

Degree of vowel epenthesis in Japanese-English bilinguals and English native speakers*

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1 Introduction

Research in language learning has revealed that foreign language learning is often heavily influenced by the learners' first language. In the case of Japanese native speakers learning English, the /r/-/l/ liquid phoneme distinction is said to be problematic in both perception and production [1]. Such difficulty occurs since the /r/-/l/ phonemes are not distinguished in Japanese [2].

Another major difficulty in Japanese native speakers when learning English is the perception and production of consonant clusters. Consonant clusters are phonotactically legal in English while Japanese disallows such sequences. Thus the phenomenon of vowel insertion called "vowel epenthesis" arises in order to avoid syllables to end with a consonant. For example, the English word "strike" is produced as /sutoraiku/ so that consonants do not position at syllable coda [2].

Tajima *et al.* [3] analyzed vowel epenthesis in English words in word-final two-consonant clusters and word-final single-consonant by Japanese native speakers and English native speakers. Their analyses revealed that Japanese native speakers were more likely to insert epenthetic vowels than English native speakers. In the case of word-final two-consonant clusters, Japanese native speakers' epenthetic vowels increased at a slow rate than at a normal rate, and emerged more within voiced consonants than within voiceless consonants. English native speakers, on the other hand, did not produce epenthetic vowels within voiced nor voiceless two-consonant clusters at a normal speaking rate.

Furthermore, Fujimoto and Funatsu [4] compared production of vowel epenthesis between consonants by Japanese and German native speakers. Their results showed that while

German native speakers insert no vowels between consonants, Japanese native speakers were highly likely to insert epenthetic vowels. The results of Japanese native speakers correspond with that of the previous study [3].

Masuda & Arai [5,6] investigated the differences in the degree of vowel epenthesis by Japanese-English bilingual and Japanese monolingual speakers by categorizing the vowel into full, partial and no epenthesis. Their results revealed that although both speaker groups share the same first language, Japanese, bilinguals outperformed Japanese monolinguals: bilinguals inserted partial epenthesis the most, while monolinguals inserted full epenthesis. Such results suggest that English proficiency has an effect on the degree of vowel epenthesis.

Dupoux *et al.* [7] pointed out the possibilities that vowel epenthesis in perception occurs since Japanese native speakers may have failed to develop consonant cluster articulation to some degree, or as a result of Japanese orthography. Their perception experiments have revealed that Japanese native speakers were highly likely to perceive epenthetic vowels between consonants even if no vowels were actually present.

The present study focuses on the comparison of the production of vowel epenthesis by Japanese native speakers with high English proficiency and English native speakers. Although differences could be observed between Japanese-English bilinguals and Japanese monolinguals in the previous studies [5,6], whether Japanese native speakers with high English proficiency perform similarly or differently from English native speakers is still unknown.

There are two aims in the present experiment. The first aim is to compare the epenthetic vowels,

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between consonants in VCCV pseudo-words by Japanese-English bilinguals and English native speakers. The epenthetic vowels are categorized into three degrees: full, partial, and no epenthesis. The second aim is to compare the differences in the effect of consonant voicing on vowel epenthesis between the two speaker groups.

2 Experiment

2.1 Participants

Seventeen Japanese-English bilinguals and ten English native speakers participated in the experiment. The standards for Japanese-English bilinguals in the present study are to have experience of living in an English-speaking country for more than 2 years (range: 2-8.5 years, mean 5.7 years), and to be highly fluent in both Japanese and English. All bilinguals received education in English during their stay abroad. The English native speakers are all speakers of American English. None of the participants reported any hearing problems. The data of the participants are shown in Table 1.

Table 1 Data of participants

	J-E bilinguals	English NS
Number of participants (Male:Female)	N=17 (5:12)	N=10 (6:4)
Age (Mean)	19-25 yrs (23.4 yrs)	19-40 (23.2 yrs)

2.2 Target words

The target words of the present study are nine pseudo-words with consonant clusters that have no meaning in either Japanese or English. The consonant clusters are categorized in terms of voicing [+/- voice] (see Table 2). There are three words in each voicing category. All words are taken from Dupoux *et al.*'s pseudo-word list [7]. C[+voice]-C[-voice] combination was not in the list. The bilinguals' data used in the present study is a part of the recordings from the previous studies [5,6].

