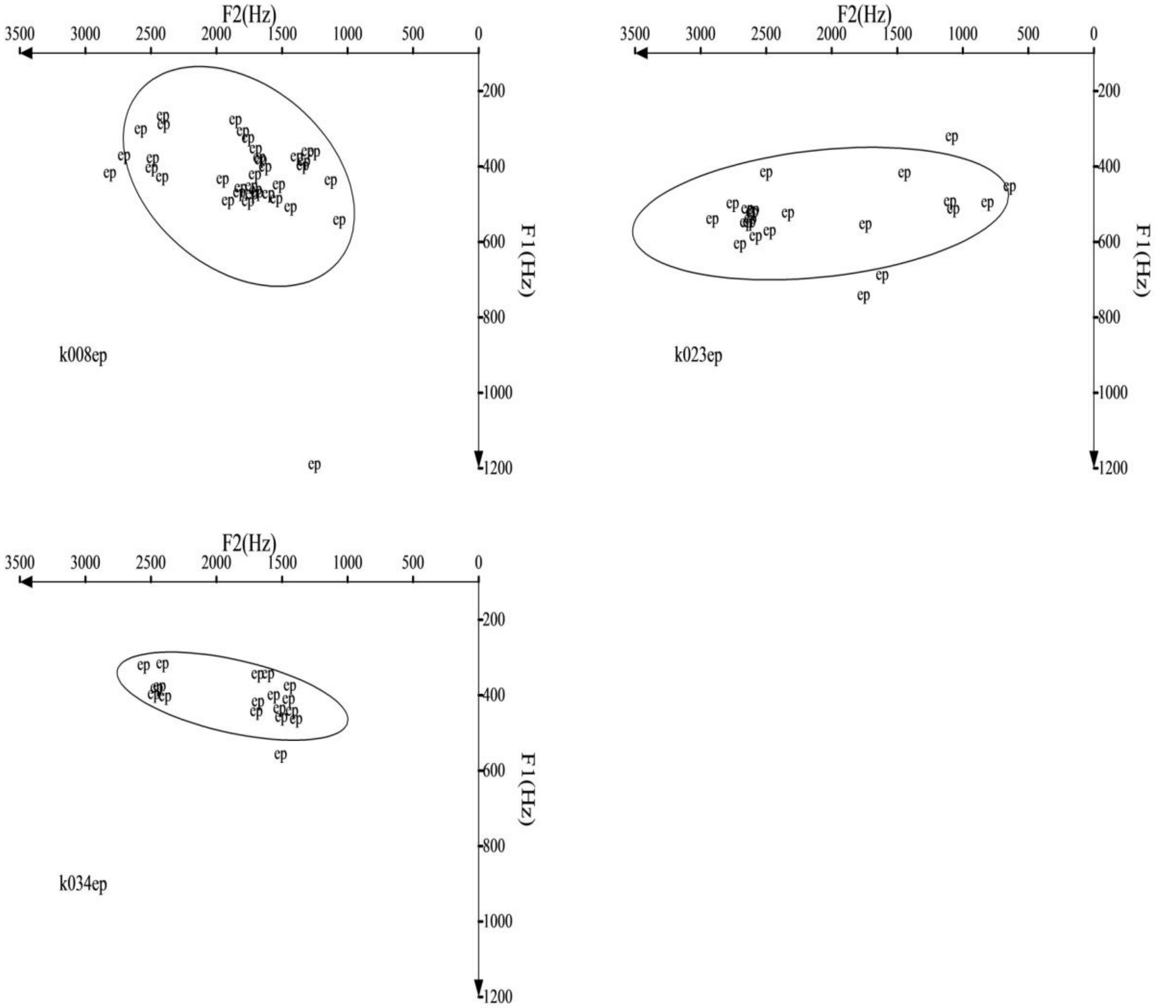


Figure 4.3 Scatter-plot of F1 and F2 patterns of three Korean female L2 speakers.

Figure 4.4 shows the epenthetic vowel patterns from four female Korean L2 speakers. Except for the three female speakers previously described, most of the female speakers were similar in their results to the male speakers in that their epenthetic vowels were close to a high-medial vowel.

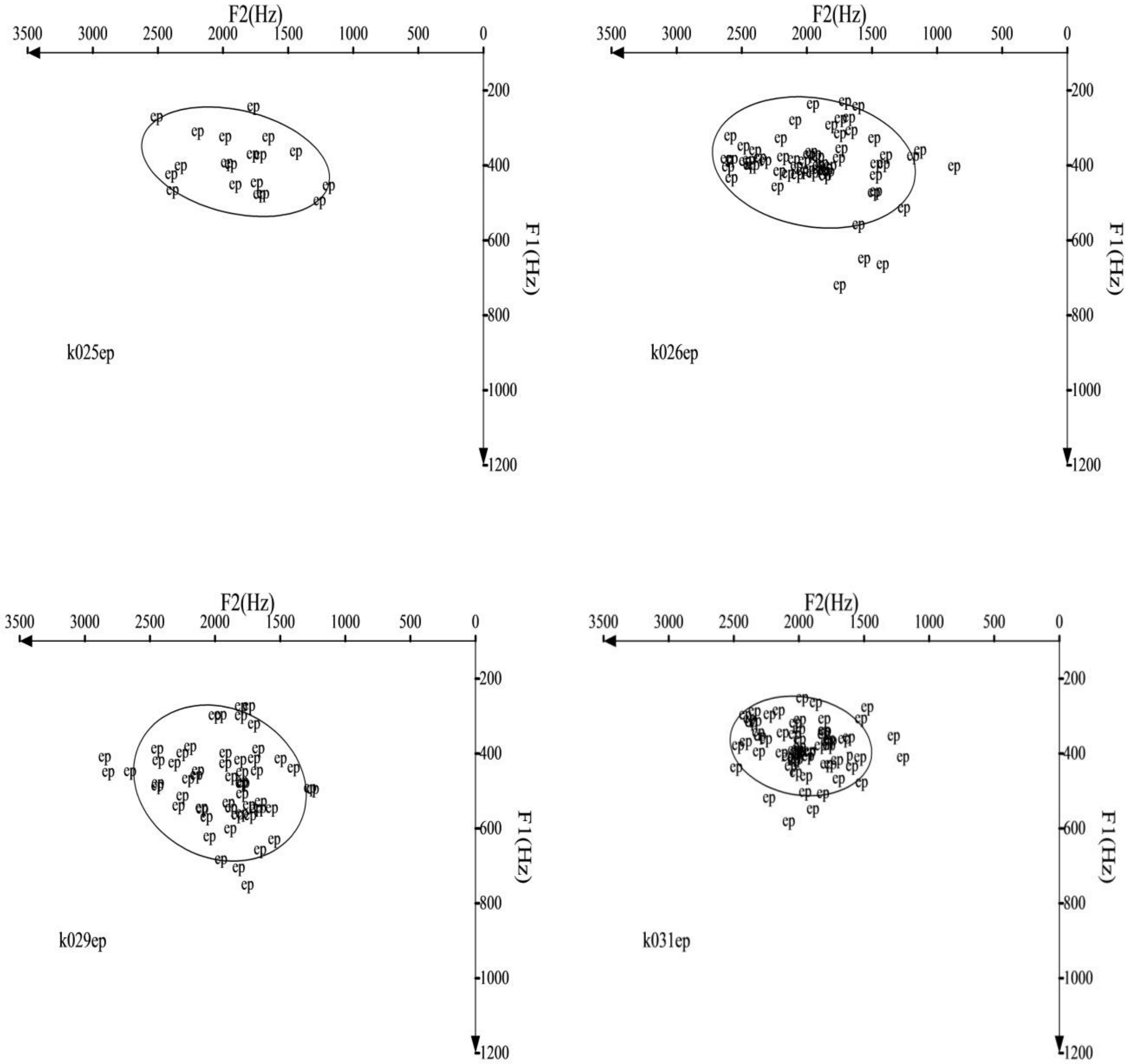


Figure 4.4 Scatter-plot of first and second formant pattern of four Korean female L2 speakers.

Figure 4.5 displays the distribution of normalised English vowels (/i/, /u/ and /ɑ/) and the mean value of the epenthetic vowel from Korean L2 speakers. Lobanov’s (1970) z-score transformation was adopted because the method is most suitable for eliminating anatomical and physiological variations (Adank et al., 2004). Each normalised formant value was calculated by subtracting the individual speaker's mean formant frequency from a formant value and dividing by the standard deviation of the formant frequency.

$$F_i^N = (F_i - \mu_i) / \sigma_i$$

The results produced three vowels: /i/, /u/ and epenthetic vowels. It seemed that epenthetic vowels were close to high vowels. The F2 value of the epenthetic vowels was between the high-front and back /i/ and /u/ vowels, but some vowels overlapped with the high-front vowel /i/.

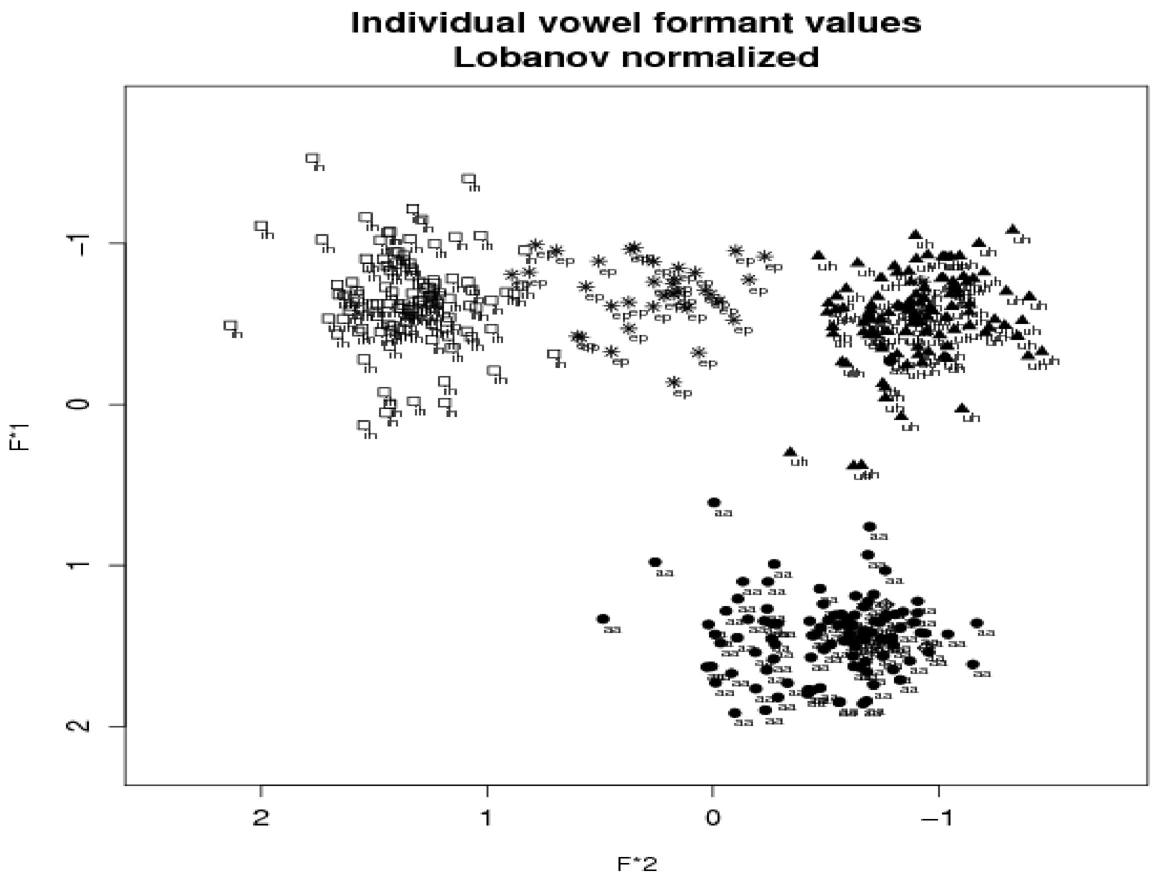


Figure 4.5 Scatter-plot of English full vowels (/i/, /u/ and /ɑ/) and epenthetic vowels produced by Korean L2 speakers.

