

Stop Epenthesis in Nasal-Fricative Clusters  
Produced by Japanese Learners of English:  
Focusing on ns-clusters and ms-clusters

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## Introduction

The phenomenon of epenthetic stops in nasal-fricative clusters in English, like [t] in ns-clusters, [p] in ms-clusters, or [k] in nθ-clusters, has been studied until now, and is written in many books. The studies are mostly focused on the epenthesis articulated by native speakers of English, especially Americans. Some have researched the duration of the epenthetic stops comparing it with that of non-epenthetic stops, and others were interested in studying their phonological aspects. Through the literature concerning this subject, we can understand various characteristics of stops in English. For instance, the environments where the stops occur, or the differences of the production between American English speakers and British English speakers. However, there are few materials regarding epenthetic stops articulated by non-native speakers of English.

In terms of the education of English in Japan, the existence of these stops is completely ignored and, probably most Japanese learners of English do not even notice this phenomenon. In spite of this situation in Japan, the knowledge of these epenthetic stops helps us understand English spoken by native speakers, because these stops seem to be extremely common in English, although, we may be able to distinguish between epenthetic stops and the underlying ones by context. In addition, it is likely that if the Japanese learners of English, especially the advanced learners, produce epenthesis in English, it sounds more like English. This paper examines whether or not Japanese produce epenthetic stops when they pronounce nasal-fricative clusters in English, and if they show epenthesis, how often, and where they show the stops will be investigated. If they do not show much epenthesis, the influence of Japanese from the view point of phonetics will be analyzed. Although there are various kinds of nasal-fricative clusters in English words or contexts, the environment studied in this paper is mainly /ns/ and /ms/ in English words, since in many studies, the epenthetic [t] in ns-clusters and [p] in ms-clusters are commonly employed, and these clusters are said to show the stops more often than any other clusters. In the investigation, we use a wide variety of ns-clusters and ms-clusters in English words, and for the ns-clusters, we classify them by the number of syllables, the position of /ns/, and the position of stress.

In chapter one, previous studies concerning various epenthetic stops will be summarized, and the method and the results of the experiment will be explained in chapters two, three, and four.

## **Chapter One:**

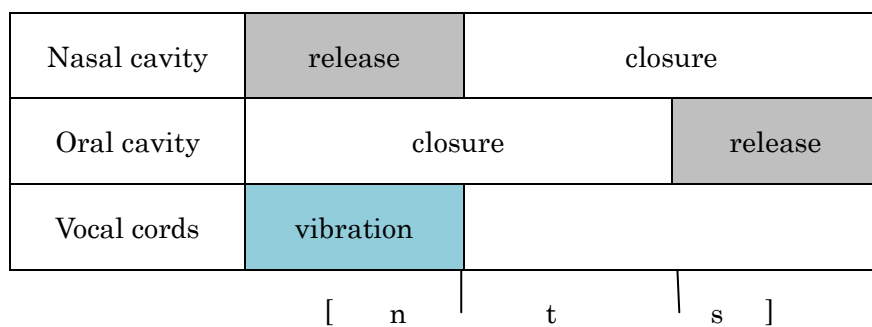
### **Previous Studies on Epenthetic Stops in Nasal-Fricative Clusters**

#### **1.1. Environments where Epenthetic Stops Occur**

##### **1.1.1. Articulatory Process**

The articulatory process of epenthetic stops, as [t] between /n/ and /s/ in ns-clusters, or [p] between /m/ and /s/ in ms-clusters, has been described by several authors, although there are few phonetic investigations concerning the epenthetic stops. The commonly described process is related to the difference of timing when we articulate the consonant clusters. To take the examples of an ns-cluster, Takebayashi (1996) explains the process as follows: When we articulate /n/ in an ns-cluster, we touch the alveolar ridge with the tip of the tongue, and lower the soft palate in order that air can escape through the nasal cavity, vocal cords vibrating. During this production of the nasal,

there is a complete closure in the oral cavity. After that, we raise the velum, allowing air to pass through the oral cavity, and voicing ceases. At the same time, we move the tip of the tongue to make friction. If the raising of the velum, the release of the oral closure and cessation of voicing occur simultaneously, the epenthetic stop [t] does not appear. However, if the velum is raised and voicing ceases before the oral closure is released, the position is for a voiceless alveolar stop, and we articulate an epenthetic stop between /n/ and /s/, i.e. [t] in this case. The same sequence of production occurs in the case of other nasal fricative clusters, e.g. /ms/, except for the difference of articulatory position. Takebayashi illustrates the mechanism with figure one.



**Figure 1.** Insertion of [t] in ns-clusters (*Takebayashi.1996: 346*)

[Translation mine.]

Ali et al (1979) find an interesting fact concerning the articulatory process in their paper of aerodynamic and acoustic investigation. They measure nasal flow, oral flow, oral air pressure, and speech signals in nasal-fricative clusters, and find that when there is silence between the end of voicing and the beginning of friction noise, peak nasal airflow occurs, and this nasal airflow continues for nearly a third of the fricative consonant. They also find that the first change in articulation is not the closure of velopharyngeal port, but the cessation of voicing. These findings

mean that the velum is not closed during the fricative, and the airflow continues to vent through the nose. It seems that if the velum is not completely closed, the oral airflow is so weak that the stop is not articulated when the oral closure is released. However, the burst of the stop does occur even in that environment in their experiment, so it can be said that the oral air pressure is enough to produce epenthetic stops. With respect to the nasal airflow, Ohala (1974) shows a different process of production. The process is that nasal airflow ceases at the same time as voicing.

Dinnsen (1980) presents his hypothesis against the traditional explanation of articulatory process when epenthesis is produced, i.e. the velic closure precedes oral release, and a stop epenthesis occurs. He doubts that the articulatory process cited above qualifies as an explanation for epenthesis, and claims as follows: “velic closure certainly does not have to precede oral release [•••] even in the case of the epenthetic stop certain gestures are being controlled or effected simultaneously, i.e. velic closure and cessation of voicing.” While he offers this hypothesis, no evidence that supports his idea is presented in his paper.

Ohala (1995) offers an interesting explanation as to the labels ‘intrusive’ or ‘epenthetic’ in his paper. He maintains that “these stops arise as epiphenomena from the assimilatory blending of two adjacent consonants, thus the labels ‘intrusive’ and ‘epenthetic’ are not totally appropriate.” For instance, in ns-clusters, the intrusive [t] comes from the denasalization of the first element of /n/, and the devoicing of /n/ under the influence of the voicelessness of fricative /s/. Instead of using the label ‘intrusive’ and ‘epenthetic’, he introduces the label, ‘emergent’, as emergent stops. This label is interesting from the viewpoint of the articulatory aspect of ns-clusters. However, in my paper, I shall only introduce his idea, and use the label ‘epenthetic’, which is used in many other papers in order to avoid confusion.

### 1.1.2. Position and Stress

The position and stress are important aspects when we think of epenthetic stops, because the existence of epenthesis is greatly influenced by these environments. As to the position of epenthesis, Ashby and Ashby (1990) mention that in the case of /n(t)s/, a nasal can be followed by a homorganic stop only within the morph, and show examples without morpheme boundary, e.g. *once*, *pronounce*, *prince*. Ali et al (1979) show in their paper that few words are heard to contain epenthetic consonants when a syllable morpheme boundary lay between a nasal and a fricative. Fourakis and Port (1986) investigate the insertion of a stop between a sonorant and a fricative consonant in syllable-final sonorant-fricative clusters in their paper. They restricted the position to syllable-final clusters, because in their account, epenthesis applies only when a sonorant and a fricative are in the same syllable. They show that in that position, epenthesis is always pronounced by Americans if the fricative is voiceless. Dinnsen (1985) claims that “the distinction between /...ns.../ and /...nts.../ is neutralized by a rule inserting an oral stop between tautosyllabic sequences of nasal plus fricative” at least in some dialects. It certainly seems true that intrusive consonants are likely to occur when they are in the same syllable. However, Nakajima (1981) presents words in which nasal-fricative clusters are not in the same syllable, and also where epenthetic stops intervene. One of them is *mansion*, /məntʃən/. Contrary to the idea of Ali et al, Yoo and Blankenship (2003), who studied how stress and the position of the ns-cluster in polysyllabic words affect [t] epenthesis, maintain as follows. “The experiment has revealed that epenthesis can occur in any stress or word position, but is likely to be longer when it is at the end of a word.” They have revealed more detailed facts in their paper, which are related to the position and stress. Regarding the position of the cluster, the word-medial groups, i.e. *census* and *consent*, exhibited virtually no stop closure durations, while word-final groups, i.e.

