Identifying the locus of L2 pronunciation: an exploratory study of geminate production by Chinese L2 learners of Japanese

Seunghun J. Lee
(International Christian U, U of Venda)
Gaku Kurita
(National Chengchi U)
Jeremy Perkins
(U of Aizu)

Lee, Seunghun J., Gaku Kurita & Jeremy Perkins (2018). Identifying the locus of L2 pronunciation: an exploratory study of geminate production by Chinese L2 learners of Japanese. *Foreign Language Education Research, 22*, 69-86.

Chinese L2 learners of Japanese are identified as showing difficulties in the production of Japanese geminates. The idea of being difficult-to-listen is embodied in the concept Comprehensibility (Derwing & Munro 2015). This study first reviews the native pronunciation of Japanese singleton vs. geminate contrast. Then, we report findings based on the pronunciation by 20 Chinese learners of Japanese and discuss the issue of comprehensibility in geminate production. While the contrast in the closure duration between singleton and geminate consonants shows a similar pattern to reported Japanese speech, the learners show large differences in the vowel duration preceding and following consonants. We report findings from a linear mixed model that was run with speaker as a random effect. The results show that participants do not make differences in vowel duration, or the difference in vowel duration is reversed from L1 Japanese speakers. Identifying the locus of the source of an L2 accent should be accompanied with intelligibility and comprehensibility. Such identification is important in increasing comprehensibility in speech that is already intelligible.

Key Words: Geminates, L2 pronunciation, Chinese L2 learners, Japanese, duration, comprehensibility.

Ⅰ. Introduction

Speaking a foreign language is a challenge for most learners; they strive for a native-like pronunciation, but it is often unrealistic, if not impossible, to achieve the goal of a native-speaker like pronunciation. Segmental as well as suprasegmental elements in speech contribute to this difficulty. When learners face a non-native sound in L2 pronunciation, (a) they may substitute a foreign sound to a similar native sound, (b) they may drop a foreign sound altogether, or (c) they may insert a segment when a foreign sound occurs in a position not permitted in their native grammar.

The patterns of adopting a non-native sound have been studied well, but the implications of these studies to L2 pronunciation education were not always clear. The focus of these studies was how L2 pronunciation deviates from the pronunciation of native speakers. Knowing these differences, it was believed that educators can apply the knowledge of these differences in developing a curriculum for L2 pronunciation. The desire by learners to produce native-like pronunciation has also led to an emphasis on the accuracy of pronunciation; how close does a learner produce a sound in L2? Pronouncing a sound in a language is part of motor skills that involve coordinated synchronization of articulators (cf. Gick et al. 2013). These articulators produce acoustic signals that are attuned to individual languages. Speakers of a language have grammaticalized knowledge of these signals, which is developed as early as 8 months (Kuhl et al. 2006).

The struggle that L2 learners face comes from two major areas; (a) languages share similar phonological categories (phonological similarities), but (b) the phonetic realization is not identical (non-identity). The phonological similarities are what drives the communication between L2 learners and speakers of a target language. When an L2 learner produces a sufficiently close sound (that is not contrastive in a target language), speakers of the target language would understand and process utterances produced by L2 learners. The non-identity in L2 pronunciation, however, is how native speakers differentiate L2 learners from another native speaker. Native speakers easily detect minute acoustic differences in L2 speech within a few words, even when the speech is produced by a fluent learner.

One of the major goals in foreign language education is teaching learners to produce L2 speech that is understandable by a native speaker (comprehensibility) and that does not evoke strenuous situations for a native speaker (intelligibility). This new paradigm in L2 pronunciation (Derwing and Munro 2015 and references therein) resulted in a fresh methodology in how to view the teaching of L2 pronunciation in classroom settings. While in SLA situations, learners have access to native pronunciation in everyday life, in foreign language education, in which exposure to an L2 are limited to classroom settings, this new paradigm on L2 pronunciation resonates more.

While many pronunciation studies tend to focus on segments (cf. Lee et al, 2014), there is an increased need of understanding how suprasegmental features such as duration or pitch play a role in understanding pronunciation. Accuracy in segments doesn't reduce accentedness derived from suprasegmental features, but native-like prosody can result in higher comprehensibility and intelligibility of the target language.

This paper addresses both of these issues by examining naturalistic data produced by intermediate Chinese learners of Japanese. While Chinese learners of Japanese have an advantage in written Japanese because of the knowledge of Chinese characters, the pronunciation by Chinese learners of Japanese has challenging aspects. Anecdotally, Japanese native speakers identify geminates as the source of low comprehensibility in Chinese accented Japanese. The second author reports that this challenge in geminate production is well recognized in college-level Japanese classes, as learners are instructed to produce geminates with 0.6-second-long stop closures. Even so, there are almost no studies that systematically investigate geminate production by Chinese learners.

In this study, we first examined the duration of singleton versus geminate consonants produced by Chinese learners. The results show that the learners were in fact producing the contrast in the stop portion of singleton and geminates in a way that is comparable to L1 Japanese speakers. If the stop portion, which is even taught in Japanese language classes, is produced well, why would Japanese speakers point to geminates as the source of Chinese accented Japanese? In other words, what aspects of geminate production in Chinese learners are resulting in the perception of accentedness when L1 Japanese speakers perceive their speech?

