

A Study of Japanese Learners' Preferred Strategies for English Plosives in Word-final Position

ISONO Toru

Faculty of International Communication, Aichi University

E-mail: isono@vega.aichi-u.ac.jp

要 旨

本論は、日本人英語学習者が英語の語末閉鎖音を発音する際に、どのような特徴を示す傾向があるのかを考察したものである。可能性としては、「語末有声音の無声化」、「母音添加」、そして「語末閉鎖音の省略」の3つが挙げられるが、日本人学習者がどれに陥りやすいかは研究者の間で意見が分かれており、いまだ結論に至っていない。本論では、過去の研究に見られる「日本人学習者全員が押し並べて一つの特徴を示す」というような考察の仕方ではなく、「日本人学習者の英語習熟度によって傾向が変わる」という仮説をたて、データを音響分析することにより実証的にその仮説を検証する。

I. Introduction

Over the past two decades a considerable number of studies have been conducted on the acquisition of Second Language (L2) pronunciation, although it has been said to have received less attention than other areas as there have been more syntactic and morpheme studies. Among the various research areas in the acquisition of L2 pronunciation, English plosives in word-final position is a subject to which a relatively great deal of effort has been devoted. The reason behind this is a strong interest in Second Language Acquisition (SLA) theories as well as in pedagogical issues.

From the pedagogical standpoint, there is fairly general agreement that many language learners have great difficulty with the voice contrasts of English plosives in word-final position. A plosive itself is a consonant which occurs in all languages. In addition, although some languages (such as Korean) do not have voiced plosives, English and Japanese have the same repertory which is classified into either voiced or voiceless. However, various restrictions are observed among languages in the positions where voice

contrasts occur. English is a language which allows voice contrasts for all kinds of plosives [p]-[b], [t]-[d], and [k]-[g], in all word-initial, -medial, and -final positions. On the other hand, many languages limit the occurrence of voice contrasts in word-final position. For example, German, Russian, Dutch, and Polish allow only voiceless plosives in word-final position, and some other languages such as Japanese, Mandarin, and Swahili, allow only sonorants or do not allow consonants in word-final position (Yavas, 1994).

It is said that the degree of learning difficulties in voice contrasts caused by these linguistic differences are predicted by Eckman's (1977) *Markedness Differential Hypothesis* (MDH). The MDH predicts that, to cite Eckman's (1985: 291) claim, "those areas of the TL (Target Language) that are different from the NL (Native Language) and are relatively more marked than in the NL will be difficult". Concerning the features which are relevant to the current study, a voiced plosive is regarded as more marked than a voiceless plosive, since the occurrence of the former in natural languages is more limited than that of the latter, as we can see from the example of Korean. Regarding the positions where voice contrasts occur, word-final is considered to be a more marked position than word-initial and -medial. This is also because the occurrence of voice contrasts in word-final position is more restricted than that of the others in language typology, as the examples of German, Russian, Dutch, and Polish suggest. Since these markedness rules are implicational rules, the existence of a voiced plosive implies that of a voiceless plosive. Similarly, the occurrence of a voice contrast in word-final position implies the occurrences of voice contrasts in word-initial and -medial positions. In summary, the existence of voice contrasts in word-final position implies the occurrences of them in all word-initial, -medial, and -final positions, and in this sense, a language maintaining voice contrasts in word-final position, such as English, is the most marked language with respect to voice contrasts. By applying this hypothesis, as Eckman (1977) notes, we can explain why German learners of English have great difficulty with a voice contrast in word-final position, although English learners of German have no difficulty with the devoicing rule in word-final position.

Since learners face great difficulty in accurately producing English voice contrasts in word-final position, they tend to adopt various strategies to reduce the burden, and the strategies emerge as either 'epenthesis', 'final plosive deletion', or 'final plosive devoicing'. When this phenomenon was widely recognised, it was natural that researchers, who were motivated by the interest for SLA research, sought to prove the universality of interlanguage phonology by emphasising that one of the strategies was the common characteristic in L2 productions, which could be observed regardless of learners' First Language (L1). For example, Oller (1974, in Tarone, 1978) claims that vowel insertion (epenthesis: e.g., 'bed' [bed] ⇒ [bedə]) seems to be one of the characteristic strategies of L2 learners, although, in First Language Acquisition (FLA), simplifying a difficult sound (final plosive deletion: e.g., 'bed' [bed] ⇒ [be]) is the usual strategy of native children under 3 years of age. Tarone (1978: 24) also asserts that "the simple open CV syllable may be a universal articulatory and perceptual unit such that the articulators tend to operate in basic CV programs in all learners".

