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What do Japanese students perceive within Spanish consonant clusters?

Junko Matsumoto

1. Introduction

Vowel epenthesis is one of the strategies used by Japanese to avoid closed syllables and consonant clusters. Kubozono (2002) noted that Japanese choose [o], [i], or [u] depending on the situation when faced with closed syllables and consonant clusters. This is because the Japanese language has an open syllable structure[i]. Although Spanish also has a largely open syllable structure (Iribarren 2005:75), it is more marked in Japanese[ii]. Although several studies have been performed regarding the pronunciation of Spanish consonant clusters by Japanese speakers (Kitamura et al. 1995; Lobo et al. 1993; Kimura 2015; etc.), to our knowledge, no studies have investigated their perceptions of these clusters except our previous studies (Matsumoto 2008 and 2014). There, we found that it is difficult for Japanese speakers to distinguish phoneme continuums such as /CCV/ (C=consonant, V=vowel) and /CVCV/. We concluded that this could be because no differences can be seen in such continuums when they are written in *katakana*—the angular Japanese phonetic syllabary that is generally used to express a word from foreign language[iii]. On the other hand, Spanish contains a phenomenon known as "*elemento esvarabático*" (the svarabhakti element)[iv]. We confirmed the existence of the svarabhakti element in a previous study (Matsumoto 2014)[v]; this makes it more difficult and complicated for Japanese students to perceive /CCV/ consonant clusters *correctly*[vi]. Therefore, the objective of the present study is to investigate what Japanese students perceive within Spanish consonant clusters when they are wrong. For this purpose, we test the following two hypotheses: Hypothesis 1 is that Japanese students perceive a svarabhakti element within /CCV/ consonant clusters, so they select the choice that is influenced by the svarabhakti element; Hypothesis 2 is that Japanese students confuse /CCV/ with /CVCV/ consonant clusters because the differences are not distinguishable when written in *katakana*; therefore, they select /u/ when C_1 is /p, b, f, k, g/ and /o/ when C_1 is /t, d/[vii].

2. Experimental Materials and methods

Participants. The study participants were 30 Japanese university students who were studying Spanish as a foreign language. All participants were native Japanese speakers[viii].

Stimuli. For the stimuli, 120 non-words were prepared, half of them including a Spanish consonant cluster[ix], and the other half including a phoneme continuum considered to be indistinguishable in *katakana*[x]. The stimuli (the carrier sentence "Leo el término X." was read 120 times, with prepared non-words appearing randomly in the place of "X".) were recorded by a native female Spanish speaker from Madrid in Tokyo Cervantes's classroom[xi] using a linear PCM recorder with a built-in microphone (PCM-D1; Sony, Tokyo, Japan)[xii].

Procedure. All 120 stimuli were presented through the speakers in classroom using the Audacity program installed on a VAIO Note TR (PCG-TR3E/B; Sony, Tokyo, Japan). The participants were asked to choose one word from six choices they thought was closest to what they had heard for each stimulus. Stimuli were presented in 5 s increments. The participants could listen to each stimulus only once (see Appendix A of the answer sheet).

3. Results

For the purposes of this paper, we used the 60 results involving /CCV/ because these focus on Spanish consonant clusters (see Appendixes B and C). A stimulus is shown on the first line, the choices are shown on the second, and the answer chosen by the participant is shown on the third. For example, in the case of "flaqui", 21 participants chose the correct answer shown below the "Ø", which means that they did not hear anything within the consonant cluster, nine chose "fulaqui" shown below the "u", which means they heard "u" within the consonant cluster, and none heard "falaqui", "felaqui", "filaqui", or "folaqui", so a 0 is shown below "a, e, i, o". In Appendix C, the choices supporting Hypothesis 1 are shaded in gray and the choices supporting Hypothesis 2 are shown in boldface.

