

Effect of consonant voicing on the vowel epenthesis of Japanese learners of English*

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1 Introduction

Foreign language perception and production are heavily influenced by the learners' first language, especially in the case of foreign language learning in adulthood. A widely known example is the Japanese natives' difficulty to distinguish English /r/ and /l/ [1]. This is due to the differences in the phonetic inventory of Japanese and English: Japanese does not have /r/ and /l/ distinction like English.

Difficulties arise not only by the phonetic difference but also by the difference in syllable structure. For example, Japanese natives are likely to produce "strike" as [sutoraiku] with a vowel inserted after every consonant [2]. Japanese are highly likely to produce epenthetic vowels between consonants [3-6], but they also have difficulty with distinguishing VCCV and VCVCV, and perceive "illusory vowels" even if no vowels are actually inserted [7]. Vowel epenthesis in perception and production occur because the Japanese phonotactics does not allow more than two adjacent consonants.

Although results of Dupoux et al.'s perception experiments with Japanese natives on pseudo-words (e.g. ebzo-ebuzo) had not taken the participants' foreign language learning background into account, Masuda & Arai [4,5] found a significant difference in the production of consonant clusters between Japanese natives with different English learning backgrounds. The degrees of vowel epenthesis were divided into three categories: full, partial, and no epenthesis. The degree of vowel epenthesis in C[+voice]-C[+voice] consonant combination was significantly different between Japanese-English bilinguals and Japanese monolinguals. 76% of bilinguals did not insert any vowels between

consonants, while 77% of monolinguals inserted full epenthesis. This result indicates that the productive ability of consonant clusters by Japanese native speakers differed with the amount of foreign language input one received. However, the results of the study [5] only reflect the vowel epenthesis of C[+voice]-C[+voice] consonant voicing combination.

The present study aims to investigate the influence of consonant voicing on vowel epenthesis, and to analyze the difference in the degree of vowel epenthesis between bilinguals and monolinguals. A widely-known phenomenon of vowel devoicing in C[-voice]-C[-voice] environment in Japanese [8] will also be an issue to be discussed about, and whether this rule will also be present in foreign utterances.

2 Experiment

2.1 Participants

Two groups of Japanese native speakers with different English proficiency participated in the study: Japanese-English bilinguals and Japanese monolinguals. The data used in the present study are taken from the previous studies [4,5].

The standards for being a Japanese-English bilingual are to have experience of living in an English-speaking country for more than 2 years, and to be highly fluent in both Japanese and English. All bilinguals received education in English during their stay abroad. The standards for being a monolingual, on the other hand, are not to have experience of living abroad for more than one month, and had received English education only in Japan. All participants' first language is Japanese. The data of the participants are shown in Table 1.

* Effect of consonant voicing on the vowel epenthesis of Japanese learners of English, by MASUDA, Hinako and ARAI, Takayuki (Sophia University).

Table 1 Data of participants

	Bilinguals	Monolinguals
Number of participants (Male: Female)	N=17 (5:12)	N=22 (14:8)
Age (Mean)	19-25 yrs (23.4 yrs)	18-25 yrs (20.8 yrs)
Length of stay overseas (Mean)	2-8.5 yrs (5.7 yrs)	less than 1 month

2.2 Target words

The consonant clusters are categorized in terms of voicing [+/- voice]. There are three voicing combinations, and three words per category were selected. All consonant clusters are positioned in the middle of the word. The nine pseudo-words in the present study are taken from Dupoux et al.'s pseudo-word list [7]. C[+voice]-C[-voice] combination was not in the list. The data used in the present study is a part of the recordings from the previous studies [4,5]. The list of the target words used for analyses is shown in Table 2.

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 Recording of material [4,5]

The nine pseudo-words used in this study, each produced by 17 bilinguals and 22 monolinguals, were recorded with a digital sound recorder (Marantz PMD 671) and a microphone (SONY ECM-959DT) at a sampling frequency of 48 kHz. A total of 351 utterances were analyzed (39 participants x 9 pseudo-words). The recordings took place in a sound-proof room.

2.4 Analysis

The epenthetic vowels between consonants were categorized by the degree of epenthesis: full epenthesis, partial epenthesis, and no epenthesis.

The criteria for each category are shown in Table 3, and examples of full, partial, none, and devoiced epenthetic vowels are shown in Figures 1-4, respectively. Partial epenthesis are divided into voiced and devoiced vowels. Utterances with devoiced vowels are labeled as partial epenthesis in the analysis. The criteria for the measurement of a devoiced vowel are unstable waveform and no voice bar. Acoustical analyses were performed using Praat [9].

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

Full	Periodic waveform, voice bar, pulse
Partial	Unstable waveform and voice bar, devoiced short vowel inserted
None	No waveform nor formants

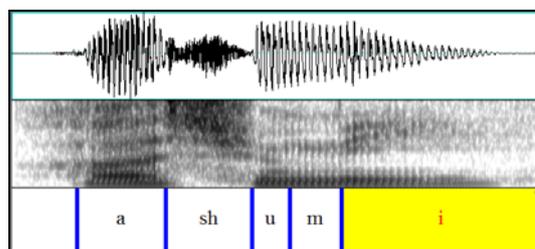


Fig. 1 Example of full epenthesis in “ashmi” (monolingual_1)

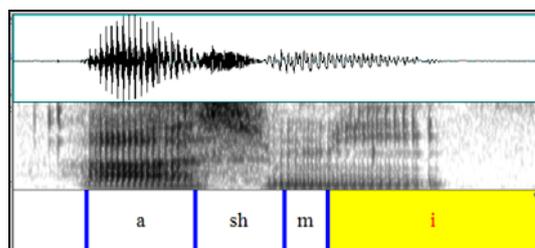


Fig. 2 Example of partial epenthesis in “ashmi” (monolingual_22)