On the contrary, some researchers tried to prove the universality of interlanguage phonology by focusing on the similarities of acquisition process between SLA and FLA, and final plosive devoicing (e.g., 'bed' [bed] ⇒ [bet]) is said to be a general process in both FLA by English native children (e.g., Edwards & Shriberg, 1983) and SLA. To put SLA more concretely, this rule known as *Terminal Devoicing*

is demonstrated not only by learners of English whose L1s have the same rule, but also by those whose L1s do not have such a devoicing process (e.g., Flege & Davidian, 1984; Edge, 1991).

As would be noticed, opinions are divided among researchers on the subject of what the common (or universal) characteristic of L2 learners for English word-final plosives is. Is it epenthesis, final plosive devoicing, or final plosive deletion? The main aim of this paper is to investigate which strategy is preferred by Japanese learners for English plosives in word-final position. In addition, it is believed that the result of the experiment might provide a clue to reconcile the conflict in the above past works.

II. Research Question and Hypothesis

As stated above, the possible strategies for English plosives in word-final position which could be adopted by Japanese learners of English whose L1 does not allow plosives in word-final position are the following three phenomena: 'epenthesis'; 'final plosive devoicing'; or 'final plosive deletion'. According to past studies, however, as in the previous argument, the opinions have been divided among researchers over which of these is preferred by Japanese learners.

Eckman (1981) hypothesised that the direction of the strategies decided by L2 learners facing difficulty with English voice contrasts in word-final position would be conditioned by the phonetic forms of their L1s, and reported that his Japanese subjects' strategies were indeed characterised by epenthesis. Although the task of modifying an English syllable ending with a plosive (such as 'bed' [bed]) to the CV syllable is completed by either epenthesis ([bedə]) or final plosive deletion ([be]), Eckman (1981) expressed doubts about the latter possibility as learners were supposed to attempt to preserve as much of the underlying representation as possible. Tajima, Erickson, and Nagao (2000), who examined 26 Japanese university students, reported that the probability of the occurrence of epenthesis varied according to the speech rate and the kinds of consonants in word-final position, though they agreed about the existence of epenthesis as a characteristic of Japanese-accented English. According to Tajima et al. (2000), epenthesis was more produced at a slower speech rate and for voiced consonants. The details of their findings will be outlined later.

The findings obtained by these studies are important with respect to confirming anecdotal evidence that epenthesis is one of the features characterising Japanese-accented English, but we cannot conclude that the preference of Japanese learners' strategy for English plosives in word-final position is epenthesis, since they did not report the rate of the occurrence of final plosive devoicing and final plosive deletion in the data. In this respect, Edge's (1991) study, which replicated and extended Eckman's (1981) work, is quite insightful. In her results, she found, in contrast to Eckman's (1981) study, that epenthesis made up 14% of the total productions of Japanese subjects, while final plosive devoicing accounted for 63% of the total productions, across all of the three tasks of storytelling, passage reading, and wordlist.

What is the reason of this contradiction in the findings between Eckman (1981) and Edge (1991)? One of the possible reasons would be attributed to the fact that both studies adopted only a few subjects who were not classified into various learning levels according to their English proficiencies. In this paper, in order to reconcile the above contradiction to some extent, we hypothesise that the preference of Japanese learners' strategy for English plosives in word-final position varies according to their learning levels. This hypothesis itself is not a novel idea, since in the concept of interlanguage phonology there

is an assumption that interlanguage becomes more native-like as learners are more exposed to the target language and they become more advanced learners.