In all cases, there were more correct than incorrect answers, except for "glequi" and "groqui" (11 correct vs. 16 incorrect answers for "glequi" and 7 correct vs. 18 incorrect answers for "groqui"). However, in the case of "glequi", there were significantly more correct than incorrect answers for any particular choice (p=.007; one-sided, direct probability calculation with different denominators). On the other hand, in the case of "groqui", the number of the correct answers was not significantly bigger than the number of incorrect answers for any particular choice (p=.224; one-sided, direct probability calculation with different denominators). This means that in all the cases except for "groqui", significantly

more participants chose the correct than the incorrect answer. In the case of “pruqui”, every participant selected the correct answer.

4. Discussion

4.1 Correct answer selected

It is natural that in almost all cases, significantly more participants chose the correct answer because each of the 30 participants answered more than 68 of the 120 questions correctly. Why were 23 participants (5 for “o” and 18 for “u”) unable to choose the correct answer when they heard “groqui”? The length of the svarabhakti element produced within the “g” and “r” of “groqui” was 54 ms, whereas the average length of the other svarabhakti elements was 37 ms (Matsumoto 2014). Conversely, in the case of “pruqui”, all 30 participants selected the correct answer, even though the length of the svarabhakti element within “p” and “r” was 54 ms, which was longer than average (Matsumoto 2014). Therefore, the relative length of the svarabhakti element may not have influenced the participants to choose the correct answer, so it is difficult to say conclusively that the length of the svarabhakti element has an effect on Japanese /CCV/ perception. This issue will need to be investigated further in future studies, as the focus of the present study was on what kind of incorrect answer was selected.

4.2 /CrV/ perception

Quilis (1993) characterizes the svarabhakti element as being similar to the vowel following the second consonant of the cluster; we reached the same conclusion in our previous study (Matsumoto 2014). Therefore, the cases shaded in gray in Appendix C, which fall under Hypothesis 1, suggest that participants perceived something like a vowel similar to the vowel following the second consonant of a cluster; for example, choosing “dar̲a̲qui” after hearing “dr̲a̲qui”, “der̲e̲qui” after hearing “dr̲e̲qui”, and “dir̲i̲qui” after hearing “dr̲i̲qui”. Regarding Hypothesis 2, hearing /u/ when C_1 is /p, b, f, k, g/ and /o/ when C_1 is /t, d/ falls under Hypothesis 2, which is shown in boldface in Appendix C; for example, choosing “doraqui” after hearing “draqui”, “curequi” after hearing “crequi”, and “buriqui” after hearing “briqui”.

When Hypotheses 1 and 2 coincided with one another (e.g., “u” of “cruqui”, “bruqui”, “pruqui”, and “fruqui”, and “o” of “droqui” and “troqui”), this led to the most frequently selected choices among all incorrect choices, except for “pruqui”, for which every participant had the correct answer.

Table 1 shows the incorrect answers classified by vowel. For example, the number of

incorrect answers for “a” indicates the total incorrectness of /Cr̲aki/ (53); i.e., the total number of answers for “craqui”, “braqui”, “draqui”, “praqui”, “graqui,” “fraqui”, and “traqui”, excluding “Ø” (the correct answer).

Table 1 *Number of incorrect answers classified by vowel*

	a (%)	e (%)	i (%)	o (%)	u (%)
N. of incorr. ans.	53	63	45	76	60
Corresp. to hyp. 1	3 (5.7)	8 (12.7)	10 (22.2)	21 (27.6)	53 (88.3)
Corresp. to hyp. 2	36 (67.9)	47 (74.6)	26 (57.8)	63 (82.9)	47 (78.3)
Hyp. 1 = hyp. 2				14 (18.7)	42 (70)

There were significantly more incorrect answers for the vowels “a, e, i, o” corresponding to Hypothesis 2 than to Hypothesis 1 (a: 3 vs. 36, $p<.001$; e: 8 vs. 47, $p<.001$; i: 10 vs. 26, $p=.006$; o: 21 vs. 63, $p<.001$, direct probability calculation, one-sided). Although more incorrect answers were seen for the vowel “u” corresponding to Hypothesis 1 than to Hypothesis 2, this difference was not significant ($p=.617$; direct probability calculation, one-sided).