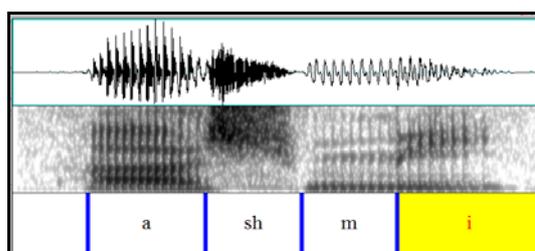


Fig. 3 Example of no epenthesis in “ashmi” (monolingual_20)

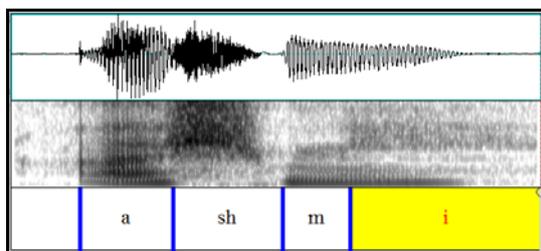


Fig. 4 Example of devoiced, partial epenthesis in “ashmi” (bilingual_7)

3 Results

3.1 C[+voice]-C[+voice]

The results of C[+voice]-C[+voice] combination are taken from Masuda & Arai [5]. The percentages for each degree of vowel epenthesis by bilinguals and monolinguals are shown in Table 4. Analysis revealed a significant difference in the percentages between bilinguals and monolinguals’ degree of vowel epenthesis in C[+voice]-C[+voice] (chi-square test, $p < 0.001$).

Table 4 Percentages for each degree of vowel epenthesis in C[+voice]-C[+voice] by bilinguals and monolinguals

	Bilingual	Monolingual
Full	1%	77%
Partial	21%	9%
None	76%	13%

3.2 C[-voice]-C[+voice]

The percentages for each degree of vowel epenthesis in C[-voice]-C[+voice] consonant clusters by bilinguals and monolinguals are shown in Table 5. The chi-square test found a significant difference between bilinguals and monolinguals’ degree of vowel epenthesis ($p < 0.001$).

Table 5 Percentages for each degree of vowel epenthesis in C[-voice]-C[+voice] by bilinguals and monolinguals

	Bilingual	Monolingual
Full	0%	73%
Partial	96%	18%
None	4%	9%

3.3 C[-voice]-C[-voice]

The percentages for each degree of vowel epenthesis in C[-voice]-C[-voice] consonant clusters by bilinguals and monolinguals are shown in Table 6. The chi-square test found a significant difference between bilinguals and monolinguals’ degree of vowel epenthesis ($p = 0.03$). The most common degree of epenthesis was partial in both speakers, and all partial insertions were devoiced.

Table 6 Percentages for each degree of vowel epenthesis in C[-voice]-C[-voice] by bilinguals and monolinguals

	Bilingual	Monolingual
Full	2%	14%
Partial (devoiced)	90%	80%
None	8%	6%

4 Discussion

The voicing combination that was most likely to provoke vowel epenthesis was the C[+voice]-C[+voice] cluster for monolinguals, while this combination was most unlikely to provoke vowel epenthesis for bilinguals. Such result suggests that the level of difficulty is different for bilinguals and monolinguals. Table 7 shows the possibility of the order of difficulty in producing consonant cluster drawn from the results of the present study.

Vowel insertion between consonants in Japanese is either /u/ or /o/ in most cases [8]. The inserted vowel was all /u/ in the present study, except for one utterance [ekishi] by a monolingual. Devoicing of vowels is most common in /i/ and /u/, especially in between voiceless consonants [8]. Analyses of the present study revealed that partial vowel insertions are likely to become devoiced in both bilinguals and monolinguals.

However, it remains an open question whether there is a difference between Japanese-English bilinguals and English monolinguals. Further investigation is needed on how Japanese-English bilinguals produce consonant clusters: like English monolinguals, or has their own unique performance.

Table 7 Order of difficulty in producing consonant clusters according to voicing

Speaker	Order of difficulty
Bilinguals	[-voice]-[+voice] > [-voice]-[-voice] > [+voice]-[+voice]
Monolinguals	[+voice]-[+voice] > [-voice]-[+voice] > [-voice]-[-voice]

5 Conclusion

The present study investigated the degree of vowel epenthesis within consonant clusters by Japanese-English bilinguals and Japanese monolinguals. We focused mainly on two factors: the level of the English proficiency of participants, and the voicing of consonants. The analyses on the degree of vowel epenthesis were performed on three voicing combinations: C[+voice]-C[-voice], C[-voice]-C[+voice], and C[-voice]-C[-voice]. The epenthetic vowels were categorized into three degrees of epenthesis: full, partial, and none.

Analyses revealed significant difference in the participant groups' degree of epenthesis in all voicing combinations. Thus English proficiency seems to influence the degree of vowel epenthesis. The results of the present study suggest that the level of difficulty regarding consonant voicing also differs among bilingual and monolingual groups' degree of vowel epenthesis. The difference between bilinguals and monolinguals was especially distinct in the C[+voice]-C[+voice] environment.

The results of the present study suggest that there are, in fact, differences in the degree of epenthetic vowels by Japanese native speakers with different English learning backgrounds.

Acknowledgment

This study work was partially supported by Sophia University Open Research Center from MEXT. We would like to thank Tsutomu Sugawara and Shigeko Shinohara for their comments and support.

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