

How Different are Vowel Epenthesis in Learner Speech and Loanword Phonology?

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ABSTRACT

Difference of learner speech and loanword phonology is investigated in terms of Korean learners' speech and their loanword adaptation of English words with a post-vocalic word-final stop. When we compared the speech of 12 Korean learners in mid-intermediate level with that of eight English speakers, the learner speech did not reflect loanword phonology of the vowel insertion after a voiced word-final stop (e.g., *rib*[i], *bad*[i], *gag*[i] vs. *tip*[=], *cat*[=], *book*[=]), but, instead, the target phonology of vowel lengthening before a voiced word-final stop (e.g., *rib*[rɪːb], *CAD*[kæːd], *bag*[bæːg] vs. *rip*[rɪp], *cat*[kæt], *back*[bæk]). A longitudinal study of learner speech before and after instruction showed some development toward the acquisition of target phonology. The results indicate that learner speech departs from loanword phonology, and approaches to target speech in a faster rate than direct ratio. Thus, native phonology predicts loanword phonology, but lends little support to learner speech. Our results also indicate that loanword phonology is constant, while learner speech changes toward the acquisition of target phonology.

Keywords: vowel epenthesis, vowel lengthening, learner speech, loanword phonology, post-vocalic stop, English loanwords into Korean, Korean learner speech of English

1. Introduction¹⁾

How different are learner speech and loanword phonology? Studies in learner speech have often evidenced loanword phonology, as in Kwon (2005) for Korean learners of English. The speculated reason is that both loanword phonology and learner speech involve an interplay between learners' native phonology and the foreign phonology. Is it true that learner speech observes loanword phonology? If so, to what extent are learner speech and loanword phonology

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similar? To answer these, we first investigate our first question: How similar or different are learner speech and loanword phonology.

The answer to the question of similarities or differences may depend on the developmental aspects of learner speech, because studies have shown that learner speech progressively assimilate to the value of the target speech (L2) as the proficiency increases (Han, 2006; Kim, 2006). In other words, there is a possibility that learner speech in its early stage is similar to the form of loanword phonology, and later develops toward the target value as L2 fluency increases. Such an assumption on developmental enhancement, however, is controversial in literature, as Scovel (1988) claims that adult learners improve insignificantly in foreign pronunciation. We, therefore, investigate our second question: Whether or not learner speech develops from the form of loanword phonology toward the form of target speech.

To answer these two questions, we analyze the vowel insertion phenomena in loanword phonology in relation to the duration alternation in target phonology. Vowels in English undergo duration alternation depending on the voicing quality of the following consonant within a syllable. For instance, the vowel duration in the word *mad* is longer than the duration in the word *mat* (Ladefoged, 2006: p. 98).

This environment for duration contrast in English is identical to the environment of vowel insertion in loanword adaptation into Korean. According to the *Official Loanword Transcription Regulations* (OLTR)²⁾, loanwords are transcribed with an epenthesis vowel after a voiced coda consonant of a syllable as in *zigzag*[zigizægɪ], but not after a voiceless one as in *book*[buk] (OLTR: Items 1 & 2 of English Loanwords). On the other hand, the duration contrast is not expected to be realized in the vowel length of loanwords, as the OLTR does not distinguish the vowel length difference of English words (OLTR: Item 7 of English Loanwords).

Along the lines of this vowel epenthesis regulation in the OLTR, we find in literature an empirical study by Oh and Kim (2006: p. 315), who count the number of vowel insertion in a loanword list compiled by the National Academy of the Korean Language and report that vowels are inserted significantly more often after a voiced word-final consonant (90%, $p < 0.001$, $n=100$), than after a voiceless one (42%, $p < 0.001$, $n=320$). We then question if such vowel insertion contrast in loanwords would also appear in learner speech.

To answer our first question of similarities or differences in learner speech and loanword phonology, we examine in learner speech 1) whether a vowel is inserted more frequently after a voiced final consonant of a word (e.g., *CAD* → *CAD*[i]) than after a voiceless one (e.g., *cat* → *cat*[ɪ]); and 2) whether a vowel is lengthened more frequently before a voiced final consonant of

2) A set of loanword transcription rules of English has been announced as the *Official Loanword Transcription Regulations* by the Korean government in March 1995. The official loanword transcription system for English was first recognized in 1986 and, since then, has been revised several times before arriving at its present form.

a word (e.g., *CAD* [kæ:d]) than before a voiceless one (e.g., *cat* [kæt]). If learner speech is similar to loanword phonology, we expect the former that is loanword phonology, but not the latter that is target phonology. Thus, 1) learners would insert a vowel more frequently after a voiced final consonant than after a voiceless one, but 2) learners would not lengthen a vowel before a voiced final consonant than before a voiceless one.

To answer our second question of whether learner speech develops from its early stage of being similar to loanword phonology, to the final stage of being similar to target phonology, we examine a development of learner speech in a longitudinal study as to 1) whether the vowel insertion difference (e.g., *CAD*[kæ:di] vs. *cat*[kæt]) decreases, and 2) the duration alternation (e.g., *CAD*[kæ:d] vs. *cat*[kæt]) increases. If learner speech develops from the form of loanword phonology to the form of target phonology, we predict that 1) learners gradually reduce the vowel insertion rate after a word final consonant, regardless of being voiced or voiceless, and that 2) learners gradually lengthen a vowel before a voiced final consonant than before a voiceless one.