Table 2 List of target words categorized in terms of consonant voicing

	Target words		
C[+voice]-C[+voice]	abge	egdo	ibdo
C[-voice]-C[+voice]	akmo	ashmi	okna
C[-voice]-C[-voice]	ekshi	ishto	oshta

2.3 Procedure

Participants were asked to repeat each word three times. The second repetition was analyzed. Thus a total of 243 utterances (17 bilinguals x 9 words, 10 English native speakers x 9 words) were analyzed. The recordings took place in a sound-proof room, using a digital sound recorder (Marantz PMD 671) and a microphone (SONY ECM-959DT) at a sampling frequency of 48 kHz.

2.4 Analysis

The recorded materials were acoustically analyzed to check whether vowel epenthesis occurred between consonants. Furthermore, the epenthetic vowels were categorized by the degree of epenthesis: full, partial, and no epenthesis (see Table 3 for details of each criteria) [5,6]. Epenthesis that do not apply to full or no epenthesis are categorized as partial epenthesis, which also includes devoiced partial vowels. Devoiced vowels are vowels with unstable waveform and without a voice bar. The examples of full, partial, none, and devoiced epenthetic vowels are shown in Figures 1-4, respectively. Examples are taken from our previous studies' Japanese monolinguals and Japanese-English bilinguals [5,6]. Acoustical analyses were performed using Praat [8].

Table 3 Criteria for the measurement of the degree of vowel epenthesis

Full	Periodic waveform, voice bar, pulse
Partial	Short pseudo-periodic waveform and voice bar/Devoiced short vowel
None	No waveform nor formants

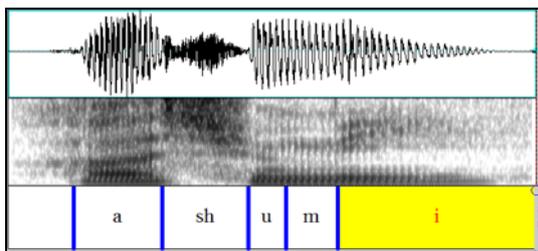


Fig. 1 Example of full epenthesis in “ashmi”

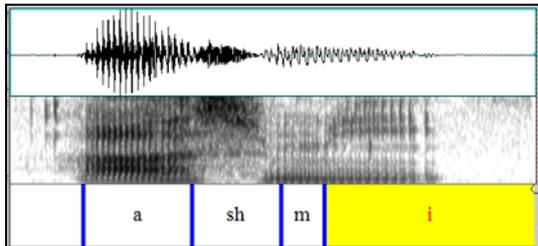


Fig. 2 Example of partial epenthesis in “ashmi”

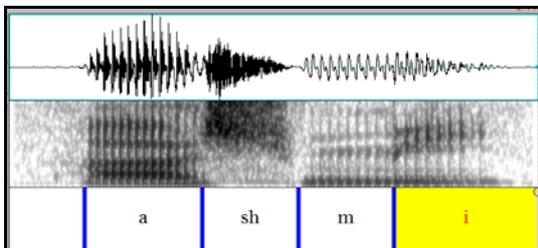


Fig. 3 Example of no epenthesis in “ashmi”

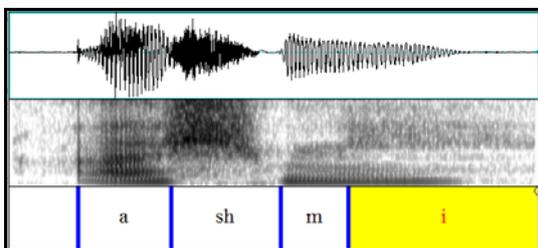


Fig. 4 Example of devoiced, partial epenthesis in “ashmi”

3 Results

3.1 Vowel epenthesis

The degree of vowel epenthesis differed significantly in Japanese-English bilinguals and English native speakers. The average numbers and percentages of each epenthesis degree by the two speaker groups are shown in Table 4. A high number of English native speakers inserted no vowel, while Japanese-English bilinguals inserted partial vowels the most.