Identifying the source of accentedness is important due to its implications to pedagogy. While teachers recognize the importance of pronunciation education (cf. Foote et al. 2011), many of them report that there is a lack of time that can be devoted to the issue of pronunciation due to demands on teaching vocabulary and grammar. Knowing the locus of the accentedness that contributes to low comprehensibility enables teachers to develop teaching methods that maximize the use of class time. As such, this paper will investigate the duration of preceding and following vowels of target consonants since both are reported to show an interplay with the geminate contrast in Japanese. We will first review acoustic correlates concerning the geminate contrast in Japanese in section 2. Our experiment and its results will be reported in section 3, which will be followed by a discussion.

Ⅱ. Geminate consonants in Japanese

Geminate consonants have a high functional load in Japanese as minimal pairs with singletons are abundant in all places of articulation. In (1), minimal pairs with a singleton versus geminate contrast are shown. The discussion in this section is taken mainly from Kawahara (2015).

Geminate consonants are longer than corresponding singleton consonants. After examining Bengali and Turkish, Lahiri and Hankamer (1988) report that closure duration is the main acoustic correlate of geminates. This observation is also embodied in the earlier mentioned teaching methods at the university of the second author, where geminates are taught as a sound with a 0.6-second-long stop closure in the Japanese classes.

(1) Singleton and geminate minimal pairs in Japanese

	Singleton	Geminate
labial	supai (spy)	suppai (sour)
	ripu (reply)	rippu (lipstick)
coronal	kate (food)	katte (selfish)
	oto (sound)	otto (husband)
dorsal	haka (tomb)	hakka (mint)
	fuku (clothes)	fukku (hook)

Japanese is a moraic language where the mora forms a basic unit for organizing rhythm; a short vowel has one mora (2a), and a long vowel has two morae (2b). A syllable with a vowel followed by a nasal coda has two morae (2c), so does a syllable with a coda consonant that is a part of a geminate, as in (2d).

(2) Morae in Japanese

a. [ha]	'tooth'	1 mora (short V)
b. [heː]	'soldier'	2 mora (long Vs)
c. [ha$_1$ɴ$_2$]	'half'	2 morae (short V + nasal coda)
d. [ha$_1$k$_2$ka]	'mint'	2 morae (short V + geminate)

The contribution of geminates to moraic count in Japanese is another reason why the acquisition of geminates is an important aspect of Japanese L2 pronunciation. If a geminate is not long enough, L1 Japanese speakers would have difficulties understanding the L2 speech.

In Kawahara (2015), the relationship between geminate contrast and vowel length is discussed. In Norwegian, for example, a vowel preceding a singleton consonant is longer than a vowel before a geminate consonant; the first part of a geminate forms a closed syllable and shortens the vowel. In Arabic, the duration of a vowel preceding a geminate is similar to that of a vowel preceding a singleton. In Japanese, this relationship is reversed from Norwegian; a vowel preceding a singleton is phonetically longer than a vowel preceding a geminate. On the other hand, vowels following a geminate are slightly shorter than those following a singleton (Idemaru & Guion-Anderson 2010; Ofuka et al. 2005).

An investigation by Kawahara (2006, 2015) reports that vowels preceding and following a singleton versus a geminate have different vowel length in L1 Japanese speech. Before a geminate, there is pre-geminate lengthening; the duration of a vowel is longer than that before a singleton. When [haka] 'tomb' and [hakka] 'mint' are compared, the vowel [a] before a singleton [k] is shorter than the vowel [a] before a geminate [kk]. Kawahara (2006) reports that pre-geminate vowels were 53.4 ms, whereas pre-singleton vowels were 36.9 ms.

In Idemaru and Guion (2008), post-geminate shortening in L1 Japanese speech is found; in the [haka] 'tomb' and [hakka] 'mint' example, the vowel [a] after a geminate [kk] is shorter than that before a singleton [k]. In their study, Idemaru and Guion report that the vowel length is 63 ms in post-geminate vowels, but 76 ms in post-singleton vowels. Coupled with the acoustic findings of pre-target vowels, the singleton-geminate distinction in L1 Japanese speech not only has a length difference in closure duration, but also a difference in the surrounding vowels.

These findings imply that L1 Japanese speakers could have greater exposure to the contrast between singleton and geminates when they first acquire the Japanese language. Tajima et al. (2013) explores this question by comparing the ratio of geminates in adult directed speech (ADS) and in infant directed speech (IDS). The ratio doesn't change much; geminates appear at a rate of 7.9% in ADS but 9 % in IDS. This minimal difference between ADS and IDS suggests that L1 Japanese speakers do not have an advantage in the acquisition of Japanese simply due to a greater exposure to it.

A perception study based on a looking paradigm by Mazuka et al. (2012) reports that when compared to 9.5-month-old infants, 4-month-old infants failed to identify the singleton-geminate difference in trials involving /pata/ versus /patta/. They suggest that children may not perceive the singleton-geminate distinction from the onset of their L1 acquisition.