Before dealing with the details of the hypothesis, it is necessary to define what ‘native-like productions’ are in the case of English plosives in word-final position. As is generally known, English native speakers also perform epenthesis, final plosive devoicing, and final plosive deletion when they produce plosives in word-final position. However, in the case of English native speakers, the occurrences of these phenomena are systematic, that is, we can easily predict when, or in what situations, they occur. Normally, English voiced plosives in word-final position have little voicing in rapid speech, such as casual speech, and the plosives in word-final position are often deleted (e.g., I don’t know [ai doun nou]). On the other hand, English voiced plosives are fully voiced in careful speech, but sometimes are accompanied by epenthesis (e.g., Tajima et al., 2000). The degree of voicing is also strongly affected by the following sounds. When English voiced plosives in word-final position are followed by voiceless consonants, they are almost devoiced (e.g., have to [hə(æ)f tu]; of course [ɔf kɔ:rs]). On the other hand, they tend to be fully voiced if the following sound is voiced¹⁾.

Taking into account these phenomena, especially for the current topic, it has been emphasised that non-native speech data must be compared to the data elicited from English native speakers (Flege & Davidian, 1984; Edge, 1991). Therefore, to prove the existence of any errors, “it would be necessary to show a substantially higher frequency for non-native than for native speakers” (Flege & Davidian, 1984: 327) or only non-target variants should be counted, as done in Edge’s (1991) study. For example, in the sense of Edge’s (1991) suggestion, to become native-like means to come not to produce non-target variants.

Another interesting finding from Edge’s (1991) study is that the Japanese subjects exhibited epenthesis more frequently in the word-list reading (29%) than in the storytelling (4%) and in the passage reading (2%). From the perspective of the variability of interlanguage, these results are inscrutable, since a learner’s interlanguage is supposed to become more accurate as more attention is paid to the form. Nevertheless, from the view of articulatory phonetics, as Tajima et al. (2000) have shown, it is quite natural that as speakers (either native or non-native) become more attentive to voiced consonants in word-final position, their productions are more frequently accompanied by epenthesis, since they try to voice final voiced consonants more completely. This phenomenon would be more significant for voiced plosives than voiced fricatives because “the articulation of stops involves build-up of air pressure behind the constriction but not involve sustained production of frication noise after constriction release” (Tajima et al., 2000: 197).

To sum up, as far as plosives in word-final position are concerned, epenthesis is likely to be exhibited when either Japanese learners transfer the underlying representations of Japanese into their English productions or when they try to accomplish the voicing rather than escaping to an easier articulation, which is devoicing or deletion. The epenthesis produced by the former process is defined as a non-target variant, but that produced by the latter can be classified as a target-variant. The non-target variant of epenthesis occurs either after voiced or voiceless plosives (e.g., [bæg] ⇒ [bægu]; and [bæk] ⇒ [bæku]), but the occurrence of target-variant epenthesis is strictly limited to a position after voiced plosives

1) It should be noted that the difference in the duration of the preceding vowel might also play an important role for English native speakers to distinguish word-final voiced plosives from word-final voiceless plosives.

(e.g., [bæg] ⇒ [bægu]). In addition, for the non-target variant, epenthesis sometimes occurs with the condition that final voiced plosives are devoiced (e.g., [bæg] ⇒ [bæku]). On the other hand, in the case of the target-variant, when epenthesis is exhibited, the voiced plosives in word-final position are necessarily fully voiced.

We are now able to present four possible strategies for English voiced plosives in word-final position in formal speech style:

- | | |
|-----------------------------------|----------------------|
| (1) non-target variant epenthesis | (non-target variant) |
| (2) target variant epenthesis | (target variant) |
| (3) devoicing | (non-target variant) |
| (4) deletion | (non-target variant) |

Although we discussed earlier that both final plosive devoicing and final plosive deletion characterise English native speakers' productions, Edge's (1991) study suggests that these phenomena hardly occur (1% for devoicing, and 0% for deletion) in formal speech style, except for the systematic occurrences particular to English outlined earlier. Hence, they can be classified into non-target variants, as long as the speech style is formal.