4.3.2 Environment of epenthesis

The frequency of epenthesis in terms of context from the 36 Korean L2 speakers was created by searching all instances of epenthesis shown during the production test in the training study. In terms of epenthesis context, the results showed that epenthesis production mostly occurred between words, rather than within words. Eleven hundred and forty three occurrences of epenthesis occurred between words, 154 occurrences of epenthesis showed within a word and 118 occurrences of epenthesis were utterance-final following a coda consonant. Table 4.2 shows the occurrences of epenthesis between words.

Context	**Consonants**	**Occurrences of epenthesis**	**Proportion**
CARRIED / FRUIT	/d/ - /f/	77	0.067
MADE / HER	/d/ - /h/	56	0.049
BRUSHED / HER	/d/ - /h/	55	0.048
PAID / HIS	/d/ - /h/	51	0.045
TIED / HIS	/d/ - /h/	49	0.043
MADE / SOME	/d/ - /s/	49	0.043
BROKE / HIS	/k/ - /h/	47	0.041
CHILD / GRABS	/d/ - /g/	44	0.038
HELPED / HER	/t/ - /h/	43	0.038
LOOKED / CLEAN	/t/ - /k/	43	0.038
HAD / NINE	/d/ - /n/	42	0.037
USED / HER	/d/ - /h/	40	0.035
FRIGHTENED / HIS	/d/ - /h/	39	0.034
PACKED / HER	/t/ - /h/	34	0.030
FOUND / HER	/d/ - /h/	31	0.027
LOST / HER	/t/ - /h/	29	0.025
CHILD / DRANK	/t/ - /h/	28	0.024
FOUND / HIS	/d/ - /h/	27	0.024
WANTED / SOME	/d/ - /s/	27	0.024
LIKE / STRAWBERRIES	/k/ - /s/	24	0.021
HIS / SISTER	/z/ - /s/	23	0.020
PAINT / DRIPPED	/t/ - /d/	21	0.018
DRANK / FROM	/k/ - /f/	19	0.017
MELTED / THE	/d/ - /ð /	18	0.016
FRONT / DOOR	/t/ - /d/	17	0.015
DRANK / SOME	/k/ - /s/	15	0.013
HIS / BROTHER	/z/ - /b/	14	0.012
HIS / SCARF	/z/ - /s/	14	0.012
HIS / STORY	/z/ - /s/	14	0.012
WIFE / HELPED	/f/ - /h/	12	0.010

HOUSE / HAD	/s/ - /h/	12	0.010
KICKED / THE	/t/ - /ð/	12	0.010
FOLLOWED / THE	/d/ - / ð /	10	0.009
DOG / DRANK	/g/ - /d/	10	0.009
CHASED / THE	/t/ - /ð/	9	0.008
HE’S / BRINGING	/z/ - /b/	9	0.008
HOUSE / HAD	/z/ - /h/	9	0.008
BAD / CRASH	/d/ - /k/	8	0.007
DROPPED / THE	/t/ - /ð/	7	0.006
WAS /BY	/z/ - /b/	5	0.004
HIS /FACE	/z/ - /f/	5	0.004
HIS /RAINCOAT	/z/ - /r/	5	0.004
NICE / GARDEN	/s/ - /g/	4	0.003
CAUGHT / THE	/t/ - /ð/	4	0.003
HIS / LEG	/z/ - /l/	4	0.003
MILK / WAS	/k/ - /w/	3	0.003
DRINKS / FROM	/s/ - /f/	3	0.003
USED / HER	/t/ - /h/	3	0.003
SHOES / WERE	/z/ - /w/	3	0.003
POLICE / CHASED	/s/ -/ʧ/	2	0.002
HIS / BILL	/z/ - /b/	2	0.002
LEMONS / GROW	/z/ – /g/	2	0.002
HIS / MUG	/z/ - /m/	2	0.002
HE’S / WASHING	/z/ - /w/	2	0.002
FRIGHTENED / HIS	/d/ - /h/	1	0.001
TOOK / SOME	/k/ - /s/	1	0.001
SHUT / THE	/t/ - /ð/	1	0.001
AT / HIS	/t/ - /h/	1	0.001
GRABS / THE	/z/ - /ð/	1	0.001
LADY’S / MAKING	/z/ - /m/	1	0.001

Table 4.2 Produced epenthesis between words.

Korean subjects produced epenthesis while reading both consonant clusters and cross-morpheme boundaries. Among the epenthesis found within word boundaries, some instances occurred at the coda position (e.g., ‘*bed* /bedɨ/’). Interestingly, most of the epenthesis occurred after stop consonants. For example, except for five target words (e.g., *scarf*, *crash*, *face*, *path* and *purse*), the words with utterance-final epenthesis ended with a stop. Furthermore, epenthesis was affected by the voicing feature of the preceding consonant. Table 4.3 shows the epenthesis in three different conditions (coda cluster, onset cluster and between syllables) and Table 4.4 displays produced epenthesis at the end (utterance-medial and utterance-final).

Context	Consonants	Occurrences of epenthesis	Conditions	Proportion
BRUSHED	/ʃ/ - /t/	58	Coda cluster	0.38
DRIPPED / DRIPPED	/p/ - /t/	29	Coda cluster	0.19
DROPPED	/p/ - /t/	13	Coda cluster	0.08
DRINKS	/k/ - /s/	11	Coda cluster	0.07
LOOKED	/k/ - /t/	9	Coda cluster	0.06
POSTMAN	/t/ - /m/	9	Between syllables	0.06
HELPED	/p/ - /t/	8	Coda cluster	0.05
CHASED	/s/ - /t/	5	Coda cluster	0.03
CHILDREN	/d/ - /r/	2	Onset cluster	0.01
KICKED	/k/ – /t/	2	Coda cluster	0.01
USED	/z/ - /d/	2	Coda cluster	0.01
DROPPED	/d/ - /r/	1	Onset cluster	0.01
DROVE	/d/ - /r/	1	Onset cluster	0.01
PACKED	/k/ - /t/	1	Coda cluster	0.01
CHILD	/l/ - /d/	1	Coda cluster	0.01
SPOON	/s/ - /p/	1	Onset cluster	0.01
HUSBAND	/z/ - /b/	1	Between syllables	0.01

Table 4.3 Produced epenthesis within a word.

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
BED <END>	/d/	17	coda (utterance-final)	0.10
DRIPPED / ON	/t/ - /ɒ/	13	coda (utterance-medial)	0.08
GROUND <END>	/d/	12	coda (utterance-final)	0.07
SCARF <END>	/f/	11	coda (utterance-final)	0.07
ROAD <END>	/d/	10	coda (utterance-final)	0.06
LEG <END>	/g/	10	coda (utterance-final)	0.06
COLD <END>	/d/	8	coda (utterance-final)	0.05
FOOD <END>	/d/	8	coda (utterance-final)	0.05
CRASH <END>	/ʃ/	7	coda (utterance-final)	0.04
MUG <END>	/g/	6	coda (utterance-final)	0.04
FACE <END>	/s/	5	coda (utterance-final)	0.03
MOUSE <END>	/s/	5	coda (utterance-final)	0.03
USED / A	/d/ - /ə/	5	coda (utterance-medial)	0.03
LAUGHED / AT	/t/ - /æ /	5	coda (utterance-medial)	0.03
GOALPOST <END>	/t/	4	coda (utterance-final)	0.02
PATH <END>	/Ɵ/	4	coda (utterance-final)	0.02
CAUGHT / A	/t/ - /ə/	4	coda (utterance-medial)	0.02
DROVE / UP	/v/ - /ə/	4	coda (utterance-medial)	0.02
HUSBAND <END>	/d/	3	coda (utterance-final)	0.02
PURSE <END>	/s/	3	coda (utterance-final)	0.02
DRIPPED / ON	/t/ - /o/	3	coda (utterance-medial)	0.02
TELLS / A	/z/ - /ə/	3	coda (utterance-medial)	0.02
MILK <END>	/k/	2	coda (utterance-final)	0.01
HAD / A	/d/ - /ə/	2	coda (utterance-medial)	0.01
LAUGHED / AT	/t/ – /æ/	2	coda (utterance-medial)	0.01
LOOKED / AT	/t/ – /æ/	2	coda (utterance-medial)	0.01
CAKE <END>	/k/	1	coda (utterance-final)	0.01
GATE <END>	/t/	1	coda (utterance-final)	0.01
RAINCOAT <END>	/t/	1	coda (utterance-final)	0.01
HAD / A	/d/ - /ə/	1	coda (utterance-medial)	0.01
HIT / A	/t/ - /ə/	1	coda (utterance-medial)	0.01
BRINGS / A	/z/ - /ə/	1	coda (utterance-medial)	0.01
LIES / ON	/z/ - /o/	1	coda (utterance-medial)	0.01

Table 4.4 Produced epenthesis at the end.

The results showed that the epenthesis was more frequent when the final consonant was voiced stops (e.g., *bed* – 17 times, *ground* – 12 times, *leg* – 10 times, *road* – 10 times, *cold* – 8 times, *food* – 8 times, *mug* – 6 times and *husband* – 3 times) than voiceless stops (e.g., *goalpost* – 4 times, *milk – 2* times, *cake* – 2 times, *gate* – 1 time and *raincoat* – 1 time). The results were identical to the findings of previous studies in that Korean L2 speakers more frequently produced epenthesis after postvocalic word-final voiced stops than other consonants (Kang, 2003).