Mazuka et al. (2012) also manipulate the closure duration of the consonant in order to investigate whether infants show any difference. Infants were exposed to three conditions: (a) naturally uttered /pata/ and /patta/, (b) naturally uttered /pata/ and /patta/ that is manipulated by lengthening the singleton, and (c) naturally uttered /patta/ and /pata/ that is manipulated by shortening the geminate. Unexpectedly, they found that the only significant condition in 9.5-month-old infants was the condition where both stimuli were naturally uttered. This finding is important because it suggests that children may need secondary cues other than closure duration when it comes to acquiring the singleton-geminate contrast.

In the case of L2 learners, it has been reported that the production of geminates is not easy to acquire. English learners of Japanese show limited improvement even after a few years of learning (Mah & Archibald 2003, Hirata 2017). Ohta et al. (2009) report that

English learners produce longer, but Chinese learners produce less longer closure duration in geminates, in comparison with L1 Japanese speakers. Masuda (2009) examines the surrounding vowels, and reports that both English and Korean learners of Japanese produce vowels preceding geminates with shorter duration than L1 Japanese speakers, which means the learners show pre-geminate shortening, as Norwegian does. In a perception study by Hardison and Motohashi Saigo (2010), beginner and intermediate level learners are shown to be alike in having difficulty in perceiving the geminate contrast in Japanese.

The main point of this section is that L1 Japanese speakers utilize acoustic cues other than closure duration in producing and perceiving the singleton-geminate contrast, even as young as 9.5 months old. In particular, vowels preceding a geminate are longer and vowels following a geminate are shorter than the counterpart of a singleton.

Ⅲ. Experiment: Geminates by Chinese learners of Japanese

This section reports an analysis of production data produced by intermediate Chinese learners of Japanese. Adopting findings from previous studies on Japanese geminates, we examined the closure duration of singletons and geminates, as well as the duration of a preceding vowel and a following vowel of these consonants. We also hypothesized that the comprehensibility of speech by Chinese learners concerning geminates is related to the production of vowel duration.

The participants were 20 intermediate level Chinese learners of Japanese, 16 of whom were female. These participants received 2 years of university-level Japanese education. The native language of ten participants was Mandarin. The other nine participants knew Mandarin as well as Taiwanese (participants 3, 4, 8, 15, 16, 17, 18, 19, 20). One participant knew Mandarin and Cantonese (participant 1). As a control group, we had two L1 Japanese speakers.

Participants read the Japanese text in (3) taken from Guillemot (2018). This text was created to verify the speaking fluency of L2 speakers, especially targeting vowel length as well as the singleton-geminate contrast. The twelve target words are enclosed in gray squares in (3).

(3) Japanese text read by participants
今日は自転車で広いデパートへ買い物に行きました。ビルの地下１階から９階までお店が沢山あります。 屋根に一本の旗がそっと揺れています。 洋服屋でセールをやっていたので、ワンピースとキャミソールを一着ずつ買いました。 ワンピースは ベージュで、肩に緑の

葉っぱとリボンが付いています。次に、文房具屋で、青いペン、雑誌と消しゴムを買った時、店員さんに飴をもらいました。病気で一緒に行けなかった娘に子供売り場で大好きな象のぬいぐるみを買ってあげました。そして、北陸新幹線の切符を買いました。来週は夫と娘と三人で金沢を旅行する予定です。その後は、美容院に予約を取りに行ったら、 ずっと会えていなかった友達に偶然会いました。昔二人で中国へ留学したことは、一生の思い出です 。二人で牛乳入りの紅茶を飲みながら、学校で好きだった授業の話に夢中になりました。帰る時は、外は雨が降っていました 。傘は持っていなくて、そのままじゃちょっと帰りづらかったので、バーでビールをのみながら雨が止むのを待ちました。

'Today I went to the department store by bicycle. It's a huge department store with many shops from the basement floor to the 9th floor. Today there is a flag softly swaying on its rooftop. I entered the department store and there were promotions at the clothes store so I bought one dress and one camisole. The dress has a beige ribbon on the shoulder and the camisole a green leaf pattern. Next, when I bought a blue pen, a magazine and an eraser at the stationeries shop, the salesman gave me some candy. At the kids floor, I bought a stuffed elephant for my daughter who is sick and couldn't come with me. After that I bought train tickets for the Hokuriku bullet train. Next week, my daughter, my husband and I are visiting Kanazawa. After that, I went to the hairdressers to make a reservation and met a friend that I haven't seen in years. A long time ago we were together in an exchange program in China. We talked about the classes we used to like back at school and about our dreams, while drinking tea. When we decided to go home, it was raining outside and the wind was so strong that it would have been difficult to go outside like that. So my friend and I went to a bar and drank beer while waiting for the rain to stop.'

Twelve target words are summarized in (4). Two examples come from each of the following conditions: place of articulation (labial, coronal, dorsal), preceding vowel (short or long), or following vowel (short or long). The surrounding phonological conditions of the target stimuli are unbalanced because the original text was designed to measure fluency. We believe, however, that the nature of the text masked the intention of this experiment from the speakers, eliciting natural pronunciation by reducing task effects.

The recordings were processed using a series of Praat scripts that semi-automatized the process of extracting measurements. The onset and offset of closure duration and vocalic portion were manually annotated. Duration from these intervals were then extracted yielding the closure duration of singleton and geminate and the duration of a preceding vowel and a following vowel of each consonant.