This paper hypothesises that, in a formal situation, as learners become more advanced, they come not to produce the non-target variants, although they continue to produce the target variant. Concretely, the number of occurrences of final plosive devoicing and final plosive deletion would decrease as learners become more advanced. For epenthesis, the number of the occurrences in itself would not differ according to the learners' learning levels, but the productions of less advanced learners would be characterised by the non-target variants, while the productions of more advanced learners would be more likely the target-variant.

III. Method

1. Subjects

The subjects who participated in the experiment consisted of three Japanese groups which were assumed to be in three different learning levels, and one English native group as a control group. The number of the subjects in each Japanese group was 10, so 30 Japanese subjects (10 subjects × 3 groups) were enrolled in the data collection. All of them were born and lived for a long time in the western part of Japan²⁾. Concerning the native control group, it consisted of 8 English native speakers who had been teaching English in Essex, East Anglia, England.

The first group of Japanese subjects was made up of 3rd and 4th year university students in Japan. Their major was English or American literature, and they were exposed to English, mostly written English, constantly in their classes. In this first group, no one had studied abroad, except 1 subject who stayed in England for a month. This group will be called the US (University Students) group (Male = 4; Female

2) The reason why people from the western part of Japan were tested was that it is said that some people living in the Kantoh area often devoiced voiced consonants and word-final vowels.

= 6).

The second group consisted of postgraduate students in a Japanese university. They majored in the study of vocabulary acquisition, syntax, language testing, and literature, so no one had studied a subject connected with any kind of pronunciation as their majors. 2 subjects had experience studying abroad. One studied in America for a year, and the other in Australia for a year. The label of this group is the PS (Postgraduate Students) group (Male = 4; Female = 6).

The third group was comprised of postgraduate students who had been studying in University of Essex, England. All of them were in the Language and Linguistics Department, and had stayed in England for more than 3 years. In the same way as the PS group, only the subjects whose majors were not relevant to any kind of pronunciation study were selected. This group is named the AS (Students studying Abroad) group (Male = 3; Female = 7).

2. Procedure

All of the subjects were asked to be enrolled in two tasks. Their speech productions were recorded using a digital recording machine. A microphone was placed diagonally in front of the subjects, and the distance between the microphone and the subjects was kept at 20 – 25 cm.

The first task was a reading-aloud test which measured the Japanese subjects' pronunciation abilities in English. The above three Japanese groups were selected to reflect various learning stages of English. Based on the subjects' years of English study and experience studying abroad, the AS group was assumed to be at the most advanced stage, the PS group the second most advanced, and the US group the least advanced. The aim of this task was to support the assumption that the groups were indeed at different levels in their pronunciation proficiency. The test material consisted of two texts taken from *MILESTONE: English Course I* (published by *Keirinkan*). It is a reading textbook for first-year high school students. The first text was directly reprinted from the textbook, but some words in the second text were changed by the researcher in order to meet the requirement that all English sounds appeared at least twice, except for the English [ʒ]. The distribution of the English [ʒ] is quite limited, so it was difficult to include the English words which include it in the two texts. The first text consisted of five sentences, and the second text was comprised of four sentences.

The second task was the word-list reading. The reason why the word-list reading was chosen among various eliciting tasks was that it was felt that the results of this task would be the most reliable indicator for the current aim, since the speech style was formal and the target words were followed by pauses. Unless they are followed by pauses, it might be sometimes difficult to accurately measure the rate of occurrence of epenthesis, because the final plosives are often assimilated by the following sounds. The subjects were instructed to produce the following six target words: *cap - cab; pat - pad; and back - bag*, and some other words which were not relevant to the current research. All of the target words manifested the [CæC] syllable, and contained English plosives in word-initial and -final positions. They were randomly shown at regular interval to each subject three times.