*intense* and *science*, exhibited longer durations in their experiment. This account conforms to the explanations addressed by many other authors.

Some studies are concerned with the position of the stressed syllable adjacent to the nasal-fricative clusters. Nakajima (1981) says in his paper that when the following syllable of a nasal-fricative cluster is stressed, there is no room for an epenthetic stop. He takes the example of *expectancy* [iks'pektən-si]. In this case, if [-si] is rather stressed, though it is not a primary stress, the gap between [n] and [s] is produced, and then, there is no need to epenthesize between [n] and [s]. In other similar cases, like *fancy* [fæn(t)si], or *fanciful* [fæn(t)sifəl], the epenthetic [t] is produced, because there is no stress in [-si]. Many researchers along with Nakajima mention that if the words or sentences which include a nasal-fricative cluster are spoken slowly, the possibility of an epenthetic stop appearing diminishes (Zwicky 1972, Hayashi 2004).

A further study about the influence of stress is made by Yoo and Blankenship (2003). They have studied the ns-cluster in polysyllabic words in four different environments: word-medial after a stressed vowel, word-final after a stressed vowel, word-medial after a stressless vowel, word-final after a stressless vowel. As a result of their experiment, it is confirmed that stress before the medial ns-cluster favors epenthesis, and that stress after the medial ns-cluster disfavors epenthesis. This result corresponds to Nakajima's account. They also reveal that stress before the final ns-cluster disfavors epenthesis, although both final clusters show more epenthesis than the other medial clusters. The examples of the words which they used for their paper is shown in table one below.

**Table 1.** The List of Words in Four Different Environments

	Word-Medial	Word-Final
After a Stressed Vowel	'Census 'Sensible	In'tense Offence
After a Stressless Vowel	Con'ceal Con'sole	'Science 'Presence

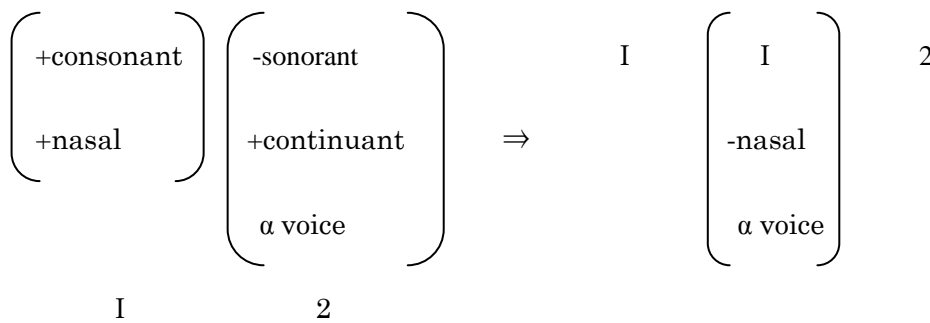
## 1.2. Variation among Dialects

As mentioned already, the difference in occurrence of epenthesis between American English and British English has been studied in many papers, and generally, American English is said to have more epenthetic stops than British English. Can we affirm that this is really true? There is no reliable evidence to support this account. Hayashi (2004) points out in her paper as follows: “it is strange that there is a difference in occurrence of epenthetic /t/ between American and British English, since there is little difference in the method of articulation of /n/ and /s/ between these dialects.” She has done an interesting experiment to reveal whether this description is true or not. The experiment was to examine words with ns-clusters using the CD-ROMs of the *English Pronouncing Dictionary* and the *Longman Dictionary of Contemporary English*. As a result, it was made clear that there is not a big difference between American and British Pronunciation in terms of the occurrence of the epenthetic [t].

Regarding the difference among dialects, Fourakis and Port (1986) investigate the two dialects of English: a South African dialect and an American mid-western dialect. Their viewpoint is that the insertion of a stop comes from language and dialect specific phonological rules that are stated in the

grammar, and they examine the sonorant-fricative clusters and the sonorant-stop-fricative clusters in their paper. They show that American speakers epenthesized in every sonorant-fricative cluster, while South African speakers maintained the underlying segmental contrasts between sonorant-fricative clusters and sonorant-stop-fricative clusters. This result confirms their account that the epenthetic stops are a product of a standard phonological process, because if the stops are a product of a universal articulatory process, the speakers of South African English should also epenthesize in every token. Hayashi's approach to epenthesis and that of Fourakis and Port are different in this respect. In other words, Hayashi argues from the point of phonetic aspects: universal articulatory process, whereas Fourakis and Port maintain from a point of language specific phonological process. This difference of approach has often been argued until now. Barnitz (1974) states that "the real story of why epenthesis occurs lies not in generative phonology, but in articulatory phonetics." This is because a synchronic sound change, e.g. *Chomsky* [tʃɑmski] > [tʃɑmpski], or a diachronic sound change, e.g. *Thomson* > *Thompson*, are not only gradual but ever progressing, and "no two performances of the same utterance are the same." Then, these changes are from a change in performance, not from a change in the phonological rule.

Ohala (1974) also maintains that the occurrence of the stops is the result of some kind of mistiming. Fourakis and Port claim that no reason is given for why this mistiming should occur, but it could be due to carelessness or to the inability to control the articulators in the movements, although they suggest that the epenthetic stops might be language specific and yet distinct from underlying stops. Dinnsen (1980), who maintains these opinions, presents the stop epenthesis rule as shown in figure two.



**Figure 2.** Stop Epenthesis Rule (Dinnsen. 1980: 178 ) modified.

Which approach we adopt is important in the study of epenthesis in English. However, since the aim of this paper is mainly to examine epenthesis in English produced by Japanese learners, not native speakers of English, we cannot conclude which approach is reliable. Still, our result of the experiment will offer a good reference regarding these approaches.

### 1.3. Speaker Variation

Apart from the discussions of dialects, there are differences among individuals. Contrary to Fourakis and Port's study, which shows that all Americans produce epenthesis, there could be individual differences as we can see from other studies. For example, in Ali et al.'s study, not all speakers pronounced epenthetic stops. In addition, Blankenship (1992) maintains in their paper that "only about one-fourth of the /ns/ consonant clusters in the TIMIT corpus of American English exhibit epenthesis, and the speakers who produced epenthesis did not exhibit it consistently." Warner and Weber (2001) also note that speakers are not consistent in pronouncing epenthesis. Therefore, the way they speak on each occasion might influence the production of epenthesis. In order to investigate the difference among speakers, and also within individuals, we need more detailed data, and need to

know how speakers produce epenthesis and how they do not produce epenthesis from the point of both phonetics and phonologies.

#### 1.4. Epenthesis in Japanese

The studies as to epenthesis in Japanese are mostly focused on vowels, because epenthetic consonants are quite limited. The most famous phenomenon regarding epenthetic vowels is the epenthesis which is found in loanwords adopted in Japanese. The examples are as follows:

Bag [bæg] → [baggu]    outlet [autlet] → [autoletto]    church [tʃɜ:tʃ] → [tʃa:tʃi]

The epenthetic vowel in Japanese loanwords is basically /u/. However, we also use other vowels, /o/ and /i/. We decide which vowels to add, depending on the previous consonant. Inozuka and Inozuka (2003) classify the environments as a follows:

**Table 2.** Vowels Added in Loanwords in Japanese (Inozuka and Inozuka. 2003: 145) modified.

Previous consonant	Vowels
/t/ or /d/	/o/
/tʃ/ or /dʒ/	/i/
Other consonants	/u/

We commonly add /u/ in loan words, except when the previous consonant is /t/, /d/ or /tʃ/ /dʒ/. This is because /tu/ and /du/ do not exist in Japanese, and we use /tsu/ and /dzu/ instead. As for /tʃ/ and /dʒ/, these phonemes appear only before /i/, so we naturally add /i/ before these consonants in loanwords. We tend to add these vowels between consonant clusters, since Japanese syllable

structures are based on CV, and allow very few consonant clusters (Warner and Weber. 2001). While, a typical English syllable structure is CVC, which means several consonants are often connected. Certainly, there are epenthetic consonants in Japanese, though the number is rather small. One of them, which is often exemplified, is *harusame* /harusame/: spring rain. This word is composed of *haru* /haru/: spring and *ame* /ame/: rain. In this case, the epenthetic /s/ intervenes between the vowel, /u/ and /a/.

Although ns-clusters also exist in Japanese, the /N/ in Japanese has various articulatory positions compared with the position of /n/ in English, namely alveolar. The pronunciation of /N/ in Japanese varies according to the following phoneme. For instance, when /N/ is followed by /p/, /b/, and /m/, the position is bilabial, i.e. /m/ in Japanese, like *sanma* [samma]: saury. If /N/ is the end of a word, the position is a uvular nasal, like *udon* [udoN]. Taylor (2007) points out that this type of pronunciation can be a negative transfer for Japanese learners of English. They often carry this pattern over to English words, especially those with *-tion* endings.