It seems that Korean L2 speakers produce more epenthesis under certain conditions. Table 4.5 shows the occurrences of epenthesis between stops and fricatives. Korean subjects produced the most frequent epenthesis between the stops and fricatives, showing 701 occurrences of epenthesis. Epenthesis was most frequent between /d/ and /h/ (e.g., *She* ***made her*** *bed*), showing 349 epentheses. They produced 138 epentheses between /t/ and /h/ (e.g., *She* ***helped her*** *husband*), 77 epentheses between /d/ and /f/ (e.g., *The lorry* ***carried fruit***), 76 epenthesis between /d/ and /s/ (e.g., *They* ***wanted some*** *potatoes*), 33 epentheses between /t/ and /ð/(e.g., *The police* ***chased the*** *car*) and 28 epentheses between /d/ and /ð/ (e.g., *They* ***followed the*** *path*). Figure 4.6 shows the rate of epenthesis production in different conditions and Figure 4.7 shows the spectrogram of epenthetic vowels between /d/-/h/ and /t/-/h/.

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
CARRIED / FRUIT	/d/ - /f/	77	between words	0.110
MADE / HER	/d/ - /h/	56	between words	0.080
BRUSHED / HER	/d/ - /h/	55	between words	0.078
PAID / HIS	/d/ - /h/	51	between words	0.073
TIED / HIS	/d/ - /h/	49	between words	0.070
MADE / SOME	/d/ - /s/	49	between words	0.070
HELPED / HER	/t/ - /h/	43	between words	0.061
USED / HER	/d/ - /h/	40	between words	0.057
FRIGHTENED / HIS	/d/ - /h/	39	between words	0.056
PACKED / HER	/t/ - /h/	34	between words	0.049
FOUND / HER	/d/ - /h/	31	between words	0.044
LOST / HER	/t/ - /h/	29	between words	0.041
CHILD / DRANK	/t/ - /h/	28	between words	0.040
FOUND / HIS	/d/ - /h/	27	between words	0.039
WANTED / SOME	/d/ - /s/	27	between words	0.039

MELTED / THE	/d/ - /ð /	18	between words	0.026
KICKED / THE	/t/ - /ð/	12	between words	0.017
FOLLOWED / THE	/d/ - / ð /	10	between words	0.014
CHASED / THE	/t/ - /ð/	9	between words	0.013
DROPPED / THE	/t/ - /ð/	7	between words	0.010
CAUGHT / THE	/t/ - /ð/	4	between words	0.006
USED / HER	/t/ - /h/	3	between words	0.004
FRIGHTENED / HIS	/d/ - /h/	1	between words	0.001
SHUT / THE	/t/ - /ð/	1	between words	0.001
AT / HIS	/t/ - /h/	1	between words	0.001

Table 4.5 Produced epenthesis between stop and fricative consonants.

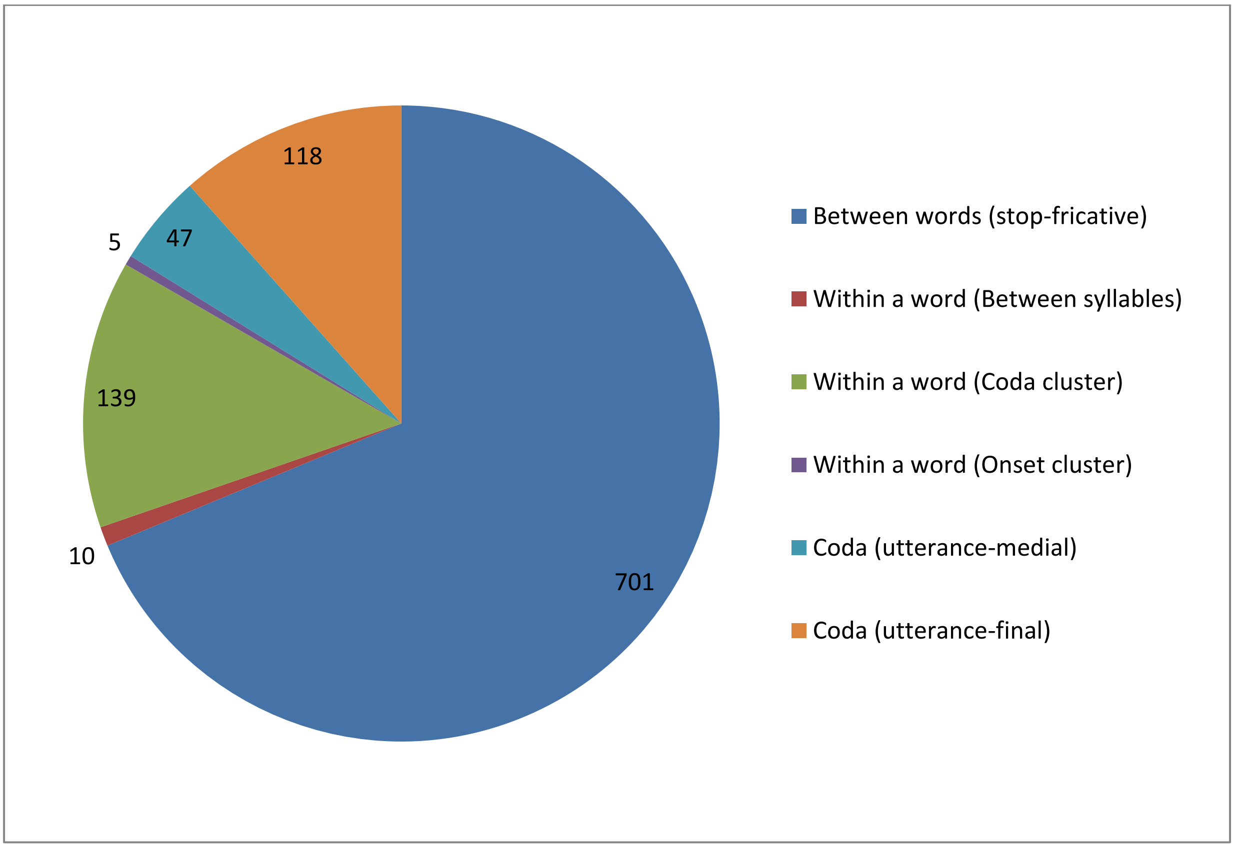


Figure 4.6 Pie chart of epenthesis production.

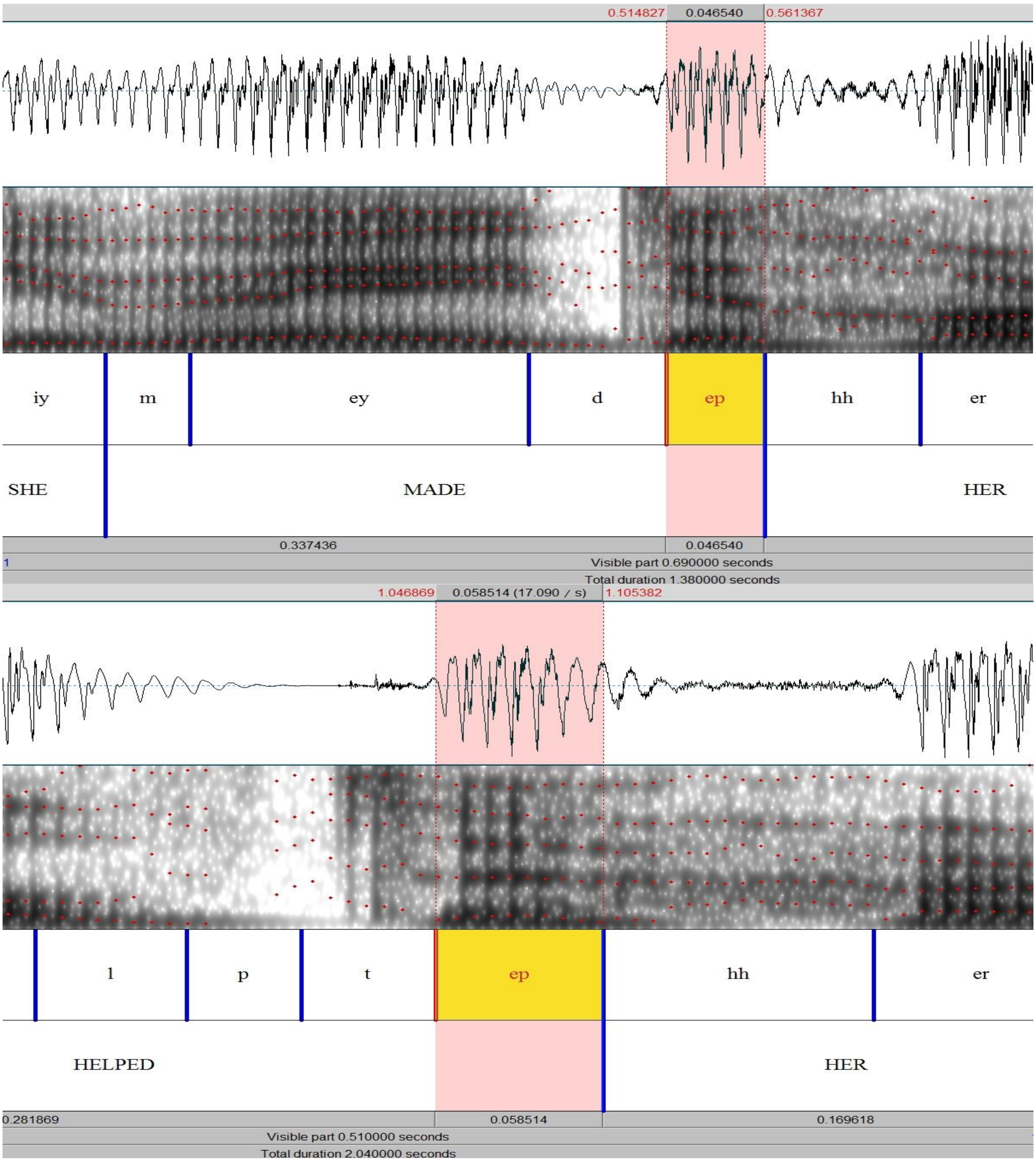


Figure 4.7 Spectrograms of '*She made her bed*' and '*The wife helped her husband*' from k003.

Voicing of consonants seemed to be related to the occurrences of epenthesis production. Tables 4.5, 4.6, 4.7 and 4.8 display the occurrences of epenthesis in terms of voicing feature and Figure 4.8 shows the rate of epenthesis production in terms of voicing feature. The results show that Korean L2 speakers produced the most frequent epenthesis between voiced and voiceless consonants, showing 575 occurrences of epentheses (e.g., *She* ***brushed her*** *hair*). They produced 318 epentheses between voiceless consonants (e.g., *He* ***broke his*** *leg*), 174 epentheses between voiced consonants (e.g., *The house* ***had nine*** *rooms*) and 74 epentheses between voiceless and voiced consonants (e.g., *The* ***paint dripped*** *on the floor).*

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
CARRIED / FRUIT	/d/ - /f/	77	between words	0.134
MADE / HER	/d/ - /h/	56	between words	0.097
BRUSHED / HER	/d/ - /h/	55	between words	0.096
PAID / HIS	/d/ - /h/	51	between words	0.089
TIED / HIS	/d/ - /h/	49	between words	0.085
USED / HER	/d/ - /h/	40	between words	0.070
FRIGHTENED / HIS	/d/ - /h/	39	between words	0.068
FOUND / HER	/d/ - /h/	31	between words	0.054
FOUND / HIS	/d/ - /h/	27	between words	0.047
FRIGHTENED / HIS	/d/ - /h/	1	between words	0.002
BAD / CRASH	/d/ - /k/	8	between words	0.014
MADE / SOME	/d/ - /s/	49	between words	0.085
WANTED / SOME	/d/ - /s/	27	between words	0.047
HIS /FACE	/z/ - /f/	5	between words	0.009
HOUSE / HAD	/z/ - /h/	9	between words	0.016
HIS / SISTER	/z/ - /s/	23	between words	0.040
HIS / SCARF	/z/ - /s/	14	between words	0.024
HIS / STORY	/z/ - /s/	14	between words	0.024

Table 4.6 Produced epenthesis between voiced and voiceless consonants.

