HOW DO L1 MANDARIN CHINESE LEARNERS PRODUCE L2 ITALIAN SINGLETON/GEMINATE CONSONANT CONTRAST?

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This study investigates L1 Mandarin Chinese - L2 Italian learners' production of Italian singleton/geminate consonant contrast. 30 Chinese undergraduate students that varied in their Italian learning experience (10 first-year, 10 second-year and 10 third-year) and 10 native Italian speakers took part in a production experiment. They read, both in isolation and in carrier-sentences, 5 disyllabic minimal pairs contrasting in consonant length. Durations of target intervocalic consonants and preconsonantal vowels were measured and converted into duration ratios for statistical analyses. The results show that the Chinese learners were able to produce short-long differences for Italian singleton vs. geminate consonants, though their duration ratios were significantly smaller than those of the native speakers. As for preconsonantal vowels, while the native Italian speakers alternated between short vowels before geminate consonants and long vowels before singletons, the Chinese learners did not distinguish between pre-singleton and pre-geminate vowel durations. Moreover, though the three groups of Chinese learners had different learning experiences, they did not differ significantly in their productions of Italian consonant length contrast. These results indicate that, for Chinese learners, the mastery of Italian consonant length contrast represents a challenge and that an increased learning experience may not help.

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INTRODUCTION

Previous studies have shown that the acquisition of L2 consonant length contrast represents a challenge for L1 Mandarin Chinese learners (henceforth Chinese learners). However, many studies have focused on L2 Japanese (e.g., Lee et al., 2018; Lu et al., 2016; Minagawa-Kawai & Kiritani, 1998; Yamakawa et al., 2021), while L2 Italian is much less investigated. To fill this gap, the present study investigates the production of Italian singleton and geminate consonants by Chinese learners.

In Italian there is a large number of disyllabic minimal pairs contrasting in consonant length (e.g., *nono* 'ninth' vs. *nonno* 'grandfather', *caro* 'dear' vs. *carro* 'wagon', etc.). These consonants can be stops (/b, d, g, p, t, k/), affricates (/tʃ, dʒ/), fricatives (/f, v, s/), nasals (/m, n/) and liquids (/l, r/), occurring in intervocalic position (for stops, see Esposito & Di Benedetto, 1999; for affricates and fricatives, see Di Benedetto & De Nardis, 2020a; for nasals and liquids, see Di Benedetto & De Nardis, 2020b). In all cases, geminate consonants are longer than their singleton counterparts. At a regular speaking rate, geminate to singleton duration ratios vary from less than 2:1 (in affricates

and fricatives) to greater than 2:1 (in stops, nasals and liquids).

Italian geminate consonants are usually considered ambisyllabic (Payne, 2005). That is, the two consonants are treated respectively as the coda of the preceding syllable and the beginning of the following one. Therefore, for Italian disyllabic minimal pairs contrasting in consonant length, the first syllables are closed in geminate words and open in singleton words. Since in Italian vowels are short in closed syllables and long in penultimate stressed open syllables (Kramer, 2009), in Italian disyllabic minimal pairs contrasting in consonant length, pre-geminate vowels, which are in closed syllables, are always shorter than the corresponding pre-singleton ones, which are in open syllables. The reduction ratios vary from –25% (in affricates) to –41% (in liquids).
On the other hand, in Mandarin Chinese, there is no consonant (and vowel) length distinction at the phonemic level. Among all Mandarin Chinese consonants, only /n/ and /ŋ/ can occur in syllabic coda position; while /ŋ/ cannot occur in onset position (Duanmu, 2007). Therefore, when a syllable with nasal coda /n/ is followed by another syllable with nasal onset /n/ (e.g., <半年> *bannian*, 'half year', /pannjɛn/), together they form a "fake" or "derived" geminate consonant. However, it should be noted that "the potential for fake geminates in Mandarin is very restricted as it only occurs through concatenation of words with identical nasals across syllables in phrases or disyllabic compounds" (Meng et al., 2021: 3). Therefore, following Tsukada et al. (2014), Mandarin Chinese speakers can be considered "quantity-insensitive".

Regarding L2 Italian, to our knowledge Costamagna et al. (2014) is the only empirical study that has investigated the production of Italian singleton and geminate consonants by Chinese learners. In this study, Italian disyllabic minimal pairs contrasting in consonant length were produced with correct geminate and singleton consonants respectively 53% and 86% of the times by B1-level Chinese learners; and with correct geminate and singleton consonants respectively 62% and 79% of the times by C2-level learners. Therefore, the authors conclude that linguistic competence does not greatly affect the productions of Chinese learners, who have more difficulty pronouncing correctly Italian geminate than singleton consonants. As for preconsonantal vowels, the average duration ratios between pre-singleton vowels and singleton consonants were 1.25 for Chinese learners and 1.39 for native Italian speakers; the ratios between pre-geminate vowels and geminate consonants were 1.04 and 0.69 respectively for the learners and the native speakers. Based on this, the authors argue that Chinese learners, attempting to produce geminate consonants, lengthen also the pre-geminate vowels. Thus, in terms of preconsonantal vowel duration, it appears that Chinese learners' gemination strategy is the opposite to that of native Italian speakers.

However, the above conclusions are based on a small sample size of Chinese learners (5 of B1 level and 6 of C2 level) and have no support of statistical tests. Thus, the validity of the authors' arguments might be under question. The present investigation aims to throw more light on how Chinese learners produce Italian singleton/geminate consonant contrast by addressing the following research questions:

RQ1 How do L1 Mandarin Chinese learners produce L2 Italian singleton vs. geminate consonant contrast?

RQ2 Do Chinese learners produce duration differences in preconsonantal vowels in Italian consonant length contrast?