When /N/ is followed by /s/ and /ε/, /N/ is pronounced as /ũ/ or /ĩ/, which are nasalized vowels. Takebayashi (1996) shows the examples: *onsei* [oũse:]: sound, *kensa* [keĩsa]: inspection. This means that the tongue does not touch the alveolar ridge during the pronunciation of /N/. As a matter of course, in English, /n/ in ns-clusters is pronounced with the tongue touching on the alveolar ridge. Again, this difference of an articulatory position might be a negative transfer for Japanese, because producing the epenthetic [t] requires the tongue to touch the alveolar ridge. Takebayashi states in his book that Japanese tend to substitute nasalized vowels for /n/ in ns-clusters and nθ-clusters, and consequently, the pronunciation sounds strange for English.

As to the ms-clusters, it does not exist in Japanese, because Japanese disfavors consonant

clusters, and people put a vowel /u/ between the two consonants, when the loanwords which include ms-clusters are adopted in Japanese. For instance, *room service* [ru:m s3:vɪs]. Japanese tend to pronounce [ru:mu sa:bɪsu] instead. These characteristics of Japanese pronunciations, which are different from those of English ones, might have some kind of influence on the speech of English spoken by Japanese.

## **Chapter Two:**

### **Method of Experiment**

#### **2.1. Materials and Subjects**

The English words used in this experiment include ns-clusters and ms-clusters, and as for ns-clusters, the words are classified by different environments, which are explained in the following section. In order to choose these words, *Cambridge English Pronouncing Dictionary* 17<sup>th</sup> edition was used, and was examined whether epenthesis was inserted in the pronunciation of the words. All the words used in the experiment show the epenthetic [t] or [p] in the dictionary, which means that many native speakers produce epenthesis, when pronouncing these words.

Thirteen Japanese participated in this experiment. All of the participants are students of Tokyo University of Foreign Studies, and their ages are 19 to 22 years old. Most of them, eleven out of

thirteen speakers, have lived in English-speaking countries for more than eight months. Among them, six people (Speaker 1 to Speaker 6) have lived for more than three years in America, and England. The other five people (Speaker 7 to Speaker 11) have lived for about one year, and the countries are Canada, Australia, America, and Britain. Two speakers (Speaker 12 and Speaker 13) have studied English only in Japan. All speakers' lengths of the experience in learning English are relatively similar: for six years to ten years. Only two speakers (Speaker 1 and Speaker 13) have been learning English for about fourteen years.

From the above, we can see that most of the speakers are advanced learners of English, and have spoken and listened to English in English-speaking countries, which means that they had good chances of hearing epenthesis uttered by native speakers. The difference of the results between these speakers and the speakers who do not have the experiences in living abroad will be examined in the following chapter.

Also, three native speakers of English participated in the experiment in order to investigate the presence of epenthesis produced by them, and where they show the epenthetic stops, comparing the previous studies explained in chapter one. Their detailed backgrounds are as follows:

**Table 3.** Backgrounds of the Three Native Speakers of English

	Sex	Age	Mother tongue	Birthplace	Experience in living abroad	Learning Japanese
A	Male	22	English	America	No	4 years
B	Male	21	English	Australia	No	11 months
C	Male	24	English	Australia	Hong Kong, France	2 years

These speakers, both Japanese and English, who do not know the purpose of this experiment, were instructed to read out eleven English sentences as naturally as possible, which contain the target words chosen. At the end of the sentences, the target words are eliminated, because all segments are lengthened in that position. As mentioned in chapter one, the possibility of appearing epenthesis diminishes, if the clusters are spoken slowly. In the experiment, the speakers are told to read out sentences, not words, to prevent them from being aware that any special word would be under study, and to prevent the words being pronounced carefully. The recordings took place in quiet group study rooms in the TUFs library.

## 2.2. Classification of Target Words

The words containing ns-clusters were classified into four different environments according to the number of syllables, the position of ns-clusters, and the position of stress. At first, they were divided into monosyllabic words and polysyllabic words, and then, the polysyllabic words were classified into four environments. The classification and the words used in this experiment are as follows:

<Classification of the environments of ns-clusters>

1. Monosyllabic words: *prince dense sense since*

2. Polysyllabic words:

(a) Word final after a stressed vowel: *in'tense de'fence*

(b) Word final after a stressless vowel: *'science 'lisence*

(c) Word medial after a stressed vowel: *'census 'sponser 'pencil 'counsel 'answer*

(d) Word medial after a stressless vowel: *con'cern*

All monosyllabic words end with /ns/ sequence. These words are put into one category, because many papers point out that ns-clusters often show epenthesis when they are at the final position of the monosyllabic words.

As for the polysyllabic words, the classification is adopted from the studies done by Yoo and Blankenship (2003), who investigated the epenthetic stops in polysyllabic words. Their studies are helpful in examining epenthesis, because the studies which are focused on the experiment of epenthesis in polysyllabic words are quite limited. Also, their classification is valid for the study, because this type of classification is popular in other papers concerning the epenthetic consonants, and it is convenient for comparing the result of this experiment with that of the previous studies. The comparison will be attempted in a following chapter.

As for ms-clusters, such a classification could not be adopted, since the words ending with ms-clusters are rather rare, and only the word medial ms-clusters after a stressed vowel contain the epenthetic [p] in the dictionary explained above. Therefore, in my study, ms-clusters in the other environments are not adopted.

<Words containing ms-clusters used in the experiment>

*'Teamster 'Samson 'Gimson 'hamster 'Thomson*

### **2.3. Acoustical Analysis**

The recording data were digitized with Praat, since epenthetic stops were often unclear, and

hard to be judged only by listening to them. Nineteen target words in the sentences uttered by each participant were carefully examined whether there were stop closure duration between /n/ and /s/, or /m/ and /s/, and consequently the words were pronounced with the epenthetic stops. The stops could be distinguished from waveforms and formants between /n/ and /s/, or /m/ and /s/. No waveform and no formant show that the epenthetic stops intervene between them. Each durational gap was compared using a unit of millisecond. Waveforms and formants differ significantly depending on the individual, so careful investigations were needed.

## **Chapter Three:**

### **Results and Discussion**

#### **3.1. Native Speakers of English**

##### **3.1.1. ns-clusters**

Although the main purpose of this paper is to investigate the epenthetic stops produced by Japanese speakers, not by the native speakers of English, the results of the three native speakers were also be examined comparing with previous studies. At First, four monosyllabic words, *prince*, *dense*, *since*, and *sense*, were examined. As we can see from table four, not all words were realized with the epenthetic [t]. The stop closure durations are from 3 ms (milliseconds) to 21 ms, and the average stop closure duration is 5.75 ms.

**Table 4.** Number of Cases Realized with the Epenthetic [t]

Word	Number of tokens	Total cases
prince	1	3
since	0	3
sense	1	3
dense	3	3

Among the three speakers, speaker A produced [t] in the words, *sense* and *dense*, and speaker B produced [t] in the words, *prince*, and *dense*. Speaker C produced [t] in the word, *dense*. Their stop closure durations are shown in table five below.

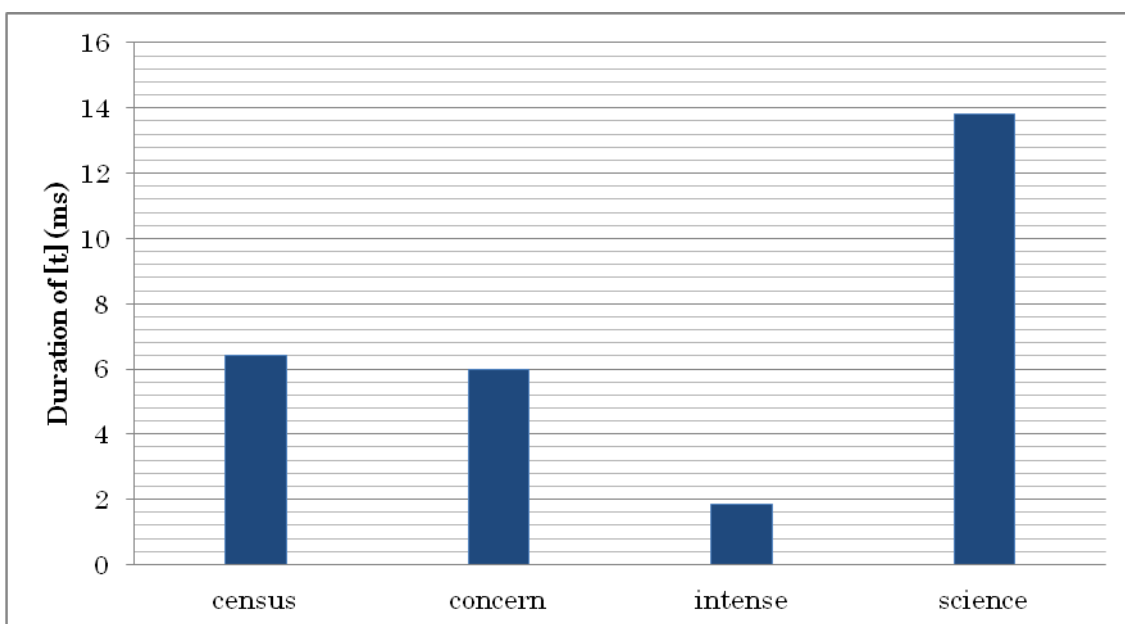
**Table 5.** [t] Closure Durations (ms) in ns-clusters in Monosyllabic Words