The remainder of this paper is to test these two working hypotheses against the data in learner speech and target speech. To do so, we conduct a phonetic experiment that involves speech data acquired from both Korean learners and native speakers of English for the words including word-final stop consonants with voicing contrasts. We then quantify insertion frequency and duration alternation of vowels, and compare learner speech with loanwords and target speech. To our knowledge, the quantification of vowel insertion and duration in learner speech is new in literature and first attempted in this study. The methods of quantification are described in detail in Section 2, and the results in Section 3. The conclusion is drawn in Section 4, that answers for how different learner speech and loanword phonology are in the light of a phonetic experiment.

2. Methods

The vowel insertion rates and the vowel durations of the 13 minimal pairs of English words with a final voiced vs. voiceless stop were analyzed for 12 Korean learners in comparison with those for eight native speakers of American English. The learner speech data were measured before and after the instruction to see the developmental pattern.

The following two working hypotheses are generated from the discussions in the preceding section, as early attempts to explain patterns observed in nature of learner speech in comparison with loanwords and target speech.

(1) HYPOTHESIS 1: Learner speech is similar to loanword phonology.

Hypothesis 1 can be confirmed, or, strictly speaking, remains provisional if two conditions are met: (1) vowel epenthesis in learner speech takes place more frequently after a voiced word-final consonant than after a voiceless one; and (2) vowel duration in learner speech is indistinct regardless of whether the word-final consonant is voiced or voiceless. On the other hand, Hypothesis 1 is rejected if one of these two conditions is not met.

The validity of Hypothesis 1 may depend on the developmental aspect of learner speech, as learner speech may be similar to loanword phonology in the earlier stage of learning, and develops toward target phonology at a later stage. We thus make another working hypothesis that learner speech develops from loanword phonology to target phonology.

(2) HYPOTHESIS 2: Learner speech develops from loanword phonology to target phonology.

Hypothesis 2 can be confirmed if a longitudinal study in learner speech shows a developmental transition from loanword phonology to target phonology. To be specific, the expectation to the longitudinal study in learner speech is that the vowel insertion rate decreases, while duration alternation increases from the stage of loanword phonology to the stage of target phonology. Thus, the confirmation of Hypothesis 2 must meet one of the following two conditions: (1) Vowel insertion rate in learner speech before instruction decreases in learner speech after instruction toward the value of target speech; and (2) vowel lengthening before a voiced final consonant in learner speech before instruction becomes greater in learner speech after instruction toward the value of target speech. On the other hand, Hypothesis 2 will not be confirmed if none of these two conditions are met. The following sections test these two hypotheses by means of an acoustic phonetic experiment.

2.1 Speech materials

Two types of speech materials were used: 1) recorded speech materials by learner and native participants and 2) listening test materials for learners. The listening test materials were the listening component of Test Of English for International Communication (TOEIC).³⁾ Two TOEIC listening tests were used as a standardized test to recognize the improvement of listening comprehension before and after instruction. The listening tests were to serve as co-variance reference to the development in speech production.

For recorded speech materials, both native and learner participants read pairs of a word and a sentence, all of which embed the minimal pairs of words with voicing contrasts at final position. Table 1 is the list, in which the final consonants to contrast are underlined.

3) TOEIC is a standardized test of English proficiency provided by the Educational Testing Service.

Table 1. Production recording list of word and sentence pairs with contrasting word-final stops

Word with a voiced consonant	Word with a voiceless consonant	Sentence with a voiced consonant	Sentence with a voiceless consonant
ba <u>d</u>	ba <u>t</u>	This is ba <u>d</u> .	This is a ba <u>t</u> .
ba <u>g</u>	ba <u>ck</u>	Your ba <u>g</u> !	You are ba <u>ck</u> !
be <u>d</u>	be <u>t</u>	He is sick in be <u>d</u> .	He lost the be <u>t</u> .
br <u>ide</u>	br <u>igh</u> t	The dress is for a br <u>ide</u> .	The moon shines br <u>igh</u> t.
CA <u>D</u>	ca <u>t</u>	Computer workers love CA <u>D</u> .	Computer workers love a ca <u>t</u> .
fee <u>d</u>	fee <u>t</u>	Please measure my cattle's fee <u>d</u> .	Please measure my cattle's fee <u>t</u> .
ki <u>d</u>	ki <u>t</u>	Please bring me the biggest ki <u>d</u> .	Please bring me the first-aid ki <u>t</u> .
leag <u>ue</u>	lea <u>k</u>	He detected a game leag <u>ue</u> .	He detected a gas lea <u>k</u> .
no <u>de</u>	no <u>t</u> e	Cut the no <u>de</u> off.	Cut the no <u>t</u> e off.
pa <u>d</u>	pa <u>t</u>	Pa <u>d</u> the blanket smooth.	Pa <u>t</u> the blanket smooth.
ro <u>be</u>	ro <u>p</u> e	It is a slick ro <u>be</u> .	It is a slick ro <u>p</u> e.
si <u>de</u>	si <u>t</u> e	Look on the bright si <u>de</u> .	Look on the right si <u>t</u> e.
ta <u>b</u>	ta <u>p</u>	It can be a paper ta <u>b</u> .	It can be a water ta <u>p</u> .

Word pairs in Table 1 are subject to the vowel insertion contrast in loanword phonology (e.g., *bed* → *bed*[i]; *bet* → *bet*[]) and the vowel lengthening contrast in target phonology (e.g., *b*[ɛː]*d* vs. *b*[ɛ]*t*). When eliciting the speech of learners using the list in Table 1, we randomized the words among themselves, and the sentences among those with the similar syllable numbers. The randomization took into consideration that duration measurements might vary depending on the length of utterances.