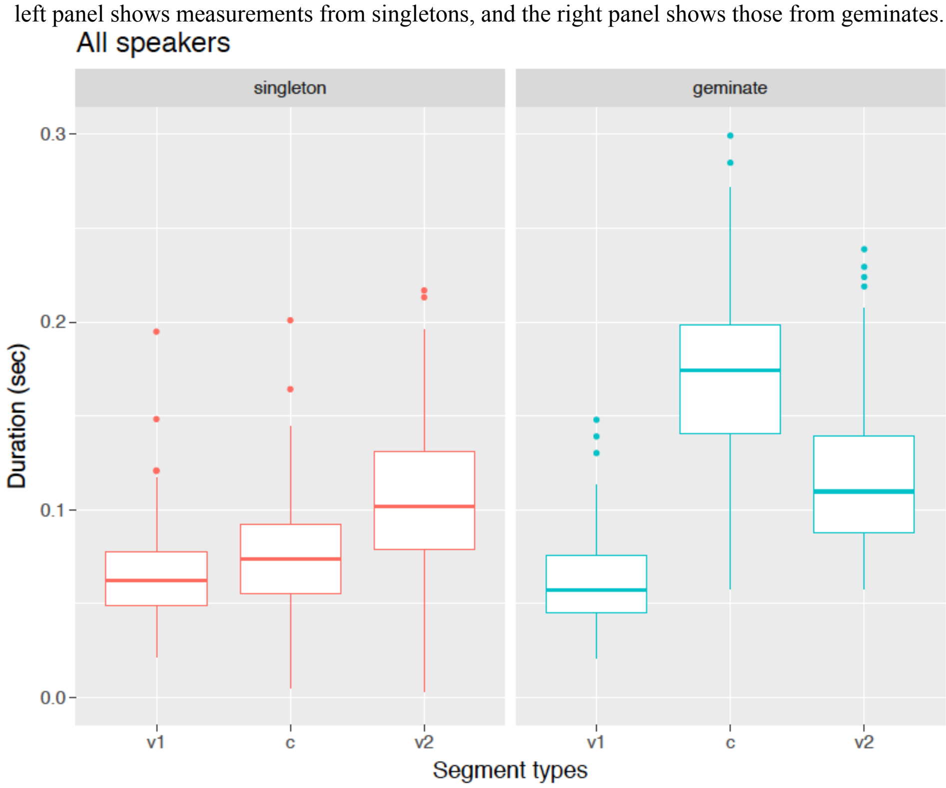
(4) Phonological conditions of target words

	singleton				geminate			
		gloss	V1	V2		gloss	V1	V2
labial	/wanpi:su/	*dress*	short	long	/kippu/	*ticket*	short	short
	/depa:to/	*department*	short	long	/happa/	*leaf*	short	short
coronal	/soto/	*outside*	short	short	/sotto/	*softly*	short	short
	/ɸɯtaɽi/	*two people*	short	short	/ittara/	*went*	short	short
dorsal	/ɽjokou/	*travel*	short	long	/gakkou/	*school*	short	long
	/takɯsaɴ/	*much*	short	short	/ikkai/	*1st floor*	short	short

When results from all participants are examined, geminates have longer closure duration that singletons ($p<0.01$). Preceding vowels (v1) and following vowels (v2) are similar in terms of their duration.

Figure 1.

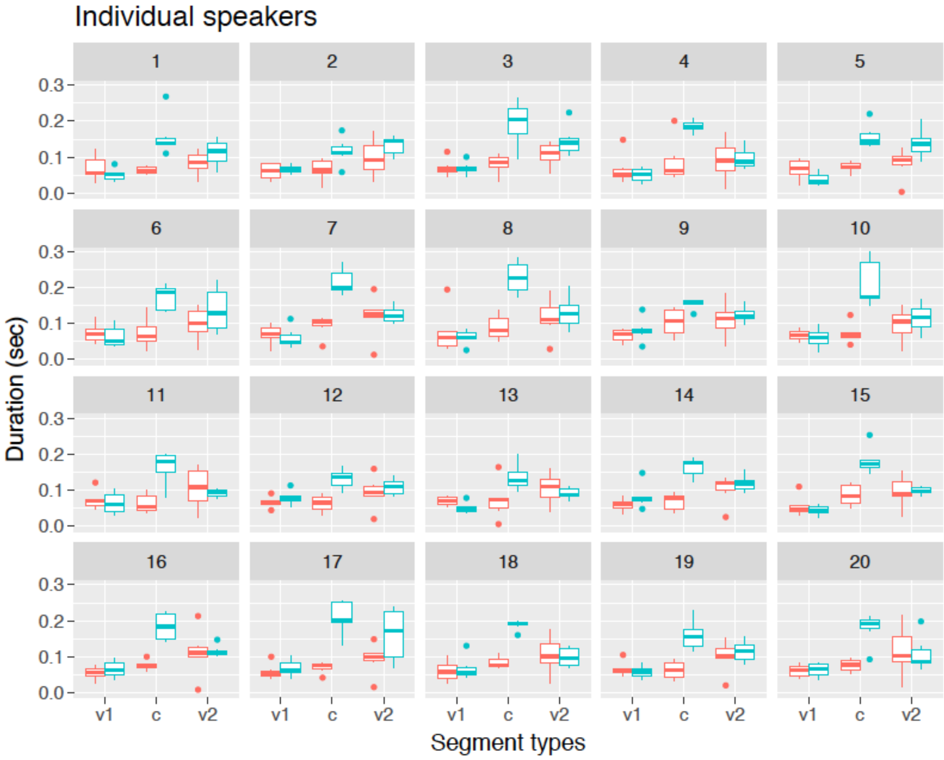
The duration of closure (c), preceding vowel (v1) and following vowel (v2) from all speakers. The left panel shows measurements from singletons, and the right panel shows those from geminates.