Word	Speaker A	Speaker B	Speaker C
prince	0	18	0
since	0	0	0
sense	17	0	0
dense	10	21	3

As we can see from table four and table five, the result is quite varied depending on the speakers. All three speakers produced the epenthetic [t] in the word, *dense*, and none of them produced the epenthetic [t] in the word, *since*. This result shows that in the same category, monosyllabic words in this case, people demonstrate various tendencies to produce the epenthetic [t] in the ns-clusters, and they do not necessarily realize [t] in all ns-clusters. This result is out of

accord with the result of Fourakis and Port (1986), who studied the insertion of a stop between a sonorant and a fricative consonant in syllable-final sonorant-fricative clusters. In their study, all American subjects inserted the epenthesis.

Secondly, 15 polysyllabic words were examined. These words were classified by the position and the stress. As an overall result, 85.7 % (twelve out of fourteen words) of the target words were produced with the epenthetic [t]. The average [t] closure durations of the four categories are shown in the graph below. Each word identifies the stress and the word-position categories of the ns-clusters: *census* (word-medial after a stressed vowel), *concern* (word-medial after a stressless vowel), *intense* (word-final after a stressed vowel), and *science* (word-final after a stressless vowel).

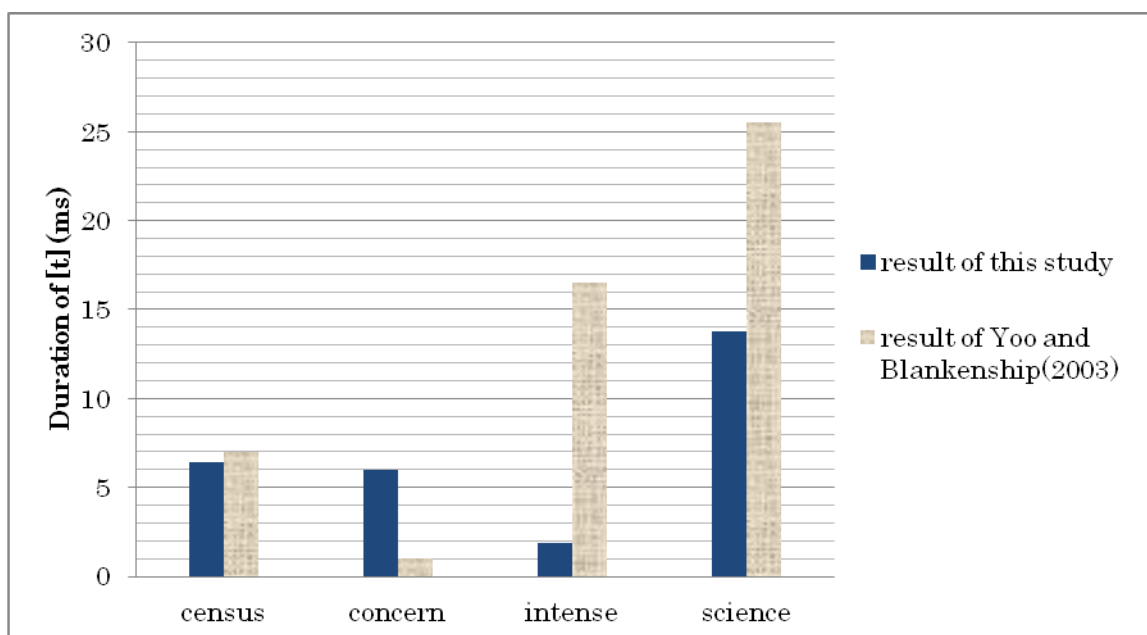


**Figure 3.** Average [t] Closure Durations (ms) in the ns-clusters

Compared with the result of Yoo and Blankenship (2003), There are some differences. Firstly, the average [t] duration of overall results is shorter than those of Yoo and Blankenship. In their

experiment, the average [t] closure duration of all categories is 12.375 ms, while the average [t] closure duration of this experiment is 7.01 ms. Secondly, the average durations of the word-medial groups, i.e. *census*, and *concern* groups, are shorter than that of the word-final after a stressed vowel group, i.e. *intense* group, in their experiment.

On the other hand, both results show that the word-final after a stressless vowel group, i.e. *science* group, has the longest duration among the four groups, which means that the “stress before the final /ns/ cluster disfavors epenthesis.” Figure four graphs the comparison between the result of this experiment and that of Yoo and Blankenship.



**Figure 4.** Comparison of [t] closure durations between this study and Yoo and Blankenship (2003)

### 3.1.2. ms-cluster

Speaker B and C produced the epenthetic [p] between /m/ and /s/ in some target words. Speaker A did not produce [p] epenthesis in the ms-clusters at all. The average [p] closure duration

of the two speakers is 12.2 ms. The detailed results are as follows:

**Table 6.** [p] Closure Durations (ms) of the Three Native Speakers of English

Word	Speaker A	Speaker B	Speaker C
Teamster	0	0	19
Samson	0	0	15
Gimson	0	0	0
hamster	0	21	16
Thomson	0	9	16

As shown in table six above, the results were varied among the speakers. This result also demonstrates the differences of the production of epenthesis among speakers, which was mentioned in chapter one.

## 3.2. Japanese Speakers

### 3.2.1. ns-clusters

None of the Japanese speakers produced the epenthetic [t] between /n/ and /s/ in the experiment. The possibility of the influence of Japanese for Japanese learners of English will be investigated in the following section.

### 3.2.2. ms-clusters

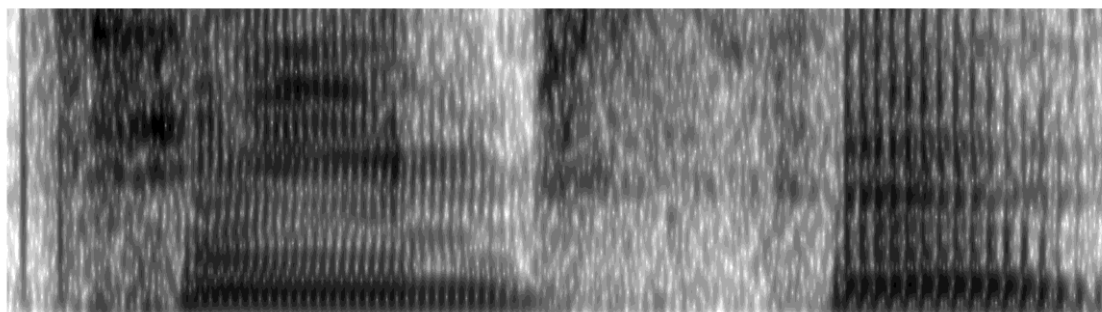
Exactly five Japanese speakers produced the epenthetic [p] between /m/ and /s/ in four out of five target words, while the other eight speakers did not produce the epenthetic [p] at all. Their stop closure durations were relatively small compared with those of the native speakers. The average


closure duration of the epenthetic [p] realized by the five speakers is 9.4 ms, while the average closure duration of the epenthetic [p] realized by the two native speakers is 12.2 ms. The background of each five speaker, and which word they pronounced with the epenthetic [p] are summarized as follows:

<Speaker 2>

Speaker 2 is male, and his major in Tokyo University of Foreign Studies (TUFS) is not English. He has lived in England for seven years, and his length of experience in learning English is six years.

He pronounced *Teamster* with the epenthetic [p], and the duration of [p] is 6 ms.