2.2 Participants

Research participants consisted of one model speaker of American English, who provided the sample speech, seven other native speakers of American English, who read the same data for learners, one instructor, who is the corresponding author, and 12 Korean learners of English. All native speakers spoke the General American English, while learners the Standard South Korean as their native language.⁴⁾ Both Korean and American speakers were college students in their

4) All the participants speak the prevailing current pronunciation of American English and South Korean, that are perceived as accentless by most people. These are spoken particularly by national broadcasters and newscasters as they are preferable to other regional accents. These are also the accents generally taught to people who wish to learn the language as a second language. General American English approximates to Standard Midwestern, that is contrasted

twenties, except the model speaker who was a college professor. The learners' English proficiency level was mid-intermediate before instruction, but later became high-intermediate after instruction with respect to the scale of five ranks in accordance to TOEIC score.⁵⁾

2.3 Data acquisition procedure

The data acquisition procedure from the Korean learners consisted of three stages: 1) pre-listening and production tests after a brief pronunciation instruction about the recording stimuli, 2) main pronunciation instruction in class that included many different aspects of pronunciation including, but not focused on, the duration alternation in the phonological environment of Table 1, and 3) post-listening and production tests. We tested the learners before and after instruction to observe their developmental patterns of speech production with respect to listening comprehension. On the other hand, the native speakers of English underwent only one stage of the recording of the production stimuli. Each recording stage was completed within a few consecutive hours to cover all the participants.

At the first stage of the data acquisition procedure, the learners took listening and production tests on the speech materials before instruction. For the listening comprehension test, the learners took the TOEIC listening test. For the production test, the learners listened to and repeated after the model native English for one time. Then, they were asked to go to one of the recording rooms where they read the production list in Table 1. All recordings were completed within a day. The acquired speech data at this stage were labeled as the learner data before instruction.

At the next stage of the data acquisition procedure, the learners were taught the class materials including the expected lengthening of vowel duration when followed by a voiced consonant. The class materials consisted of conversational and reading speech with some art works from poems, chants, and pop-songs. During the instruction, the teacher explained the expected differences of vowels in English and loanwords, and the learners listened to and repeated after the model speech in the stimulus list, once more. The teacher gave a one-time feedback on the learner speech for each speaker. Further, the model speech was made available by web-downloads for optional practices at home. The classroom instruction on pronunciation lasted for 7 weeks.

with Southern American English, several Northeastern accents, and other distinct regional accents and social group accents like African American Vernacular English. Standard South Korean approximates to the Seoul dialect, that is contrasted with several Southern or Eastern accents.

5) According to *TOEIC Can-Do Guide*, different ranks are assigned as a valid indication of English language proficiency to oral comprehension section on a scale ranging from 5 to 495 points: 1) 5-100, 2) 105-225, 3) 230-350, 4) 355-425, and 5) 430-495. The learner participants in this project belong to Rank 3 before instruction, but later became Rank 4 after instruction.

At the last stage of the data acquisition procedure, the learners were tested again on the listening comprehension by a new set of TOEIC listening tests. Then, they were again asked to read and record the materials in one of the recording rooms. All recordings are completed in an hour. The acquired speech data at this stage were labeled as the learner data after instruction.

In contrast with the learners, the native English speakers in this study did not have any lesson or training session. They were immediately asked to read the recording list twice. All of the native English speakers have acknowledged that they understood the meanings of all sentences in the recording list. The second-time recording was taken for the data, although the first-time recording was occasionally taken to replace a weak, noisy or unnatural speech signal.

A total of 1,664 words were acquired from the recorded corpus of native and learner speech from 13 pairs of English words with voicing contrasts ($1,664 = 13 \text{ words} \times 2 \text{ voicing contrasts} \times 2 \text{ word and sentence} \times (12 \text{ learners} \times 2 \text{ recordings} + 8 \text{ English native speakers including the model speaker} \times 1 \text{ recording})$).

2.4 Analysis

To analyze the data, we first identified whether the speaker inserted a vowel after the final consonants. Vowel epenthesis was determined by the presence of F1 and F2 on the spectrogram. Next, we measured the vowel duration before the final consonant. Figure 1 illustrates our methods of determining the presence of an epenthetic vowel and measuring the duration of the vowels with respect to the spectral pattern and intensity level with periodic cycles.

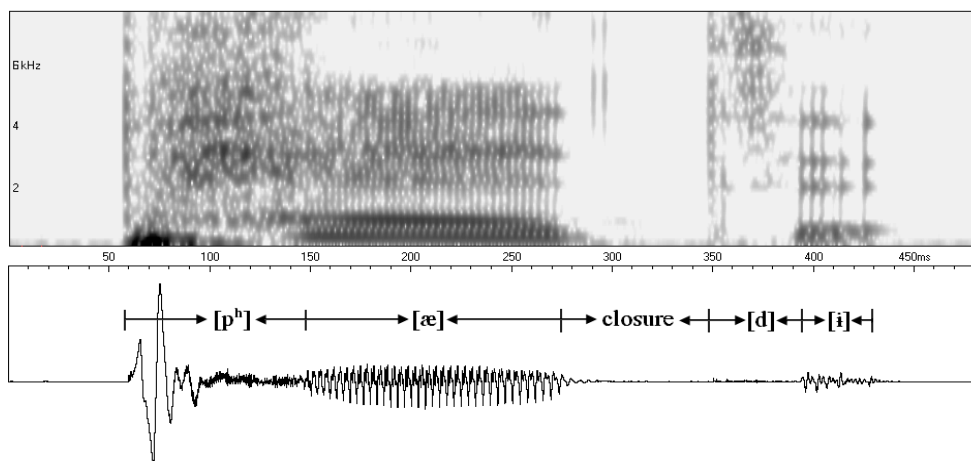


Figure 1. Duration measurement of the vowel before a voiced word-final consonant and the recognition of epenthetic vowel after the consonant in learner speech [pædi] for *pad*, spoken by a female Korean learner of English before instruction.

