Acoustics Analysis of Japanese Geminate Consonant Pronounced by Indonesian Japanese Learners

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ABSTRACT
In Japanese there is one of basic concepts in pronunciation called *sokuon* or geminate consonants. Geminate consonant in Japanese is represented with a small *"tsu"* letter, for example: *ippo, sakka, kappu*, and so on. The Japanese geminate consonants must be pronounced correctly because the pronunciation can distinguish the meaning and can also affect the naturalness of the speech. This study is aimed to analyze the Japanese geminate consonant pronounced by Indonesian Japanese learners. Sound samples were recorded based on "reading text" model. The respondents were asked to read a Japanese text in which there were 21 vocabularies containing geminate consonants. The results of the recording were analyzed using impression analysis conducted by Japanese native speaker. Next, those were compared to the result of acoustic analysis using Praat to find duration of the "frictional sound" when the respondents pronounced the words. These words contain geminate consonants of fricatives. Then, the "silent sound" produced when pronouncing words that contain geminate consonants of stops. The results show that there are many Indonesian Japanese learners who have not yet pronounced the geminate consonants sound correctly, or naturally. After measuring the duration using Praat, it can be understood that unnatural assessment occurs in the vocabulary which is pronounced with too short geminate consonants duration. However, apart from the duration of the geminate consonants being too short, unnatural judgments also occur in vocabulary which is pronounced with too long duration. This is because the words which are pronounced seem strange and they are unnatural.

Keywords: *Acoustics analysis, Geminate consonants, Indonesian Japanese learners, Japanese.*

1. INTRODUCTION

The phonetic aspect has almost always been neglected in the Japanese language learning process. As its impact, Japanese language learners' knowledge about Japanese phonetics is not sufficient. Moreover, several phoneticians and phonologists from both Japan and Indonesia such as Satou (1986), Ogata (1993), Sukegawa (1993), Kashima (2002), and Nayoan, Yokoyama, Isomura, Usami, and Kubota (2012), suggest that there are several problems in the Japanese pronunciation experienced by language learners. Some of those problems are closely related to segmental sounds (vowels and consonants) and suprasegmental sounds (intonation, accents, etc.) which are performed by Japanese language learners in Indonesia.

According to segmental sounds, the researcher found that there are problems in the pronunciation of special sounds *(tokushuon)* in Japanese, especially in double consonants or long consonants sounds (geminate consonants) pronounced by Japanese language learners. In Japanese, geminate consonant is written with a small "*tsu*" letter. Geminate consonants are denoted by the phoneme /Q/. Some examples of geminate consonants are *ippo* 'one step', *sakka* 'author', *kappu* 'cup, and many more. These geminate consonants are generally in the middle of a word and sometimes they are used at the end of a word. However, Geminate consonants cannot be used at the beginning of a word and cannot be used alone little "*tsu*" letter only.

Pronouncing the geminate consonants sound correctly when communicating is very important because there are several vocabularies with similar pronunciation but have different meanings such as the words *machi* 'city' and *macchi* 'matches' or the words *kite kudasai* 'please come' and *kitte kudasai* 'cut off please'. This concern also relates to the naturalness of speech. In Indonesian, there are also double consonants, especially in the word which has undergone the addition of the *-kan* suffix, for example in the word "*meleta**kk**an*". When

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pronouncing "*meleta**kk**an*", the silent sound resulting from the presence of a double consonant -Qk will not be significantly distinguished the form when pronouncing the word "*meleta**k**an*". This does not cause any difference in meaning arising from the pronunciation of "*meleta**kk**an*" and "*meleta**k**an*". Therefore, Indonesians generally pronounce it more often as "*meleta**k**an*".

Thus, it can be understood that the concept of double consonant sounds in Japanese and Indonesian is different. This matter makes it difficult for Japanese language learners to apply Japanese geminate consonants sounds in speaking. Therefore, this research is needed to identify these problems.