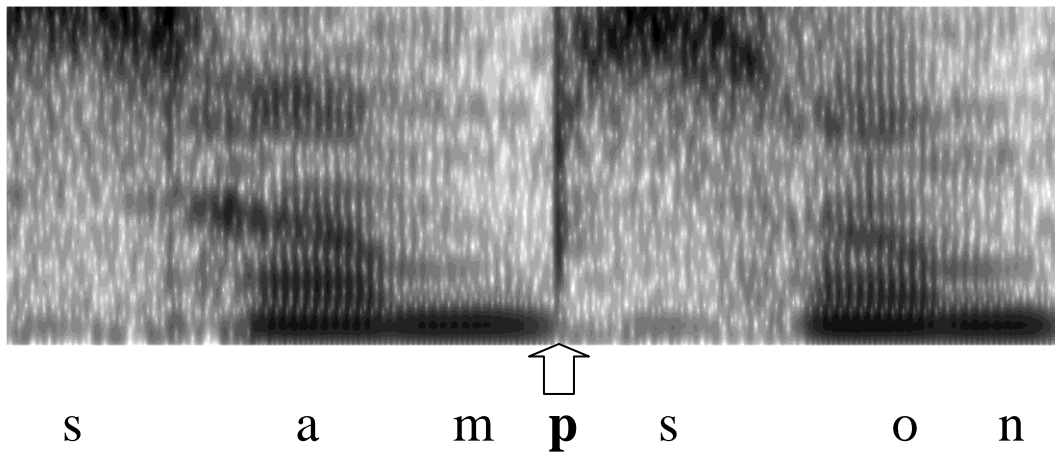
t            ea            m                        p            s            t            er

**Figure 5.** Sound Spectrogram of *Teamster* Produced by Speaker 2

<Speaker 4>

Speaker 4 is female, and her major in TUFS is not English. She has lived in America for five years, and her length of experience in learning English is seven years.

She pronounced *Samson* with the epenthetic [p], and the duration of [p] is 5 ms.



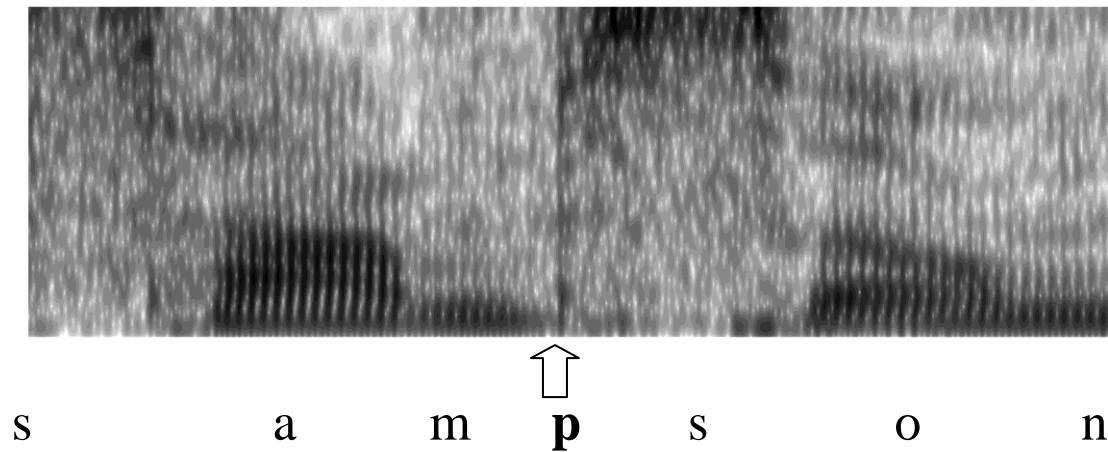
**Figure 6.** Sound Spectrogram of *Samson* Produced by Speaker 4

In the sound spectrogram above, the formant of /m/ can be seen as a dark band at the bottom, and the formant of /s/ can be seen as a dark band at the top. There is a sharp discontinuity between /m/ and /s/, and this phenomenon means that [p] epenthesis intervenes.

<Speaker 6>

Speaker 6 is female, and her major in TUFS is not English. She has lived in England for three years and six months, and her length of experience in learning English is ten years.

She pronounced *Samson* with the epenthetic [p], and the duration of [p] is 13 ms.

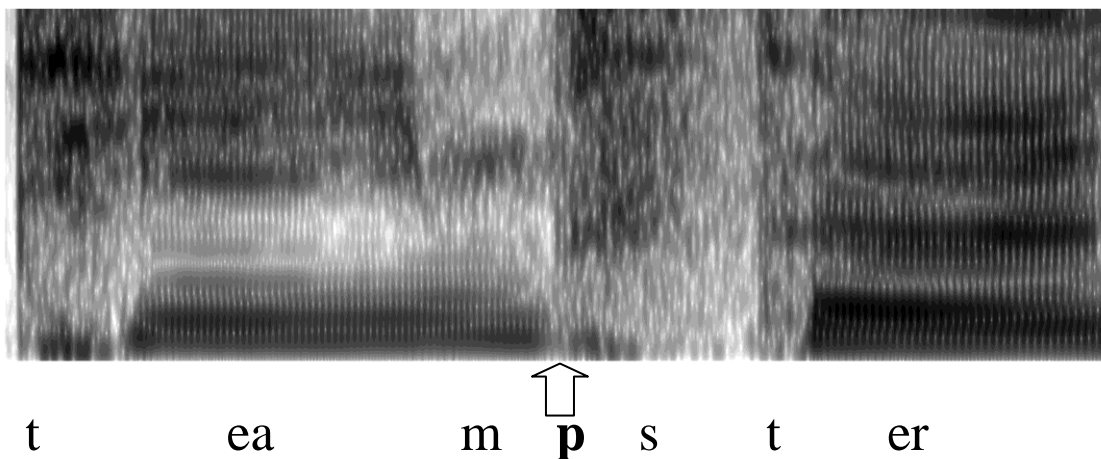


**Figure 7.** Sound Spectrogram of *Samson* Produced by Speaker 6

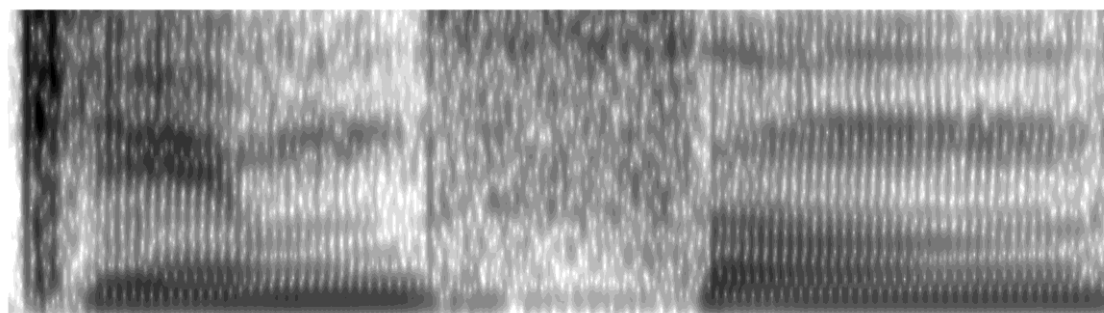
<Speaker 11>

Speaker 11 is female, and her major in TUFS is English. She has lived in Canada for eight months, and her length of experience in learning English is ten years.

She pronounced *Teamster*, and *Gimson* with the epenthetic [p], and the durations of [p] are 9 ms, and 5 ms respectively.



**Figure 8.** Sound Spectrogram of *Teamster* Produced by Speaker 11



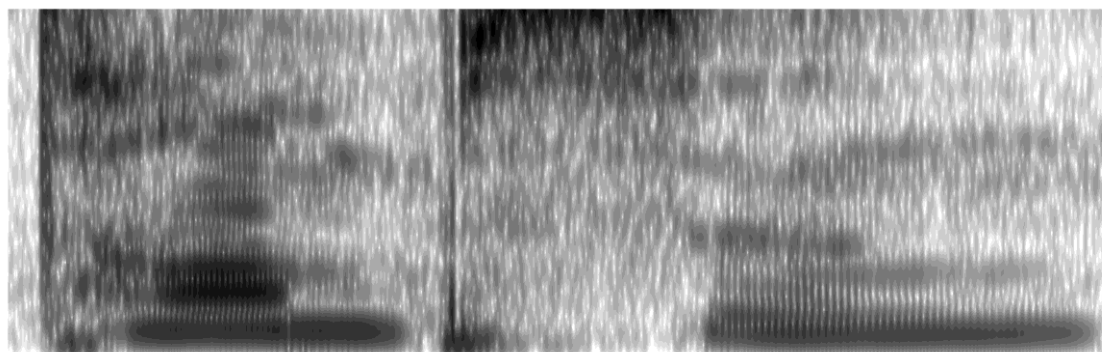
g i m <sup>↑</sup> p s o n

**Figure 9.** Sound Spectrogram of *Gimson* Produced by Speaker 11

<Speaker 12>

Speaker 12 is female, and her major in TUFS is English. She has never lived abroad, and her length of experience in learning English is ten years.