3. Acoustic Measurements

For the data of English plosives in word-final position, 684 different productions (38 subjects [30 Japanese and 8 English subjects] × 6 words × 3 repetitions) were elicited. In the process of storing the

data in a computer, the data were digitized at 16-k Hz sampling rate, with a 16-bit amplitude resolution. By using a digital waveform editor and a digital sound spectrogram (*SUGI Speech Analyzer*, produced by *ANIMO Ltd.*), each of the productions were characterised according to the following three acoustic features:

- (1) Stop closure duration time
- (2) Voiced closure duration time in the stop closure duration time
- (3) Presence/absence of epenthesis

Stop closure duration time was regarded as the interval from the end of a vowel to the release of a final plosive. Voiced closure duration time in the stop closure duration time was defined as the interval from the end of a vowel to the point where voicing energy was no longer detected. The criteria for the judgement of the presence or absence of epenthesis were those adopted by Tajima et al. (2000) as follows:

- (1) A clear vowel-like formant structure must be visible on the spectrogram, particularly the first formant.
- (2) The waveform must show periodicity from phonation.
- (3) Very short epenthetic vowels must contain at least two pitch periods.

(Tajima et al., 2000: 196)

In the case of any traces of a plosive in word-final position, such as the release or the burst of final plosive, being undetectable, the production was classified into final plosive deletion. However, since a digital sound spectrograph was the method adopted for the analysis, enabling the researcher to detect almost inaudible signs, the occurrences which were defined as final plosive deletion were consequently quite rare compared with other studies which had adopted perceptual judgement as the method of analysis (See details in Appendix 1).

IV. Results

1. The Subjects' Pronunciation Proficiency

When the speech productions of the first task (the reading-aloud test) were edited by the researcher, only 3 native speakers' speech productions were randomly selected as the representatives of the NS group, and the other 5 native speakers' productions were removed from this reading-aloud test, in order to save time scoring the task. In addition, the first text was divided into two parts in order to control the length of the texts. Finally, the speech samples were blocked so that the same part for all subjects was on the same block. Naturally enough, they were randomised in each block with the requirement that the subjects in the same group did not occur back to back.

Consequently, a total of 99 different stimuli (3 paragraphs \times 33 subjects [30 Japanese and 3 English subjects]) were created. Each of them was separately presented through a headphone, to each of 8 English native listeners who had teaching experience. Their task was to determine the degree of the speaker's foreign accent on a 9 point scale from 'heavy foreign accent' (1 point) to 'no foreign accent' (9 points).

They were encouraged to use the full range of the scale. They were told that they would be listening to the readings of Japanese and English speakers, but they were not told either the number of groups or that each speaker would be heard more than once. The timing of scoring was left to the listeners whether they would score after or during listening to each speech sample.

The foreign accent score for each subject was calculated as the sum of 24 scores (8 listeners \times 3 paragraphs). The foreign accent score for each group was calculated as the mean of subjects' scores in each group. The table presented below shows the foreign accent scores and the SDs for each of the groups in the current experiment.

One-way ANOVA revealed that the difference for Japanese groups was significant, $F(2, 27) = 32.2$,

Table 1 Mean values of foreign accent scores and the SDs

	US group	PS group	AS group	NS group
Mean (SD)	123.6 (6.5)	147.2 (22.2)	173.7 (6.6)	215.6 (0.5)

(Minimum Mean = 24, Maximum Mean = 216)

$p < .001$, and according to Bonferroni's Post Hoc Tests, there was a significant difference in all cases, at the .05 level. Therefore, as far as the Japanese subjects who participated in this current experiment were concerned, we can say that the most advanced group was the AS group, followed by the PS group and the US group.

2. Results for the Second Task

Each group's rates of occurrences of final plosive devoicing, final plosive deletion, and epenthesis, in the second task, were calculated. With reference to the criterion for the occurrence of devoicing for a final voiced plosive, when the degree of voicing for a final voiced plosive, which is the ratio of stop closure duration time to voiced closure duration time, was less than 50%, the productions were defined as being devoiced in this experiment. In all of the cases, the number of occurrences was divided by the maximum number of possible occurrences. For example, for each Japanese group, the maximum possible