Table 2 shows the number of incorrect answers classified by consonant. For example, the number of incorrect answers for “b” indicates the total incorrectness of /b̲rVki/ (29); i.e., the total number of answers for “braqui”, “brequi”, “briqui”, “broqui”, and “bruqui”, excluding “Ø” (the correct answer).

Table 2 *Number of incorrect answers classified by consonant*

	c (%)	b (%)	d (%)	p (%)	g (%)	f (%)	t (%)
N. of incorr. ans.	55	29	44	27	60	56	26
Corresp. to hyp. 1	17 (30.9)	8 (27.6)	15 (34.1)	2 (7.4)	20 (33.3)	19 (33.9)	14 (53.8)
Corresp. to hyp. 2	42 (76.4)	26 (89.7)	15 (34.1)	23 (85.2)	53 (88.3)	44 (78.6)	16 (61.5)
Hyp. 1 = hyp. 2	10 (18.2)	6 (20/7)	4 (9.1)	0 (0)	13 (21.7)	13 (23.2)	1 (3.8)

A higher number of incorrect answers corresponded to Hypothesis 2 than to Hypothesis 1 for consonants “c, b, p, g, f, t”. Although this difference was significant for “c, b, p, g, f”

(c: 17 vs. 42, p=.002; b: 8 vs. 26, p=.003; p: 2 vs. 23, p<.001; g: 20 vs. 53, p<.001; f: 19 vs. 44, p=.002, direct probability calculation, one-sided), the difference for "t" was not (14 vs. 16, p=.856, direct probability calculation, one-sided). The number of correct answers for the consonant "d" was the same in regard to both Hypotheses 1 and 2.

Because of the character of svarabhakti element, choosing an incorrect answer corresponding to Hypothesis 1 should NOT be able to be judged wrong from acoustics perspective. According to Carbonell (2008)[xiii], even native Spanish speakers have to learn not to perceive a svarabhakti element less than about 27 ms as a vowel through the process of first language acquisition. In Japanese, consonant clusters are not permitted, so Japanese students should perceive something like a vowel within them. However, when choosing the incorrect answer, the participants in the present study tended to select the answers that corresponded to Hypothesis 2, not Hypothesis 1, which is closer acoustically to the stimuli. It suggests that Japanese students might perceive the svarabhakti element as "u".

4.3 Cases in which the svarabhakti element was not present

In our stimuli, no svarabhakti elements were perceived within the /ClV/ consonant cluster (Matsumoto 2014); this result supports Widdison's conclusion (2004). In addition, no svarabhakti element was perceived in four cases involving the /CrV/ consonant cluster ("crequi", "criqui", "frequi", and "fruqui"). Although no svarabhakti element was perceived in these cases, the most frequently selected incorrect answers corresponded to Hypothesis 2. This phenomenon was also reported by Dupoux et al. (1999); Japanese tend to perceive an illusory epenthetic [u] within consonant clusters. This finding suggests that the svarabhakti element is probably not important in terms of perception among Japanese students because regardless of its presence, they almost always perceive /u/ within Spanish /CCV/ consonant clusters when they are wrong.

4.4 General discussion

What do Japanese perceive within Spanish consonant clusters when they cannot select the correct phoneme continuum? The most frequently selected answer in almost every case was "u", which is indistinguishable when written in *katakana*. As it were, Hypothesis 1—Japanese perceive the svarabhakti element within /CCV/ consonant clusters, so they select the choice influenced by its characteristics—was not proven, and Hypothesis 2—Japanese confuse /CCV/ with /CVCV/, which is indistinguishable when written in *katakana*—was proven in

the present study.