As seen in Figure 1, we measured the duration of the vowel [æ] before the voiced final consonant [d] and recognized the epenthetic vowel [i] after the consonant in the word *pad* [pædi]. To maintain consistency in measurements, we followed the details of the measurement manual that specified the boundary location on the waveform.

The measured duration values (in milliseconds) were normalized by the mean duration between long and short counterparts of the contrasting unit. We then calculated the durational variability in terms of value difference of the pair divided by the mean. We shall refer to this variability as "Pairwise Variability," whose formula is in (3).

$$(3) \text{ Pairwise Variability (\%)} = 100 \times 2 (d_l - d_s) / (d_l + d_s)$$

(where: Pairwise Variability (%) = normalized Pairwise Variability of the duration between a long unit and its shorter counterpart, d_l = the duration of the long unit, d_s = the duration of the short unit)

In (3), a pair of long and short units is normalized by the mean values.⁶⁾ The measurement purports to find whether the duration for a long unit is sufficiently larger than that of the short counterpart.

3. Results and discussion

The results of the study are shown in Table 2 for vowel insertion and Table 3 for vowel duration.

6) In another proposal (Jian, 2004), normalization is termed in the absolute value, in order to compare the variability of any successive units. For our own purpose, however, we do not use the absolute value, since the directionality in our data has to be fixed by the long and short contrasts of the target vowels. In other words, we want to detect the negative value of the cases when the learner participants pronounce the long and short duration alternations of vowels in the reverse way.

Table 2. Insertion rate for a vowel after a voiced word-final consonant is compared to the rate after a voiceless one. The consonants are placed at the final position of minimal pairs of words, which are embedded *in words* and *in sentences*. The rates for learner speech before and after instruction are compared to loanwords and target speech.

Speech Type	<i>In words</i>			<i>In sentences</i>		
	Average vowel insertion rate, % (insertion no./observed no.)		Difference in insertion rate (V1-V2)	Average vowel insertion rate, % (insertion no./observed no.)		Difference in insertion rate (V1-V2)
	After a voiced word-final consonant (V1)	After a voiceless word-final consonant (V2)		After a voiced word-final consonant (V1)	After a voiceless word-final consonant (V2)	
Loan words*	90 ^A (90/100)	42 ^B (135/320)	48	90 ^A (90/100)	42 ^B (135/320)	48
Learner before	19 ^a (30/156)	15 ^a (24/156)	4	24 ^a (38/156)	29 ^a (45/156)	-5
Learner after	19 ^a (29/156)	16 ^a (25/156)	3	27 ^a (42/156)	24 ^a (38/156)	3
Target speech	10 ^a (10/104)	3 ^a (3/104)	7	13 ^a (13/104)	3 ^b (3/104)	10

^{AB} Values with different superscripts within the same row of either *In words* or *In sentences* columns are different at $p < 0.001$ by t-test.

^{aa} Values with same superscripts within the same row of either *In words* or *In sentences* columns are NOT different at $p \geq 0.05$ by t-test.

^{ab} Values with different superscripts within the same row of either *In words* or *In sentences* columns are different at $p < 0.01$ by t-test.

* Statistics for loanwords are taken from Oh & Kim (2005).

Table 2 indicates that vowel insertion rate in loanwords is significantly ($p < 0.001$) greater when the word-final consonant is voiced than when it is voiceless, whereas the rate in learner speech and target speech does not observe such conspicuous distinction of vowel epenthesis depending on the voicing quality of word-final consonants. The loanword values are indifferent in both word level and sentence level, as loanwords in nature represent the lexical forms of words. The difference in the vowel insertion rate when the word-final consonant is voiced from the rate when the consonant is voiceless is as great as 48% in loanwords, but equal or less than 10% in learner speech and target speech. For these reasons, the vowel epenthesis phenomenon in learner speech is closer to that in target speech than that in loanwords.

For the visual comparison, Table 2 is graphically contrasted in Figure 2.

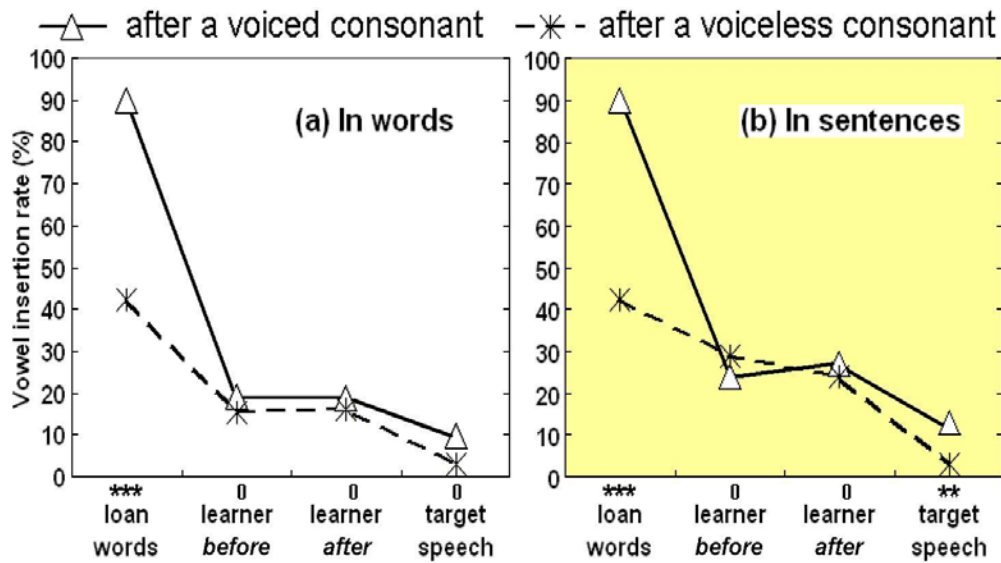


Figure 2. Insertion rate (%) for a vowel after a voiced consonant is compared to the rate after a voiceless one. The consonants are placed at the final position of minimal pairs of words that are embedded (a) in words and (b) in sentences. The rates for learner speech before and after instruction are compared to loanwords and target speech (***, ** and ⁰ denote statistical differences of vowel insertion rates after a voiced *vs.* voiceless consonant at $p < 0.001$, $p < 0.01$ and at $p \geq 0.05$).