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
BROKE / HIS	/k/ - /h/	47	between words	0.148
HELPED / HER	/t/ - /h/	43	between words	0.135
LOOKED / CLEAN	/t/ - /k/	43	between words	0.135
PACKED / HER	/t/ - /h/	34	between words	0.107
LOST / HER	/t/ - /h/	29	between words	0.091
CHILD / DRANK	/t/ - /h/	28	between words	0.088
LIKE / STRAWBERRIES	/k/ - /s/	24	between words	0.075
DRANK / FROM	/k/ - /f/	19	between words	0.060
DRANK / SOME	/k/ - /s/	15	between words	0.047
WIFE / HELPED	/f/ - /h/	12	between words	0.038
HOUSE / HAD	/s/ - /h/	12	between words	0.038

DRINKS / FROM	/s/ - /f/	3	between words	0.009
USED / HER	/t/ - /h/	3	between words	0.009
PACKED	/k/ - /t/	2	between words	0.006
POLICE / CHASED	/s/ -/ʧ/	2	between words	0.006
TOOK / SOME	/k/ - /s/	1	between words	0.003
AT / HIS	/t/ - /h/	1	between words	0.003

Table 4.7 Produced epenthesis between voiceless consonants.

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
CHILD / GRABS	/d/ - /g/	44	between words	0.25
HAD / NINE	/d/ - /n/	42	between words	0.24
MELTED / THE	/d/ - /ð /	18	between words	0.10
HIS / BROTHER	/z/ - /b/	14	between words	0.08
FOLLOWED / THE	/d/ - / ð /	10	between words	0.06
DOG / DRANK	/g/ - /d/	10	between words	0.06
HE'S / BRINGING	/z/ - /b/	9	between words	0.05
WAS /BY	/z/ - /b/	5	between words	0.03
HIS /RAINCOAT	/z/ - /r/	5	between words	0.03
HIS / LEG	/z/ - /l/	4	between words	0.02
SHOES / WERE	/z/ - /w/	3	between words	0.02
HIS / BILL	/z/ - /b/	2	between words	0.01
LEMONS / GROW	/z/ – /g/	2	between words	0.01
HIS / MUG	/z/ - /m/	2	between words	0.01
HE'S / WASHING	/z/ - /w/	2	between words	0.01
GRABS / THE	/z/ - /ð/	1	between words	0.01
LADY'S / MAKING	/z/ - /m/	1	between words	0.01

Table 4.8 Produced epenthesis between voiced consonants.

Context	Consonants	Occurrences of epenthesis	Condition	Proportion
PAINT /DRIPPED	/t/ - /d/	21	between words	0.28
FRONT / DOOR	/t/ - /d/	17	between words	0.23
KICKED / THE	/t/ - /ð/	12	between words	0.16
CHASED / THE	/t/ - /ð/	9	between words	0.12
DROPPED / THE	/t/ - /ð/	7	between words	0.09
CAUGHT / THE	/t/ - /ð/	4	between words	0.05
MILK / WAS	/k/ - /w/	3	between words	0.04
SHUT / THE	/t/ - /ð/	1	between words	0.01

Table 4.9 Produced epenthesis between voiceless and voiced consonants.

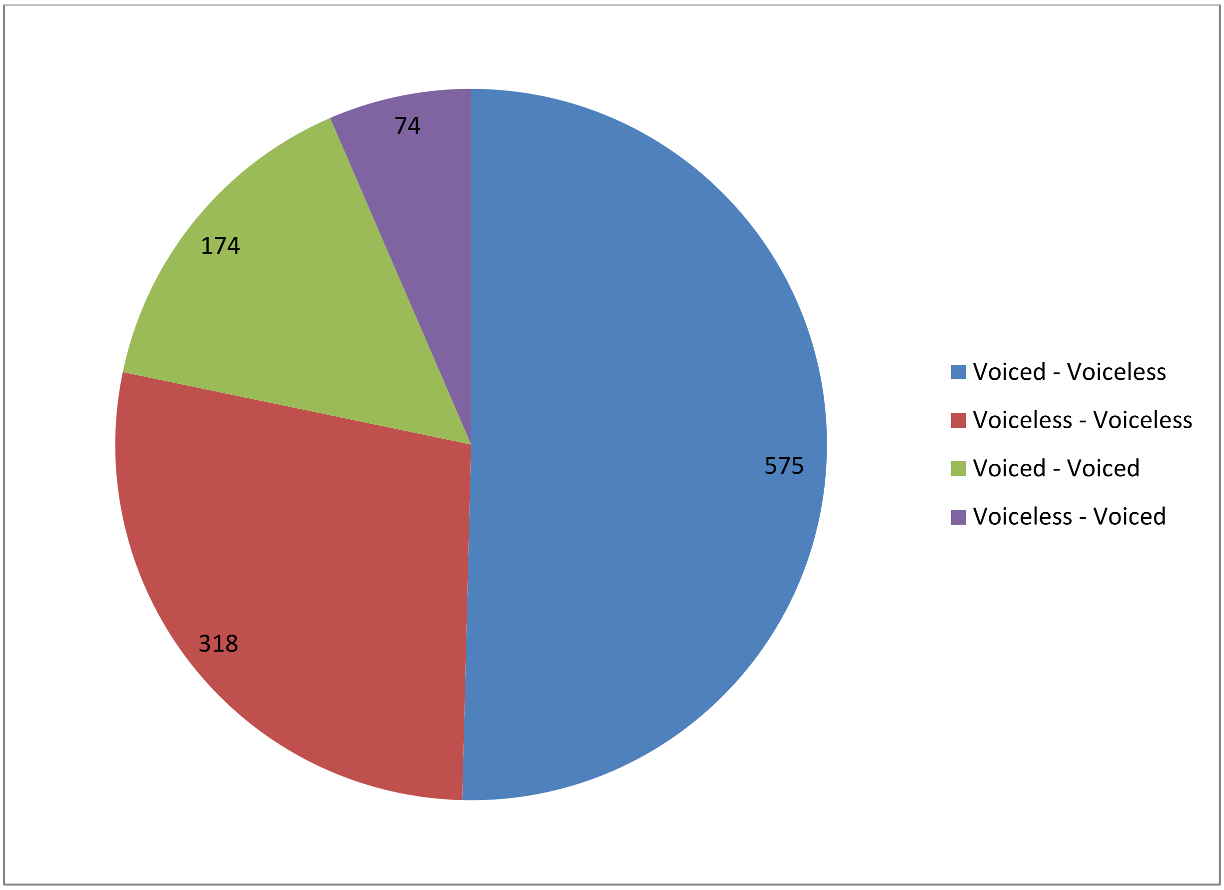


Figure 4.8 Pie chart of produced epenthesis in terms of voicing features.

4.3.3 Extra-phonological factors

Two extra-phonological factors were analysed. First, the effect of English experience was investigated. The length of time learning English and living in an English-speaking country were collected from all Korean subjects through a questionnaire. Then, the relationship between those English experience factors and the amount of epenthesis production were analysed. The results showed that the length of time learning English was not statistically correlated with epenthesis production (r = .265, p > .05). For example, k031 reported that she had been learning English for 30 years. However, she produced 67 epenthetic vowels. However, k016 had been learning English for 15 years but only produced five epenthetic vowels. The results of length of time living in an English-speaking country were not much different; a lack of significant correlations with the number of epenthesis produced was found with this factor (r = -.022, p > .05). For example, some participants produced many epenthetic vowels despite relatively long lengths of residence. Specifically, k007 reported that he had lived in an English-speaking country for 10 years. However, he produced 85 epenthetic vowels. Yet, k004 reported that she had lived for three months in an English-speaking country but produced only three epenthetic vowels. Therefore, it is plausible that epenthesis production is unrelated to the duration and amount of exposure.

As length of learning English and living in English-speaking countries were not linked to epenthesis production, the results of the speech-in-noise recognition test spoken by the SBEs were used to see whether this measure is linked to epenthesis because recognition in noise could reveal dialog comprehension. The Pearson correlation test also showed no strong correlation between the results of the noise recognition test spoken by the SBEs and epenthesis production (r = -.2769, p = .1021), supporting that English experience is not linked to epenthesis production.

Some of the Korean L2 speakers may have been affected by orthography. When Korean L2 speakers read BKB sentences, they inserted epenthetic vowels when the word contained the past-tense suffix '-ed' (e.g., *dripp**ed***, *brush**ed***). The amount of epenthetic vowels produced with this suffix was counted, and the proportion of those vowels was calculated. The results showed that only 143 of 1,550 epenthetic vowels were linked to the past-tense suffix '-ed', and 25 of 36 Korean L2 speakers may have been affected by this orthography. Table 4.10 displays the proportion of epenthesis production affected by orthography. The effect of orthography varied in that some subjects produced more than 50% of their total amount of epenthetic vowels, but other subjects did not seem to be affected by orthography, showing 0% of orthographic epenthesis production. Pearson correlation tests expressed no significant correlation between length of time learning English and the total number of orthographic epentheses (r = .0065, p = .97). Length of time living in an English-speaking country was also not significantly correlated with the amount of orthographic epenthesis (r = -.0503, p = .7707). No significant correlation was found between length of time learning English and the proportion of orthographic epenthesis (r =-.2507, p = .1403). Likewise, no strong correlation was found between length of time living in an English-speaking country and orthographic epenthesis proportion (r = -.1597, p = .3522).

Subjects	**No. of epentheses**	**No. of epentheses by orthography**	**Proportion**
K001	47	4	0.09
K002	19	11	0.58
K003	41	4	0.10
K004	3	0	0
K005	42	1	0.02
K006	12	0	0
K007	85	7	0.08
K008	37	0	0
K009	65	11	0.17
K010	27	3	0.11
K012	56	5	0.09
K013	6	2	0.33
K014	15	2	0.13
K015	8	4	0.50
K016	5	1	0.20
K017	20	1	0.05
K018	14	0	0
K019	64	1	0.02
K020	13	0	0
K021	5	1	0.20
K022	76	4	0.05
K023	22	16	0.73
K025	19	0	0
K026	63	0	0
K027	208	13	0.06
K029	57	7	0.12
K030	2	0	0
K031	67	2	0.03
K032	38	8	0.21
K033	50	5	0.10
K034	18	0	0
K035	272	11	0.04

K036	5	0	0
K037	38	12	0.32
K038	0	0	0
K039	31	7	0.22

Table 4.10 Proportion of orthographic epenthesis.

