Title: Perception and production of geminate and single consonants by learners of Japanese language
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1. Introduction

In general, it is said that is it very difficult for Japanese language learners to produce and perceive geminate stop consonants. This study focuses on geminate and single stop consonants produced and perceived by learners of Japanese and examine the relationship between the production and perception.

2. Literature review

2.1 What is a geminate?

The Japanese consonant system includes the geminate, which is phonologically transcribed as [Q] and it is one of the most indispensable features to explain Japanese phonology. In general, there are four environments in which geminates occur. First, verb inflections trigger the appearance of geminates. When a verb stem ends with /t/, /r/, or /w/, and a suffix whose first sound is /t/ is attached to it, the suffix /t/ changes into the geminate /tt/. Geminates also appear in words of Sino-Japanese origin (e.g., [kekka] 'result'). Geminates also occur in contractions of native expressions in Japanese (e.g., katippuri < kati-huri 'a manner of winning'). Another environment in which geminates are observed is in loan words (Shibatani, 1990). The contrasts between geminates and single consonants play a significant role in the Japanese language in the above-mentioned environments as well as other environments and the failure to produce and identify the distinction has a possibility to cause miscommunication.

Then, how do native Japanese speakers distinguish the difficult geminate and single consonant contrasts? Bechman (1982) measured the lengths of the geminates and single consonants produced by native Japanese speakers. Her study revealed that the mean ratio between geminates and single consonants is 2.5:1 when voice onset time (VOT) is included and 2.79:1 when VOT is not included. In her study, she denies the mora theory, but her findings indicate native Japanese speakers distinguish the contrast between geminates and single consonants by controlling the length of a word.

2.2 Production of geminate by learners of Japanese

Besides Beckman, many researchers have examined the contrasts between geminates and single consonants in Japanese and revealed that geminate and single stop consonant contrast is one of the most difficult features to master for learners of Japanese. Han (1992) investigates the closure duration and VOT of geminates and single stop consonants produced by native Japanese speakers and American English speaking learners of Japanese. In her study, she found that native Japanese speakers distinguish geminate and single consonant by controlling the closure duration time, like other researchers have indicated. In addition, she found the ratio of geminate to single stop closure produced by native Japanese speakers was in 2.8:1.0, while there were not significant differences between the closure time of geminates and that of single stop consonants produced by learners of Japanese. Although the proficiency levels of the subjects were advanced and their length of stay in Japan was more than one year, they could not distinguish single and double consonant contrast like native speakers did in her study. Thus, her finding clarified that the timing control of geminates and single stop consonants is one of the most important keys for Japanese language learners to master geminates and single consonants contrast.

While these previous studies collected data from learners of Japanese enrolled in Japanese

language courses at universities, Harada (2002) investigated the production of elementary school students attending a Japanese immersion school. He examined how the production of Japanese single and geminate stops produced by English-speaking children enrolled in the first grade, third grade, and fifth grade is dissimilar to that of native Japanese speakers. He found that closure duration of geminates and single consonants produced by students studying at an immersion school were significantly longer than those of monolingual children and bilingual adults. However, the contrasts produced by immersion students were still distinct from those of native Japanese speakers. He also compared the differences between grades, but there was no clear distinction between grade levels.

From these previous studies it is clear that the timing control of geminate consonants is one of the most significant phonological skills that learners of Japanese need to acquire in order to perceive and produce geminate consonants accurately. However, it is still is difficult to master for nonnative Japanese speakers, regardless of high proficiency levels, length of stay in Japan, and age of learners.

2.3 Perception of geminate by learners of Japanese

The above-mentioned previous studies investigated the geminates and single consonants produced by learners of Japanese and revealed how difficult it is to produce the single and geminate consonant contrasts. Then, how about perception? Do learners also find it difficult to perceive the consonant contrasts as well as to produce them?

Masuko and Kiritani (1990) examined the perception of mora sounds in Japanese by non-native Japanese speakers. In their study, they conducted a listening test in which subjects were asked to identify single voiceless consonants and the corresponding geminates. The subjects of this study consisted of learners of Japanese from Thailand, Korea, China, and Indonesia. Their length of stay in Japan and proficiency levels varied. In the listening test, they made similar errors in identifying the contrasts. The error rates of confusion of the two consonants among the four groups were close to each other (Chinese: 23%, Thai: 26%, Indonesia: 10%, Korea 19%). Thus, the results indicate that perception of the single and geminate contrasts is difficult as well as production regardless of learners' L1, proficiency level, and the length of stay in Japan.

