Do Japanese ESL learners' pronunciation errors come from inability to articulate or misconceptions about target sounds?

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This paper aims to examine whether Japanese English-as-a-Second-Language (ESL) learners' pronunciation errors are due to their inability to articulate, or to misunderstandings of target phonemes and the English phonological system. Four Japanese ESL learners read an English passage and some particular segments were analyzed for errors. After the analysis, each participant was interviewed about the errors. Results showed that the participants often purposely pronounced the same phoneme written with the same alphabet letter differently. For example, <v> in "gave" and that in "traveler" were misunderstood to be different phonemes. On the other hand, different phonemes spelled with different alphabet letters were often purposely pronounced the same. For example, <ar> in "hard" and <ir> in "first" were misunderstood to be the same phoneme. In addition, participants did not understand the whole picture of the English phonological inventory. I argue that the participants' mispronunciations are often due to the fact that they reportedly had not yet been taught basic English symbol–sound correspondence rules, not necessarily due to their inability to produce particular sounds. Since letter knowledge precedes phoneme awareness, the participants were not quite aware of English phonemes. If Japanese ESL learners in general adopt the same behaviour, pronunciation lessons need to pay more attention to Japanese ESL learners' understanding of the basic English phonological system, not only to what learners actually produce.

1 Introduction

This paper examines second language (L2) learners' understandings of the phonological system of a target language at the segmental level. The motivation of this study comes from the author's speculation that pronunciation errors by L2 learners are not necessarily errors, but instead may result from learners' own interpretations of L2 phonology due to learners' language backgrounds in which they have not yet been taught the phonological system of their target language. For example, if a Japanese English-as-a-Second-Language (ESL) learner

mispronounces "change" as [tʃɛndʒ][1] when it is supposed to be pronounced as [tʃendʒ], it would be careless to immediately conclude that the learner has difficulty in the distinction between the tense vowel [e], as in "pain," and the lax vowel [ɛ], as in "pen," because the learner's first language (L1) does not have this tense and lax distinction. There is a possibility that the learner has not yet been taught the basics of the English vowel system, and the learner misunderstands that "change" is supposed to be pronounced as [tʃɛndʒ]. If this is the case, the learner has yet to attempt to pronounce "change" as [tʃendʒ], and there is no way to know whether the learner has difficulty with [e]. Once the learner has been taught to pronounce "change" as [tʃendʒ], the learner might produce it without difficulty. Apparently, in the area of L2 pronunciation, analyses of learners' understandings of L2 phonology are less common than phonetic or phonological analyses of what learners actually pronounce. To address this gap in the research, this paper examines whether Japanese ESL learners have proper knowledge of English sounds when they commit pronunciation errors.

2 Background

2.1 Literature review

L2 learners' pronunciation errors are caused by factors other than difficulty in production. One possible factor is cognitive skills. For example, according to a finding of Fraser's (in press) study of /l/ and /ɹ/ distinction by Asian ESL learners, the participants produced these sounds without much difficulty, despite the fact that participants were unaware that /l/ and /ɹ/ were two different phonemes, which change lexical meaning in English.

Another possibility is what Richards (1971) called "false concepts" and what Stenson (1974) termed "induced errors" (as cited in Brown, 2007). These are errors caused by misleading teaching. In fact, Suarez and Tanaka's study (2001) with 88 Japanese college students found that 40% of the students claimed that their pronunciation problems came from a lack of pronunciation instruction in their six years of English curriculum in junior and senior high school. Another 24% felt psychological barriers had hampered correct pronunciation: when students try to pronounce English accurately, they are afraid of being teased or they feel embarrassed. From a teacher's perspective, according to Muroi's (2005) observation in Summer Teacher Training, about 30% of the Japanese teachers of English answered that they had never taught pronunciation to their students.

[1] Phonemic transcriptions of English vowels in this paper are based on "American English "R-Colored" Vowels as Complex Segments" Green (2001).

More specifically, Avery & Ehrlich (2003) explained an example of induced errors. They suggest that many mispronunciations by Portuguese speakers come from the influence of the Portuguese spelling system rather than from difficulty producing particular sounds; teachers with Portuguese students often familiarize themselves with the Portuguese spelling system. According to Bayraktaroğlu (2008), in terms of L2 learners' pronunciation errors, L1 orthographic interference and L1 phonological interference are completely different; the former is differences of one-to-one letter–sound correspondence between L1 and L2, while the latter is differences in the sound systems. The Japanese writing system has *Romaji*, Japanese Romanization, in which the symbol–sound correspondence rules are quite different from those in English in many respects. If Japanese learners of English familiarize themselves with the sound–spelling correspondences of Japanese Romanization similar to Portuguese learners of English, then their pronunciation errors may be a result of orthographic influence.

Moreover, L2 learners may need orthographic knowledge of the target language in order to understand its phonological system. Siegel and Wade-Woolley (1997) stated that phonological processing and literacy are strongly related. According to Carroll's (2004) study about first language (L1) acquisition, letter knowledge precedes phoneme awareness; letter learning helps children learn to separate phonemes from phonetic contexts and identify the same phoneme in different words. As well, according to Cook (2004), English speakers may understand that an alphabet character corresponds to an individual phoneme. When the number of alphabet characters and the number of phonemes do not match, for example "month" (five characters) and /mʌnθ/ (four phonemes), adult English speakers try to reconcile the contradictions in information, which results in difficulties in identifying the number of phonemes in the words (C. Pytlyk, in-class presentation). Furthermore, Goble (2002) revealed that his participants, Japanese college students, astonishingly lacked awareness that English loanwords in Japanese and their English counterparts are different entities, and the students' pronunciation and spelling errors showed an inordinate amount of loanword influence. Since Japanese has many loanwords from English, Japanese ESL learners' mispronunciations may come from loanword interference, rather than an inability to articulate. If Japanese ESL learners are not taught the English spelling system, they might be deficient in phonological awareness in English as well. It is worth examining this possibility.

2.2 Research questions

The present study is designed to address the following two questions:

1) When Japanese ESL learners make pronunciation errors, do they try to pronounce target sounds but fail to articulate the targets, or do they misunderstand or not know the target sounds to begin with? I specifically examine some segmental errors, namely the consonants /θ/, /ð/, /v/, /l/, /ɹ/, /f/, /h/, the distinctions between /s/ and /ʃ/, /t/ and /tʃ/, and /d/ and /dʒ/ before high front vowels, and the vowels /æ/, /ɛ/ and /e/.[2]

2) If Japanese ESL learners do not have knowledge of target sounds, what lessons do they need to understand target sounds properly?

3 Methods

3.1 Participants

There were four participants, labelled as P1, P2, P3 and P4. They were all Japanese ESL learners in British Columbia, Canada. Like the majority of Japanese people, all of the participants had studied English in junior and senior high school for six years. All of them claimed that they were not confident with their pronunciation, nor could they read the International Phonetic Alphabet (IPA), except P4, who was trying to learn the IPA on her own. P1 had been taught English by her mother who spoke British English, so P1's pronunciation might have been influenced by this exposure to the British accent. P1 was working, P2 was in a lower-intermediate class, and P3 and P4 were in an intermediate English class in an ESL school. Table 1 summarizes a number of the participants' traits.

Table 1. Summary of participant characteristics. Nb: Kansai= Osaka and Kyoto area. Kanto= the area around Tokyo.

	P1	P2	P3	P4
Age:	33	28	20	19
Gender:	F	F	F	F
Length of residence in Canada:	3 years	5 months	5 months	5 months
Home region in Japan:	Kansai	Kanto	Kanto	Kansai

[2] These segments are often considered problematic sounds for Japanese ESL learners (Avery et al, 2003; Ohata, 2004; Taniguchi, 2009).

3.2 Stimulus and procedure

The experiment took place over two days. On the first day, the participants read an English passage and Japanese nonsense words, and were asked to complete four phonemic contrast identification tasks. After their recordings were analyzed, I later talked to each participant individually about the results of the analysis. On the first day, the participants read the English passage, "The North Wind and the Sun" from the *Handbook of the International Phonetic Association* (p.44) (reproduced in the Appendix).