Ten English words were shown to create the most orthographic affect for Korean L2 speakers: *brushed*, *dripped*, *dropped*, *looked*, *helped*, *chased*, *packed*, *kicked* and *used*. Interestingly, the frequency of orthographic epenthesis differed with each word. The frequency of orthographic epenthesis varied from 2 to 64. The target word *brushed* most frequently contained an epenthetic vowel, accounting for 48% of the total orthographic epenthesis. Nineteen Korean subjects produced epenthetic vowels when reading *brushed*.

Word	Frequency	Percentage	Number of subjects
Brushed	64	48%	19
Dripped	28	21%	11
Dropped	14	11%	7
Looked	7	5%	2
Helped	7	5%	6
Chased	5	4%	2
Packed	3	2%	1
Kicked	2	2%	2
Used	2	2%	1
Total	**132**	**100%**	**51**

Table 4.11 The frequency of orthographic epenthesis and percentage for each target word.

Figure 4.9 shows an epenthetic vowel in the target word *brushed*. The spectrogram for '*brushed'* shows that epenthetic vowels were inserted after the voiceless consonant. The gap between F1 and F2 was wide, suggesting that this epenthetic vowel was close to the high-front vowel /i/. This result may be due to the fact that the consonant preceding /i/ has a palatal component (Lee, 2000).

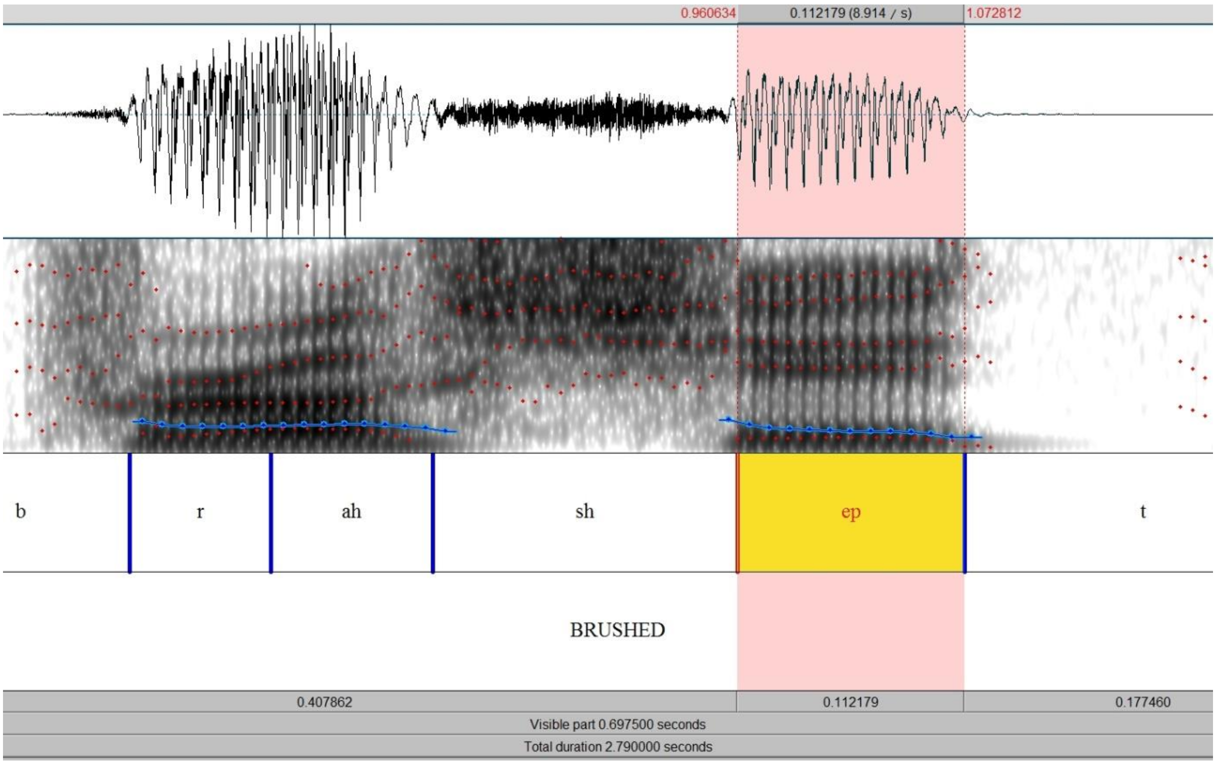


Figure 4.9 Spectrogram of *brushed* with an epenthetic vowel from k003.

However, similar patterns were found with other target words, such as *dripped* and *dropped*. Figures 4.10 and 4.11 show that the F1 and F2 values of epenthetic vowels were widely separated, suggesting that those vowels were close to the high-front vowel. This gap could be caused by the preceding vowel or a strong orthographical effect. Regarding *dripped*, the preceding vowel was /i/, which is high front. Thus, the following epenthetic vowel might be assimilated. However, this theory cannot be applied to the word *dropped* because the preceding vowel is not a high vowel. It could be caused by the orthographical effect that the subject read the '-ed' suffix as an /ɪ/ vowel because the letter 'e' is frequently pronounced as /ɪ/.

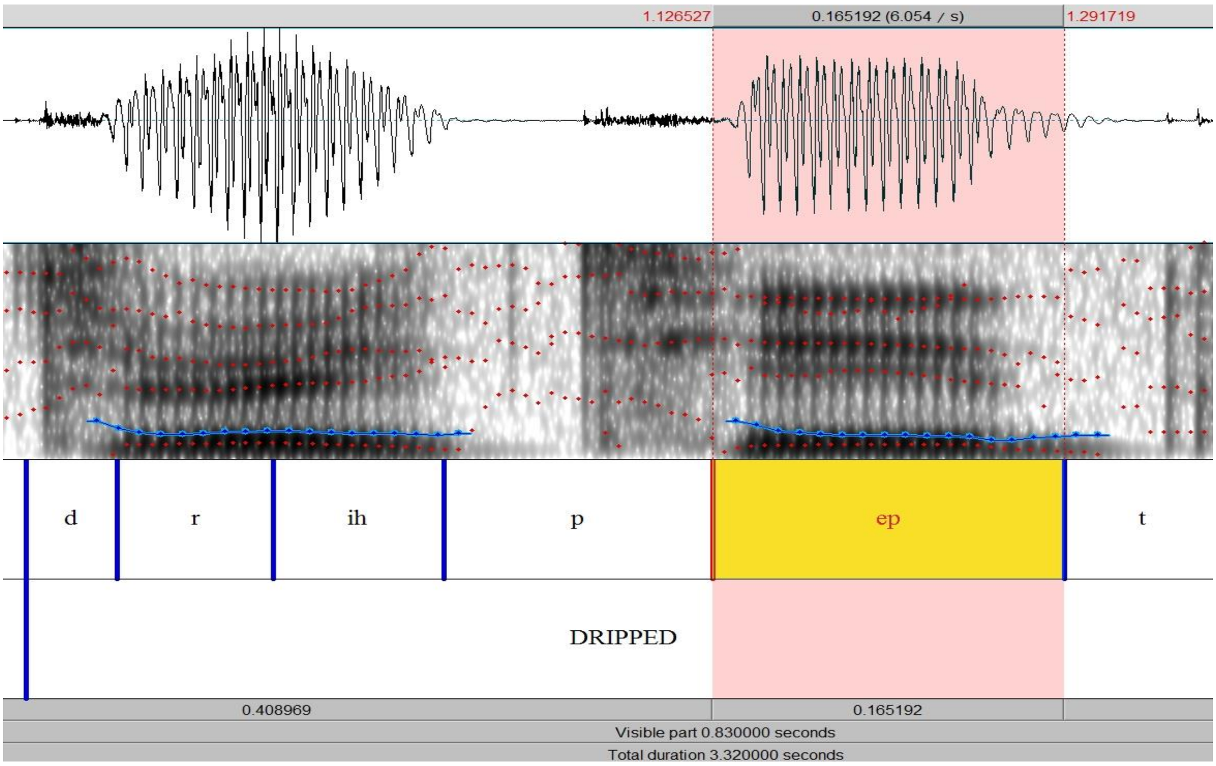


Figure 4.10 Spectrogram of *dripped* with an epenthetic vowel from k009.

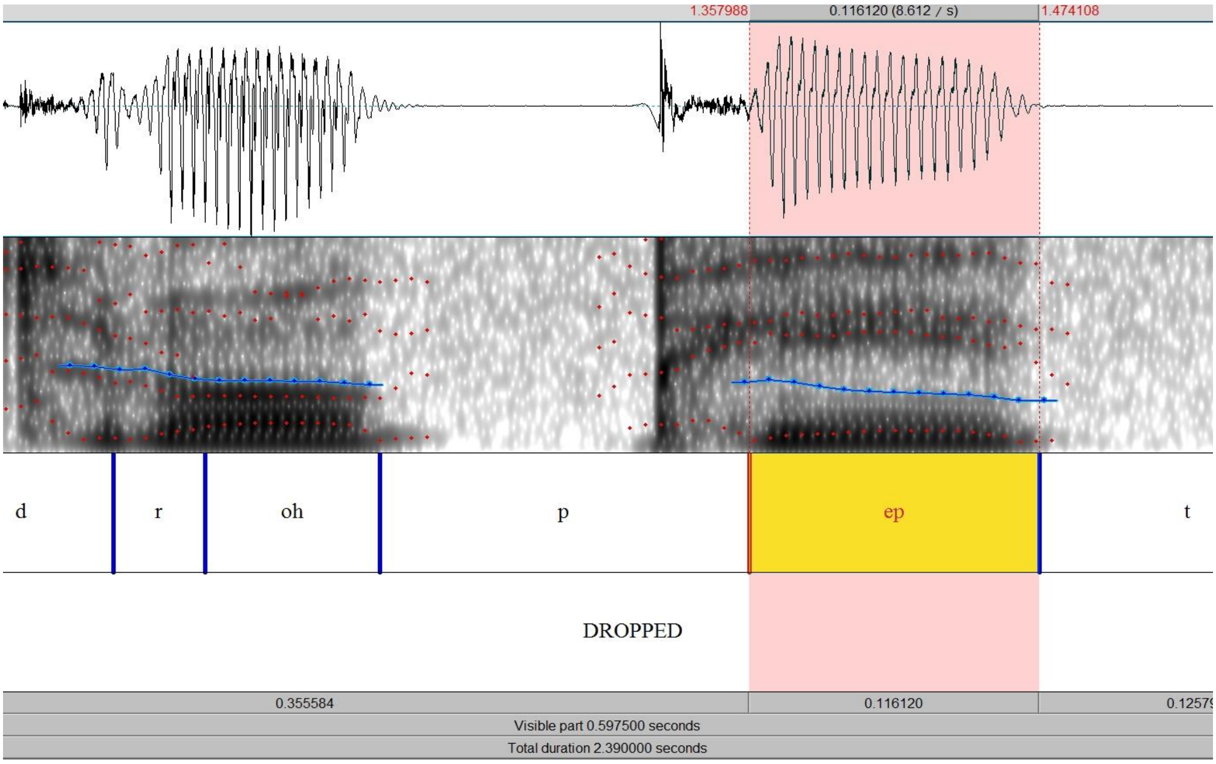


Figure 4.11 Spectrogram of *dropped* with an epenthetic vowel from k023.