According to Kubozono (1997:17), "Native Japanese speakers divide words into *mora*[xiv] and count the length of words by the number of *moras*"[xv]; this helps explain our results. Furthermore, the results of the present study support those of Dupoux et al. (1999). We know that in Japanese, closed syllables are rarely permitted, and thus epenthesis is one of the primary strategies used by Japanese students to utter consonant clusters. The results of the present investigation clearly proved not only the utterance, but also the perception of this phenomenon. The phoneme continuum in Spanish /CCV/ consonant clusters is only one syllable, but Japanese students have to divide it into two *moras*, and this is the reason why they confuse /CCV/ as /CVCV/, which is in fact two *moras*. Owing to this isochronism in Japanese *mora*, Japanese perceive two words having a different number of syllables but the same number of *moras* and the same length. On the other hand, according to Iribarren (2005:34-35), Spanish has a syllable-timed rhythm and a sentence length that depends on the number of syllables[xvi]. Therefore, theoretically, Spanish /CVCV/ clusters have to be uttered at double the length of /CCV/ clusters because /CVCV/ clusters have two syllables while /CCV/ only have one. However, for Japanese students, /CCV/ clusters are as long as /CVCV/ clusters because they both have two *moras*. This explains our results that the existence or the length of the svarabhakti element was irrelevant.

The results were contrary to our expectations, which were that /o/ would be selected as epenthesis within C_1 and C_2 when C_1 was /t, d/ after a dental stop, and that /u/ would be selected more frequently in the cases of "triqui", "truqui", "draqui", and "driqui". To explain these findings, we suggest two possibilities. The first is an exception previously noted by Kubozono (2002:83): "The English word 'tree' is pronounced with an epenthetic [u], i.e., [tsuri:], *[tori:]". The second possibility is that we could be in a transitional period regarding the choice of epenthesis in loanword expression. The reason for this remains unclear; however, previously, /i/ was borrowed after /k/, whereas currently, /u/ is chosen. In this way, it could be possible that /u/ will be chosen more frequently than /o/ after a dental stop in the future[xvii].

5. Conclusions

In this study, Japanese students had a markedly high degree of difficulty distinguishing between Spanish phoneme continuums such as /CCV/ and /CVCV/ consonant clusters. Therefore, we investigated what actually they perceive within the /CCV/ consonant cluster.

We hypothesized that Japanese students would catch some characteristics of the svarabhakti element within the /CrV/ consonant cluster (Hypothesis 1) and that Japanese students would confuse /CCV/ as /CVCV/ because they are indistinguishable when written in *katakana* (Hypothesis 2). It was evident that the students' perceptions were not affected by the svarabhakti element. In addition, Hypothesis 2, but not Hypothesis 1, was supported by statistically significant results showing that Japanese students perceive /u/ within Spanish /CCV/ consonant clusters, even if the first consonant is a dental stop. These results suggest that when Japanese students listen to a foreign language, they cannot help but assess the length of the cluster by the rhythm of the *mora*, which is exclusive to the Japanese phoneme system.

Notes

[i] Historically, in Japanese, only the CV syllable structure has been allowed. As a result of borrowing Chinese words and loanwords from other foreign languages, Japanese also accepts closed syllables such as VC and CVC. However, the number of closed syllables allowed by modern Japanese is very limited, accounting for only about 10% of the total (Kubozono 1998; Kimura 2006).

[ii] About 70% of syllables in Spanish are open syllables (Callenada & Madsen 1987; Dauer 1983).

[iii] For example, "プレ" is the only way to express the /pre/ and /pure/ sounds in *katakana*. When Japanese see "プレ", there is no way to know whether the original sound was /pre/ or /pure/.

[iv] This is a vowel-like element produced within the consonant clusters when native Spanish speakers pronounce a phoneme continuum consisting of a plosive (/p, b, t, d, k, g/) or a labiodental fricative (/f/) + tap (/r/). According to Quilis (2006:337-338, 1988:296), in 1892 Rodolfo Lenz reported that this phenomenon had been observed among educated Chileans. After that, it was referenced by Navarro (1918:385-386), Gili (1921:274), Malmberg (1965:31-39) and others. Rico (2012:85) acknowledges its physical existence, but mentions that native Spanish speakers do not hear it.