This reading task is designed to examine how participants interpret the segments mentioned in the research question 1. This story is familiar to many Japanese speakers and I expected that the participants would feel more comfortable with a familiar story than an unknown story. As well, this passage is commonly used in phonetic demonstrations. I handed the participants a sheet of paper with the passage on it a few minutes before recording, so they did not have time to ask native speakers about pronunciation or to check a dictionary. However, I taught them the sounds and meanings of presumably new words, such as "oblige" and "cloak." After practicing a couple of times, they were recorded. Recording was done in the Phonetics Lab at University of Victoria with a Luna 1.1 inch large diaphram condenser microphone, M-Audio Firewire 410, with PRAAT set to 44100 Hz.

Participants also recorded 10 nonsense Japanese words written with the Katakana syllabary. Table 2 shows the stimuli words presented to each participant. Some segments mentioned in Research Question 1, such as /l/ and /ɹ/, are obviously not distinctive phonemes in Japanese. Conversely, the contrasts in Table 2 are sometimes considered problematic (Avery & Ehrlich, 2003; Ohata, 2004) although these contrasts are also sometimes considered to exist in Japanese (Matsuzki, 1993; Inozuka, 2009). This task was designed to ascertain whether Japanese ESL learners have to articulatorily practice the distinctions between /s/ and /ʃ/, /t/ and /tʃ/, and /d/ and /dʒ/ before high front vowels, and the distinction between /ɛ/ and /e/, or if Japanese ESL learners can economically utilize L1 distinctions for these L2 distinctions.

Table 2. The 10 nonsense Japanese stimulus words. Nb: In Japanese [ti] and [tʃi] are distinctive, and so are [di] and [(d)ʒi] (Matsuzaki, 1993). Whether [ʃi] and [si] are distinctive is debatable; I argue that it depends on lexical classes.

ティー	[tiː]	チー	[tʃiː][3]		
ディー	[diː]	ジー	[(d)ʒiː]	ズィー	[(d)ziː][4]
シー	[ʃiː]	スィー	[siː]		
ベタ	[beta]	ベータ	[beːta]	ベイタ	[beita]

The words were aligned in this order on the sheet from which the participants read. They were asked to pronounce the words in a natural Japanese way. Since Japanese has phonemic pitch patterns,[5] which are not shown with regular orthography, most of the participants asked me about what pitch pattern they should use. Then, I answered that they could use whichever they felt was natural.

Participants also completed four phonemic contrast identification tasks. They were shown the homophones and minimal pairs in Table 3 and were asked to identify whether the words in each pair were the same or different in pronunciation. They were also asked to identify the difference between any two words they felt were not homophones. For example, I asked, "Do you know whether 'meat' and 'meet' are the same or different in pronunciation?" If participants confidently answered, "Yes, they are the same," I gave them a credit. If they showed uncertainty, "Um, I'm not sure. Maybe the same?" I did not give them a credit even if the answer was right as this may have been accidentally correct. The purpose of these tasks was to examine their L2 phonological and orthographic awareness in general. Since this task did not involve production, I could focus my investigation on the participants' understanding. The reason I chose these pairs is that each pair of words would likely be pronounced in the same way by Japanese speakers as a result of loanword adaptation processes. I tried to examine whether the participants could identify the phonemic structure of each word without being distracted by Japanese loanword adaptation.

[3] The transcription of the Japanese voiceless lamino-alveolo-palatal fricatives vary between [ʃ] and [ɕ] for the voiceless one, and between [ʒ] and [ʑ] for the voiced one (Pan, Utsugi and Yamazaki 2004). In this paper, I use [ʃ] and [ʒ] in order to be consistent with the English counterparts.

[4] In Japanese [dʒ] and [ʒ] are allophonic variations of one phoneme, and so are [dz] and [z] (Inozuka & Inozuka, 2009).

[5] Japanese is known as a pitch accent language in which pitch is the primary indicator of accent (stress) (Avery & Ehrlich, 2003).

Table 3. Phonemic contrast identification tasks

"meat"	versus	"meet"
"ear"	versus	"year"
"bone"	versus	"born"
"who'd"	versus	"food"

On the second day, I conducted semi-structured interviews with each participant in their L1, Japanese. Each interview lasted 30 to 40 minutes. I mainly asked participants what sound they actually tried to pronounce. This interview was designed to examine whether the participants' pronunciation errors were due to *mis-articulation of intended target* or *misunderstanding of target*. I used this method in order to best ascertain each participant's understanding in a straightforward manner. Below are examples of the questions:

- "Did you try to pronounce [θ] in 'north'?"
- "Did you try to pronounce [v] in 'gave,' 'of,' and 'traveler'?""
- "You pronounced [v] in 'gave' but pronounced [b] in 'of.' Can you come up with any reason?"
- "You said you did not try to distinguish /l/ and /ɹ/, and in fact you mostly did not. However, you pronounced native-like [ɹ] in 'wrap.' Can you come up with any reason?"

Below are examples of participants' answers:

- "Yes, I tried to pronounce [θ] to distinguish it from [s]."
- "No, I didn't put any extra effort into /θ/ and just pronounced [s] just as Japanese speakers commonly do."

When a participant mispronounced /θ/ as [s] and answered that she tried to pronounce [θ], her error was analyzed as mis-articulation of the intended target. When a participant mispronounced /θ/ as [s] and answered that she intended to pronounce [s], her error was analyzed as misunderstanding of target.

3.3 Analysis of the recordings

The transcribers were a phonetically trained native speaker of North American English and myself, a native Japanese speaker and trained phonetician. For the English data, the transcription was based on whether or not they produced the target phoneme; if a segment produced by a participant was obviously accented but was still easy to understand, it was considered correct. If a participant's production sounded like a different phoneme or was difficult to be categorized as any English phoneme, we transcribed what they actually pronounced. For the Japanese data, the transcribers judged what English phonemes could be represented by their productions.

4 Results and discussion

Overall, in terms of English phonemes that are generally considered problematic for Japanese ESL learners, participants quite often intended to pronounce different sounds. In other words, their mispronunciations often came from their understanding of what phonemes they were supposed to produce. More interestingly, the participants' own interpretations of English phonology varied much more than I expected from sound to sound, from word to word, and from individual to individual. Below are the details of each phoneme.

4.1 Results for /θ/

There are four occurrences of /θ/ in the passage, all of which are in the word "north." All the participants realized /θ/ as [s]. However, what is important in this paper is not the productions themselves, but whether the participants knew that the target was /θ/. For example, if P1 misunderstood that the target was /s/, instead of /θ/, she actually did not attempt to pronounce [θ]. In this case, I would conclude that she tried to pronounce [s] four times and successfully produced it four times. Consequently, what a teacher would then want to consider is teaching the proper target phoneme as it is identified orthographically, rather than articulation of [θ]. Therefore, I asked the participants if they knew that the target was /θ/, or if they intended to pronounce the dental fricative [θ].

- P1 reported she had never tried to pronounce [θ] although she knew that /θ/ and /s/ should be different. Therefore, she actually intended to pronounce [s] and she successfully produced what she was aiming to produce. In this case, there is no way to know if she was able to produce [θ] at the time of the recording because she had not attempted it.
- P2 reported she knew that the target was /θ/ and tried to pronounce it.
- P3 reported she knew that the letters <th> sounded different from the letter <s>, but she was more influenced by the English loanword in Japanese "ノース" [noːsɯ], which means "north." Since her underlying representation was /noːsɯ/, but not /nɔɹθ/, there is no way to examine if she was able to produce [θ] in this experiment.
- P4: Like P2, P4 reportedly tried to pronounce [θ].

The table below shows how many times the participants intended to produce the target phoneme and how many times they did so. Since P1 and P3 did not intend to pronounce [θ], the number of "Intended" is 0.