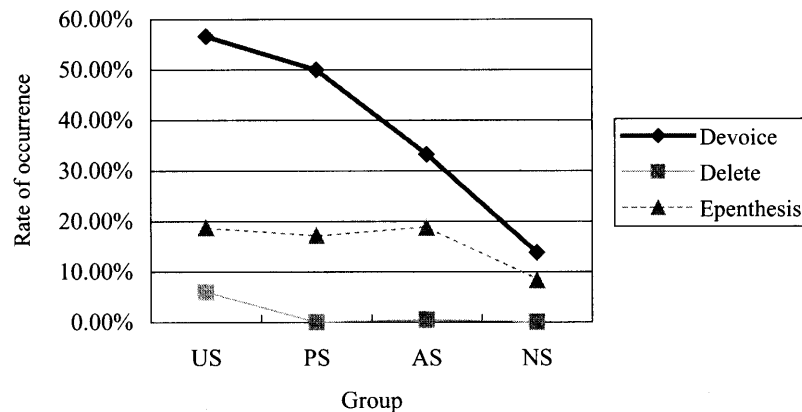


Figure 1 Results on the second task

number of occurrences of final plosive deletion or epenthesis was 180 (6 plosives \times 3 repetitions \times 10 subjects), however, for final plosive devoicing, it was 90 (3 voiced plosives \times 3 repetitions \times 10 subjects). Figure 1 reveals the results.

Along the horizontal axis, the four groups are in order from left to right: the US, PS, AS, and NS groups, which means these groups are ordered from a less advanced to a more advanced group. The rate of occurrence of final plosive devoicing is represented by a thick solid line, that of final plosive deletion by a thin solid line, and that of epenthesis by a dotted line.

As the figure shows, the results confirm the hypothesis that the rates of occurrence of final plosive devoicing and final plosive deletion, which are classified as non-target variants, decrease as the subjects become more advanced learners. In particular, the occurrence of final plosive deletion was hardly observed in the productions of the PS, AS, and NS groups.

On the other hand, for the rate of the occurrence of epenthesis, a noticeable difference was not obtained among the Japanese groups, and only the NS group's data were characterised by a comparatively low rate of the occurrence. The rates of the occurrence of epenthesis which were compared for six different plosives are presented in Table 2.

Table 2 Rates of occurrences of epenthesis

	[p]	[t]	[k]	[b]	[d]	[g]
US	10.0%	10.0%	6.6%	30.0%	30.0%	26.6%
PS	0%	0%	0%	33.3%	36.6%	33.3%
AS	0%	0%	0%	36.6%	40.0%	36.6%
NS	0%	0%	0%	29.1%	8.3%	12.5%

The results obtained from this analysis entirely support the findings reported in Tajima et al. (2000) that the voicing of a voiced plosive has a considerable effect on the rate of the occurrence of epenthesis. Tajima et al. (2000) also hypothesised that bilabial plosives would be more likely to be followed by epenthesis than alveolar and velar plosives, since "an anterior place of articulation allows greater pressure build-up inside the vocal tract than a posterior one" (p. 197). As far as the results in the current experiment are concerned, their claim was verified in the data for the NS group, but not in the data for the Japanese groups³).

Looking at the differences in the occurrence of epenthesis according to the subjects' learning levels, it was found, as hypothesised, that the PS and the AS groups, which were the more advanced groups, exhibited epenthesis only when word-final plosives were voiced, however, the US group, which was a less advanced group, performed epenthesis whether word-final plosives were voiceless or voiced, although the occurrences of epenthesis after voiceless plosives were less than expected.

In addition, when focusing on the differences in the degree of voicing among final voiced plosives accompanied by epenthesis, we found a clear difference between the US group and the PS, AS groups, as represented in Table 3 (See details in Appendix 2).

3) The fact that the NS group's data supported the claim of Tajima et al. (2000) seems to support the validity of their claim.

Table 3 Degree of voicing for voiced plosives accompanied by epenthesis

	US group	PS group	AS group	NS group
Degree of voicing	39.2%	69.7%	77.2%	97.5%

According to one-way ANOVA, the group difference was significant, $F(3, 99) = 12.4, p < .001$. Bonferroni's Post Hoc Tests revealed that although a significant difference was not found among the PS, the AS, and the NS groups, the value of the US group was significantly lower than the values of the other three groups. This result suggests that the subjects in the US group were likely to exhibit epenthesis even when they devoiced final voiced plosives (e.g., [bæg] ⇒ [bæku]), but the subjects in the PS and the AS groups exhibited epenthesis only when they sufficiently voiced final voiced plosives similar to the NS group.