Even though there are many problems revolving around pronunciation by Japanese language learners, research on phonetics and phonology of Japanese in Indonesia are still limited. Likewise, research related to the geminate consonants sound has not yet been carried out in Indonesia even though the geminate consonants sound is very important in communicating using Japanese. It is because the geminate consonants sound can distinguish meaning when pronounced incorrectly. Research on the geminate consonants sound was conducted by Sukegawa (1993). Sukegawa did the research in the form of a questionnaire to 23 Japanese language teachers in their respective countries. From the results of this study, it is known that problems regarding the special sounds of the Japanese language (long vowel sounds - *cou'on*), double consonant sounds (geminate consonants), and consonant sound "n" (*hatsuon*) occupy the top position. The problem regarding the geminate consonants is in the second position. It is explained that the duration of the geminate consonants sound is too short. According to Fujisaki and Miyoko (1977), and Han (1994), phonetic studies have shown that, other things being equal, consonant length is signaled primarily by consonant duration. Thus, the closure duration of [t] is much longer in /*kit.ta*/ 'cut (past)' than in /*ki.ta*/ 'came'. Geminate fricatives have a much longer fricative duration than single tone: e.g., [s] is considerably longer in /*kas.sen*/ 'battle' than in /*ka.sen*/ 'underline' (Kubozono, Ito, & Mester, 2008).

Haiping, Mori, and Kasuya (2006) in his paper explained that in the case of Japanese native speakers, there is a clear linear relationship between the average mora length in a word and the geminate and long-sound lengths, regardless of the speaker. However, in the case of native Chinese speakers, the variation from the straight line is large. Moreover, the result of each individual length in pronouncing the word also have large differences. Furthermore, Toda (2007) reviewed previous studies on the acquisition of geminate consonants by the Japanese language learners. Toda claims that understanding the rhythmic organization of learners' first language and their pronunciation of Japanese as a second language, is essential to capture the reality of the acquisition of Japanese geminate consonants. Toda in his paper also discusses the methodological issues concerning durational measurements to investigate the rhythmic organization of languages for future study.

In research conducted by Sukegawa (1993), the analysis was carried out using the assessment of native speakers and no acoustic analysis was carried out in the form of duration measurements. Similar to Sukegawa's research, Toda's research did not discuss the measurement of geminate consonants duration. However, Toda discussed the method of measuring duration to investigate rhythm for future research. Therefore, in this research, the researcher used acoustic analysis to find the duration of the geminate consonants sounds pronounced by Japanese language learners.

Acoustic phonetics is a part of phonetics which studies the sound of language in terms of sound as a physical phenomenon. The sounds are investigated for their vibration frequency, amplitude, intensity, and so on (Johnson, 2011). The geminate consonants sound when pronounced correctly will produce two things. First, if the geminate consonants sound is followed by a plosive sound /p/, /t/, /k/ as well as an affirmative sound /tɕ/, /dʑ/, /dz/, /ts/, it becomes a [t] sound and there will be a silent sound (empty sound) when reciting it. Second, if followed by the fricative sound /s/, /ɕ/, /h/, the hissing sound of the fricative sound will be longer (Kashima, 2002). The silent sound when viewed using a spectrogram will appear as an empty part, in other words. There is no energy in that part. On the contrary, the hissing sound on the geminate consonants will appear on the spectrogram as a longer black part. The silent part and the hiss part are the duration that will be measured. By knowing the duration pronounced by the learner when reciting the geminate consonants sound, it will be known whether the Japanese learner has pronounced the sound correctly or not. Acoustic analysis in this study uses a software called Praat. Praat was created by Paul Boersma and David Weenink from the University of Amsterdam. Praat has many varied functions regarding how to analyze sound.

2. METHOD

The researcher used quantitative analysis methods in this research to process numerical data resulting from measuring the geminate consonants sound duration pronounced by Japanese language learners. The duration measurement was carried out using software to analyze the sound, namely Praat. After the results of the quantitative analysis were obtained, a qualitative analysis was carried out to describe the meaning of the numbers generated from the quantitative analysis to obtain the explanation of the factors causing errors in pronouncing Japanese geminate consonants.