Table 4. Results for /θ/. Nb: "Occurrences: *T*"= The total occurrences in the passage; "Occurrences: Int"= How many times the participants intended to pronounce the target sound; "Correct: Int"= The number of correct productions when the participants intended to pronounce the target; "Correct: Acc"= The number of accidentally correct productions.

Target: /θ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	4	0	0	0	[s]: 4
P2	4	4	0	0	[s]: 4
P3	4	0	0	0	[s]: 4
P4	4	4	0	0	[s]: 4

4.2 Results for /ð/

There are 23 occurrences of /ð/ in the passage. The following summarizes participants' comments.

- P1: Just like [θ], she had never tried to pronounce [ð] and always realized it as the Japanese /z/ although she knew that /ð/ was not the Japanese /z/. In fact, she pronounced both [dz] and [z], which are allophonic variations of the Japanese /z/.
- P2 reported that targets were different from /z/ because the target was spelled as <th>, but not <z>. She said that she tried to distinguish between /ð/ and /z/ although she was not quite sure of the sound quality of /ð/. In fact, all of her /z/s were consistently pronounced as [z] or a somewhat devoiced [z]; she pronounced [ð] five times. She also pronounced the dental stop [d̪] nine times, which was close to the target /ð/ but was categorized as /d/. In fact, since the combination of phonological features [+continuant] and [−sonorant] is relatively difficult, stopping or affricating a fricative such as /ð/ to [d] is common in child language (Bernhardt & Stemberger, 1998).
- P3 reported definitely trying to distinguish between /ð/ and /z/. Moreover, she was aware that when function words, such as "the," "that" and "than" were followed by a difficult word in pronunciation, such as "traveler," she ignored the correct pronunciation of [ð] in order to concentrate her effort on the next word. Therefore, like P2, she understood the target correctly and she was aware of her errors.
- P4: Like P3, P4 reported trying to distinguish between /ð/ and /z/, which means she understood the target correctly. The big difference from P3 is

that she did not quite realize her production was not [ð], but its characteristic was much like the Japanese /z/.

Incidentally, all the participants did not know the cross-linguistic phonetic difference of /z/ between English and Japanese; the default form of J/z/ is the affricate [dz] (Grenon, 2008). Nevertheless, P1 produced the pure fricative [z] more often than [dz]. I will mention this phonetic issue in §4.13.

The table below shows how many times the target actually occurs in the passage, how many times the participants intended to produce the proper target, how many times the participants correctly pronounced the target when intending to do so, and how many times the participants accidentally pronounced the target. Also summarized are the incorrectly pronounced sounds of each participant. Since P4 missed the word "the" in the passage on one occasion, her occurrences were counted as 22. The question mark beside the number in the column of "Occurrences: Intended" means that the participant was not sure if she really intended to pronounce the target.

Table 5. Results for /ð/; Int= intended, Acc= accidental. Nb: In Japanese, [dz] and [z] are allophonic variations of the phoneme /z/ (J/z/) (Tsuzuki, 1996; Grenon, 2008; Vance, 2008; Inozuka and Inozuka, 2009). [d̪] is more dental than [d]. "?" indicates that the participants themselves were not really sure if they were aware of the target sounds.

Target: /ð/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	23	0	0	0	[z]: 20 [dz]: 3
P2	23	23?	5	0	[d̪]: 9 [dz]: 7 [z]: 2
P3	23	23	4	0	[d̪]: 8 [dz]: 8 [z]: 3
P4	22	22	0	0	[dz]: 11 [z]: 11 [ts]: 1

4.3 Results for /v/

There are six occurrences of /v/ in the passage: "gave," "of," and four occurences of "traveler."

- P1 reported she did not distinguish between /v/ and /b/, and substituted /v/ with the Japanese /b/. In fact, she pronounced both [β] and [b], which are allophonic variations of the Japanese /b/. Her /v/ in "of" sounded like [v], but it was actually the weakened version of /b/,[6] suggesting she accidentally hit the target.

[6] [β], [b] and [v] are all allophonic variations of /b/ in Japanese (Inozuka et al., 2009).

- P2: Due to having learned “gave” and “of” in Japan, P2 incorrectly memorized that “gave” and “of” were [geib(ɯ)] and [ob(ɯ)] respectively. Therefore, she misunderstood that the target sound was /b/, instead of /v/. As for “traveler,” she reportedly knew that there was [v], but she ignored the correct pronunciation of [v] in order to concentrate her effort on [l] and [ɹ].
- P3: As for “traveler” and “of”, she misunderstood that /v/ in these words was /b/. She explained that since she quite frequently used the word “traveler” in her conversation in Canada, she made up her own way to pronounce it. As for “of,” just like P2, she was not aware that “of” has a [v]. She pronounced [v] in one of the occasions of “traveler” but it was actually the weakened version of /b/, similar to P1. As for “gave,” she tried to pronounce [v] and successfully pronounced it. Therefore, she got one correct [v] out of one attempt.
- P4 reported possibly trying to pronounce [v] in “gave.” However, she actually pronounced this with a [b]. As for “traveler” and “of,” she consciously used the Japanese /b/. She mentioned that she concentrated too much on [l] and [ɹ] in “traveler” and could not afford to think about [v], just like P2.

Most of the time, the errors regarding /v/ were due to inappropriate intentions, rather than production problems. Only one instance, by P3, was appropriately intended and correctly produced.

Table 6. Results for /v/; Int= intended, Acc= accidental. Nb: “?” indicates that the participants were not really sure if they were aware of the target sounds.

Target: /v/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	6	0	0	1	[β]: 3 [b]: 2
P2	6	0	0	0	[β]: 5 [b]: 1
P3	6	1	1	1	[β]: 4
P4	6	1?	0	0	[β]: 5 [b]: 1

4.4 Results for /l/ and /ɹ/ in onset position

Japanese ESL learners often spend much time attempting to acquire the contrast between the North American English /l/ and /ɹ/ (E/l/ and E/ɹ/) because Japanese has only one liquid, /ɾ/, that can appear as [l] and even [ɹ] allophonically or in quasi-free variation (Magnuson, 2008). This distinction is so extensively studied that I put /l/ and /ɹ/ in the same section. From the point of view of this study, I

will give more credit to the participants who tried to distinguish between them but did not quite hit the target than to those who did not try to distinguish between them but accidentally hit the target. In examining whether the participants' attempts to distinguish /l/ and /ɹ/ affected the sound quality, I categorized their productions along two parameters following Magnuson (2008): *rhoticity versus laterality* and *central oral stricture*.[7] In this scheme, [l] is lateral and narrow while [ɹ] is rhotic and open.

There are 17 occurrences of /l/ in onset position, including consonant clusters, and 10 occurrences of /ɹ/ in onset position, including consonant clusters.

- P1 reported not trying to distinguish between /l/ and /ɹ/ in onset position at all. In fact, she almost consistently used rhotic liquid for both /l/ and /ɹ/. Interestingly, according to Magnuson (2008), J/ɾ/ is most commonly realized as a raised alveolar flap, but P1 pronounced [ɹ] much more often than a flap. The study by Akahane-Yamada, Aoyama, Fledge, Guion and Yamada (2004) showed that Japanese ESL learners more successfully acquire E/ɹ/ than E/l/ because the difference between E/ɹ/ and J/ɾ/ is perceptually more salient than the difference between E/l/ and J/ɾ/. In this way, P1 acquired E/ɹ/ and over-generalized it for /l/.
- P2 reported trying to distinguish between E/l/ and /ɹ/. In fact, she quite consistently pronounced more rhotic and open sounds, namely [ɹ] and [ɻ], for /ɹ/ while pronouncing lateral and narrow sounds, namely [l] and [ɭ], for /l/.
- P3 reported knowing that /l/ and /ɹ/ were supposed to be distinguished; however, she abandoned this contrast in her inter-language due to her low self confidence. In fact, she almost uniformly used rhotic and open sounds, namely [ɹ] and [ɻ], and the flap [ɾ] for both /l/ and /ɹ/. Interestingly, she pronounced an accurate [ɹ] in "wrap". However, she mentioned that the <w> in the spelling of "wrap" encouraged her to round her lips, which accidentally resulted in quite native-like [ɹ]. She was sure that she would pronounce the homophone "rap" with flap [ɾ]. Therefore, her [ɹ] was actually an accidental production caused by her misconception of the spelling and English phonotactics[8] where the sequence of /*wɹ/ at word-initial is not allowed.
- P4: Like P2, P4 said that she tried to distinguish between E/l/ and /ɹ/. In fact, she more successfully distinguished /l/ from /ɹ/ than P1 and P3. She pronounced [ɹ] better in "traveler" and "agree" than other words. She mentioned that she more frequently used the words "travel" and "agree"

[7] "Rhoticity" is "[ɹ]-like quality," while "laterality" is "[l]-like quality." "Central oral stricture" is how narrow or wide the space in the oral cavity is (Magnuson, 2008).