To summarise, English experience, in terms of length of time learning English or living in an English-speaking country, did not affect vowel epenthesis. Furthermore, the results of the speech-in-noise recognition test spoken by the SBEs were not related to epenthesis production, supporting that English experience is not linked to epenthesis. Orthographical effects do not seem to be related to epenthesis production among Korean L2 speakers because only 9% of epenthesis production was related to orthography. The results further expressed that epenthetic vowels in target words were easily affected by a preceding consonant (e.g., /ʃ/ or /s/), but some of them were independent, as well.

4.4 Discussion

The present study investigated the acoustic characteristics of epenthetic vowels produced by 36 Korean L2 speakers. Three main findings were found. First, most epenthetic vowels have high F1 values and varied F2 values. Second, a preceding vowel can affect the acoustic characteristics of the following epenthetic vowel. Third, the frequency of epenthesis is affected by the environment.

Epenthetic vowels have high F1 and varied F2 values, which has also been supported by previous studies. According to the results of previous studies that investigated Korean full vowels (Kwak, 1988; Igeta & Arai, 2011; Chang, 2012), epenthetic vowels were quite close to the Korean high-mid vowel /ɨ/. The present study confirmed that epenthetic vowels are close to high-mid or high-front vowels (Lee, 2009). This study also supported the conclusion that learners of English usually insert the shortest vowels (Dupoux et al., 2011). Korean L2 speakers may have inserted an epenthetic vowel that was close to /ɨ/ because this vowel is the shortest vowel among Korean full vowels (Koo, 1998). Normalised mean values of the epenthetic vowels showed that they were distributed between English high-front and back vowels with some overlapping, suggesting that most epenthetic vowels were created near the high-medial vowels, but some were created more front because of environmental effects.

The results of investigating the contexts of epenthesis clearly indicate that epenthesis seems to occur in certain contexts. First, the results show that most epenthesis occurred in word junctions, rather than consonant clusters, with more than 80% of epenthesis produced between words. Second, epenthesis is affected by consonant manner in word junctions. The results demonstrate that Korean subjects produced the most frequent epenthesis between obstruents, such as stops and fricatives. Some previous studies show vowel epenthesis occurring more frequently after voiced consonants than voiceless ones (Kang, 2003).

However, no earlier studies seemed to identify obstruents as the most important category of consonants in the environment for epenthesis. Third, epenthesis was affected by the voicing feature of consonants at the word boundary. The results show that Korean subjects produced more epenthesis between voiced and voiceless consonants. Although Kabak and Idsardi (2007) revealed that Korean learners of English may suffer perceptual epenthesis for all consonantal contact not allowed in Korean (*consonantal contact hypothesis)* and a syllable structure violation in terms of the coda consonants (*coda condition hypothesis),* the present study provided the practical data that epenthesis production occurred between words rather than within consonant clusters.

The investigation of extra-phonological factors showed both English experience and orthography were unrelated to epenthesis production. The results showed that length of time learning English, living in an English-speaking country and the results of the noise recognition test spoken by the SBEs were not correlated with the amount of epenthesis. The results show that 9% of epenthesis seemed to be affected by orthography, thus orthography does not play a major role in epenthesis, except perhaps for some individual subjects.

Despite these interesting findings, this study has limitations that should be considered for future studies. First, in terms of English experience, this study only investigated the length of time learning English and living in an English-speaking country, but more measures may affect English experience. For example, the total amount of epenthesis could be different with respect to how often Korean L2 speakers use English in their daily lives. Previous studies have shown that that the amount of native language usage affects the pronunciation of the second language (Flege et al., 1997). The amount of epenthesis could be different between subjects speaking English more than several hours per day and those speaking less than one hour per day. Second, 'occurrences' could not clearly reflect the differences between the triggering environments accurately. Although all Korean subjects read all the given BKB sentences and had the same chance to produce an epenthetic vowel in every environment, there could be some consonant sequences in the sentence not triggering epenthesis (e.g., no epenthesis between [g-d] sequences in '*The do**g** **d**rank from a bowl'*). Therefore, the pie charts are not necessarily an accurate quantification of what happens in real life. They simply summarise the classification of examples in the data.

Based on these limitations, future studies should investigate epenthetic vowels with various measures. First, further studies could examine whether Korean L2 subjects with different levels of English-speaking abilities will produce different amounts of epenthesis. The relationship between English-speaking test scores and the amount of epenthesis should be examined. Furthermore, the duration of English-speaking time should be considered. In terms of phonetic approaches, future studies could investigate whether English typological factors interrupt proper English consonant pronunciation. Bayraktaroğlu (2008) showed that Turkish L2 speakers were affected by the English orthographic system, producing production errors including epenthesis. Therefore, Korean L2 speakers might also be affected by the different orthographic system.

Chapter 5: General Discussion

This thesis presents three studies. The first investigated Korean second-language learners (L2) with varying degrees of English experience to determine whether they had difficulties with vowel epenthesis and whether the frequency of production and perception epentheses was linked. Through an individual approach, this study aimed to determine whether vowel epenthesis was more closely related to the perception and production of segments (vowels and consonants) or prosody. Several perception and production tasks, such as reading sentences, vowel and consonant identification tests, reading target words that may have epenthetic vowels and stress identification and epenthetic vowel perception were completed by 32 Korean L2 speakers. The first study demonstrated three main findings. First, the results supported previous studies wherein Korean L2 speakers showed a large variability in production epenthesis, which revealed difficulties in vowel epenthesis. In perception, native English speakers were more accurate than Korean L2 speakers, suggesting that Korean participants suffered perception epenthesis. Second, this study found that production and perception epentheses are not related. This finding supported the previous theory that difficulties with phonotactic constraints are realised differently in speech production and perception among L2 speakers (Kabak & Idsardi, 2003). Third, the first study showed that vowel epenthesis was more closely linked to vowel production and perception abilities than other measures, such as segments or prosody. The results also showed that the amount of production epenthesis was inversely related to vowel abilities, suggesting that respondents who better produced and perceived English vowels showed less epenthesis. Moreover, stress recognition abilities were moderately correlated with epenthesis, suggesting that supra-segmental abilities can affect vowel epenthesis.

The second study focused on training 36 Korean L2 speakers in English vowels and prosody. The goal in the work was to decipher whether training in English vowels and prosody reduced the total amount of epenthesis and improved other segmental and supra-segmental abilities. First, the study found that the focus and stress abilities of Korean L2 speakers could be improved through focus-stress auditory training, similar to previous training studies with segments. Second, the work demonstrated that each type of training independently improved vowel and prosody abilities despite some overlap. The results revealed that vowel training worked better for training vowel abilities, and focus-stress training was more effective for prosody. Thus, it is plausible that different training approaches are required to achieve an overall greater training effect. Third, the study found that Korean L2 speakers showed a reduced amount of production and perception epentheses after training. Both vowel and prosody training helped decrease epenthesis, but there was no significant interaction between training methods, which supported the first study, which suggested that vowel epenthesis was linked to both segmental and supra-segmental abilities.

The third study examined epenthetic vowels using acoustic measures and extra-phonological factors. The results demonstrated three main findings. First, epenthetic vowels had relatively high F1 values and a wide range of F2 values, suggesting that epenthetic vowels could be located near high-vowel categories. Most of the epenthetic vowels were inserted near Korean high-mid vowels, but some vowels were inserted near the front vowel due to co-articulation with surrounding vowels. Second, vowel epenthesis was affected by the contexts. The results showed that the epenthesis was frequently seen with word junctions between obstruents (e.g., stops-fricatives), which partly supports previous studies stating that epenthesis was shown following coda position (Kabak & Idsardi, 2007). Third, Korean learners were not affected by English background and were very weakly affected by orthography. English experience, which is one of the extra-phonological factors, was not related to production epenthesis. However, orthography, the other extra-phonological factor, very weakly affected the amount of production epenthesis. Nine percent of all production epenthesis was affected by the English past-tense suffix '-ed'; approximately 70% of the participants were affected by this suffix. These findings support previous studies, which showed that vowel epenthesis could occur when L2 learners perceive non-native orthography (Detey & Nespoulous, 2008).

In terms of the speech production and perception relationship, the present study showed that prosody production and perception could be linked to each other. It also found that production and perception epentheses were unrelated to one another, which indicated the independence of production and perception abilities in segments. The results support the findings of a past study wherein Korean L2 speakers used different strategies in speech production and perception (Kabak & Isardi, 2003). However, the results of prosody training differed from segment training in that perception training helped develop prosody production abilities. It could be interpreted that strategies for prosody production and perception can be dependent.

This thesis developed new methods. In the second study, new prosody training was shown to improve prosody perception and production. Past studies have shown an improvement after segment training with a computer-based system. For example, Iverson and Evans (2009) successfully trained German and Spanish learners in English vowels. This present study also showed an improvement after prosody training. Previous training methods (de Bot, 1983) required an instructor. However, computer-based training provided auditory training sessions to Korean L2 speakers without an instructor, suggesting that these learners could train themselves without time or space limitations.

This present thesis revealed that vowel epenthesis could be related to overall English experience. In the first study, Korean L2 students showed a significant variability in vowel recognition tasks. This variability could be an indicator of overall English abilities. Therefore, it could be concluded that the relationship between vowel epenthesis and vowel recognition was strongly related to overall English abilities. Furthermore, some correlations between vowel epenthesis and supra segmental factors, such as contrastive stress recognition, could be accepted because contrastive stress recognition ability and speech rate may measure overall English experience.

Given that epenthesis is linked to overall English abilities, the claim that vowel epenthesis is caused by phonotactics is explainable. That is, phonotactic constraints could play an important role when the overall English abilities are low. L1 phonotactics may cause epenthesis, but this only creates a problem when L2 learners have difficulties in other aspects of speech perception and production. The training study supported this theory, revealing that production and perception epentheses were reduced after vowel and prosody training. It could be interpreted that Korean L2 learners had improved overall English abilities so they were less affected by phonotactics.

Production epenthesis does not seem to be strongly linked to English experience. The results showed that production epenthesis did not strongly correlate with the length of time spent learning English or living in English speaking countries, or overall listening comprehension. Therefore, it may not be that overall English abilities trigger all epenthesis. Still, there might be specific underlying aspects of phonetic processing (e.g., vowel recognition) that combine with phonotactics to produce epenthesis.