2.4 Relationship between production and perception of geminate by JFL learners

Although Masuko and Kiritani revealed that it is also difficult to acquire the ability to perceive geminates and single consonants, we do not know well how perception and production are related in acquiring geminates and single consonant contrasts. It has not been clarified which is more difficult, perception or production, and whether perception precedes production or other way around.

Hirata (1998) is one of the researchers who investigated the perception and production relation in Japanese language. In her research, she investigated how learners improve the ability to produce and perceive Japanese durational contrast, which include long vowels, geminate consonants, moraic nasal, and a combination of these elements after they receive training. In this research, she found that it was effective to train learners to help them acquire the durational contrast, but production ability and perception ability were not developed in the same way. From these results, she questions the developmental relationship between perception and production.

As Hirata could not state the perception and production relation clearly, the issue of perception and production is very difficult to determine. Many studies have investigated the relationship and have given various opinions. Some researchers claim that a correlation between perception and production does not exist, but some researchers assert that the correlation does exist. Flege (1999) reviewed many studies that investigated L2 perception

and production. He concludes that perception and production correlates with each other in L2. However, he also mentions that the correlation is not very strong since there is a possibility that learners' loyalty to L1, their age, and methodological factors prevent the correlation from becoming higher. The following two studies also investigated the correlation between production and perception of adult L2 learners and their results were different. Gass (1984) focused on VOT of initial /b/ and /p/ and investigated the development of perception and production abilities by adult learners of English who had little exposure to English spoken by native speakers. In this study, subjects were asked to make judgments about the phonological contrasts for the perception task and they were asked to read word lists containing the phonological contrasts for the production task. This study found that learners became able to produce /p/ and /b/ in a native-like fashion before their perception appeared to be like native speaker perception. Moreover, the result revealed that the development pattern of perception and production was not a parallel relationship. In this study, the production ability showed less variability first and then it showed greater variability, while perceptual development moved toward native-like perception in decreasing the influence of native language and increasing the influence of a target language. Thus, this study indicates that the acquisition of production ability precedes that of perception and that development patterns of production and perception are different.

Rochet (1995) also examined the relationship between production and perception ability of adult L2 learners, however, his findings seem to be the other way around. In his study, he investigated the effects of perceptual training on the perception and production of voicing contrasts in the stop consonants of standard French. Subjects of this study were Mandarin Chinese speakers and the length of the training was three hours. In the training session, subjects listened to voiced and voiceless examples until they were able to tell the distinction between two categories. The results of the post-test after the training session revealed that the training successfully modified the perception of the voicing contrasts. Moreover, the results of the post-test after the training session revealed that learners' mean VOT duration of target initial voiceless came close to that of French speakers. Thus, the perceptual training had positive effects on production of voicing contrasts by learners as well as perception. This experiment indicates that improvement in perception is accompanied by improvement in production. Although the languages and phonological features that these two studies focused on are different, it is interesting that the results of the research, which both investigated perception and production ability in L2, were opposite. These results indicate that perception and production in L2 are still unknown areas and those of Japanese also need to be investigated more.

3. Research questions

From the previous studies regarding Japanese geminate and single stop consonant contrasts and the relationship between production and perception ability in L2, it is clear that geminates and single stop consonants are significantly difficult for nonnative Japanese speakers to produce and perceive. However, there are two points that have not been clarified enough. First, they have not investigated whether there are any differences between geminate and single stop consonants produced by Japanese language learners whose proficiency levels are different. Most of the previous studies examined the production and perception of advanced learners and did not compare the differences among learners at different levels well. Secondly, perception and production relationship in L2 is still an unknown area. Therefore, we do not know whether accurate production of geminates and single consonant contrasts will make learners able to perceive them correctly, or that successful perception will enable them to produce the contrast. Thus, the development pattern of production and perception of geminate and single stop consonant contrast is another area which needs to be investigated.

Therefore, the questions to be investigated in this project are the following: 1) whether the geminates and single stop consonants produced by learners of Japanese are different depending on their proficiency levels in Japanese, and 2) whether there is any relationship between their production and perception of the geminates and single stop consonants.

4. Subjects

The subjects of this present study were 12 native English speakers studying Japanese language at an American college. 4 (one female and three male) were enrolled in second year Japanese course, 4 (one female and three make) were enrolled in third year Japanese course, and 4 (two female and two male) were enrolled in forth year Japanese course.