In Figure 2, the average vowel insertion rate (%) of loanwords is significantly ($p < 0.001$) greater after a voiced word-final consonant (triangle marks) than that after a voiceless one (star marks). On the other hand, the difference is not conspicuous in both learner speech and target speech. The results of average vowel insertion rates in Figure 2 are consistently observed in individual pairs of words, as shown in Figure 3.

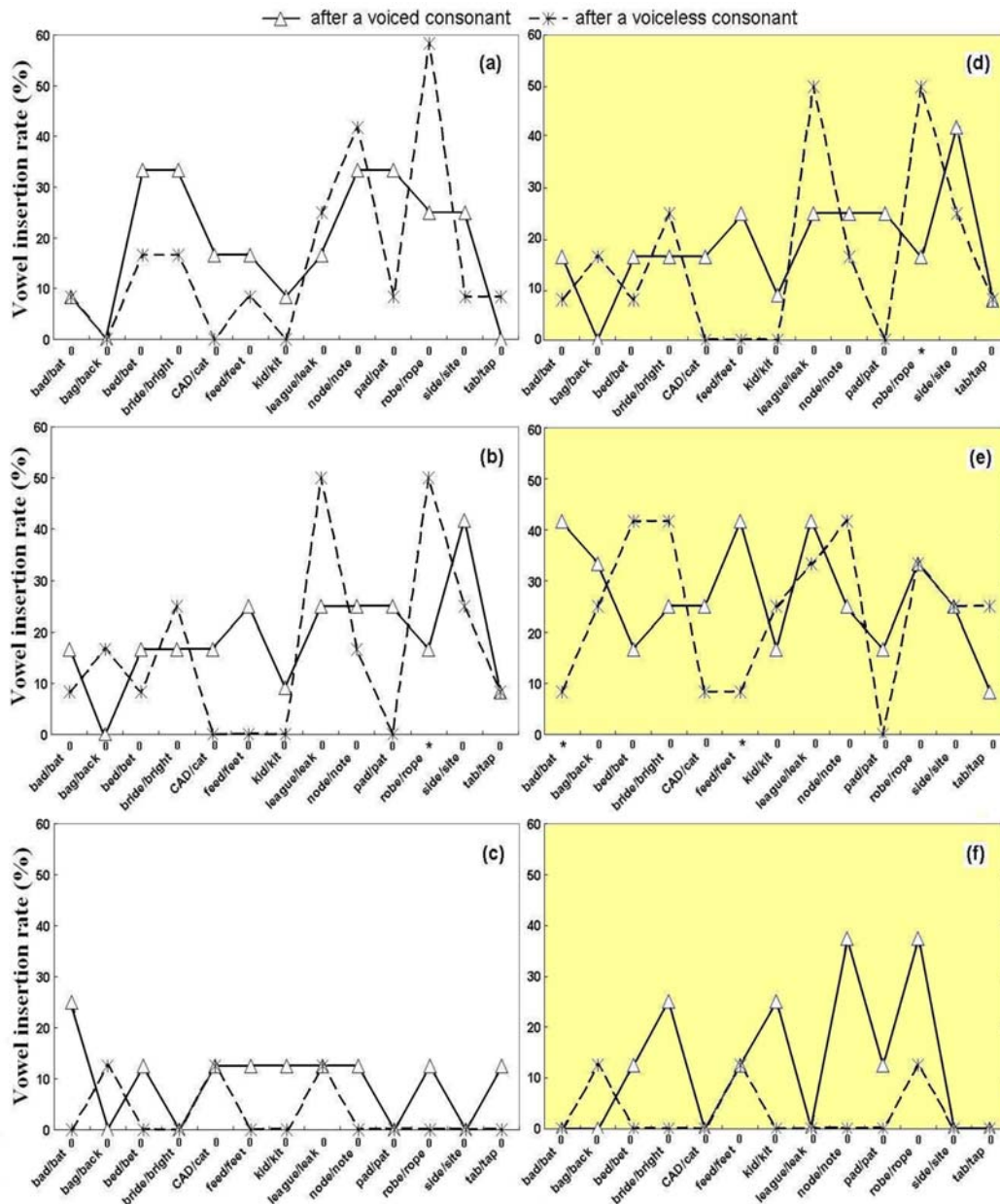


Figure 3. Insertion rates (%) for a vowel after a voiced consonant are compared to the rate after a voiceless one. The consonants are placed at the final position of minimal pairs of words that are embedded in words and sentences. The rate differences are mostly insignificant for both words in learner speech before instruction (a), and after instruction (b), and in target speech (c), and for sentences in learner speech before instruction (d), and after instruction (e), and in target speech (f) (* and ⁰ denote statistical differences of vowel insertion rates after a voiced *vs.* voiceless consonant at $p < 0.05$ and at $p \geq 0.05$).