Respondents in this study were students of the Japanese language education study program, Semarang State University who had learned Japanese language skills at the level of JLPT (Japanese Language Proficiency Test) level 3. The respondents were 10 students. In addition, for comparison, the voices of 4 Japanese native speakers (2 males and 2 females) were taken through audio from OJAD (Online Japanese Accent Dictionary) which is created by Minematsu Nobuaki from the University of Tokyo.

In this study, an analysis was carried out on two things. First, the Japanese native speakers assessed the geminate consonants sound pronounced by Indonesian Japanese learners. Second, using the Praat software, the researcher measured the duration of geminate consonants sound in the form of acoustic analysis. The steps done by the research were as follows. First, the researcher asked the respondents to read a Japanese script of 21 vocabularies containing geminate consonants sounds, such as *yukkuri, zutto, omotte*, and it was recorded. However, for the native speaker's voice, the script was inputted into OJAD online media with the *Suzuki-kun* feature. Then, the voice was recorded based on the 4 speakers' voice, namely 2 men and 2 women. Next, the recordings were downloaded.

From the script, vocabularies which contain geminate consonants sounds was taken using Praat software. Then, the sound of the Japanese language learner's geminate consonants was listened by Japanese native speakers to be assessed whether it was pronounced correctly or not. The assessment given by native speakers is in the range of values from 1 to 4, with the following details: 1 = unnatural, 2 = less natural, 3 = slightly natural, and 4 = natural. Thus, the total numbers of vocabularies analyzed were 210 vocabularies. The assessment results from native speakers were then analyzed using statistics.

After that, the geminate consonants sound was analyzed acoustically using Praat by means of labeling to determine the position of the geminate consonants sound. Then, the part containing the geminate consonants sound was measured to determine its duration. The duration measurement was carried out using the "ProsodyPro" script created by Xu (2013). The results of the assessment from native speakers and the results of the duration measurement were analyzed to determine the characteristics of the Japanese geminate consonants sounds pronounced by Japanese language learners.

Here is the example of labelling in duration measurement using Praat in the word "*yuQkuri*"

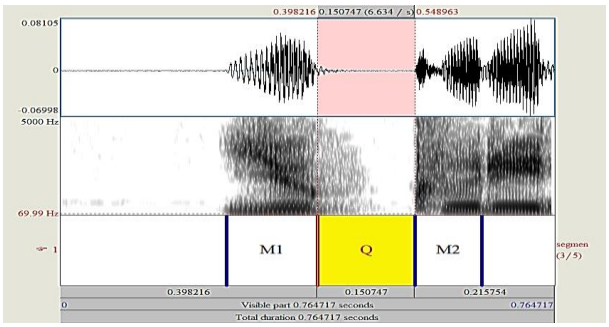

Figure 1 Labelling in the word "*yuQkuri*".

In the figure above, M1 is the marker for the "*yu*" mora, Q is the silent sound resulting from the pronunciation of the geminate consonant. M2 is the marker for the "*ku*" mora, while the "*ri*" mora is not given a marker because it has no effect in the analysis.

3. FINDINGS AND DISCUSSION

3.1. Analysis of Native Speaker Assessment Result

The 21 vocabularies containing geminate consonants which were used in this research are geminate consonant fricative -Qsh: *i**ssh**uukan* and *ke**ssh**in*; geminate consonants plosive -Qp: *ka**pp**u, shi**pp**ai* (1) and *shi**pp**ai* (2); plosive -Qt*: i**tt**ari, i**tt**e, kasana**tt**e, ma**tt**aku, muka**tt**e, na**tt**e* (1), *na**tt**e* (2), *na**tt**e* (3), *omo**tt**e (1), omo**tt**e (2), ya**tt**o, zu**tt**o (1), zu**tt**o (2)*; and plosive -Qk: *ke**kk**yoku, ki**kk**ake and yu**kk**uri.*

From the results of the study, it can be seen that based on the assessment of native speakers, 76.7% of the geminate consonants sounds pronounced by Indonesian students are pronounced naturally and 23.3% are pronounced unnaturally. From 23.3% of unnatural data, it can be understood that plosive consonants -Qt are most pronounced unnaturally, which is 12.9%. The second highest are plosive consonants -Qk for 5.2%. Then, the plosive consonants -Qp is 4.3%. Finally, the fricative consonant -Qsh is 1%

Based on the analysis of the assessment conducted by native speakers, the results are shown in Table 1.