[8] Phonotactics deals with restrictions in a particular language on the permissible combinations of phonemes.

than “strong” or “around,” and she felt more comfortable pronouncing [ɹ] in familiar words.

Interestingly, P1 and P3, who did not try to distinguish /l/ from /ɹ/, performed notably worse with /l/ than P2 and P4, who tried to distinguish these. Conversely, P1 and P3 performed quite well with /ɹ/. Akahane-Yamada et al.’s finding that Japanese ESL learners acquire [ɹ] earlier than [l] might apply only to those who do not intend to distinguish /l/ from /ɹ/. Once they try, they might acquire [l] earlier than [ɹ] because [l] is less marked than [ɹ]. Moreover, English speaking children typically acquire [l] earlier than [ɹ] (Vihman, 1996).

Table 7. Results for /l/ in onset position; Int= intended, Acc= accidental. Nb: Ø= no consonant; [l] = the alveolar lateral; [ɺ] = the alveolar lateral flap; [ɾ] = the alveolar flap; [r] = the alveolar trill; [ɻ] = the lowered flap (the tongue does not quite touch the roof of the mouth); [ɹ] = the alveolar rhotic approximant.[9]

Target: /l/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	17	0	0	2	[ɹ]: 8 [ɾ]: 2 [ɻ]: 2 [ɺ]: 1 Ø: 2
P2	17	17	13	0	[ɺ]: 3 [ɻ]: 1
P3	17	0	0	1	[ɻ]: 6 [ɹ]: 5 [ɾ]: 5
P4	17	17	12	0	[ɾ]: 3 [r]: 2

Table 8. Results for /ɹ/ in onset position; Int= intended, Acc= accidental.

Target: /ɹ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	10	0?	0	9	[ɾ]: 1
P2	10	10	6	0	[ɾ]: 3 [ɻ]: 1
P3	10	0	0	4	[ɾ]: 4 [ɻ]: 2
P4	10	10	5	0	[ɾ]: 5

[9] According to the studies by Tsuzuki (1996), Magnuson (2008), and Inozuka et al. (2009), all of these sounds are possible allophones of J/ɾ/.

4.5 Results for velarized /l/ in coda position

- P1 reported not thinking about the difference between /l/ and /ɹ/ at all, so her correct production is considered to be accidental.
- P2 reported attempting to pronounce [l] but did not pronounce it successfully.
- P3 reported not attempting to distinguish between /l/ and /ɹ/. Just like onset position, she used the rhotic sound [ɹ] for /l/.
- P4 tried to pronounce [l] but actually produced [ɾ], which is neither rhotic nor lateral (Magnuson, 2008).

All in all, their realizations of /l/ in coda position seems the same as those in onset position; however, both P2 and P4 failed to pronounce [l].

Table 9. Results for velarized /l/ in coda position/; Int= intended, Acc= accidental, Ø= no consonant.

Target: /l/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	1	0	0	1	
P2	1	1	0	0	Ø: 1
P3	1	0	0	0	[ɹ]: 1
P4	1	1	0	0	[ɾ]: 1

4.6 Results for /ɹ/ in coda position

/ɹ/ occurs 20 times in coda position. I divided them into three smaller groups based on the preceding vowel: /ɔɹ/ as in "north," /ɑɹ/ as in "hard," and /ɝ/ in both a stressed syllable (as in "first") and an unstressed syllable (as in "stronger"). /ɔɹ/ occurs 8 times, /ɑɹ/ occurs once, and /ɝ/ occurs 11 times.

We will first examine /ɔɹ/ separately from /ɑɹ/ and /ɝ/ because the participants behaved interestingly. /ɔɹ/ occurs in three different morphemes, "north," "warm," and "more" in the passage, and all the participants consistently pronounced /ɔɹ/s in three different ways depending on the morpheme as shown in Table 10 below.

- P1 reported not really being aware that she pronounced "or" in "north" and <ar> in "warm" differently. However, she mentioned that she consciously pronounced <or> in "north" differently from the others because she was influenced by the pronunciation of Japanese teachers of English.

- P2 reported not knowing that <or> in "north," <ar> in "warm" and <or> in "more" were phonemically the same, and she was influenced by English loanwords. However, she was taught the pronunciation of "warm" by a native speaker in an ESL school, so she pronounced only "warm" and "warmly" correctly. Therefore, she was actually able to produce [ɔɹ] but misunderstood that <or> in "north" and <or> in "more" were not [ɔɹ]. In other words, she could not generalize the skill of pronouncing [ɔɹ] to words other than "warm."
- P3: As mentioned in §3.1, she pronounced "north" in the same way as the loanword [noːsɯ]. As for "warm", she misunderstood that <ar> in "warm" might be more like <ar> in "hard." As for "more," she pronounced it acceptably. However, she mentioned that, when facing <r>, she became intimidated and sometimes pronounced it strangely. Therefore, [ɔɹ] in "more" was counted as an accidentally correct production.
- P4 reported intending to pronounce the /ɔɹ/ in three different ways, consistent with what she had been taught in junior high school.

According to the participants' feedback, the three different realizations of /ɔɹ/ are not caused by phonetic environments. Rather, they are misconceptions that the /ɔɹ/ in all three instances was supposed to be different.

Table 10. Results for /ɔɹ/; Int= intended, Acc= accidental. Nb: "?" indicates that the participants themselves were not really sure if they were aware of the target sounds.

Target: /ɔɹ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	8	0	0	0	[oʊ] in "north" [oː] in "warm" [oa], [oə] in "more"
P2	8	2	2	0	[oː] in "north" [oa] in "more"
P3	8	0	0	2	[oː] in "north" [ʌː] in "warm"
P4	8	0	0	0	[oː] in "north" [aː] in "warm" [oə] in "more"

Note that the quality of the Japanese /a/ (J/a/) is between the cardinal vowels [a] and [ɑ], and it has a wider range of allophonic variations than the other Japanese vowels; [a], [ə], [ʌ] and [ɑ] can all be allophones of J/a/ (Tsuzuki, 1996). The participants produce J/a/ as [a], [ə], and [ʌ]. In addition, English loanwords in Japanese, "north," "warm" and "more" are typically adapted into [noːsɯ], [woːmɯ] and [moa] respectively.

Next, I will examine /ɑɹ/ and /ɝ/. Although /ɑɹ/ occurred only once in the

passage, it is interesting to compare /ɑɹ/ and /ɝ/.