When individual participants are examined as shown in figure 2, a more comprehensive picture emerges. The closure duration of geminates is twice as long as that of singletons in all participants even though the duration was not as long as L1 Japanese speakers (cf. Ohta et al. 2009). In the target words in our study, most preceding vowels (v1) are short (eleven out of twelve). If the participants produce preceding vowels similar to L1 Japanese speakers, we expect that the duration of a vowel in the pre-singleton condition be shorter than that in the pre-geminate condition. However, the results show that the duration of preceding vowels is identical, or in some cases, the duration of the vowel before a geminate is shorter than before a singleton; such a pattern is different from L1 Japanese speakers (cf. Kawahara 2015).

Figure 2.

The duration of closure (c), preceding vowel (v1) and following vowel (v2) of each speaker. For a speaker, the left panel comes from singletons and the right panel comes from geminates.



The target words are more unbalanced when it comes to the following vowel (v2): seven of them are short and five of them are long. L1 Japanese speakers show post-geminate lengthening, so we would expect at least some lengthening effect after geminates if participants utilize a similar phonetic profile as L1 Japanese speakers. The results in figure 2 show that the average duration of v2 is very similar after a singleton and after a geminate, which suggest that there is no lengthening effect.

We also examined the vowel duration between short and long vowels, which is also an important phonological contrast in Japanese. It turns out that some speakers (in particular #5, #7, #12, #14, #16, #17) have no clear length distinction between a short vowel and a long vowel after the singleton, which may be a confounding factor of the current experimental stimuli.

The results were further tested using a linear mixed model in order to examine the effect of various factors. In particular, we were interested in the following four hypotheses in (5).

(5) Hypotheses tested in a linear mixed model analysis
   a. Is the duration of closure (c) different in geminates vs. singletons?
   b. Is the duration of v1 in geminates shorter than the duration of v2?
   c. Is the duration of v2 in singletons shorter than the duration of v1?
   d. What is the effect of gender, POA of a consonant, length of v1 or v2, or comprehensibility given (b) and (c)?

A linear mixed model fit using the REML method was used to predict the dependent variable, closure duration. An initial model had "Type" ("geminate" vs. "singleton") as the only fixed effect and "Speaker" as a random intercept. In order to test whether other factors may affect closure duration, similar models with one additional effect for each of Place of Articulation ("POA"), Gender and Comprehensibility were also considered. Likelihood ratio tests were performed to assess whether each additional factor was significant.

Model 2 with POA included as a fixed effect provided a better fit for the closure duration than the initial nested model in a likelihood ratio test ($\chi^2(2) = 10.84$, $p < 0.01$)). This indicates that POA significantly affects closure duration. Next, a likelihood ratio test was performed comparing model 2 with similar models that included fixed effects for gender and comprehensibility. The likelihood ratio test indicated that neither gender ($\chi^2(1) = 0.085$, $p = 0.77$), nor comprehensibility ($\chi^2(2) = 2.46$, $p = 0.29$) significantly affected closure duration.

A final model was considered that included a fixed effect for the interaction between Type and POA. A likelihood ratio test compared this final model with model 2, finding that the interaction between Type and POA significantly affects closure duration ($\chi^2(2) = 15.54$, $p < 0.001$). As a result, model 5 was selected as the optimal model. Geminates involved significantly longer closure than singletons ($\beta = 0.113$, $t = 10.405$, $p < .0001$). However, dorsal geminates had significantly shorter closure times than other geminates ($\beta = -0.038$, $t = -2.49$, $p < .05$). A summary of the model 5 results is given in Table 1 below; t-tests use Satterthwaite's method. Closure duration is plotted by POA and Type in Figure 3 below.