Table 1. Overall native speaker assessment results

Geminate Consonants	Total	Natural		Unnatural	
		Number	%	Number	%
-Qsh	20	18	8,6	2	1,0
-Qp	30	21	10,0	9	4,3
-Qt	130	104	49	26	12,9
-Qk	30	19	9,0	11	5,2
Total	210	162	76,7	48	23,3

However, it can be seen in the table that the plosive consonant -Qt has the highest number of unnatural pronunciations because the vocabularies containing the geminate consonants sound with the -Qt consonant also has the most occurrence for the total of 130 words. The other plosive consonants, namely -Qp and -Qk, are 30 words each, and the fricative consonants of -Qsh are 20 words. If a comparison is made among the number of natural and unnatural vocabularies obtained from the data analysis, it can be understood that the plosive consonants of -Qk are most pronounced unnaturally, as much as 36.7%, followed by the plosive consonant -Qp 30%, plosive consonant -Qt 21% and fricative consonant -Qsh 10%.

3.2. Analysis of Duration Measurement Using PRAAT

Based on the duration measurement using Praat on Japanese language learners with the native speakers, the results are as shown in Table 2.

From Table 2, it can be understood that the length of the geminate consonants sound duration pronounced by Japanese learners, the geminate consonants with the plosive consonant -Qt, has the longest duration, which is 173 ms. It is followed by fricative consonant -Qsh 160 ms, plosive consonant -Qp 146 ms, and plosive consonant -Qk 127 ms. The durations of the consonant geminate consonants -*tt* and -*ssh* pronounced by Japanese learners are longer than those pronounced by native speakers, while the geminate consonants with plosive consonants -Qp have the same duration for both learners and native speakers. However, in the plosive consonant -*kk*, the duration of the geminate consonants pronounced by native speakers is longer than that of Japanese learners.

Then, the results of measuring the duration of Japanese language learners in detail can be seen in Table 3. From Table 3, it can be understood that the geminate consonants sound in the fricative consonant -Qsh has a duration range from 103 to 242 ms. The plosive consonant -Qp is 56 to 258 ms. The plosive consonant -Qt is 63 to 563 ms. The plosive consonant -Qk is 52 to 293 ms.

Table 2. Comparison of the average duration of the geminate consonants among learners and native speakers (ms)

Geminate Consonants	Japanese Learners	Native speakers
-Qsh	160	132
-Qp	146	146
-Qt	173	135
Qk	127	132

Table 3. Duration of the learners' geminate consonants (ms)

Geminate Consonants	Duration (ms)
-Qsh	103 - 242
-Qp	56 - 258
-Qt	63 - 563
-Qk	52 - 293

From Table 3, it can be seen that the geminate consonants in fricative consonants have the highest minimum duration of all. It happened because at the time of measurement, the hissing sound produced in the geminate consonants is measured and added with the consonant following it. It is done because the hissing sound produced from the geminate consonants and the hissing sound of the accompanying consonant cannot be separated at the time of measurement. In addition, it can be seen that the plosive consonant -Qt has the longest duration range among other consonant sounds.

3.3. The Relation between Geminate Consonants Duration and Naturalness

From sections 3.1 and 3.2, it has been understood that two findings were found from the analysis of geminate consonants sounds, namely the findings of the native speaker's assessment of the natural pronunciation of geminate consonants in Japanese language learners and the findings of measuring the duration of the geminate consonants sound. In this section, the researchers discussed the relationship between the duration of the geminate consonants and the natural pronunciation of Japanese learners. The relation can be seen in Table 4.