- P1 reported not knowing that <ar> in "hard" and <ir> in "first" were different. In addition, she did not know that there was [ɹ] in those words (in a rhotic dialect). Although P1's mother, who has a British English background, taught her English when she was young, she did not know <ir> in "first" and <er> in "consider" or "other" were different in British English.
- P2: Like P1, P2 reported not knowing that <ar> in "hard" and <ir> in "first" were different. She said that she could produce the [ɹ]-like sound if she tried, as shown in §4.4 and §4.6, but she also insisted that [ɹ] in onset and coda sounded like completely different entities for her. This can be explained in terms of Brown's (2000) finding that Japanese subjects perceived E/l/ and E/ɹ/ in onset with only 31% accuracy while they did so in coda with nearly 100% accuracy (cited in Archibald, 2005). P2 also misconceived that the English letter <r> in coda position was the same as the Japanese symbol <ー>, which phonemically lengthens the preceding vowel. In fact, she quite consistently pronounced the long vowel [aː] for both /ɑɹ/ and /ɝ/. She misinterpreted the English orthographic information and did not know that English lacks the contrast of vowel length, unlike her L1.
- P3 reported not knowing <ar> in "hard" and <ir> in "first" were different. In fact, she pronounced [ɝ] in "hard" as she intended. However, as for the word "were," she said that she ignored [ɹ]. She pronounced "were" as [waː], as she intended. My interpretation of this is that she attempted /ɝ/ ten times out of 11 occurrences and succeeded four times. The problem is that she was not sure if /ɝ/ in each word in the passage was phonologically the same.
- P4: Like P2, she reported misconceiving that the letter <r> played the role of phonemically lengthening its preceding vowel. She also did not know that English lacks the contrast in vowel length present in her L1. In fact, she pronounced "hard" as [haːd] where [a] was lengthened, just as P1 and P2 did, while she pronounced <ir> "first" as [ɑɹ]. However, she believed that Japanese speakers can pronounce [ɹ], so that she was not intimidated by [ɹ]. She might have been aware that [ɹ] can appear as an allophone of J/ɾ/. The problem is that she did not know that /ɝ/ in each word in the passage was phonologically the same. In fact, the phonetic quality of her /ɝ/ varied from occasion to occasion even when her production was within the phonologically acceptable range. She mentioned that she pronounced /ɝ/ instinctually. Therefore, it may not be appropriate to consider that she attempted to pronounce /ɝ/.

All in all, the errors regarding post-vocalic /ɹ/ were mostly due to inappropriate intentions.

Table 11. Results for /ɑɹ/; Int= intended, Acc= accidental.

Target: /ɑɹ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	1	0	0	0	[aː]: 1
P2	1	0	0	0	[aː]: 1
P3	1	0	0	0	[ɝ]: 1
P4	1	0	0	0	[aː]: 1

Table 12. Results for /ɝ/; Int= intended, Acc= accidental.

Target: /ɝ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	11	0	0	0	[aː]: 9 [ɑː]: 1 [a]: 1
P2	11	0	0	0	[aː]: 9 [ə]: 2
P3	11	10?	4	0	[ə]: 4 [aː]: 1 [a]: 1 [oʊ]: 1
P4	11	0?	0	4	[aː]: 6 [ɑɹ]: 1

Again, [a], [ə] and [ɑ] are possible allophonic variants of J/a/. Note also that vowel length is phonemic in Japanese: e.g. /soɾi/ (sled) versus /soːɾi/ (Prime Minister).

4.7 Results for /f/ and /h/

It is important to note that Japanese has phonemic contrast between /f/ and /h/ which is neutralized before the vowel /ɯ/. Also, phonetically J/f/[10] is the bilabial fricative [ɸ] (Vance, 2008; Inozuka et al., 2009). In a questionnaire administered to 13 experienced ESL teachers in British Columbia, Canada, one respondent (and advanced ESL level instructor) pointed out the /f/ and /h/ distinction as one of Japanese learners' problems. As well, Berman, Lambacher, Martens, & Nelson (2001) found that Japanese learners perceptually confused /f/ and /h/ before [u]. Therefore, it is worth examining it. /f/ occurs five times and /h/ occurs eight times in the passage. The results show that the contrast between E/f/ and E/h/ does not seem problematic, except for "fold" and "who."

[10] Vance (2008) phonemicized the Japanese bilabial fricative as /f/. In this paper, I follow Vance's method. (cf. Akamatsu, 2000)

- P1 reported being aware of the cross-linguistic phonetic difference between E/f/ and J/f/. She pronounced the labio-dental [f], except <f> in "first" was [ɸ]. [ɸ] is more marked than [f] (Maddieson, 1984, 2005). Based on Eckman's Markedness Differential Hypothesis (2003), if one's L1 has a more marked sound, the less marked counterpart in L2 is not difficult to acquire. Therefore, her acquisition of [f] is not surprising although [ɸ] still appeared. She pronounced <f> in "fold" as [h], and she said that it was a slip of tongue. E/f/ is sometimes adapted as both J/f/ and J/h/ in loanwords: e.g. "telephone" can be pronounced and written as either /teɾefoN/ or /teɾehoN/[11] (Matsuzaki, 1992, 1993). She might have been influenced by that. As for "who," she did not know that <wh> in "who" and <f> in "food" were different. Therefore, she simply transferred L1 phonetics and phonotactics, namely neutralization of /h/ and /f/ before /ɯ/, and ended up with [ɸ] in "who."
- P2 reported not being aware of the phonetic difference between E/f/ and J/f/. Therefore, she was going to pronounce the bilabial [ɸ] and consistently did so. However, it was still within the acceptable range of E/f/. As for "who," she did not know that <wh> in "who" and <f> in "food" were different, like P1. J/f/ (or /h/) before a high back vowel was typically pronounced as [ɸ], similar to P1, but she happened to produce [h], or weakened [ɸ], in "who." Therefore, I consider it accidental.
- P3: Like P1, P3 reported being aware of the phonetic difference between E/f/ and J/f/. However, she pronounced "fold" as "hold," just as P1 did. The difference from P1 is that P3 more consistently produced [f] than P1, but she simply misread "fold" as "hold" and intended to pronounce "hold." As for <wh> in "who," she did not know that it was different from <f> in "food," like P1 and P2. Therefore, she simply transferred L1 phonetics and phonotactics, like P1.
- P4: Like P1 and P3, P4 reported being aware that E/f/ was not [ɸ], and she pronounced [f] in some words. However, she pronounced [ɸ] in "off." She said that she pronounced easy words, like "off," in the Japanese way, whereas she was careful with relatively difficult words. However, her [ɸ] was still phonologically within E/f/. The problem is that she purposely pronounced <f> in "off" and <f> in the other words differently, when English does not have this contrast. As for <wh> in "who," she did not know that it was different from <f> in "food," like all the other participants. P4 misconceived that <wh> in "who" was [f], and clearly pronounced "who" as [fu].

In some dialects, <wh> is categorized as /hw/ which is distinct from /w/. "Who" pronounced by P1 and P3 were phonologically within the acceptable range of

[11] /N/ stands for placeless moraic nasal.

such dialects. However, P1 and P3 did not intend to pronounce <wh> this way. In fact, they pronounced "when" as [wɛn]. Therefore, in this case, their L1 transfer happened to be within the acceptable range.

Table 13. Results for /f/; Int= intended, Acc= accidental. Nb: "?" for P4 is due to her purposely distinguished [f] and [ɸ] although English does not have this contrast.

Target: /f/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	5	5	4	0	[h]: 1
P2	5	5	5	0	
P3	5	4	4	0	[h]: 1
P4	5	5?	5	0	

Table 14. Results for /h/; Int= intended, Acc= accidental.

Target: /h/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	8	**7**	**7**	0	[ɸ]: 1
P2	8	**7**	**7**	1	
P3	8	**7**	**7**	0	[ɸ]: 1
P4	8	**7**	**7**	0	[f]: 1

4.8 Results for /t/, /d/ and /s/ before high front vowels

According to Ohata (2004), Japanese ESL learners may pronounce "seat" and "tip," for example, as like "sheet" and "chip" because they transfer the Japanese allophonic alternation of /t/, /d/, and /s/ which become [tʃ], [dʒ] and [ʃ] respectively before high front vowels. Such allophonic alternations occur in some classes of lexicon in Japanese; for example, the inflectional variations of the verb "win," /kata/ and /kato/(irrealis), /kati/(adverbial), /katɯ/(conclusive), and /kate/(imperative), in which the stem is /kat/, are pronounced as [kata], [kato], [katʃi], [katsɯ], and [kate] respectively. My focus is on whether this L1 transfer occurs at the level of their understanding or at the level of their production ability. I examined /s/, /t/ and /d/ before either /i/ or /ɪ/, namely "succeeded," "consider," "disputing," "did" and "immediately." Based on those allophonic

alternations, these words are expected to be pronounced as [səkʃidɛd] (or [səkʃidʒɪd]), [kənʃɪdɚ], [dʒɪspjutʃɪŋ], [dʒɪd] and [ɪmidʒiətli].