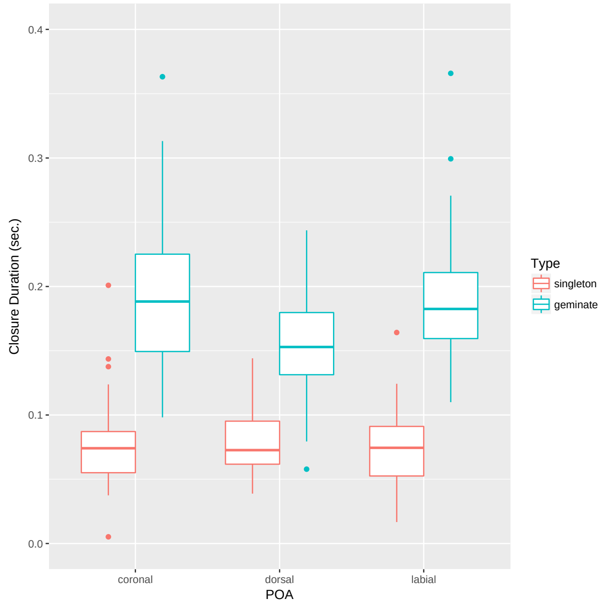
Table 1

Summary of the mixed effects model for consonant closure duration

Predictor	Coefficient (sec.)	SE coefficient	t-value	p
Intercept	0.077	0.0084	9.197	<.0001
Type – Geminate (Singleton baseline)	0.113	0.0109	10.405	<.0001
POA – Dorsal (Coronal baseline)	0.0003	0.011	0.026	0.98
POA – Labial (Coronal baseline)	–0.0046	0.011	–0.42	0.67
Type – Geminate x POA – Dorsal	–0.038	0.015	–2.49	<.05
Type – Geminate x POA – Labial	0.022	0.015	1.43	0.16

Figure 3.

Closure duration of singletons and geminates in three places of articulation.



Vowel duration depended on vowel length, position relative to the consonant and place of articulation of the consonant. Initial investigation showed that vowel durations around dorsal consonants behaved very differently with respect to the factors being tested. As a result, the data was split with one part containing data for labial and coronal consonants, and the other part containing data for dorsal consonants.

Vowel durations with coronal and labial consonants depended only on Position and Length. The optimal mixed model is summarized in Table 2 and Figure 4. Vowels had longer duration following a consonant than preceding it ($\beta = 0.052$, $t = 16.085$, $p < .0001$). Additionally, short vowels had shorter duration than long vowels ($\beta = -0.031$, $t = -7.474$, $p < .0001$).

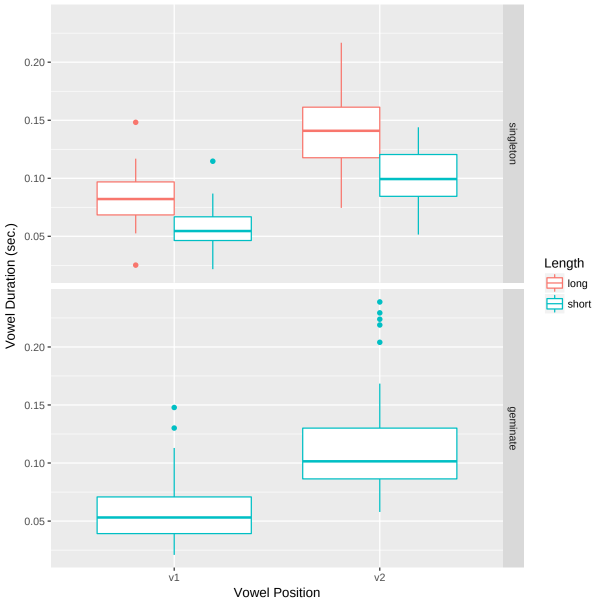
Table 2

Summary of the mixed effects model for vowel duration with labial and coronal consonants

Predictor	Coefficient (sec.)	SE coefficient	t-value	p
Intercept	0.087	0.0044	19.923	<.0001
Segment – v2 (v1 baseline)	0.052	0.0033	16.085	<.0001
Length – short (long baseline)	–0.031	0.0042	–7.474	<.0001

Figure 4[1].

Vowel duration with coronal & labial consonants by position, consonant type and vowel length



The hypothesized interaction between Type and Vowel Position was tested by

1 There were no long vowels co-occurring with geminate labials or coronals.

comparing the above model with a similar model that contained an interaction between Type & Position. A likelihood ratio test showed that there was no significant interaction effect (χ^2 (2) = 2.196, p = 0.33)). Notably, consonant type was absent from the optimal model, indicating that there is no difference in vowel durations with geminates or singletons, as can be confirmed by inspecting Figure 4.

Regarding other potential effects, neither gender (χ^2(1) = 0.2716, p = 0.60)), nor comprehensibility (χ^2(2) = 2.821, p = 0.24)) were found to have significant effects on vowel duration in likelihood ratio tests with similar models containing those effects.

In the partition containing only dorsal consonants, again main effects of vowel position and length were discovered. This time, however, the effect of vowel position was negative, with shorter vowel duration following the consonant (β = –0.045, t = –6.350, p < .0001). Due to sparsity in the collected data, this observation can only be observed in Figure 5 below in short vowels with singleton dorsal consonants. As before, short vowels had significantly shorter duration than long vowels (β = –0.074, t = –9.012, p < .0001). In addition to these main effects, an interaction between segment and type was found, as hypothesized: Vowel duration was longer when following a geminate, than otherwise expected (β = 0.032, t = 3.494, p < .001). Due to data sparsity, we can only observe this in a long vowel following a dorsal consonant. This is the only case where a difference in vowel duration is seen depending on whether a consonant is a geminate or a singleton; this is shown in Figure 6. We can see in Figure 5, that the experiment included a contrast in short vowels preceding both singletons and geminates, with no difference in the vowel duration. Correspondingly, there was no main effect of Type (β = 0.001, t = 0.235, p = 0.81).