Therefore, the results described above for the occurrences of 'epenthesis', 'final plosive devoicing', and 'final plosive deletion' support the hypothesis advanced earlier. Based on the results, we can assume that the occurrence of devoicing overwhelms that of epenthesis in the data of learners at the beginners' stage, but the difference becomes smaller as their learning stage progresses. This is due to the fact that the rates of the occurrences of final plosive devoicing and final plosive deletion, which are regarded as non-target variants, significantly decrease as the subjects become more advanced learners. On the other hand, for the occurrence of epenthesis, Japanese learners' epenthesis is characterised by both non-target and target variants when they are at the beginning stage. However, with the progress of the learning stage, their epenthesis comes to be limited to the target variant although the rates of the occurrence of epenthesis themselves do not significantly differ according to the subjects' learning levels. In short, the current study clarifies that the strategy which is preferred by Japanese learners for English plosives in word-final position systematically varies according to their proficiency levels. Taking this result into account, we can say that it is not surprising to see various contradictions in past studies, which did not pay enough attention to the above fact, in the relationship between language groups and their preference for strategies.

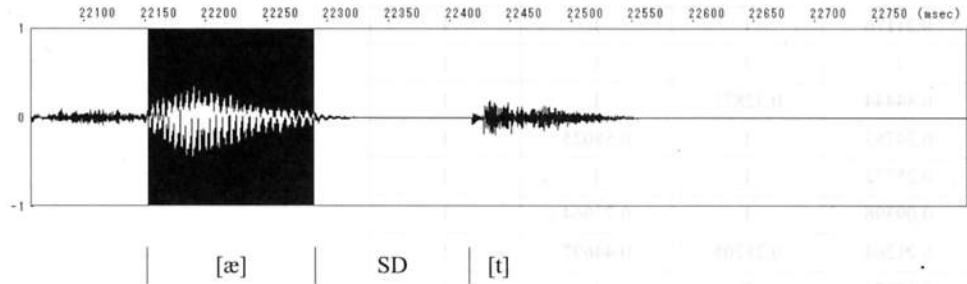
V. Conclusion and Discussion

The results of the current study clarify that Japanese learners of English tend to exhibit final plosive devoicing, in addition to epenthesis for English voiced plosives in word-final position. Since final plosive devoicing is not a strategy performed by Japanese learners when they speak Japanese, this finding is important to support the idea that the acquisition process of L2 pronunciation is not necessarily conditioned by L1 sound systems, rather, it has autonomy which is also observed in FLA when English speaking children acquire English. Furthermore, there is a question regarding the contradiction between Eckman (1977) and Edge (1991) of whether epenthesis or final plosive devoicing characterises Japanese learners' preferred strategy for English voiced plosives in word-final position. This experiment, rather than rejecting one of the alternatives, directs attention to the transitional characteristics of interlanguage phonology, and suggests that the preference might vary according to learners' learning proficiency based on the analysis of the data. This finding questions the validity of past studies which had sought universal rules in interlanguage phonology by specifying a particular strategy of a language group, since it clarifies that

a strategy adopted by a language group should be a matter to change according to learners' learning levels.