She pronounced *Thomson* with the epenthetic [p], and the duration of [p] is 25 ms.



th o m <sup>↑</sup> p s o n

**Figure 10.** Sound Spectrogram of *Thomson* Produced by Speaker 12

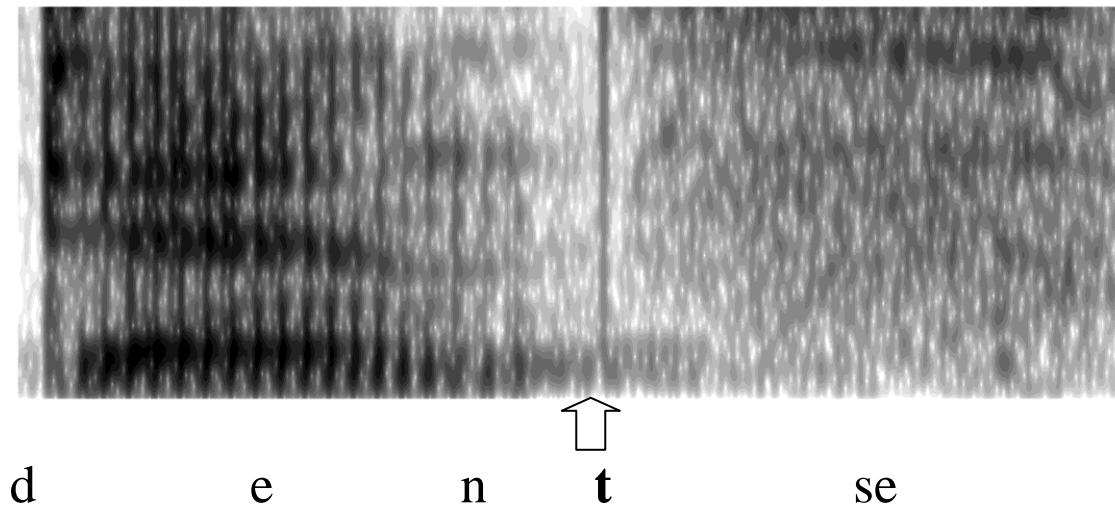
As mentioned above, five speakers realized the epenthetic [p] in four out of five target words. The interesting point is that no one realized [p] between /m/ and /s/ in the word, *hamster*, although

they did in the other target words. On this point, the influence of Japanese will be discussed in section four. With respect to the background of the five speakers, who produced the epenthetic [p], four out of five speakers have lived abroad. They lived in America, England, and Canada, so the countries are varied. Accordingly, it seems that which country they have lived has nothing to do with the production of the epenthetic [p]. As to the length of their stay, three out of four speakers have lived for more than three years, and one speaker has lived for about one year. Speaker 12 has never lived abroad, but her stop closure duration is 25 ms, which is the longest among the five speakers. From this result, the speakers with no experience living in English-speaking countries also produce the epenthetic [p] in ms-clusters.

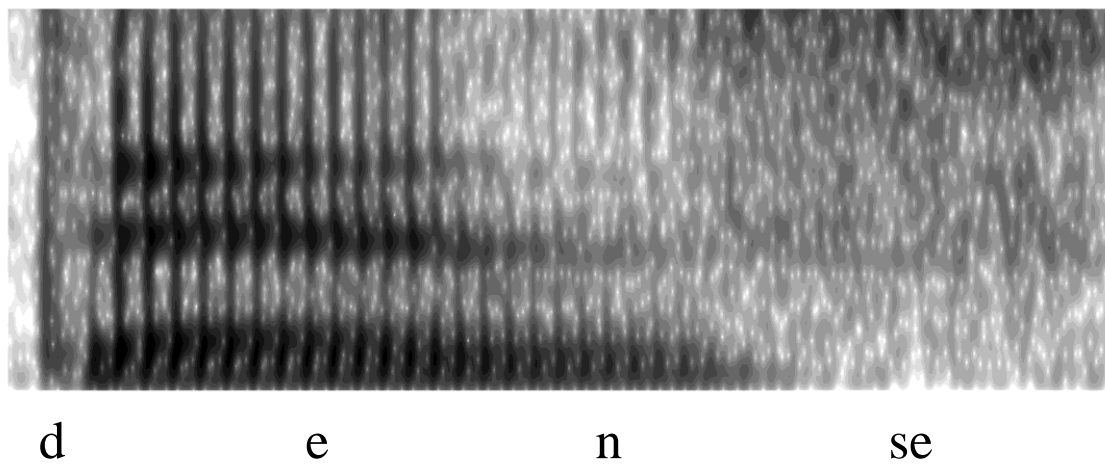
### **3.3. The Difference between Native Speakers and Japanese Speakers**

As to the ns-clusters, none of the thirteen Japanese speakers produced the epenthetic [t] in this experiment, while three native speakers did in some words. The reason why the Japanese speakers did not realize the epenthetic [t] will be investigated in the next section.

As to the ms-clusters, five out of thirteen Japanese speakers realized the epenthetic [p] in the words, *Samson*, *Teamster*, *Gimson*, and *Thomson*, while two out of three native speakers of English produced the epenthesis in the words, *Samson*, *Teamster*, *Thomson*, and *hamster*. The average duration of [p] produced by the Japanese speakers: 9.4 ms is shorter than that of [p] produced by the native speakers: 12.2 ms.



**Figure 11.** Sound Spectrogram of *dense* Produced by Speaker B



**Figure 12.** Sound Spectrogram of *dense* Produced by a Japanese Speaker

Figures 11 and 12 show the sound spectrograms of *dense* produced by a native speaker and a Japanese speaker. On the one hand, in figure 11, the formant of /n/ in the word, *dense* disappears before /s/. There is a sharp discontinuity between /n/ and /s/. This phenomenon demonstrates that the epenthetic [t] intervenes. On the other hand, in figure 12, the formant of /n/ continues into the formant of /s/. This phenomenon demonstrates that the epenthetic [t] does not intervene.

### 3.4. Influence of Japanese

#### 3.4.1. ns-clusters

In chapter one, epenthesis in Japanese, and the pronunciations of /N/ in Japanese were summarized. Then, in this section, the influence of Japanese on ns-clusters in English will be examined. As mentioned in chapter one, Japanese tend to pronounce /n/ in ns-clusters as nasalized vowels. Considering the result that none of the Japanese pronounced the epenthetic [t] in the ns-clusters, there is one definite possibility that this way of pronouncing /n/ in Japanese might have the influence on the pronunciations of /n/ in the ns-clusters produced by the Japanese speakers. If so, the reason why they did not produce the epenthetic [t] in the experiment will be clarified. In order to investigate the pronunciations of /n/ in the ns-clusters, the sound spectrograms were used. The procedure of the examination is as follows: (1) the formants of /n/ in the word, *national* realized by each Japanese speaker were investigated to recognize the formants of [n] (we need to investigate each speaker's formants, since the formants differ significantly depending on individuals.) (2) The formants of /n/ in the ns-clusters were investigated whether or not the different formants of /n/ in *national* appear, and the formants of nasalized vowels can be seen. According to Ladefoged (2001) and Ladefoged and Maddieson (1996), the formants of nasals and nasalized vowels have the following characteristics in sound spectrograms.

#### <Characteristics of nasals>

1. All nasals (m,n,ŋ) have first formants which have distinctly less energy than vowels.
2. All nasals have very low frequencies, around 200 Hz.
3. There is also another formant visible in the neighborhood of 2500 Hz, but there is comparatively little energy in that region.

<Characteristics of nasalized vowels>

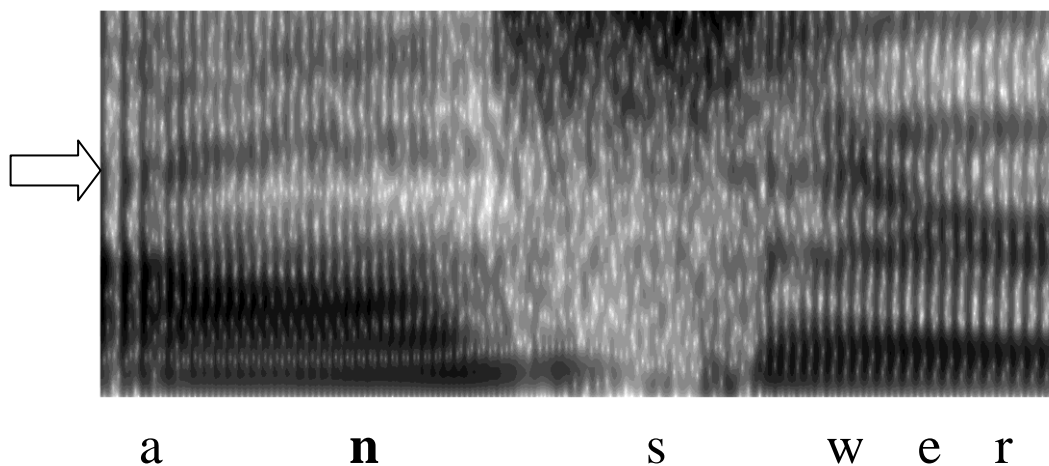
1. Nasalized vowels have wider first formant bandwidths than oral vowels.
2. The increase in bandwidth is also evident in the second formant of the vowels, /e/ and /æ/.
3. The first formant is weaker than oral vowels.
4. The third formant is higher than oral vowels.