In Figure 3, the vowel insertion rates (%) in learner speech (a, b, d, e) are not greater after a voiced word-final consonant (triangle marks) than the rates after a voiceless one (x marks), as the difference is insignificant for most cases in learner speech and target speech. In this respect, learner speech is similar to target speech (c, f). These insignificant rate differences are contrastive to that of loanwords in Figure 2, where loanwords demonstrate significantly greater a vowel insertion rate after a voiced word-final consonant (90%, $n=100$) than the rate after a voiceless one (42%, $n=320$). In other words, learner speech is different from loanwords in that (1) learner speech, regardless of whether before or after instruction, does not contain epenthesis vowels after a voiced final consonant as frequently as in loanwords, and that (2) the difference in the vowel insertion rate after the voiced consonant and that after voiceless consonant is insignificant in learner speech, but significantly large (48%) in loanwords. We thus conclude as follows:

- (4) HYPOTHESIS 1 REJECTED: Learner speech is different from loanword phonology in that only in loanwords, but not in learner speech, vowel insertion takes place more frequently after a voiced final consonant than after a voiceless one.

Hypothesis 1 is rejected because vowel epenthesis in learner speech takes place indistinctly regardless of whether the following word-final consonant is voiced or voiceless.

For Hypothesis 2, our longitudinal study of seven weeks does not show that vowel epenthesis in learner speech before instruction significantly decreases after instruction toward the value of target speech. We thus consider that Hypothesis 2 has not been confirmed as to whether learner speech progressively develops toward target speech.

- (5) HYPOTHESIS 2 NOT CONFIRMED: Vowel insertion in learner speech before instruction does not decrease in learner speech after instruction toward the value of target speech.

Hypothesis 2 has not been confirmed because the vowel insertion rate in learner speech does not show a development in the line from loanword phonology to target phonology during the 7-week instruction. Apparently neither of our Hypotheses 1 & 2 have been confirmed by our first experiment in vowel insertion rate.

Let us now consider the durational aspects of the same speech data to evaluate the validity of these two hypotheses. Table 3 demonstrates the duration measurements of vowels before voiced and voiceless final consonants in learner speech before and after instruction in comparison with those in target speech.

Table 3. Duration of a vowel before a voiced word-final consonant is compared to the duration after a voiceless one. The consonants are placed at the final position of minimal pairs of words, which are embedded *in words* and *in sentences*. The durations for learner speech before and after instruction are compared to loanwords and target speech.

Speech Type	<i>In words</i>			<i>In sentences</i>		
	Average vowel duration (msec±SD*)		Pairwise variability (%)	Average vowel duration (msec±SD)		Pairwise variability (%)
	Before a voiced word-final consonant	Before a voiceless word-final consonant		Before a voiced word-final consonant	Before a voiceless word-final consonant	
Loan words**	221±0 nd	221±0 nd	0	190±0 nd	190±0 nd	0
Learner <i>before</i>	256±55 ^A	187±41 ^B	31	217±41 ^A	167±29 ^B	27
Learner <i>after</i>	289±63 ^A	185±35 ^B	43	256±36 ^A	183±26 ^B	34
Target speech	276±51 ^A	165±22 ^B	49	227±46 ^A	152±20 ^B	39

* SD = Standard Deviation

** Values for loanwords are projected from the average value in target speech, but with no standard deviation.)

nd = not determined

^{AB} Values with different superscripts within the same row of either *In words* or *In sentences* columns are different at $p < 0.001$ by t-test.

Table 3 indicates that vowel duration for learner speech and target speech is significantly ($p < 0.001$ for all cases) longer when the word-final consonant is voiced than when it is voiceless. On the other hand, the loanword values are indifferent regardless of whether the word-final consonant is voiced or voiceless, as the long and short vowel durations in English are indistinctly adopted for its duration into Korean. Thus, the Pairwise Variability between the vowel durations before the voiced word-final consonant and before the voiceless one, is none (0%) in loanwords, but ranges as large as 27% to 49% in learner speech and target speech. In other words, the speakers lengthened the vowels before voiced word-final consonant for 27% to 49% of the average duration. For these reasons, the vowel lengthening phenomenon in learner speech is closer to that in target speech than that in loanwords. Furthermore, learner speech develops toward the target speech phenomenon as L2 proficiency increases (31% > 43% > 49% for word-level, 27% > 34% > 39% in sentence level). As measured by Pairwise Variability, the

7) The values for loanwords have no standard deviation in accordance to the Item 7 for English Loanwords in the current edition of *Official Loanword Transcription Regulations*. It states that long vowels in loanwords from English are indistinctly transcribed for its duration from other vowels in Korean.

duration alternation before instruction shows a significant ($p < 0.001$ for both words and sentences) development after instruction toward the value of the target speech.

For the visual comparison, Table 3 is graphically contrasted in Figure 4.