Contrary to the prediction, as shown in Tables 15 through 17, all the participants correctly pronounced these phonemes. In addition, participants said that the aforementioned predicted sounds were highly unlikely even in Japanese accented English, except [kənʃɪdɚ] for "consider" and possibly [səkʃid] for "succeed" were acceptable.

According to 15 scholars' interpretations of Japanese phonology in Matuzaki's (1993) paper, [ti] and [tʃi] are unanimously considered contrastive in Japanese except in some lexical classes mentioned above, and so are [di] and [dʒi]. Whether [si] and [ʃi] are contrastive in Japanese is debatable. Nogita (2010) argues that [si] and [ʃi] are not contrastive in core lexical classes, but they are in peripheral lexical classes such as technical terms and social dialects. As well, in Nogita's experiment, 93 monolingual standard Japanese speakers all distinguished [si] and [ʃi] regardless of their age. Thus, there is no reason that Japanese ESL learners have difficulty in pronouncing [t], [d], and [s] before high front vowels.

Additionally, the participants also recorded Japanese nonsense words written in Japanese orthography, and all of them distinguished "ティー" [tiː] from "チー" [tʃiː], "ディー" [diː] from "ジー" [(d)ʒiː], and "シー" [ʃiː] from "スィー" [siː] (as mentioned in §4.13). Therefore, if Japanese speakers pronounce /t/, /d/, and /s/, before high front vowels as [tʃ], [dʒ], and [ʃ], it makes more sense to consider that such errors are caused by other factors, such as loanword interference. In fact, there is variation in loanword adaptation. For example, [tɪ] in "tip" and [di] in "radio" were adapted as [tʃi] and [(d)ʒi] respectively, while "tea" [ti] and [dɪ] in "Disney" were adapted to [tiː] and [di] respectively.[12] The L1 transfer regarding [t], [d], and [s] is confined to loanword interference, but the transfer is not likely to occur in words that are not a part of Japanese vocabulary, such as "succeeded," "consider," "disputing," "did," and "immediately."

[12] Before the government in Japan standardized the writing system in 1991, the Agency for Cultural Affairs stipulated that in loanwords, [ti]/[tɪ] and [di]/[dɪ] in the original words should be written as "チ" [tʃi] and "ジ" [(d)ʒi] respectively as much as possible (with a few exceptions) (Matsuzaki, 1992).

Table 15. Results for /t/ before /i/ or /ɪ/; Int= intended, Acc= accidental.

Target: /t/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	1	1	1	0	
P2	1	1	1	0	
P3	1	1	1	0	
P4	1	1	1	0	

Table 16. Results for /d/ before /i/ or /ɪ/; Int= intended, Acc= accidental.

Target: /d/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	3	3	3	0	
P2	3	3	3	0	
P3	3	3	3	0	
P4	3	3	3	0	

Table 17. Results for /s/ before /i/ or /ɪ/; Int= intended, Acc= accidental.

Target: /s/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Accl	
P1	2	2	2	0	
P2	2	2	2	0	
P3	2	2	2	0	
P4	2	2	2	0	

4.9 Results for /æ/

As mentioned in §4.6, the Japanese /a/ is situated between the cardinal vowels [a] and [ɑ], and Japanese lacks a vowel in the low front region. I observed six occurrences of /æ/ in content words, namely “wrap,” “last,” and four occurrences of “traveller”. Since a vowel in a function word is often reduced to schwa, I did not include function words, such as “and” and “that.”

- P1 reported having never tried to pronounce [æ]. Despite her British background, she did not know <a> in "wrapped" and <a> in "last" were often pronounced differently in British English. However, she mentioned that she purposely pronounced "can't" as [kɑnt], instead of [kænt], even when talking to Canadian people because of her preference of British accent. At the same time, she realized that <a> in "can't" in British English was the same as J/a/, and in fact, the quality of her production had the characteristics of J/a/. Her production of /æ/ was a mixture of Japanese interference and over-generalization of British accent.
- P2 reported misconceiving that /æ/ in the passage was supposed to be the same as J/a/. Because of Japanese Romanization rule in which the letter <a> corresponds to the vowel J/a/, she had been habituated to this L1 symbol–sound correspondence.
- P3: Like P2, P3 also pronounced the letter <a> as J/a/ even in the English contexts.
- P4: She did the same as P2 and P3.

The results indicate that all of the participants did not try the low front [æ], but used J/a/.

Table 18. Results for /æ/; Int= intended, Acc= accidental. Nb: [a], [ʌ] and [ɑ] can be allophones of J/a/.

Target: /æ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	6	0	0	0	[ʌ]: 4 [a]: 2
P2	6	0	0	0	[a]: 3 [ʌ]: 2 [ɑ]: 1
P3	6	0	0	0	[ʌ]: 5 [a]: 1
P4	6	0	0	0	[a]: 5 [ʌ]: 1

4.10 Results for /e/ and /ɛ/

Ohata (2004) pointed out that Japanese ESL learners may make errors between the tense vowel /e/ and the lax vowel /ɛ/ because the Japanese vowel system does not have the tense-lax distinction. However, Ladefoged (2006) mentioned that the terms "tense" and "lax" are really just labels, as opposed to simply a matter of phonetic tenseness versus laxness. I will examine whether such errors come from Japanese ESL learners' misconceptions or their inability of production. /e/ occurs in "came," "they," "make," "take," and "gave," while /ɛ/ occurs in "when,"

"attempt," "confess," and two occurrences of "then." Since P1 misread "they" as "then," I counted four for the occurrences of /e/.

- P1 reported knowing that /e/ and /ɛ/ in the passage were different, but she also mentioned that she pronounced them "by instinct." She diphthongized /e/ and made it longer than /ɛ/. However, as long as she pronounced it "by instinct," the consistency may not be guaranteed.
- P2: She pronounced E/ɛ/ in the passage as the Japanese short monophthong /e/, likely because of the Japanese Romanization where it corresponds to the letter <e>. As for E/e/, she pronounced the target words as she was taught in junior high school. However, she was not sure that E/e/ in "came," "make," "take," and "gave" were the same as E/e/ in "they" because the spelling looked different.
- P3: She was sure that E/e/ in the passage was relatively diphthongized, while E/ɛ/ was relatively monophthongized. In fact, she distinguished them clearly in production.
- P4: She thought that E/e/ and E/ɛ/ in the passage were different, but it was because she had memorized those words with the Japanese pronunciation. She did not have connection to E/e/ and E/ɛ/ in the English phonological system. A lack of knowledge may be the reason of her mispronunciation.

Importantly, as I will mention in §4.13, the participants pronounced the nonsense Japanese words written in Japanese orthography: [beta], [beːta] and [beita].[13] The vowel part of the first syllable in each word was categorized as E/ɛ/, E/ɛ/ and E/e/ respectively, by the North American judge (see §3.3). The distinction of length did not change the English categories. Therefore, the fact that Japanese does not use the label of "tenseness" for grouping vowels does not mean Japanese speakers cannot distinguish between E/e/ and E/ɛ/. Since E/ɛ/ is one-mora and E/e/ is two-mora (Duran, 2005), Japanese speakers can pronounce these two by efficiently deploying the Japanese one-mora /e/ and the two-mora vowel sequence /ei/. However, E/e/ is usually adapted to three different Japanese categories depending on the words, namely J/eː/, J/ei/, and J/e/ – although J/e/ is not as common as the other two (Okada, 2004). For example, the English words "game," "paint," and "change" are adapted to /geːmɯ/, /peiNto/, and /tʃeNdʒi/. This inconsistent loanword adaptation may confuse Japanese learners of English. It makes more sense to consider that Japanese ESL learners' errors regarding E/e/ are because of loanword interference, not their inability to articulate.