[v] We found the svarabhakti element in 31 of 35 cases; it was not found in "crequi", "criqui", "frequi" nor "fruqui" (Matsumoto 2014).

[vi] This and words such as correct, incorrect, etc., used in this paper do not mean acoustical correctness, but rather correspondence between the spelling and the utterance of the speaker on recording.

[vii] This condition will be explained in the next section.

[viii] All 30 participants answered more than 68 of the 120 stimuli correctly. Comparing the number of correct and incorrect answers for all 120 questions, 68 was significant (p=.085; direct probability calculation, one-sided). All statistical analyses in this paper were performed using js-STAR 2012.

[ix] Yamada (1998:21) stated: "it is not generally agreed that /tl/ is a consonant cluster". Therefore, in this paper, we do not consider /tl/ a consonant cluster.

[x] We hypothesize that Japanese students select /u/ within C_1 and C_2 when C_1 is /p, b, f, k, g/ and /o/ when C_1 is /t, d/ following the custom of loanwords in Japanese from a foreign language (Kubozono 2002).

[xi] This was carried out on a floor that was not holding any other classes, and the recording was carried out while checking the waveforms to ensure that there were no other noises.

[xii] With a 44.1-kHz sampling rate and 16-bit quantization.

[xiii] We are unsure where Carbonell got the length of 27 ms.

[xiv] *Mora* is a concept used to express a peculiar Japanese unit of length. It has a kind of syllable-timed rhythm, but different, and every *kana* should be uttered because each *kana* has an isochronism.

[xv] All translations in this paper were done by the author.

[xvi] However, Lahoz (2012:105-109) mentions that in every language, various rhythm patterns can be seen, so it is not appropriate to divide language into two traditional rhythm groups such as syllable-timed rhythm and stress-timed rhythm.

[xvii] Actually, *el Diccionario de bolsillo Español-Japonés, Japonés-Español* adopts a /u/ after a dental stop.

Appendix A

Part of the answer sheet

1	craqui – caraqui – queraqui – quiraqui – coraqui – curaqui
2	floqui – faloqui – feloqui – filoqui – foloqui – fuloqui
3	frequi – farequi – ferequi – firequi – forequi – furequi
4	fliqui – faliqui – feliqui – filiqui – foliqui – fuliqui
5	pluqui – paluqui – peluqui – piluqui – poluqui – puluqui
⋮	⋮