5. Materials

The material for this present study contains a set of nine minimal pairs (18 words total) demonstrating the single/geminate distinction among voiceless stops. Three pairs were selected for each [p]: [pp], [t]: [tt], and [k]: [kk], The 18 words are two or three moras in length and their structures are CVCV or CVQCV. The 18 words are presented in the Appendix. They are all nonsense words, since subjects' familiarity or unfamiliarity with a certain word can influence their perception and production ability. It allows this study to investigate true perception and production ability, rather than rely on previous knowledge. Most of these words were placed in short sentences and the structure of the sentence was 'sore wa ____ desu.' In addition, all of the materials were presented in the Japanese orthography.

This present study consists of a perception task and a production task. For the perception task, 18 sentences were recorded, which contained the 18 words and were produced by a native speaker of Japanese, and students listened to the recordings. In the production task, two sets of 18 cards were used. On each card, one sentence with one of the 18 words was written.

6. Procedure

In the perception task, subjects listened to the 18 sentences twice and they were asked to write down the words on a worksheet in which the other parts of the sentence ('sore wa desu.') were already presented. For the production task, they were asked to read aloud the 18 sentences on the 18 cards twice. In order to avoid the influence of test taking order, I had half of the subjects take the perception test first and the other half take the production task first.

7. Data analysis

The perceptional analysis of the subjects' production was conducted by the researcher of this study, who is a native speaker of Japanese. Each of the 432 utterances (18 sentences x 2 repetitions x 12 subjects) was judged whether the subject was able to produce geminates or single consonants or not by the evaluator. If the production was appropriately identifiable, the utterance was assigned 2 points. If the production was not clear enough and it was heard as a stop sound between geminate and single consonants, the utterance was given 1.5 points. If the subjects produced unnecessary geminates or they did not produce geminate when they needed to, their utterance was given 1 point. The 216 words (18 sentences x 12 subjects) that the subjects dictated in the perception task were also scored. If the word the subjects wrote down was correct, it received 2 points. If the word contained an unnecessary geminate or there was no geminate, it received 1 point. If the word was completely different, it was given 0 points.

8. Results

8.1 Production task

The production task scores of each stop sound and those of geminates and single consonants are shown in Table 1 and 2. Table 1 shows, the mean of each stop consonants

produced by the subjects from the fourth year group were higher except for the /p/. The mean of the subjects in the second and third year groups are very close except for the /k/. There was no consistency with the consonants marked the highest and lowest score among three grades. Table 2 shows that the mean of the subjects enrolled in the fourth year classes was the highest in both geminates and single consonants. Furthermore, their mean score of geminates was higher than that of single consonants, while the score of single consonants was higher than those of geminates for the subjects enrolled in second and third year. The mean of single consonants by the first year subjects was 1.79 and the score was lower than that of the second year subjects. On the other hand, the mean score of geminates by the first year subjects was 1.74 and that of the third year subjects was 1.71. Thus, the first year subjects scored higher than the third year subjects. However, the difference was only 0.93 and the mean scores were very close.

Table 1. Mean scores of each consonant in the production task

	/p/	/pp/	/t/	/tt/	/k/	/kk/
4th year	1.87	1.97	2.0	2.0	1.97	2.0
3rd year	1.88	1.70	1.92	1.88	1.94	1.69
2nd year	1.88	1.82	1.86	1.75	1.79	1.79

Table. 2 Mean scores of single consonants and geminates in the production task

	Geminates	Single consonants
4th year	1.97 (99.4%)	1.86 (98.6%)
3rd year	1.71 (87.8%)	1.87 (95.8%)
2nd year	1.74 (89.2%)	1.79 (92.0%)

8.2 Perception task

The results of the perception task are shown in Table 3. It shows that the subjects in the fourth year received full points in the task. The mean score of the second year subjects was 29.5 and that of the third year students was 28.0. Thus, their mean scores were very close. However, there were two subjects who misjudged single consonants as geminates in the second year, while there was no subject who showed the same misjudgment in the third year group. The only way the third year subjects lost points was that they misjudged geminates as single consonants.

Table 3. Mean scores of the perception task

	4th year	3rd year	2nd year
Mean point	36.0 (100%)	28.0 (77.8%)	29.5 (82.0%)

9. Discussion

Since second and third year subjects' mean scores of production of geminates (2nd year = 1.74, 3rd year = 1.71) were lower than those of single consonants (2nd year = 1.79, 3rd year = 1.87), the results confirmed that geminates were more difficult to produce than single stop consonants. However, the fourth year subjects' mean score of geminates (1.97) was higher than that of single consonants (1.89) and the mean score of geminates by the fourth year subjects was much higher than those of other two groups. Therefore, these results among three groups indicate that there were differences in production ability of geminates and single consonants among the three groups. It seems that it was not difficult for the fourth year

students to produce geminates, while the second and third year subjects found it still difficult to produce geminates. These results imply that the higher the course the subjects are enrolled in, the higher the mean scores are. Thus, the results suggest that the proficiency levels are related to the production ability of geminates and single consonant contrasts. I assume that the reason fourth year subjects marked lower mean scores on single consonant production was not because single consonants were difficult to produce, since the mean score was still higher than those of the other two groups. It might be because they were very careful and conscious about geminates and that psychological effects influenced their single consonants production.