Table 3

Summary of the mixed effects model for vowel duration with dorsal consonants

Predictor	Coefficient (sec.)	SE coefficient	t-value	p
Intercept	0.144	0.0093	15.553	<.0001
Segment – v2 (v1 baseline)	–0.045	0.0071	–6.350	<.0001
Type – geminate (singleton baseline)	0.001	0.0058	0.235	0.81
Length – short (long baseline)	–0.074	0.0082	–9.012	<.0001
Segment – v2 x Type – geminate	0.032	0.0092	3.494	<.001

Figure 5.

Vowel duration with dorsal consonants by position, consonant type and vowel length

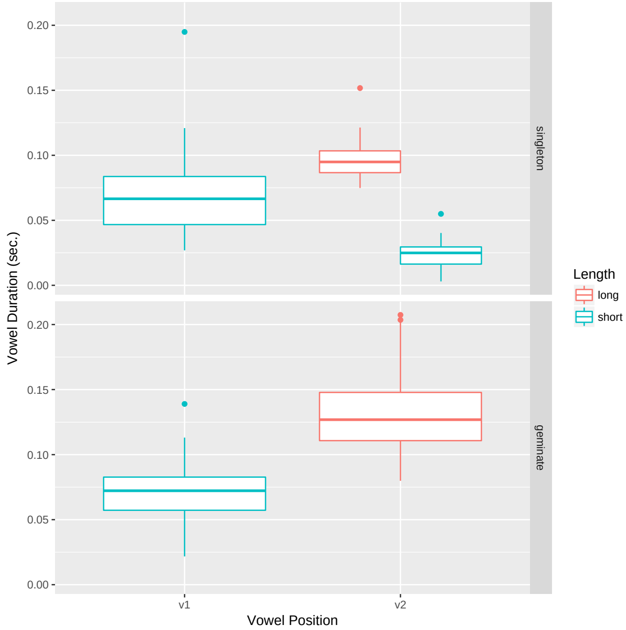
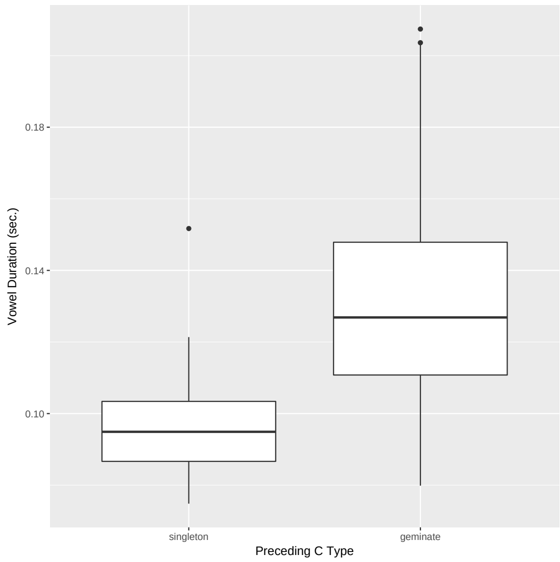


Figure 6.

Vowel duration in long vowels following singleton and geminate dorsals



In addition, to the main effects reported above, effects for gender and comprehensibility were investigated with no significant effect found for either in likelihood ratio tests (gender: $\chi^2(1) = 0.1877$, $p = 0.66$; comprehensibility: $\chi^2(2) = 0.4032$, $p = 0.82$).

In sum, the LMM results reconfirm that the closure duration in singleton is shorter than that of geminates, regardless of place of articulation and speaker variation. The vowel duration before and after labials or coronals has no difference, which suggests that the participants are not following the patterns shown in L1 Japanese speakers: pre-geminate lengthening and post-geminate shortening. The pattern in dorsal consonants shows that participants produce vowel length in the opposite way from L1 Japanese speakers; post-geminate vowels are longer than post-singleton vowels when the vowel is long. Pre-geminate vowels are not different from pre-singleton vowels in terms of duration, which is also different from L1 Japanese speakers. Thus, our study suggests that the relative vowel duration before and after geminates may contribute more to the difficulty in comprehensibility, than the production of the closure duration itself.

IV. Conclusion

We want to stress that the speech by the participants, Chinese learners of L2 Japanese, was intelligible, but it was not always easy to listen to (difficult comprehensibility) as judged by the second author. The results of the LMM model reveal the importance of vowels surrounding target consonants. The locus of difficult comprehensibility was not the closure duration between singletons and geminates, which were produced relatively well by the L2 participants. What seems to be the locus of the difficult comprehensibility may stem from differences in the vowel duration preceding and following geminates.

These findings show that we need to consider what is important in teaching the pronunciation of Japanese geminates in an L2 classroom. Learners seem to have no problem in producing longer closure duration for geminates, which suggest that the 0.6-second-stop closure rule is effective. The question then is how educators can improve the pronunciation of the learners. Our study suggests that a focus on surrounding vowels be implemented in the classrooms. Teachers may use audio stimuli and ask students to discriminate original speech and manipulated speech that has shorter or longer vowel duration. If students can identify the difference, they could adopt the knowledge in their production of L2 speech. This type of awareness task on vowel duration may assist the acquisition of geminate production (cf. Hardison & Motohashi-Saigo 2010).