The studies described in this paper have several limitations. First, the amount of English use among participants was not considered. It is expected that the amount of vowel epenthesis could vary based on the amount of English used in daily life. For example, some Korean L2 speakers who use English more than 10 hours a day might be more advanced than learners who speak English less than one hour a day. In addition, the language background of the L2 learners was not controlled. Previous studies have shown that language background can have an effect on learning English vowels and prosody. For example, Francis et al. (2008) showed that Mandarin Chinese speakers were better than native English speakers when learning Cantonese words because Chinese speakers were accustomed to tone differences. This concept is applicable to Korean L2 speakers. It is known that the Kyungsang dialect is a tonal language among Korean dialects. Thus, Kyungsang dialect users could learn English prosody more efficiently because they are accustomed to learning English intonations. Some Korean L2 speakers who participated in the present study were Kyungsang dialect users. Thus, they may have learned English contrastive stress patterns more quickly than other dialect users, which could have affected the total results. Third, there was no control group in the training study, which could be a possible weakness. The inclusion of an untrained group would have generated more reliable results.

To overcome the limitations shown in this thesis, the amount of English use and language background should be investigated when choosing participants. For example, in future studies, participants should be asked to report how often English is used in daily life. The questionnaire should also assess participants' language backgrounds. After the questionnaire, participants should take a simple English oral test to determine how many words they know and use in conversation. Additionally, when investigating training effects, a control group should be established to confirm whether training helps improve trained abilities.

The findings of the current study contributed to the understanding of vowel epenthesis. For example, the study showed that L2 English ability triggered vowel epenthesis and that perception training helped reduce epenthesis because overall English experience was developed. Furthermore, the computer-based training was effective in teaching English vowels and prosody to Korean L2 learners. Nowadays, students invest much time and money to find native English speakers capable of effectively teaching English pronunciation and prosody. However, computer-based training in vowel production and prosody will ultimately save time and money.

This thesis revealed various factors that may produce epenthesis in production and perception among Korean L2 speakers, demonstrating that vowel and prosody recognition abilities can affect production and perception epentheses. The present thesis also suggested that epenthesis could be stronger when other aspects of speech production and perception factors are weaker. Advanced learners produced less epenthesis and saw improvement in production and perception abilities through training. Furthermore, environmental factors such as surrounding consonants or voicing features can produce epenthesis. This production occurred more frequently at word junctions than within words. To understand the problems faced by L2 learners, further investigations on how listeners' different speech abilities interact with one another are needed.

References

Adank, P., Smits, R. & van Hout, R. (2004) A comparision of vowel normalization procedures for language variation research. *Journal of the Acoustical Society of America*, 116, 5, 3099 – 3017.

Ahn. G.S. (2012) A Study of Korean Students' Perception on English Vowel Epenthesis. *Studies in English Education*, 17, 1.

Bayraktaroğlu, S. (2008) Orthographic interference & the teaching of British Pronumciation to Turkish learners. Journal of Language & Linguistic Studies, 4,2, 107 – 143**.**

Bench, J., Kowal, A. & Bamford, J. (1979) The BKB (Bamford-Kowal-Bench) sentence lists for partially-hearing children. *British Journal of Audiology*, 13, 108-112.

Borden, G., Gerber, A., & Milsark, G. (1983) Production & perception of the /r/-/l/ Contrast in Korean Adults Learning English. *Language Learning*, 33, 3, 449-526.

Bradlow, A. R., Pisoni, D. B., Yamada, R.A. & Tohkura, Y. (1997) Training Japanese listeners to identify English /r/ & /l/ IV: Some effects of perceptual learning on speech production. *Journal of the Acoustical Society of America*, 101, 2299-2310.

Chang, S.Y. & Kim, M.S. (2006) English Sentence Stress Patterns in Korean College Students. *English Language & Linguistics*, 21, 73-95. (in Korean)

Chang, Y., Hong, J., & Halle, P. (2007) English cluster perception by Taiwanese Mandarin speakers. *Proceedings of 16th International Congress of Phonetic Sciences, Saarbrücken,* Germany.

Cho, M.H., & Jeong S.Y. (2013) Perception & production of English vowels by Korean learners. *Studies in phonetics, phonology and morphology*, 19,1. 155-177.

Cutler, A. (1986) Forbear is a homophone: Lexical prosody does not constrain lexical access, *Language and Speech* 29.3. 201-220

Davidson, L. (2005) Addressing phonological questions with ultrasound. *Clinical Linguistics and Phonetics*, 19, 619-633.

Davidson, L. (2006) Phonology, phonetics or frequency: Influences on the production of non-native sequences. *Journal of Phonetics*, 34, 104-137.

Davidson, L. (2011) Phonetic, Phonemic & Phonological factors in cross-language discrimination of phonotactic contrasts. *Journal of Experimental Psychology: Human Perception and Performance*, 37, 1, 270-282.

Dehaene-Lambertz, G., Dupoux, E. & Gout, A. (2000) "Electrophysiological Correlates of Phonological Process: A Cross-linguistic Study", *Journal of Cognitive Neuroscience*, 12, 4, 635-647.

Delatorre, F. & Koerich, R. D. (2006) Brazilian EFL learners' epenthesis production on English words ending in *ed*. Unpublished working paper.

Detey, S. & Nespoulous J. (2008) Can orthography influence second language syllabic segmentation? Japanese epenthetic vowels & French consonantal clusters. *Lingua* 118. 66-81.

De Jong, K. & Park, H. (2012) Vowel epenthesis & segment identity in Korean learners of English. *Studies in Second Language Acquisition*, 34, 127-155.

De Bot, K. (1983) Visual Feedback of Intonation I: Effectiveness & Induced Practice Behaviour. *Language and Speech*, Vol. 26: 4, 331-350.

Dupoux, E., Hirose, Y., Kakehi, K., Pallier, C. & Mehler, J. (1999) Epenthetic Vowels in Japanese: A Perceptual Illusion. *Journal of Experimental Psychology: Human, Perception and Performance.* 25. 6. 1568-1578.

Dupoux E., Peperkamp S. & Sebstian-Gallas, N. (2001) A robust method to study stress “deafness”, *Journal of the Acoustical Society of America* 110, 3., 1606-1618.

Dupoux, E., Sebastian-Galles, N., Navarrete, E. & Peperkamp, S. (2008) Persistent stress "deafness": The case of French learners of Spanish. *Cognition*, 106, 2, 682-706.

Dupoux, E., Parlato, E., Frota, S., Hirose, Y. & Peperkamp, S. (2011) Where do illusionary vowels come from? *Journal of Memory and Language,* 64, 199-210.

Flege, J., E. & Eefting, W. (1987) Cross-language switching in stop consonant perception & production by Dutch speakers of English. *Speech Communication,* 6. 185-202.

Flege, J.E. (1993) Production & perception of a novel, second-language phonetic contrast. *Journal of the Acoustical Society of America*, 93, 1589-1608.

Flege, J.E., Frieda, E.M. & Nozawa, T. (1997) Amount of native-language (L1) use af fects the pronunciation of an L2. Journal of Phonetics, 25, 169 -186.

Frankiewicz, J. (2001) A syllabic analysis of vowel epenthesis in the suffix –ed in English. *Poznan Studies in Contemporary Linguistics*, 37, 53-69.

Francis, A.L., Cioccaa, V., Ma, L. & Fennd, K. (2008) Perceptual learning of Cantonese lexical tones by tone and non-tone language speakers. *Journal of Phonetics*, 36, 268 – 294.

Funatsu, S., Imaizumi, S., Fujimoto, M., Hashizume, A. & Kurisu, K. (2008) Do Japanese speakers perceive nonexistent vowels in non-native consonant clusters? *Proceedings of Acoustics’08, Paris,* France.

Grainger, J., Van Kang, M., N. & Segui, J. (2001) Cross-modal repetition priming of heterographic homophones. Memory & Cognition, 29, 1, 53-61.

Gass, S. (1984) Development of speech perception & speech production abilities in adult second language learners. *Applied Psycholinguistics*, 5, 51-74.

Goto, H. (1971) Auditory perception by normal Japanese adults of the sounds “L” & “R”. Neuropsuchologia, 9, 317-323.

Han, J.I. (1996) The effects of pronunciation – based listening practice on Korean EFL learners. *Journal of English Education*, Vol 51, No. 4, 36 – 56.

Han, J.I. (1999) The Effective teaching of English pronunciation based on the analysis of Korean EFL Learners’ pronunciation error patterns, *Studies of curriculum education*, 3, 2

Hardison, D., M. (2004) Generalization of computer-assisted prosody training: quantitative & qualitative findings. *Language Learning & Technology*, 8.1, 34-52.

Hardison D., M.(2005) Contextualized computer-based L2 prosody training: Evaluating the Effects of Discourse Context & Video Input. *The Computer Assisted Language Instruction Consortium Journal (CALICO Jounral)*, 22 (2), 175-190.

Hattori, K., & Iverson, P. (submitted) Independence of speech production & perception: Training Japanese speakers to produce English /r/-/l/. *Cognition*.

Hazan, V. Sennema, A, Iba, M.& Faulkner, A. (2005) Effect of audiovisual perceptual training on the perception & production of consonants by Japanese learners of English., *Speech Communication*, 47, 360 - 378.

Hirata, Y. (2004) Training native English speakers to perceive Japanese length contrasts in word versus sentence contexts. *Journal of the Acoustical Society of America*, 116, 4, 2384 – 2394.

Hong, S.Y. (2010) A phonetic study on the prosodic realization of Korean English utterance. *Journal of Human Studies*, 26, 243~276 (in Korean)

Huckvale, M. (2004) ACCDIST: A metric for comparing speakers' accent. *Proceedings of the International Conference on Spoken Language Processing*, Jeju, Korea.

Huckvale, M. (2007) Hierachical clustering of speakers into accents with the accdist metric. *16th Proceedings of International Congress of Phonetic Sciences*, Saarbrücken, Germany.

Iverson P., Hazan, V., & Bannister. K. (2005) Phonetic training with acoustic cue manipulations : A comparison of methods for teaching English /r/-/l/ to Japanese adults. *Journal of the Acoustical Society of America*, 3267-3278

Iverson. P. & Evans, B. G. (2007) Learning English vowels with different first-language vowel systems : Perception of formant targets, formant movement & duration. *Journal of the Acoustical Society of America*, 122(5). 2842-2854.

Iverson, P. & Evans, B. G. (2009) Learning English vowels with different first-language vowel systems II: Auditory training for native Spanish & German speakers. *Journal of the Acoustical Society of America*. 126(2) 866-877.

Iverson, P., Pinet, M. & Evans, B. G. (2011) Auditory training for experienced and inexperienced second-language learners: Native French speakers learning English vowels. *Applied Psycholinguistics*, 1-16.

Jang, T.Y. (2009) Rhythm Metrics of Spoken Korean. *Language & Linguistics*. 46, 169-186.