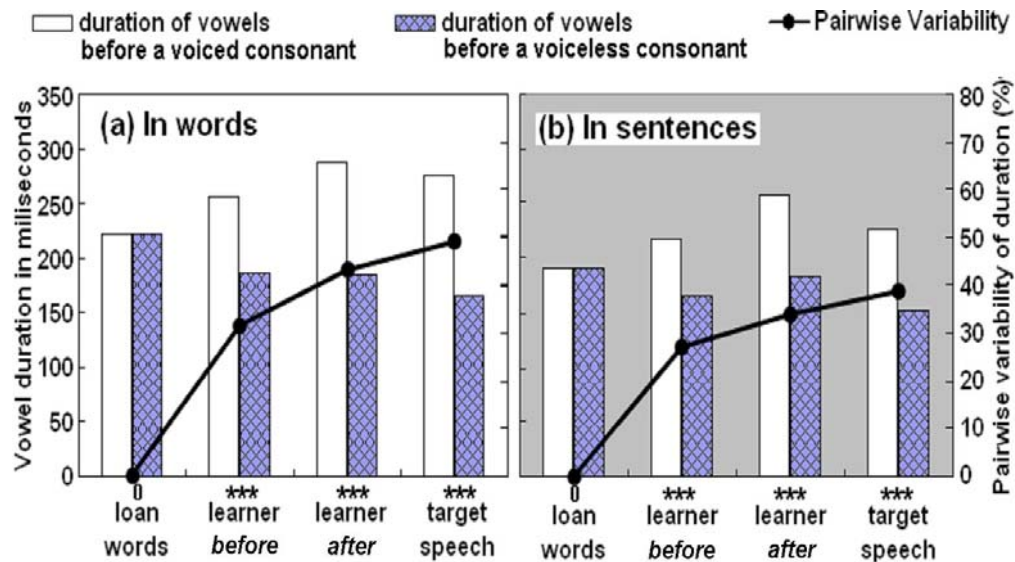


Figure 4. Duration (*msec*) of a vowel before a voiced consonant is compared to the duration before a voiceless one. The consonants are placed at the final position of minimal pairs of words that are embedded (a) in words and (b) in sentences. The duration difference is represented in terms of the Pairwise Variability (%). The values for learner speech before and after instruction are compared to loanwords and target speech (***) and 0 denote statistical differences of vowel duration before a voiced vs. voiceless consonant at $p < 0.001$ and at $p \geq 0.05$).

In Figure 4, the average vowel duration (*msec*) is significantly ($p < 0.001$) longer before a voiced consonant (white bars) than before a voiceless consonant (diagonally shaded bars) in learner speech before instruction, after instruction, and in target speech, but not in loanwords (same duration by nature). The length contrast is represented by Pairwise Variability (solid lines) in that the values in both learner speech and target speech are positive, but 0% in loanwords. The Pairwise Variability of vowel durations before voiced and voiceless final consonants significantly ($p < 0.001$) increases from the value of learner speech before instruction to the value of learner speech after instruction, toward the value of target speech (31 < 43 < 49 *msec* for word level; 27 < 34 < 39 *msec*, for sentence level).

The results of average vowel duration in Figure 4 are consistently observed in individual pairs of words, as shown in Figure 5.