From Table 4, it can be understood that the geminate consonants in the fricative consonant -Qsh which is considered natural by native speakers is in the 122-242 ms duration range, while the duration below 122 ms is considered unnatural.

Table 4. The relation between geminate consonants duration and naturalness

Geminate Consonants	Duration (ms)	Natural (ms)	Total	Unnatural (ms)	Total
-Qsh	103-242	122-242	18	103-109	2
-Qp	56-258	120-258	21	56-115	9
-Qt	63-563	122-286	103	63-121 and 308-563	22 +5
-Qk	52-293	112-293	19	52-108	11

As shown in Table 4, there are two words which are less than 122 ms in length. Then, the geminate consonants on the plosive consonant -Qp which is considered natural is in the duration range of 120-258 ms. Therefore, the duration of the geminate consonants which is less than 120 ms is considered unnatural. There are pronunciations of 9 words which are considered unnatural because they are in the 56-115 ms duration range. Furthermore, the geminate consonants in the -Qt plosive consonant which is considered natural is in the duration range of 122-286 ms. Thus, the duration of the geminate consonants less than 122 ms is considered unnatural. There are pronunciations of 22 words which are considered unnatural, namely in the duration range of 63-121 ms. However, there is an interesting thing about this geminate consonant with plosive consonants -Qt. The -Qt geminate consonants are considered unnatural if the duration is below 122 ms and above 286 ms. The geminate consonants which are pronounced with the duration of 308 ms to 563 ms are also considered as unnatural. There are pronunciations of 5 words in this duration that are considered unnatural. The duration which is in the range of 308 to 563 ms is considered unnatural because it is too long, so that the spoken word sounds strange. Finally, the geminate consonants in the plosive consonant -Qk which is considered natural is in the duration range of 112-293 ms. Therefore, the duration of the geminate consonants less than 112 ms is considered unnatural. There are pronunciations of 11 words which are considered unnatural in the duration range of 52-108 ms.

Based on the research results, it can be understood that it will sound unnatural when Indonesian learners pronounce the Japanese geminate consonants with a short duration. The short duration for each geminate consonant which is considered unnatural by native speakers is different. This can be known through the results of acoustic analysis using Praat. However, it is generally understood that geminate consonants pronounced under the duration of 100 ms are considered unnatural. In this paper, it is showed that 23.3% of the geminate consonants pronounced by Indonesian Japanese learners was pronounced unnaturally and it was caused by the duration of the geminate consonants that pronounced too short. This is in accordance with Sukegawa (1993). He said that the duration of the geminate consonants pronounced of Indonesian Japanese learners is too short. Thus, it can be shown that duration measurement in geminate consonants is very important to investigate rhythmic organization of languages, as stated by Toda (2007). Moreover, Haiping et al. (2006) stated that there is a clear linear relationship between the average mora length in a word and the geminate regardless of the speaker.

4. CONCLUSION

From the results of the study, it can be concluded that the geminate consonants sound pronounced by Indonesian learners are 23.3% unnatural based on the native speaker's assessment. From this data, it can be understood that there are many Indonesian Japanese learners who have not yet pronounced the geminate consonants sound correctly, or naturally. From the results of the analysis, it can be understood that the plosive consonant -Qk is most pronounced unnaturally, which is 36.7%. It is followed by plosive consonant -Qp 30%, plosive consonant -Qt 21% and fricative consonant -Qsh 10%.

After measuring the duration, it can be understood that unnatural assessment occurs in the vocabulary that is pronounced with too short geminate consonants duration as described in Table 4. However, apart from the duration of the geminate consonants being too short, unnatural judgments also occur in vocabulary that is pronounced with the duration that is too long, above 308 ms. This is because the words that are pronounced seem strange and they are unnatural.

The researcher hoped that Japanese language learners can understand geminate consonants correctly so that they can improve their ability to pronounce geminate consonants in particular and the pronunciation of other Japanese sounds in general. In addition, this research is also expected to be a material for further research discussion.

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