Kabak, B. & Idsardi, W. (2003) Syllabically conditioned perceptual epenthesis. *Proceedings of the Berkeley Linguistics Society*, 29, 233-245.

Kabak, B. & Idsardi, W. (2007) Perceptual distortions in the adaptation of English consonant clusters: Syllable structure or consonantal contact constraints? *Language & Speech* 50, 1, 23-52.

Kang. O. (2002) *Korean phonology*, Taehaksa. (in Korean)

Kang, Y. (2003) Perceptual similarity in loanword adaptation: English postvocalic word-final stops in Korean. *Phonology* 20. 219-273.

Ko, K.S (1997) Teaching English Stress & Rhythm. A Collection of Education studies from Incheon National University. 13, 237 -258

Koo, H.S. (1998) The influence of Consonant Environment upon the Vowel Duration. *Phonetic Science* 4, 1. 7-17. (in Korean)

Koo, H.S & Oh, Y.J. (2001) An analysis of English vowels of Korean learners of English & English native speakers. *Journal of the research of Korean education*, 16, 1- 12 (in Korean)

Kim, M.H,. Kang, S.M. & Kim K.H. (2008) Acoustic Analysis of Koreans' Production Errors in English-with reference to nasalization & lateralization. *Speech Science*, 15, 3, 53-63.

Kim, K.M. (2009) Coronals in epenthesis in loanwords with comparison to velars. *Toronto Working Papers in Linguistics* 30, Special issues on Coronal, 53–68.

Kim, K.M. & Kochetov, A. (2011) Phonology & phonetic of epenthetic vowels in loanwords : Experimental evidence from Korea. *Lingua* 121, 511- 532.

Kwak, D.G. (2003) A study on the Korean students' recognition for the English intonation. *Education research studies*, 1-21 (in Korean)

Kwak, D.G. & Shin, S.E. (2005) A study on the Korean students' recognition for the English fricatives. *Education research studies*, 1-24 (in Korean)

Lambacher, S.G., Martens, W.L., Kakehi, K., Marasinghe, C.A. & Molholt, G. (2005) The effect of identification training on the identification & production of American English vowels by native speakers of Japanese. *Applied Psycholinguistics*, 26, 227 – 247.

Lee, G. M., Kim, J.W. Lee, S. U.(2000) *Korean phonology*. Hakyeonsa

Lee, H.Y. (2000) The pronunciation of English consonant cluster by Koreans. *The Korean Society of Phonetic Sciences and Speech*, 40, 79-89.

Lee, J.K. & Lee, Y.W. (2011) Speech intelligibility of Korean learners' & a native English speaker's production of English tense & lax vowels: Focusing on high vowels. *Studies in Phonetics, Phonology & Morphology*, 17, 3, 497-520. (in Korean)

Lee, S.S. (2009) Syllable Structure constraint & the perception of biconsonantal clusters by Korean EFL learners. *English language & literature*, 55, 6, 1193-1220.

Lee, S.B. (2011) An Analysis of H* Production by Korean Learners of English according to the Focus of English Sentences in Comparison with Native Speakers of English and Its Pedagogical Implications. *Journal of the Korean Society of Phonetic Science and Speech Technology*, 3, 3, 57 -62.

Lively, S.E., Logan, J.S & Pisoni, D.B. (1993) Training Japanese listeners to identify English/r/&/1/. II: The role of phonetic environment & talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America*, 94, 3. 1242 - 1255

Logan, J.S. Lively, S.E. & Pisoni, D.B (1991) Training Japanese listeners to identify English /r/ & /l/: A first study. *Journal of the Acoustical Society of America*, 89,2. 874 – 886.

Monahan, P.J., Takahashi, E., Nakao, C., Idsardi, W. (2008) Not all epenthetic contexts are equal: differential effects in Japanese illusory vowel perception. *Proceedings of Japanese / Korean Linguistics* 17.

Moon, D. (1991) A study of Suprasegmental pronunciation of English Learners. *A collection of papers of Woosuk University*, 279-297(in Korean)

Nasir, S. N. & Ostry, D.,J. (2009) Auditory plasticity & speech motor learning. *Proceedings of National Academy of Sciences of the United State of America*, 106, 20470-20475.

Nishi, K. & Kewley – Port, D. (2007) Training Japanese listeners to perceive American English Vowels : Influence of training sets. *Journal of Speech, Language & Hearing Research*, 50, 1496 – 1509.

Park, E.J. (1980) A comparative study on Suprasegemtal Phonemes of Korean & English for the English learning. *The modern English society of Korea*, 18, 73-119.

Parlato-Oliveira, E., Christophe, A., Hirose, Y., Dupoux, E. (2010) Plasticity of illusory vowel perception in Brazilian-Japanese bilinguals. *Journal of the Acoustical Society of America*, 127, 6, 3738-3748.

Peperkamp, S, Vendelin, I. & Dupoux, E. (2010) Perception of predictable stress: A cross-linguistic investigation. *Journal of Phonetics* 38, 422-430.

Pinet, M., Iverson, P. & Huckvale, M. (2010) Second-language experience & speech-in-noise recognition: Effects of talker-listener accent similarity. *Journal of the Acoustical Society of America.* 128, 3, 1357-1365

Pitt, M. A. (1998) Phonological processes & the perception of phonotactically illegal consonant clusters. *Perception & Psychophysics*. 60., 941-951.

Ramírez C.J. (2006) Acoustic & perceptual characterization of the epenthetic Vowel between the clusters formed by consonant + Liquid in Spanish. *Proceedings of the 2nd Conference on Laboratory Approaches to Spanish Phonetics & Phonology*. 48-61.

Rauber, A.S., Escudero, P., Ricardo A. H. Bion, R. A. H., & Baptista O.B. (2005) The Interrelation between the perception & production of English vowels by native speakers of Brazilian Portuguese. *Proceedings of Interspeech*, 2913 -2916.

Rhee, S.C & Choi, Y.K. (2001) A statistical observation of vowel epenthesis in English loanwords in Korean & its significance. *Studies in Phonetics, Phonology & Morphology* 7,1, 153-176. (in Korean)

Ryu, S.R. (1996) The comparison of English & Korean Suprasegmental Phonemes for the Korean learners of English. *The Choong-Won Review of Humanities*, 15, 143-166. (in Korean)

Sheldon. A. (1985). The relationship between production & perception of the /r/-/l/ contrast in Korean Adults learning English: A reply to Borden, Gerber & Milsark. *Language Learning*, 35, 1, 107-133.

Sheldon, A. & Strange, W. (1982) The acquisition of /r/ & /l/ by Japanese learners of English: Evidence that speech production can precede speech perception. *Applied Psycholinguistics*, 3, 243-261.

Shelton, R., L. & Johnson, A., F. (1977) Delayed judgment speech sound discrimination & /r/ or /s/ articulation status & improvement. *Journal of Speech, Language & Hearing Research*, 20, 704-717.

Shibuya, Y. & Erickson, D. (2010) Consonant cluster production in Japanese learners of English. *Proceedings of Interspeech* 2010, Makuhari, Japan

Shin, D.J & Iverson, P. (2011) Individual difference in vowel epenthesis among Korean learners of English, *Proceedings of 17th International Congress of Phonetic Sciences*. 1822-1825.

Tak, J.Y. (2000) Reanalysis on vowel epenthesis in Korean-accented English. *Journal of English Education*, 55, 2, 133-146. (in Korean)

Van Donselaar, W., Kuijpers, C., Cutler, A. (1999) Faciliatory Effects of Vowel epenthesis on word processing in Dutch. *Journal of Memory & Language* 41, 59-77.

Venderlin I. & Peperkamp, S. (2006) The influence of orthography on loanword adaptations. *Lingua* 116, 996-1007.

Wang,Y., Spence, M.M., Jongman A. & Sereno, J.A. (1999) Training listeners to perceive M&arin tones. *Journal of the Acoustical Society of America*, 106,6, 3649-3658.

White, L. & Mattys, S.L. (2007) Calibrating rhythm: First language & second language studies. *Journal of Phonetics*, 35, 501-522.

Yom, M.S. (2003) Korean difficulties on English Stress & Rhythm. *Woosong Review*, 1-11. (in Korean)

Yom.M.S. (2003) English sentence stress & speech rhythm of Korean English learners, *Woosong Review*, 9, 530-548. (in Korean)

Yoon, K.C., Heo, A.N. & Ahn, S.C. (2010a) Teaching English Intonation through Learner Utterances with Cloned Native Intonation. *Modern Studies in English Language & Literature,* 54, 1. 147-171.

Yoon, K.C. Oh, J.Y. & Ahn. S.C. (2010b) Teaching English prosody through English poems with cloned native intonation. *Journal of English literature*, 55, 4. 775-794. (in Korean)

Yoon, K.C. (2011) Using the Prosody Cloning Technique in Teaching English Prosody. *Studies in English Language & Literature*, 37, 1, 245-271. (in Korean)

Appendix

Appendix 1: English words used in pre, mid and final test and focus-stress training

abstract

abuse

address

ally

attribute

combine

compact

concert

conduct

confines

conflict

conscript

console

consort

construct

contest

contract

convert

desert

digest

discard

discount

exploit

extract

forbear

forearm

goatee

goaty

impact

implant

import

impress

incense

incline

increase

insert

insult

intercept

interchange

intrigue

invite

object

overlay

permit

present

proceeds

progress

protest

rebel

recap

recess

record

refund

reject

relay

remake

research

retail

subject

suspect

transfer

transform

transplant

transport

transpose

trsutee

trusty

underground

uplift

upset

Appendix 2 : BKB sentences used in pre, mid and final test and focus-stress training

A boy fell from the window

A boy ran down the path

A cat sits on the bed

A girl kicked the table

A letter fell on the mat

Baby broke his mug

Children like strawberries

Father looked at the book

He broke his leg

He found his brother

He frightened his sister

He paid his bill

He's bringing his raincoat

He's washing his face

Lemons grow on trees

Mother made some curtains

She brushed her hair

She drinks from her cup

She found her purse

She made her bed

She used her spoon

Somebody took the money

The book tells a story

The car hit a wall

The cat caught a mouse

The child drank some milk

The child grabs the toy

The children dropped the bag

The cleaner used a broom

The cook cut some onions

The cook's making a cake

The cow lies on the grass

The dog drank from a bowl

The floor looked clean

The football hit the goalpost

The girl caught the cold

The girl lost her doll

The house had a nice garden

The house had nine rooms

The lady packed her bag

The lady's making a toy

The lorry carried fruit

The lorry drove up the road

The man tied his scarf

The milk was by the front door

The paint dripped on the ground

The police chased the car

The postman brings a letter

The postman shut the gate

The shoes were very dirty

The sun melted the snow

The train had a bad crash

The wife helped her husband

They are looking at the clock

They followed the path

They laughed at his story

They took some food

They wanted some potatoes

They're climbing the tree

They're crossing the street

They're watching the train