In the perception task, the subjects in the fourth year group showed the highest mean scores (36.0) and the mean point of the third year (28.0) followed that of the second year subjects (29.5). Although the subjects in the second year marked higher score than third year subjects, the former group included several subjects who perceived single consonants as geminates while subjects in the latter group were able to perceive all simple consonants correctly. From the results, I assume that the subjects in the third year have better established the ability to perceive the contrast distinction. Thus, what the results suggest is that learners perceive the geminate and single consonants correctly as they gain proficiency in Japanese. This indicates that the proficiency levels are also related to the perception ability of geminate and single consonant contrasts as well as the production ability of the contrasts.

The results seem to clarify that proficiency level is related to both the production and perception ability so far. Then, how about the relationship between the two abilities? The fourth year subjects' percentage of both the production and perception were very similar and almost perfect, but the percentage of the production test of geminates and single consonants were 99.4% and 98.6% respectively. The third year group marked 87.8% on the production test of geminates and 95.8% on the production test of single consonants, while they marked 77.8% on the perception test. With regard to the second year group, the geminate and single consonant percentages were 89.2% and 92 % respectively and the percentage of the perception test was 82%. Thus, we can assume that the fourth year students acquired production and perception abilities, however, third and second year students found it more difficult to perceive geminates and single consonants than to produce them. In other words, they have the sill to distinguish the contrast in their utterance, but they are not successfully able to identify the distinction between the geminates and single consonants when they listen to the contrasts. From these results, it is apparent that learners master the production ability first and then they acquire the perception ability next.

10. Conclusion

To summarize, the results of this study has found that there are differences in production ability of geminate and single consonant contrasts depending on learners' proficiency levels. The subjects of this study produced the consonant contrasts more accurately as they gain proficiency in Japanese. Furthermore, the subjects with higher proficiency level were able to perceive the contrast better than those with lower proficiency level. Thus, all these results reveal that proficiency level correlates with production and perception ability of geminate and single consonant contrasts and confirmed the first research question of this study. With regard to the relationship between production and perception abilities, this study revealed that it is more difficult for learners to perceive the geminate and single consonant contrasts than produce them. Therefore, we can see that both production and perception ability correlate to learners' proficiency level. Furthermore, the acquisition of production ability precedes that of perception, and this is the answer to the second research question.

Thus, the results of this study seem to suggest that learner's proficiency levels correlate the ability of the production of geminate and single consonant contrasts. It is also assumed that the production ability precedes the perception ability. However, since the number of the

subjects for this study was small, further investigations are necessary with larger amounts of data and subjects. In order to find a more effective way to enable learners acquire the difficult phonological skills, it is important to know more precisely how nonnative Japanese speakers find it difficult to produce and perceive the consonant contrasts and how they develop the two skills.

Appendix

Below is a list of sentences used in the production and perception tasks.

1. それは	めべ	です。	(sore wa me**p**e desu.)
2. それは	めっぺ	です。	(sore wa me**pp**e desu.)
3. それは	らば	です。	(sore wa ra**p**a desu.)
4. それは	らっぱ	です。	(sore wa ra**pp**a desu.)
5. それは	ほぽ	です。	(sore wa ho**p**o desu.)
6. それは	ほっぽ	です。	(sore wa ho**pp**o desu.)
7. それは	らた	です。	(sore wa ra**t**a desu.)
8. それは	らった	です。	(sore wa ra**tt**a desu.)
9. それは	ほと	です。	(sore wa ho**t**o desu.)
10. それは	ほっと	です。	(sore wa ho**tt**o desu.)
11. それは	めて	です。	(sore wa me**t**e desu.)
12. それは	めって	です。	(sore wa me**tt**e desu.)
13. それは	ほこ	です。	(sore wa hook desu.)
14. それは	ほっこ	です。	(sore wa ho**kk**o desu.)
15. それは	めけ	です。	(sore wa me**k**e desu.)
16. それは	めっけ	です。	(sore wa me**kk**e desu.)
17. それは	らか	です。	(sore wa ra**k**a desu.)
18. それは	らっか	です。	(sore wa ra**kk**a desu.)

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