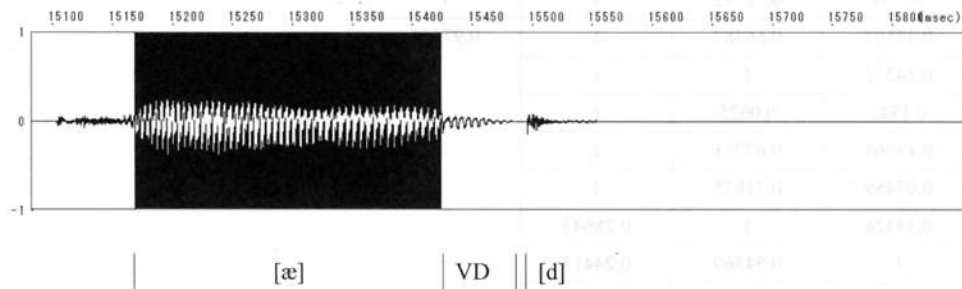
Appendix 1

An example of 'pat' [pæt] in English



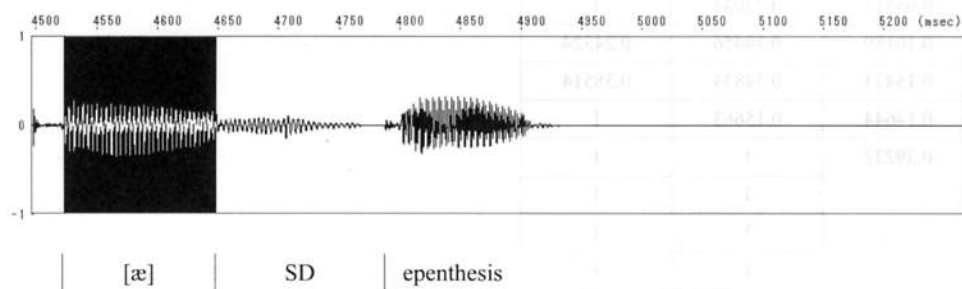
SD=Stop closure duration time

An example of 'pad' [pæd] in English



VD=Voiced closure duration time in the stop closure duration time

An example of epenthesis in 'pad' [pæd]



Appendix 2

US	PS	AS	NS	(Group)
V-ratio	V-ratio	V-ratio	V-ratio	
0.13402	0.64865	0.18462	1	
0.21176	1	1	1	
1	1	1	1	
0.84444	0.32877	1	1	
0.34783	1	0.58025	1	
0.25773	1	1	1	
0.09396	1	0.77064	1	
0.21264	0.28205	0.44697	1	
0.19333	0	1	1	
0.47727	0.48958	1	1	
0.85841	1	1	0.69444	
0.576	0.75532	1	1	
0.37107	0.66387	1	0.97454	
0.24272	1	1		
0.1342	0.0625	1		
0.13068	0.67281	1		
0.07489	0.71875	1		
0.34328	1	0.28643		
1	0.54369	0.24413		
0.72917	0.81172	0.52128		
0.66154	0.38579	1		
0.24762	1	1		
0.65517	0.73043	1		
0.10189	0.39456	0.24324		
0.15423	0.74834	0.38514		
0.14644	0.15663	1		
0.39232	1	1		
	1	1		
	1	1		
	1	1		
	0.22667	0.05221		
	0.69742	0.26984		
		0.26923		
		1		
		0.77218		

V-ratio = the ratio of "stop closure duration time" to "voiced closure duration time"

References

- Eckman, F. 1977. "Markedness and the contrastive analysis hypothesis." *Language Learning*, 27: 315-330.
- Eckman, F. 1981. "On predicting phonological difficulty in second language acquisition." *SSLA*, 4(1): 18-30.
- Eckman, F. 1985. "Some theoretical and pedagogical implications of the markedness differential hypothesis." *SSLA*, 7: 289-307.
- Edge, B. 1991. "The production of word-final voiced obstruents in English by L1 speakers of Japanese and Cantonese." *SSLA*, 13: 377-393.
- Edwards, M. and Shriberg, L. 1983. *Phonology: applications in communicative disorders*. San Diego, CA: College Hill Press.
- Flege, J. and Davidian, R. 1984. "Transfer and developmental processes in adult foreign language speech production." *Applied Psycholinguistics*, 5: 323-347.
- Major, R. 1987. "A model for interlanguage phonology." In Ioup, G. and Weinberger, S. (eds.), *Interlanguage Phonology: the acquisition of a second language sound system*. New York: Newbury House.
- Tajima et al. 2000. "Phonetic analysis of vowel epenthesis in native Japanese speakers' production of English words." *Proceedings in Japan Phonetic Association in 2000*.
- Tarone, E. 1978. "The phonology of interlanguage." In Richards, J. (eds.), *Understanding Second and Foreign Language Learning*. Rowley, Mass.: Newbury House.
- Yavas, M. 1994. "Final stop devoicing in interlanguage." In Yavas, M. (eds.), 1994, *First and Second Language Phonology*. San Diego, CA: Singular.