Appendix B

Results of /ClV/

claqui					
Ø	a	e	i	o	u
23	0	2	1	0	4

blaqui					
Ø	a	e	i	o	u
23	0	1	0	0	6

plaqui					
Ø	a	e	i	o	u
27	0	0	0	0	3

glaqui					
Ø	a	e	i	o	u
23	0	1	0	0	6

flaqui					
Ø	a	e	i	o	u
21	0	0	0	0	9

clequi *					
Ø	a	e	i	o	u
13	0	2	2	0	12

blequi					
Ø	a	e	i	o	u
27	0	0	0	0	3

plequi					
Ø	a	e	i	o	u
17	0	0	0	0	13

glequi					
Ø	a	e	i	o	u
11	0	2	0	1	16

flequi					
Ø	a	e	i	o	u
26	0	0	1	0	3

cliqui					
Ø	a	e	i	o	u
19	0	2	4	0	5

bliqui					
Ø	a	e	i	o	u
20	0	0	3	0	7

pliqui					
Ø	a	e	i	o	u
13	0	0	11	0	6

gliqui					
Ø	a	e	i	o	u
20	0	0	0	0	10

fliqui					
Ø	a	e	i	o	u
22	0	0	0	0	8

cloqui					
Ø	a	e	i	o	u
14	1	1	0	2	12

bloqui					
Ø	a	e	i	o	u
15	0	0	0	2	13

ploqui					
Ø	a	e	i	o	u
21	0	1	1	0	6

gloqui					
Ø	a	e	i	o	u
19	0	0	0	0	11

floqui					
Ø	a	e	i	o	u
14	0	2	1	2	11

cluqui					
Ø	a	e	i	o	u
16	0	1	2	2	8

bluqui					
Ø	a	e	i	o	u
18	0	0	0	0	12

pluqui					
Ø	a	e	i	o	u
20	0	0	1	0	9

gluqui					
Ø	a	e	i	o	u
19	0	0	0	1	10

fluqui					
Ø	a	e	i	o	u
19	0	0	1	2	8

***** There was an unanswered subject in spite of force judgment.

Appendix C

Results of /CrV/

craqui					
Ø	a	e	i	o	**u**
19	1	3	1	0	**6**

braqui					
Ø	a	e	i	o	**u**
26	0	0	0	0	**4**

draqui					
Ø	a	e	i	**o**	u
21	1	1	0	**0**	7

praqui					
Ø	a	e	i	o	**u**
23	0	1	0	0	**6**

crequi					
Ø	a	e	i	o	**u**
19	0	1	0	0	**10**

brequi					
Ø	a	e	i	o	**u**
23	0	1	0	0	**6**

drequi					
Ø	a	e	i	**o**	u
24	0	0	0	**3**	3

prequi					
Ø	a	e	i	o	**u**
20	0	0	1	0	**9**

criqui					
Ø	a	e	i	o	**u**
22	0	0	4	0	**4**

briqui					
Ø	a	e	i	o	**u**
24	0	0	1	1	**4**

driqui					
Ø	a	e	i	**o**	u
21	0	1	2	**0**	6

priqui					
Ø	a	e	i	o	**u**
25	0	0	2	0	**3**

croqui					
Ø	a	e	i	o	**u**
16	0	1	0	1	**12**

broqui					
Ø	a	e	i	o	**u**
24	0	0	0	0	**6**

droqui					
Ø	a	e	i	**o**	u
18	0	0	0	**8**	4

proqui					
Ø	a	e	i	o	**u**
25	0	0	0	0	**5**

cruqui					
Ø	a	e	i	o	**u**
19	0	0	0	1	**10**

bruqui					
Ø	a	e	i	o	**u**
24	0	0	0	0	**6**

druqui					
Ø	a	e	i	**o**	u
22	0	0	0	**4**	4

pruqui					
Ø	a	e	i	o	**u**
30	0	0	0	0	**0**

graqui					
Ø	a	e	i	o	**u**
25	1	0	0	0	**4**

fraqui					
Ø	a	e	i	o	**u**
21	0	0	0	0	**9**

traqui					
Ø	a	e	i	**o**	u
22	0	0	0	**7**	1

grequi					
Ø	a	e	i	o	**u**
20	0	0	0	0	**10**

frequi					
Ø	a	e	i	o	**u**
14	1	5	2	1	**7**

trequi					
Ø	a	e	i	**o**	u
27	0	1	0	**2**	0

griqui					
Ø	a	e	i	o	**u**
21	0	0	1	0	**8**

friqui					
Ø	a	e	i	o	**u**
23	0	0	0	0	**7**

triqui					
Ø	a	e	i	**o**	u
29	0	0	0	**0**	1

groqui					
Ø	a	e	i	o	**u**
7	0	0	0	5	**18**

froqui					
Ø	a	e	i	o	**u**
20	0	0	1	1	**8**

troqui					
Ø	a	e	i	**o**	u
24	0	0	0	**6**	0

gruqui					
Ø	a	e	i	o	**u**
17	0	0	0	0	**13**

fruqui					
Ø	a	e	i	o	**u**
16	1	0	0	0	**13**

truqui					
Ø	a	e	i	**o**	u
22	0	0	0	**1**	7

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