Table 4 Numbers and percentages of each epenthesis degree

	Bilingual (N=153)	English NS (N=90)
Full	2 (1.3%)	0 (0%)
Partial	106 (69.3%)	19 (21.1%)
None	45 (29.4%)	71 (78.9%)

$p < 0.01$ (Chi-square test)

3.2 Effect of consonant voicing

The results of C[+voice]-C[+voice], C[-voice]-C[+voice], and C[-voice]-C[-voice] combinations are shown in Tables 5-7. Significant differences were found between Japanese-English bilinguals and English native speakers, except in C[+voice]-C[+voice]. The percentages may not add up to 100% due to rounding.

Table 5 Numbers and percentages for each degree of vowel epenthesis in C[+voice]-C[+voice]

	Bilingual (N=51)	English NS (N=30)
Full	1 (2.0%)	0 (0%)
Partial	11 (21.6%)	6 (20.0%)
None	39 (76.5%)	24 (80.0%)

$p = 0.7$ (Chi-square test)

Table 6 Numbers and percentages for each degree of vowel epenthesis in C[-voice]-C[+voice]

	Bilingual (N=51)	English NS (N=30)
Full	0 (0%)	0 (0%)
Partial	49 (96.1%)	10 (33.3%)
None	2 (3.9%)	20 (66.7%)

$p < 0.01$ (Chi-square test)

Table 7 Numbers and percentages for each degree of vowel epenthesis in C[-voice]-C[-voice]

	Bilingual (N=51)	English NS (N=30)
Full	1 (2.0%)	0 (0%)
Partial (devoiced)	46 (90.2%)	3 (10.0%)
None	4 (7.8%)	27 (90%)

$p < 0.01$ (Chi-square test)

4 Discussion

The present study was conducted under two aims. The first aim was to investigate the presence of epenthetic vowels within consonant clusters by Japanese-English bilinguals and English native speakers. The second aim was to investigate the effect of consonant voicing on vowel epenthesis.

The overall vowel epenthesis in the two speaker groups differed significantly: almost 70% of bilinguals inserted partial vowel while almost 80% of English natives did not insert any vowel (Table 4). In comparison, Japanese monolinguals inserted 55% full, 36% partial, and 9% no vowel [6] (Table 8).

Table 8 Numbers and percentages of each degree of epenthesis by Japanese monolingual speakers [6]

	C[+voice]- C[+voice] (N=66)	C[-voice]- C[+voice] (N=66)	C[-voice]- C[-voice] (N=66)
Full	51 (77%)	48 (73%)	9 (14%)
Partial	6 (9%)	12 (18%)	53 (80%)
None	9 (13%)	6 (9%)	4 (6%)

The results of the previous study [6] and the present study show that the voicing of consonants does have an effect on Japanese native speakers, although there was a variation between Japanese monolinguals and Japanese-English bilinguals. However, English native speakers' performance was constant, with no vowel insertion in any of the voicing combinations. This result suggests that even highly fluent Japanese-English bilinguals do not perform similar to English native speakers, and that the bilinguals' overall performance, without considering the consonant voicing, is positioned between English native speakers and Japanese monolinguals.

While most Japanese monolinguals inserted full epenthesis in C[+voice]-C[+voice], most Japanese-English bilinguals and English native speakers did not insert any vowel. The vowel in C[-voice]-C[+voice] combination varied the most among the three speaker groups: a large proportion of English natives inserted no vowels, Japanese-English bilinguals inserted partial

vowels, and Japanese monolinguals inserted full vowels. In C[-voice]-C[-voice], most English natives inserted no vowels, while both Japanese-English bilinguals and Japanese monolinguals inserted partial vowels. The vowels in C[-voice]-C[-voice] by Japanese native speakers (both bilinguals and monolinguals) were often devoiced [6] which may be interpreted as L1 influence since high vowels between voiceless consonants are often devoiced in Japanese [2].

5 Conclusion

The experiment in the present study revealed that the highest percentage of the degree of epenthesis was none for English native speakers, while Japanese-English bilinguals were likely to insert partial vowels. These results suggest that the productive ability of consonant clusters by Japanese-English bilinguals is different from that of English native speakers, even though the bilinguals were highly fluent in English.

Acknowledgment

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