[13] J/e/ is between the cardinal vowels [e] and [ɛ], so it can be transcribed as [ẹ].

Table 19. Results for /e/; Int= intended, Acc= accidental.

Target: /e/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	4	4?	4	0	
P2	5	5?	5	0	
P3	5	5	5	0	
P4	5	0?	0	0	[ɛ]: 5

Table 20. Results for /ɛ/; Int= intended, Acc= accidental.

Target: /ɛ/					
	Occurrences		Correct		Incorrectly pronunciations (sound: occurrences)
	T=	Int	Int	Acc	
P1	5	4?	4	0	[iː]: 1
P2	5	5?	5	0	
P3	5	5	5	0	
P4	5	5?	5	0	

4.11 Summary of segmental errors

Table 21 summarizes the numbers of errors due to production problems, errors due to inappropriate intentions, and accidentally correct productions. To see tendencies, I divided the errors into two types: "Consonants" (/θ/, /ð/, /v/, /l/, pre-vocalic /ɹ/, /f/, /h/, /s/, /ʃ/, /t/, /tʃ/, /d/, and /dʒ/) and "Vowels (Rhymes)" (/æ/, /ɛ/, /e/, /ɔɹ/, /ɑɹ/, and /ɝ/). As mentioned above, when the participants themselves were not sure whether or not they intended to pronounce appropriate targets, I marked this with a question mark in the corresponding results tables. In this summary I ignore those question marks.

Of the total 281 pronunciation errors, 186 (66.2%) were due to inappropriate intentions while 95 (33.8%) were due to production problems. Twenty-six productions that appeared to be correct were actually accidental. In detail, among 98 errors regarding vowels or rhymes, 92 (93.9%) were due to inappropriate intentions. This large number should not be ignored. In the errors regarding consonants, there are individual differences; P2 and P4 exhibited fewer inappropriate intentions than the others, and P2 and P4's total pronunciation errors were also fewer than the others'. Interestingly, in spite of P2's proficiency

in English being the lowest and that of P1 the highest, while P2 made the fewest errors in both. Based on these limited data, there seems to be no correlation between English proficiency and understanding of pronunciation.

Table 21. Summary of the results for the segmental errors: inappropriate intentions vs. production problems. Nb: Pro= the number of "production problems"; Int= the total number of "inappropriate intentions;" Acc= the number of "accidentally correct" productions.

	Consonants			Vowels (Rhymes)			Total		
	Errors		**Acc**	Errors		**Acc**	Errors		**Acc**
	Pro	**Int**		Pro	**Int**		Pro	**Int**	
P1	50		**13**	27		0	77		**13**
	1	**49**		0	**27**		1	**76**	
P2	37		**1**	24		0	61		**1**
	31	**6**		0	**24**		31	**30**	
P3	52		**6**	20		**2**	72		**8**
	19	**33**		6	**14**		25	**47**	
P4	44		**0**	27		**4**	71		**4**
	38	**6**		0	**27**		38	**33**	
T=	183		**20**	98		**6**	281		**26**
	89	**94**		6	**92**		95	**186**	

4.12 Results for the phonemic contrast identification tasks

According to the participants' comments and the summary of their errors, the participants seem to lack phonological awareness in English in many cases. In order to examine their phonological awareness more deeply, I asked the participants whether the homophone pair and minimal pairs were the same in pronunciation or not: meat/meet, ear/year, bone/born, and who'd/food. Since this task does not involve production, I could focus on the participants' understanding.

The result was that none of the participants were certain whether the words in each pair were the same or different in pronunciation. What is intriguing is that their production of both "meat" and "meet" sounded (almost) the same.[14] Nevertheless, the participants were still not certain that these words were

[14] Both "meat" and "meet" as loanwords in Japanese are also homophones: [mi:to].

homophones. Another interesting point is that between "ear" and "year," the pronunciation difference is obviously shown in the spelling, namely presence or absence of <y>, but none of them paid attention to it and became perplexed. The comments from each participant listed below are intriguing with respect to the participants' own interpretations of English phonology.

- P1: Between "who'd" and "food," she guessed that the tongue position might be different. (She did not mention for what sound the tongue position might be different.) What is interesting here is she paid attention to tongue position, rather than phonological categorization.
- P2 reported not knowing what the difference was, but she misunderstood that "meat" and "meet" were different because the spellings were different. Meanwhile, "bone" and "born" were the same because Japanese EFL learners typically pronounced these words in the same way, [boːN]. She inconsistently referred to either spelling or Japanese EFL learners' pronunciation or loanwords.
- P3 said that she had been pronouncing the two words in each pair probably in the same way, except she was taught that "ear" and "year" were different in junior high school although she was not sure what the difference was.
- P4 claimed that she had no awareness of the connection between spelling and sounds in English, or no knowledge about the English pronunciation system. In contrast, in Japanese she had the clear connection between orthography and sounds, and had the whole picture of the Japanese phonological system. Therefore, she had no idea about these English homophones and minimal pairs.

The participants' comments indicated that they do not really have a clear picture of the English sound system. Moreover, although they often referred to English loanwords in Japanese or the rules of Japanese Romanization, they did not fully depend on the Japanese phonology. Hocket (1960) defined linguistic sounds as discrete, whereas non-linguistic sounds form a continuum. More specifically, according to D. McKercher (personal communication, November, 2009), linguistic sounds must be categorized as phonemes in particular languages, while non-linguistic sounds cannot be categorized as phonemes. Since the participants often could not categorize sounds in the stimuli as particular English phonemes, they often might have pronounced English words with non-linguistic continuum sounds. In this way, the participants' vowel and rhotacized vowel qualities [15] varied substantially. It will be worth examining whether their vowel qualities will be more consistent after they learn the structure of English vowel inventory.

[15] "Rhotacized vowels" = /ɔɹ/, /ɑɹ/, and /ɝ/.

4.13 Orthographic pairs reading results

As mentioned earlier, when participants read Japanese stimuli written in Japanese orthography, they distinguished between [si] and [ʃi], [ti] and [ʧi], and [di] and [(d)ʒi]. As for their [e], [eː] and [ei], the first two can be categorised as E/ɛ/ while [ei] can be categorized as E/e/.

Interestingly, P1 (the participant with the longest residency in Canada at three years) showed different phonetic characteristics than P2, P3 and P4, whom had all lived Canada for five months in. P1 aspirated [t] in both a word-initial and word-medial position, and did not show pre-voicing for [d], [dʒ], or [b], and did not affricate [z]. In contrast, P2, P3, and P4 did not quite aspirate [t], (except P2 aspirated word-initial [t]) and often showed pre-voicing for [d], [dʒ], [b], and even [dz], and also pronounced the affricate [dz], instead of [z]. Japanese /z/ is typically the affricate [dz] (Grenon, 2008), as mentioned in 4.2 above. Vance (2008) mentioned that, according to some descriptions, Japanese /p/, /t/, and /k/ are typically weakly aspirated in word-initial position or in an accented syllable, and unaspirated elsewhere. According to Takada (2008), in Tokyo and Kansai region, voiced stops typically have negative voice onset time (VOT) values,[16] in other words "pre-voicing". Recall that P2 and P3 are from near Tokyo and P1 and P4 are from Kansai region. Therefore, P2, P3, and P4 showed typical phonetic characteristics in the Japanese stimuli, whereas P1 showed different characteristics. Since P1 had been in an English environment much longer than the others, her L1 may have been influenced by her L2. In fact, in Haraguchi's (2003) study, advanced Japanese ESL learners acquire English aspiration patterns without special endeavour. However, as shown in §4.1 to §4.10, P1's phonological realization was similar to that of the other participants. This implies that longer length of residence may help Japanese adult ESL learners acquire phonetic characteristics, but may not help them construct L2 phonological categorization. Incidentally, according to Hirayama (1994), Kyoto dialect speakers do not affricate /z/. Since P1 is from near Kyoto, her true fricative [z] is possibly not from L2 influence, but rather a characteristic of her L1 dialect.