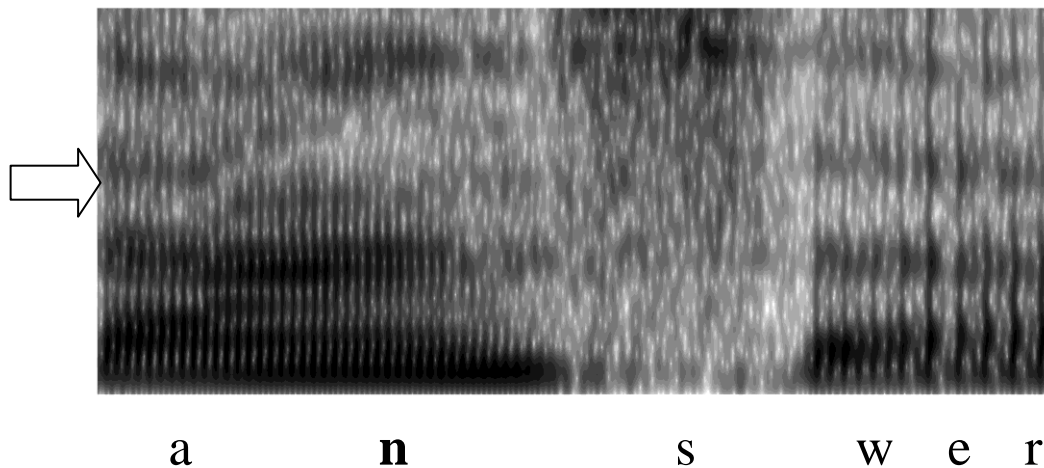
Ladefoged mentions that one of the problems in describing nasalization is that these characteristics do not affect each vowel in the same way. In addition, as these characteristics are seen in the spectrograms of the non-native speakers of Japanese, we need careful investigation for deciding which vowel is nasalized. The characteristics of one, two, and three are seen in the spectrograms of native speakers of English, and the last characteristic is seen in the spectrograms of Palantla Chinantec speakers, who are the aboriginal people in Mexico. If a different formant is realized in /n/ in the ns-clusters, and the formant has one of the characteristics of nasalized vowels cited above, the possibility that /n/ was pronounced as a nasalized vowel can be accepted.

The ns-clusters used in this investigation are chosen from each category: *dense* from monosyllabic words, *answer* from the word-medial after a stressed vowel position, *concern* from the word-medial after a stressless vowel position, *intense* from the word-final after a stressed vowel position, and *science* from the word-final after a stressless vowel position. In these five words, three of the five vowels before the ns-clusters is /e/, because it is convenient to compare if the vowels are the same. As to the word *answer*, this word is selected in order to examine the vowel, /æ/. And, as for the word-medial after a stressless vowel position, since the word containing the vowel, /e/ before the ns-clusters does not exist in the category, *concern* will be examined. The indistinct tokens will be eliminated, because it is often difficult to distinguish the nasal from the nasalized

vowels.

The result of the investigation is that all of the words chosen showed the formants of /n/ in ns-clusters which are different from /n/ in *national*. Among 65 tokens, 48 tokens (74%) showed at least one clear characteristic of nasalized vowels cited above. The formants of the other tokens were not distinct enough. What is interesting is that among the five categories, the formants of /n/ in the word, *answer* showed the most obvious characteristics of nasalized vowels, especially the fourth characteristic, i.e. the third formant is higher than oral vowels. The examples which display this characteristic are shown in figure 13 (the arrows point the third formants.) We can maintain that the /n/ in the ns-clusters pronounced by Japanese is replaced by the nasalized vowels in most of the target words, and that this result is due to the influence of the pronunciation of Japanese as Takebayashi (1996) states in his book. However, we should bear in mind that not all words were examined, and approximately 30 % of the words chosen are still indistinct. A further investigation is needed concerning this point.





**Figure 13.** Sound Spectrograms of *answer* Produced by two Japanese Speakers

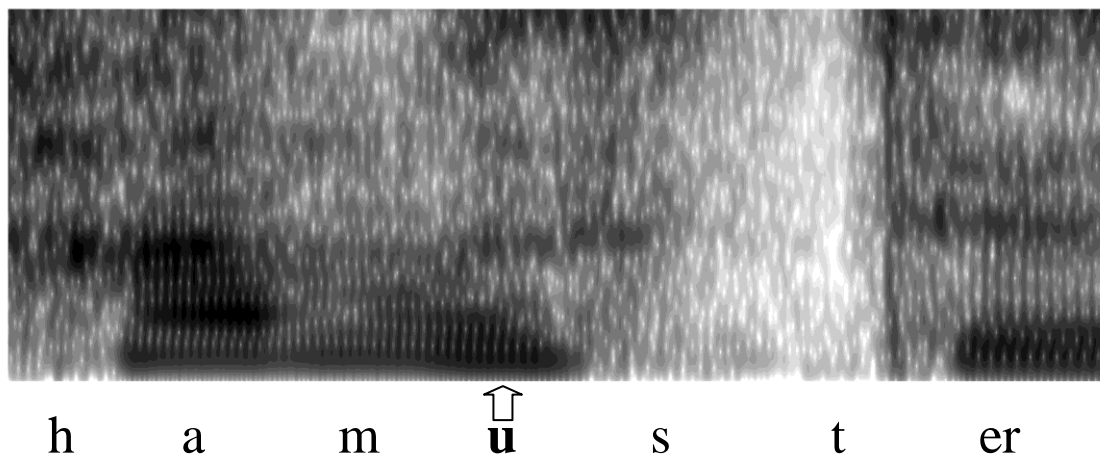
### 3.4.2. ms-clusters

In Japanese, ms-clusters do not exist, and even if the foreign words including ms-clusters are adopted in Japanese, people put the vowel, /u/, between /m/ and /s/. As mentioned in the previous section, none of the Japanese speakers pronounced the word, *hamster* with the epenthetic [p]. Then, the possibility that they inserted the vowel, /u/ between /m/ and /s/ in this word should be considered, and this possibility will be easily examined by using sound spectrograms. This is because vowels show darker formants than nasals in a sound spectrogram, and each vowel has distinctive formants, though the formants differ to some degree depending on individuals. All ms-clusters pronounced by the thirteen Japanese speakers were investigated whether they inserted the epenthetic vowel, /u/. The result is that as for the word, *Gimson*, no one inserted the epenthetic vowel, /u/. As for *Teamster*, *Samson*, Speaker 10 inserted /u/ respectively, and *Thomson* was also pronounced with the insertion of /u/ by speaker 6. And lastly, as for the word, *hamster*, six Japanese speakers (Speakers 2, 4, 6, 7, 10, and 11) inserted the vowel, /u/. This is a good number of people compared with the other tokens.