This study is the start of a larger project. We plan to run perception tests with L1 Japanese speakers, asking them to judge intelligibility and comprehensibility of speech produced by Chinese L2 learners of Japanese. As the goals of pronunciation education moves beyond accuracy, more studies that are based on phonetic findings of L1 are called for. Identifying the exact locus of L2 pronunciation will allow researchers and educators alike to develop how learners in general pattern when it comes to non-native contrast in the target language.

REFERENCES

Boersma, Paul (2001). Praat. *Glot International* 5: 341-345.

Derwing, T. M., M. J. Munro. (2015). *Pronunciation Fundamentals: Evidence-Based Perspectives for L2 Teaching and Research*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Foote, J.A., A.K. Holtby, T.M. Derwing (2011). Survey of the teaching of pronunciation in adult ESL programs in Canada, 2010. *TESL Canada Journal* 29(1): 1-22.

Gick, Bryan, Ian Wilson, Donald Derrick. (2013). *Articulatory Phonetics*. Wiley-Blackwell.

Guillemot, Celeste (2018). Examining Japanese L2 learners' pronunciation: A Japanese oral proficiency test" *Educational Studies* 60: 127-132.

Hardison, Debra, Miki Motohashi-Saigo. (2010). Development of perception of second language Japanese geminates: Role of duration, sonority, and segmentation strategy. *Applied Psycholinguistics* 31: 81-99.

Hirata, Yukari (2017). Second language learners' production of geminate consonants in Japanese. In: Kubozono, Haruo (ed.) *The Phonetics and Phonology of Geminate Consonants*. Oxford University Press. 162-183.

Idemaru, K., S. G. Guion. (2008). Acoustic covariants of length contrast in Japanese stops. *Journal of International Phonetic Association* 38(2): 167-186.

Idemaru, K., S. Guion-Anderson. (2010). Relational timing in the production and perception of Japanese singleton and geminate stops. *Phonetica* 67(1-2): 25-46.

Kawahara, Shigeto (2006) Mimetic gemination in Japanese: A challenge for Evolutionary Phonology. *Theoretical Linguistics* 32(3): 411-424.

Kawahara, Shigeto (2015). The phonetics of sokuon, obstruent geminates. In Haruo Kubozono (ed.) *The Handbook of Japanese Language and Linguistics: Phonetics and Phonology*. Mouton. 43-73.

Kuhl, Patricia K., E. Stevens, A. Hayashi, T. Deguchi, S. Kiritani and P. Iverson (2006). Infants show a facilitation effect for native language phonetic perception between 6 and 12 months. *Developmental Science* 9: F13-F21.

Lahiri, Aditi and Jorge Hankamer. (1988) The timing of geminate consonants. *Journal of Phonetics* 16: 327-338.

Lee, Albert, Peggy Mok. (2016). Durational correlates of Japanese phonemic quantity contrasts by Cantonese-speaking L2 learners. *Speech Prosody 2016*: 597-601.

Lee, Junkyu, Juhyun Jang, Luke Plonsky (2014). The effectiveness of second language pronunciation instruction: A meta-analysis. *Applied Linguistics* 36 (3), 345-366.

Mah, Jennifer, John Archibald. (2003). Acquisition of L2 Length Contrasts. *Proceedings of the 6th Generative Approaches to Second Language Acquisition Conference* (GASLA 2002), ed. Juana M. Liceras et al., 208-212. Somerville, MA: Cascadilla Proceedings Project.

Masuda, Kyoko. (2009). Influence of L2 on the acquisition of Japanese mora timing by native speakers of English and Korean. *Nihongo Kyouiku* (Journal of Japanese Language Teaching) 141: 3-13.

Mazuka, Reiko. (2012). "Nyuji no onsei hattatsu" (In Japanese). (Development of infant speech perception). *The Journal of the Acoustical Society of Japan*, 68(5), 241-247.

Ofuka, E., Y. Mori, S. Kiritani. (2005). Sokuon no chikaku ni taisuru senkoo koozoku boinnchoo no eikyoo. [Perception of Japanese geminate stop: the effect of the duration of the preceding / following vowels]. *Journal of the phonetic society of Japan* 9-2, 59-65.

Ohta, Eiji, Steven Snyder, Makoto Kariyasu. (2009). Acoustic phonetic features of Japanese geminate consonant and elongated vowel produced by non-native Japanese learners: case study of temporal coordination of English/Chinese native speaker. *Journal of Kyushu University of Health and Welfare* 10, 181-186.

Tajima, Keiichi, Kuniyoshi Tanaka, Andrew Martin, Reiko Mazuka. (2013). Is the mora rhythm of Japanese more strongly observed in infant-directed speech than in adult-directed speech? *The Journal of the Acoustical Society of America* 133(5):3341.

Lee, Seunghun J.
Associate Professor of Linguistics
Dept. of Psychology and Linguistics at International Christian University
3-10-2 Osawa Mitaka
Tokyo 181-8585 Japan
Tel: +81 (0)422-33-3243
Email: seunghun@icu.ac.jp

Received on 29 May 2018
Reviewed on 4 June 2018
Accepted on 10 June 2018