Another interesting phonetic characteristic is that P1 and P4 added a glide in the Japanese [(d)ziː] and [siː] data, like [(d)zwiː] and [swiː], or unrounded [(d)zɯiː] and [sɯiː]. Conversely, they did not show such glide insertion in the English data. For example, they did not pronounce "succeeded" as [səksɯidɪd]. Their purposely differentiated productions may be due to orthographical interference. In the Japanese syllabary system, when a new syllable comes into use, it is written with the combination of two existing symbols (a big symbol and a small symbol), instead of creating a new symbol (Inozuka, 2009). For example,

[16] In the Tokyo area, younger speakers more often show positive VOT values in voiced stops than older speakers do (Takada, 2008).

the new syllables [(d)zi] and [si] are written with <ズィ> and <スィ> respectively. This two-symbol structure may cause some Japanese speakers to add an extra sound.

5 Discussion

5.1 Pedagogical implications

The pronunciation error patterns of these Japanese ESL learners can be divided into the following four types, summarized in Table 22.

Table 22. Summary of four types of the errors committed by the participants.

A:	A lack of phonological knowledge or misunderstanding of target sounds
B:	Abandonment of particular phonemes in learners' inter-language
C:	Difficulty in articulation or a lack of knowledge of the sound quality of a target phoneme
D:	Accidentally correct productions

Only C is a phonetic error, but the others are caused by misunderstanding. In fact, in many of the cases, the participants did not intend to pronounce the proper target phonemes. If native Japanese-speaking learners of English adopt the same behaviour, articulatory training often does not help them improve their pronunciation. The findings of this research suggest that pronunciation lessons need to stress learners' understanding of target sounds and the phonological system of the target language, and not only what learners actually produce. Each type of error is discussed in more detail below.

5.1.1 Type A: Lack of phonological knowledge/ misunderstanding target sounds

Learners do not know what they are supposed to pronounce. Learners often do not consider the target sound as a discrete phonological category, but as a non-linguistic sound. For example, the participants were not sure whether /e/'s in "gave" and "they" were the same. Therefore, their productions phonetically varied over a wide range. Another example is the participants' misunderstanding that /ɔɹ/s in "north," "warm," and "more" were supposed to be pronounced differently. The source of this type of error is that learners have not been taught the English symbol–sound correspondence rules. As Carroll (2004) stated, letter knowledge precedes phoneme awareness, as mentioned in 2.1. Learners need to know the concept of discrete phonological categorization with the visual cue, the

orthography. As well, as Makino (2008) mentioned, learners need to be shown all the English consonants and vowels to grasp the whole picture of the phonological inventory.

5.1.2 Type B: Abandonment of particular phonemes in learners' inter-language

Learners know what the target sound is, but they have abandoned the particular phoneme in their inter-language. For example, P3 knew that the English /l/ and /ɹ/ were different from the Japanese /ɾ/, but she gave up trying to acquire E/l/ and E/ɹ/, and substituted both with J /ɾ/. According to the participants' comments, they did not know why some particular phonemic contrasts, such as E/l/ and E/ɹ/, must be distinguished, and so they were not motivated to practice the contrasts. In order to help them understand the concept of contrasts, other ESL learners' errors or JSL (Japanese as a second language) learners' errors seemed effective. For example, naming the /p/ and /f/ confusion by Korean speakers and the /p/ and /b/ confusion by Arabic speakers, which are not problematic for Japanese speakers, helped the participants understand what the confusions like /l/ and /ɹ/ sound like.

5.1.3 Type C: Difficulty in articulation or a lack of knowledge of the sound quality of a target phoneme

Learners know what the target phoneme is and attempt to pronounce it, but fail to meet the target in terms of articulation, or can meet the target in isolation or careful speech but cannot afford it in a practical situation. Alternatively, they misunderstand the sound quality of the target phoneme. For example, P3 tried to pronounce /ð/ in the right place, but sometimes she affricated it. This type of error is a purely phonetic issue. Learners need some phonetic tips or need some practice on their own.

5.1.4 Type D: Accidentally correct productions

Learners accidentally met the target, but their production of target sounds was not intentional. In other words, it can be called a covert error. For example, P3 pronounced a target-like [ɹ] in "wrap", but actually she intended to pronounce /wɾ/, which happened to be realized as [ɹ]. Although this type of error may be difficult to find, the source of the error is the same as either A or B. Therefore, if learners understand the concept of phonological categorization and symbol–sound correspondence rules, this type of error can be avoided.

5.2 Limitations of the analysis

Firstly, this study's data were limited as some sounds appeared in only one word. For example, /θ/ appeared only in the word "North", and /ɑɪ/ appeared only once in the whole passage. There is no way to know how the participants pronounce these sounds in other words. However, this study was still able to identify the participants' understandings of these sounds, as mentioned in §4.1 and §4.6.

Secondly, the participants themselves were often not sure of what they intended to pronounce, which made it difficult to judge whether they attempted the proper target sounds or not. Moreover, they often used their L1 sound without understanding the L2 phonological inventory, and the L1 sound happened to be within the acceptable L2 target phoneme. For example, when they consistently used J/e/ for E/ɛ/, it sounded correct, but if they did not picture E/ɛ/, or so called "Short E", it is questionable whether they intended to pronounce the proper target or not. In these ambiguous cases, I put a question mark. At the same time, these ambiguous cases indicate that the participants did not understand the target sounds.

5.3 Future research

Firstly, this study found that the participants lack phonological and orthographical awareness in English in many cases. I should examine whether the finding from this qualitative study are generalizable by performing more quantitative research.

Secondly, P1 with three years of residence in Canada had better sound qualities of [ɹ] and aspiration than the other participants, while in terms of phonological and orthographical awareness, P1 was similar to the others. For example, P2 and P4 (with only five months of residence in Canada) performed much better than P1 in the /l/ and /ɹ/ distinction. Longer residence may help learners improve phonetic accuracy but may not help learners naturally acquire L2 phonological mapping and spelling rules. Since the participants had been exposed to English loanwords or strongly Japanese accented English for a long time, this exposure may have prevented them from constructing the L2 rules. This has to be studied with more participants in the future.

6 Conclusion

When Japanese ESL learners mispronounce English, they often intend to pronounce different sounds due to their misconception about target sounds, or due to their own interpretations of English phonology, as opposed to current ideas about Japanese learners' articulatory inability to produce particular sounds. Especially, in this experiment, the participants' errors regarding vowels or vowels followed by /ɹ/ were due to misguided intentions 93.9% of the time. Japanese ESL learners' misconceptions are likely due to their often not having been taught the basics of English phonological and orthographical systems. Therefore, the same phoneme spelled with the same alphabet letter(s) is often purposely pronounced differently when it appears in different words, For example, <v> in "gave" and that in "traveler" are misunderstood to be different phonemes. On the other hand, different phonemes spelled with different alphabet letters are often purposely pronounced the same: <ar> in "hard" and <ir> in "first" are in this way misunderstood to be the same phoneme(s). Moreover, even in the production of the notorious /l/ and /ɹ/, there was a clear difference in their productions between those who tried to distinguish them and those who did not. Insofar as Japanese ESL learners have not yet been taught the basic English symbol–sound correspondence rules, they would be limited to pronouncing according to their own interpretations of English phonology. If Japanese ESL learners have not yet pronounced their L2 sounds according to true English phonology, there is no way to know whether they actually have difficulty in producing particular sounds. It would be safe to avoid immediately concluding that pronunciation errors by Japanese ESL learners come from their articulatory inability to produce.

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Appendix

Reading Task: The North Wind and the Sun

The north wind and the sun were disputing which was stronger, when a traveler came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the traveler take his cloak off should be considered stronger than the other. Then the north wind blew as hard as he could. But the more he blew the more closely did the traveler fold his cloak around him; and at last the north wind gave up the attempt. Then the sun shone out warmly, and immediately the traveler took off his cloak. And so the north wind was obliged to confess that the sun was the stronger of the two.