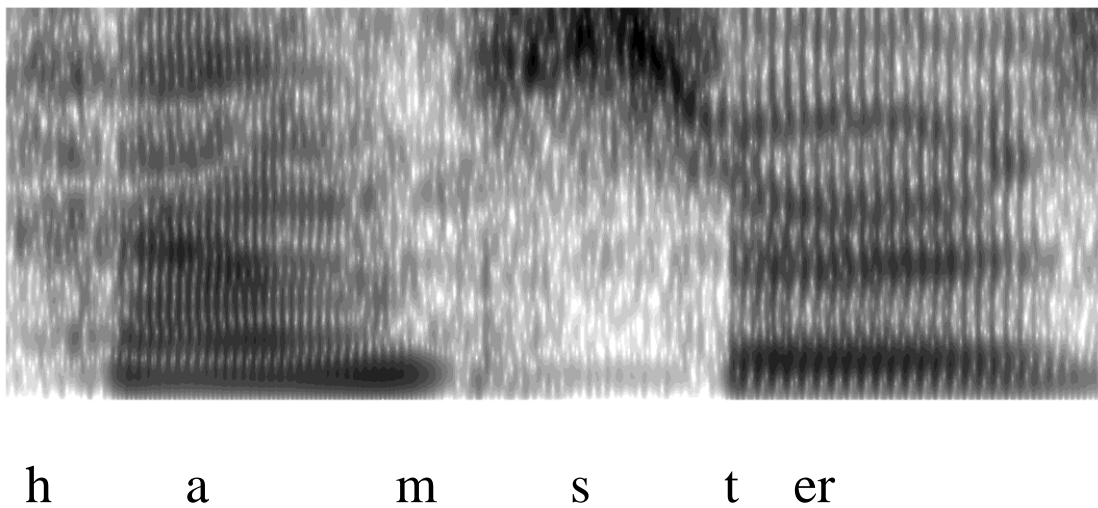
Among the six speakers, who put a vowel between /m/ and /s/ in the word, *hamster*, all

people had experienced living abroad, and three out of six speakers (Speakers 2, 4, and 6) have lived in English speaking countries for more than three years. The other three speakers have lived in English speaking countries for about one year. In addition, Speakers 6 and 10 showed epenthesis in the other ms-clusters, *Teamster*, *Samson*, and *Thomson*. Considering this result, it seems that their experiences in studying abroad do not have much relation with the insertion of the epenthetic vowel regarding the target words. However, we should consider that in this experiment, the number of speakers who have never lived abroad is only two. The possible reason for their insertion of a vowel in the word, *hamster*, is as follows: We might be able to attribute this insertion of /u/ to the influence of Japanese, because the word, *hamster*, is already adopted and spread in Japanese, and of course, people insert the vowel, /u/, between /m/ and /s/ in Japanese.

The formant of *hamster* which was pronounced with the epenthetic vowel, /u/, and the formant with no insertion of the vowel, /u/ are shown in figures 14, and 15.



**Figure 14.** Sound Spectrogram of *hamster* with the Insertion of /u/



**Figure 15.** Sound Spectrogram of *hamster* with No Insertion of /u/

## **Chapter Four:**

### **Conclusion**

This paper aims to analyze the epenthetic stops in nasal-fricative clusters produced by Japanese students, focusing on ns-clusters and ms-clusters. If epenthesis is not produced, clarifying the reason is also the aim of this paper. In addition, the epenthetic stops produced by native speakers of English were studied in order to compare them with previous studies. Since no study concerning the epenthetic consonants in English produced by Japanese learners of English was found, the comparison of the productions of Japanese speakers between this study and the previous studies was not possible. However, the comparison between Japanese speakers and native speakers of English was made.

The results of this study are summarized as follows.

<Results of the native speakers of English>

(1) As the result of the productions of the native speakers of English, the word-final after a stressless vowel group, i.e. *science* group, showed the longest durations among the four categories of polysyllabic words. This result accords with the result of Yoo and Blankenship (2003). The word-final after a stressed vowel group, i.e. *intense* group, showed the shortest durations, which does not accord with the result of Yoo and Blankenship.

(2) As a general tendency, the productions of native speakers of English confirmed that there is an individual variation for the production of the epenthetic [t] and [p]. Not all ns-clusters and ms-clusters were produced with the epenthetic consonants, and the tendencies are varied among the three speakers, especially in monosyllabic words and ms-clusters.

<Results of Japanese speakers>

(3) None of the Japanese subjects exhibited the epenthetic [t] in the ns-clusters. The adequate reason is that they pronounced /n/ in the ns-clusters as nasalized vowels, which is the influence of the pronunciation of Japanese. Approximately 70 % of the words chosen showed the characteristics of nasalized vowels in the sound spectrograms. The most obvious feature was that the third formant was higher than oral vowels.

(4) Exactly five out of thirteen Japanese speakers exhibited the epenthetic [p] in the ms-clusters, while the other eight speakers did not produce [p] at all. As for their backgrounds, three out of five speakers had experienced living in English-speaking countries for more than three years, and one speaker had lived in Canada for about one year. One last speaker did not have any experience living abroad. The tendency is not clearly shown that the speakers who have had experiences living in English-speaking countries are likely to produce epenthesis.

(5) As for the ms-clusters, the insertion of the vowel, /u/ was quite rare, but for the word *hamster*, six

out of thirteen Japanese speakers inserted the vowel, /u/ between /m/ and /s/. The reason for their insertion might be due to the fact that the word, *hamster*, is already adopted in Japanese, and is quite familiar to Japanese. In addition, all speakers who inserted the vowel, /u/, have had experiences living in English-speaking countries.

(6) The average duration of the epenthetic [p] produced by the Japanese speakers is 9.4 ms, which is shorter than that of native speakers of English: 12.2 ms.

The results lead us to the conclusion that Japanese students are unlikely to produce the epenthetic [t] in ns-clusters on account of the influence of the pronunciation of Japanese, and Japanese students produce the epenthetic [p] in ms-clusters on occasion, although there is the possibility that they produce the epenthetic vowel /u/, instead. It seems that overseas experiences are not so related to the productions of epenthesis in this experiment. Considering the difference of [p] closure durations, the epenthetic [p] of the Japanese speakers is weaker than that of native speakers.

Although this is not the main purpose of the study, the Japanese subjects were asked whether or not they had recognized the existence of the epenthetic consonants in English after the recordings. None of the Japanese speakers had recognized this phenomenon, although most of them had the good possibilities of hearing epenthesis produced by the native speakers of English. From the aspect of the perception of epenthetic stops, Warner and Weber (2001) maintain as follows: “Listeners apply knowledge of what is typical in the language in parsing speech.” For example, “Japanese listeners parse even a signal from which the vowel [u] has been deleted as having that vowel present” when foreign words are borrowed, and the vowel [u] intervenes to break up consonant clusters. In the same manner, the Japanese subjects are unlikely to perceive stop epenthesis, because the epenthetic [t] or [p] do not exist in Japanese, and these stops violate the syllable structure constraint in Japanese.

Since the recording data of the native speakers is composed of the productions of only three

subjects, the data of more subjects could have shown clearer tendencies. The problem of the limitation of the number of subjects might also be indicated in the investigation of the Japanese speakers. Among them, only two subjects did not have the experience of living abroad, so the data of a larger number of subjects and also, the data of a larger variety of subjects are needed for a more detailed study. As for the investigation of nasalized vowels in the speech of the Japanese subjects, the investigation which visibly shows the characteristics might be needed, since the formants of nasal vowels are often unclear. As the study of epenthetic stops produced by Japanese students is insufficient, various other epenthetic consonants in English will be interesting subjects for further research of investigation of Japanese learners of English.

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## Appendix

### 1. Sentence list

- ① The **sponsor** avoided a direct **answer** regarding the project.
- ② **Since Thomson** got a good grade in **science**, he decided to study biology in the university.
- ③ **Prince** Charles made some interesting comments about national **defense** forces.
- ④ Mary got a driver's **license**, and now lives in comfort in the country.
- ⑤ I was walking in a **dense** fog in the forest, and lost my **sense** of direction.
- ⑥ One of the **counsels** was writing something in his notebook with a **pencil** during the trial.
- ⑦ An **intense** meeting was held **concerning** this year's **census** of the country.
- ⑧ The **Teamsters** Union, which was formed in America, is one of the largest unions in the world.
- ⑨ The mobile phone which I bought yesterday is a **Samson** product.
- ⑩ In 2002, **Gimson** started up a new company by himself.
- ⑪ Among various animals, **hamsters** make great pets for children.

**Table 2. [t] and [p] closure durations of the native speakers of English**

## Speaker A

Word	duration(ms)
sense	17
dense	10
concern	10
science	19

## Speaker B

Word	duration(ms)
prince	18
dense	21
answer	37
pencil	33
science	41

Word	duration(ms)
Thomson	9
hamster	21

## Speaker C

Word	duration(ms)
dense	3
answer	13
census	12
concern	8
defence	8
intense	3
license	10
science	13

Word	duration(ms)
Thomson	16
Samson	15
teamster	19
hamster	16

**Table 3. Presence or absence of the characteristics of nasalized vowels in the speech of the Japanese speakers**

	Speaker 1	2	3	4	5	6	7	8	9	10	11	12	13
dense	+	-	+	+	+	-	+	-	+	+	+	+	+
answer	+	+	-	+	+	+	+	+	+	+	-	+	+
concern	-	-	+	+	-	+	+	+	-	+	-	+	+
intense	+	+	+	+	-	+	-	+	+	+	+	-	+
science	+	-	-	+	+	+	-	+	+	+	+	+	-

Presence of the characteristics of nasalized vowels= +

Indistinct tokens= -