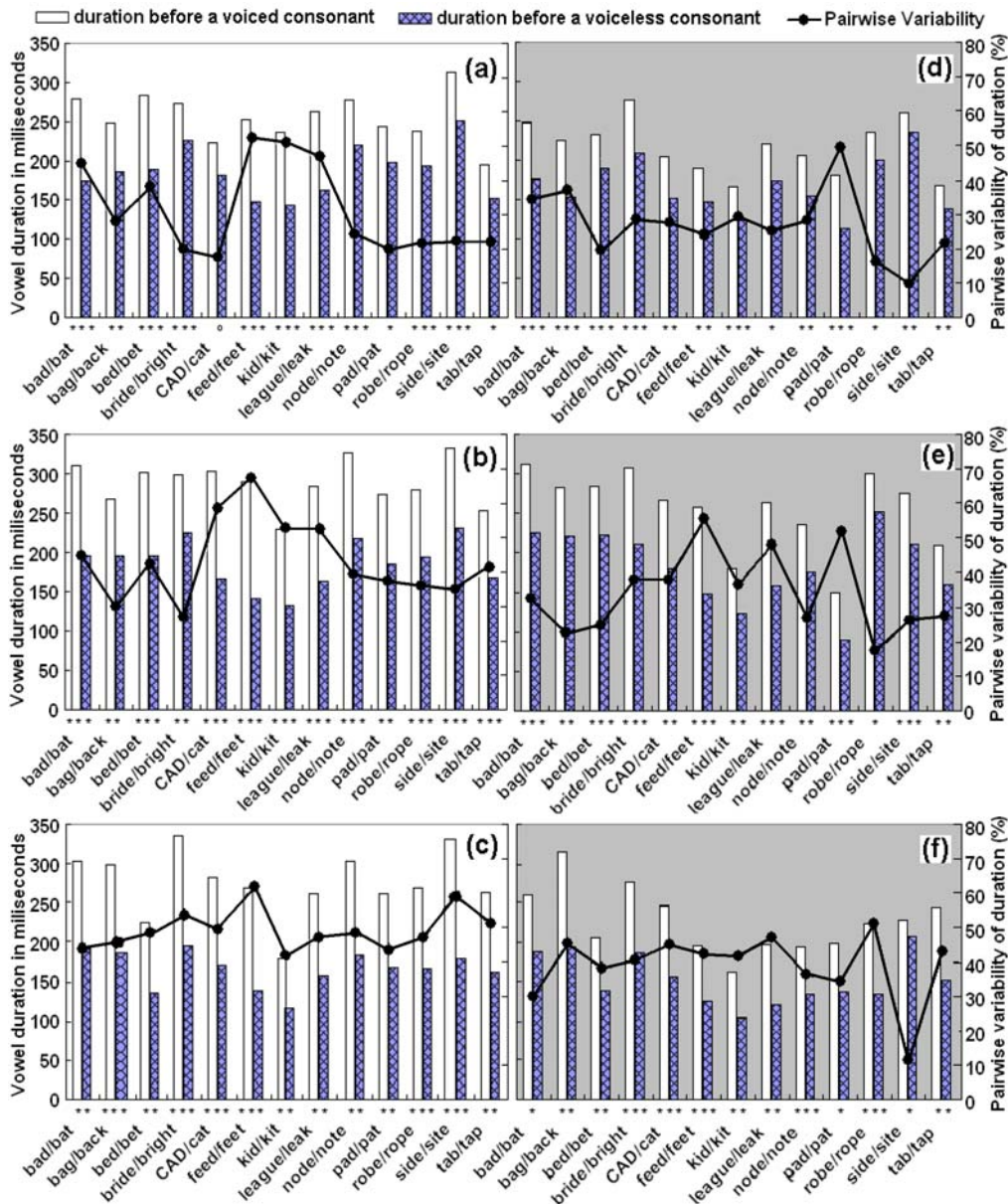


Figure 5. Duration (*msec*) of a vowel before a voiced consonant is compared to the duration before a voiceless consonant. The consonants are placed at the final position of minimal pairs of words, and embedded in words and sentences. The duration difference is represented in terms of the Pairwise Variability (%). The values are mostly significant for both words in learner speech before instruction (a) and after instruction (b), and in target speech (c), and for sentences in learner speech before instruction (d) and after instruction (e), and in target speech (f) (***, **, * and ⁰ denote statistical differences of vowel duration before a voiced *vs.* voiceless consonant at $p < 0.001$, $p < 0.01$, $p < 0.05$ and at $p \geq 0.05$).

In Figure 5, the vowel duration (*msec*) in learner speech (a, b, d, e) are by and large significantly longer before voiced word-final consonant (white bars) than the duration after a voiceless one (diagonally shaded bars). In this respect, learner speech is similar to target speech (c, f), as the duration difference is significant ($p < 0.05$ for most cases) in learner speech and target speech.⁸⁾ These significant rate differences are contrastive to that of loanwords in Figure 4 where loanwords demonstrate no difference between the vowel duration before a voiced word-final consonant and that before a voiceless one. In other words, learner speech behaves differently from loanwords in that (1) learner speech, regardless before or after instruction, lengthens vowels before a voiced final consonant as target speech does, and that (2) the difference in the vowel duration before a voiced consonant and that before a voiceless consonant is significant for learner speech, while insignificant for loanwords. We thus conclude that Hypothesis 1 is rejected.

- (6) HYPOTHESIS 1 REJECTED: Learner speech is different from loanword phonology in that only in learner speech, but not in loanwords, vowel duration is longer before a voiced final consonant, than before voiceless one.

On the other hand, the average Pairwise Variability (%) for learner speech and target speech shows a progressive development toward the target speech phenomenon as shown in Figure 4. We thus consider that Hypothesis 2 is confirmed.

- (7) HYPOTHESIS 2 CONFIRMED: Vowel lengthening before a voiced final consonant in learner speech before instruction becomes greater in learner speech after instruction toward the value of target speech.

For (7), it is important to note that the improvement does not start from loanword stage, or in the proportionally intermediate value between loanwords and target speech. Learner speech before instruction, a mid-intermediate level of proficiency, is far different from loanwords and similar to target speech. Some improvement does take place, but not in a definite progressive correlation to the course from loanwords to target phonology. In this respect, Kim (2007) reports that the majority of non-native phenomena resembles a developmental pattern in Figures 2 and 4: significantly stronger forces of remaining faithful to L2 foreign phonology than

8) There is no correlation to vowel insertion and vowel lengthening in learner and native speech when we compared the duration of the preceding vowels when a vowel is inserted after a voiced consonant, with the duration when a vowel is not inserted.

modifying L2 foreign word to conform to L1 native phonology at an intermediate level of learner speech.

Next, we would like to consider if learners' proficiency in spoken English has been improved by confirming the validity of our independent co-variant criterion of the listening comprehension task. The listening comprehension tests in TOEIC have been conducted twice before and after instruction with the methods in Section 2. The results on a scale ranging from 5 to 495 points are summarized in Table 4.

Table 4. Scores of TOEIC listening tests for learners before and after instruction.

Results	TOEIC listening tests	
	Before instruction	After instruction
Average Score \pm SD*	285 \pm 58 ^A	373 \pm 54 ^B

^{AB} Scores with different superscript within the same row are different at $p < 0.001$ by t-test.

* SD = Standard Deviation

According to Table 4, listening comprehension has been significantly ($p < 0.001$) improved after instruction. From this fact, we infer that the production improvement in Figures 4 and 5 accompanies an improvement of listening comprehension. From these results of listening tests that conform to our production experiment, we summarize in (8) the results of vowel insertion and vowel lengthening with respect to the voicing feature of the following word-final consonant.

- (8) Vowel insertion and vowel lengthening in learner speech
- a. have stronger forces to obey the target phonology and to resist loanword forms.
 - b. develop closer to the target phonology as the proficiency increases.

For (8a), learner speech departs from loanwords to be faithful to target phonology. Fewer vowel insertion and productive duration alternation as in target phonology manifest themselves in learner speech. For (8b), learner speech is a form that develops closer to target speech. The Pairwise Variability of vowel duration increases as L2 proficiency increases.

4. Conclusion

The results indicate that learner speech is far more distant from loanwords, and much closer to target phonology. First, in terms of vowel insertion, only loanwords, not so much of learner speech, epenthesize a vowel after a voiced word-final consonant. Secondly, in terms of vowel

duration, only learner speech and target speech, not loanwords, lengthen the vowel before a voiced word-final consonant. We further note that the duration difference between vowels before a voiced word-final consonant and a voiceless one increases toward the value of target speech, along with the improvement of L2 proficiency of learners.

To conclude, learner speech is far more faithful to target phonology than loanword phonology. Our findings in this experiment demonstrate the fact that learner speech at the mid-intermediate level of L2 proficiency consistently obeys the duration alternation of target phonology, and disobeys the vowel insertion of loanword phonology. Another difference between learner speech and loanword phonology is that learner speech develops toward target phonology, while loanword phonology is constant. Needless to mention is an additional fact that loanwords conform to native phonotactics, whereas learner speech does not.

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