RQ3 Are Chinese learners with more learning experience better at acquiring Italian consonant length contrast than those with less experience?

METHODS

To address the questions above, a production experiment was run.

Participants

The experiment had 30 Chinese learners and 10 native Italian speakers as participants. The 30 Chinese learners were undergraduate students majoring in Italian at Dalian University of Foreign Languages in China, subdivided according to their L2 Italian learning experience as follows: 10 first-year students (1MC group: Female = 9, Male = 1, Mean age = 19.1), 10 second-year students (2MC group: Female = 10, Male = 0, Mean age = 19.9), and 10 third-year students (3MC group: Female = 8, Male = 2, Mean age =20.9). The 10 native Italian speakers (NIT group: Female = 7, Male = 3, Mean age = 21.8) were undergraduate students from the Veneto region in the North-East of Italy. Northern Italian speakers are generally believed to tend to degeminate consonants (e.g., Canepari & Giovannelli, 2008; Cavanaugh, 2005); however, Mairano & De Iacovo (2020) show that this is not the case.

Stimuli

The target word stimuli were five high-frequency disyllabic minimal pairs contrasting in consonant length (a total of 10 words, see Table 1). The target consonants consisted of voiceless stops /p, t, k/, nasal /n/ and lateral /l/. The target word stimuli were first repeated twice randomly in isolation. They were then inserted in the carrier-sentences (*Leggo* ___ *bene* 'I read ___ well') and repeated twice in random order. The stimuli in isolation and in the carrier-sentences were printed on a paper sheet for the subjects to read.

Table 1

Target word stimuli for the production experiment

Consonant	Target word stimuli
/p/	*papa* 'pope' vs. *pappa* 'pulp'
/t/	*dita* 'fingers' vs. *ditta* 'company'
/k/	*Luca* 'person's name' vs. *Lucca* 'city's name'
/n/	*pena* 'penalty' vs. *penna* 'pen'
/l/	*pala* 'shovel' vs. *palla* 'ball'

Procedure

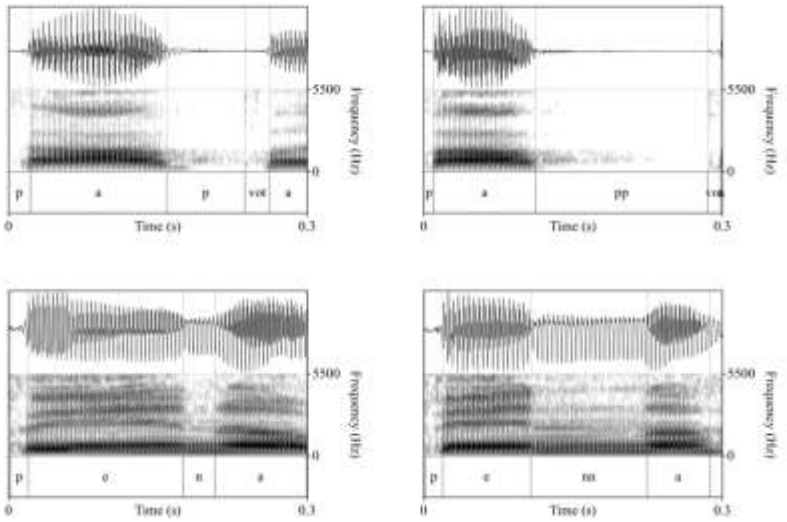
The participants were asked to read the stimuli at a normal speed. After every 20 words/sentences, there was a cartoon picture to remind the participants to have a short break. The recordings of the native Italian speakers took place in the Language and Communication Lab of the University of Padova in Italy, using a Roland R09 voice recorder with a sampling rate of 44.1 kHz and 16-bit resolution. The recordings of the Chinese learners were administered in a quiet setting at Dalian University of Foreign Languages in China, using a Zoom H4n Pro voice recorder with a sampling rate of 44.1 kHz and 16-bit resolution.

Annotation and Measurements

The target intervocalic consonants and preconsonantal vowels were first labeled in Praat (Boersma & Weenink, 2020). As shown in Esposito & Di Benedetto (1999), closure duration is the primary cue for gemination in Italian stops. Therefore, the stop consonants in the present experiment were labeled from the offset of the preceding vowel to the release burst of the stop consonant; the VOT was not included. The lateral and nasal consonants were labeled from the offset of the preceding vowel to the onset of the following vowel. See Figure 1 for some sample graphs illustrating how the annotation was made in Praat. Afterwards, the durations of the target consonants and preconsonantal vowels were extracted using a Praat script (Lennes, 2002).

Figure 1

Acoustic waveforms and spectrograms at a 300 ms time scale of (i) papa 'pope' (upper left panel); (ii) pappa 'pulp' (upper right panel); (iii) pena 'penalty' (bottom left panel); and (iv) penna 'pen' (bottom right panel) produced by the participant IT-7 in the IT group.



Analyses

Following Lee & Mok (2018) that addressed the production of L2 Japanese quantity contrasts by L1 Cantonese speakers, the duration values were converted into duration ratios for statistical analyses. A total of 1600 target tokens were elicited (10 target word stimuli X 2 contexts X 2 repetitions Í 40 participants = 1600). Of these tokens, half had intervocalic singleton consonants, the other half had intervocalic geminate consonants. Therefore, we should have had 800 geminate to singleton consonant duration ratios and 800 pre-singleton to pre-geminate vowel duration ratios. However, in measuring duration values, 56 unmeasurable /misread tokens with intervocalic consonants (26 singletons, 30 geminates) and 61 unmeasurable /misread tokens with preconsonantal vowels (28 pre-singleton and 33 pre-geminate) were discarded. Thus, in converting duration values to duration ratios, because of the abovementioned missing values, we obtained 751 effective consonant duration ratios and 747 effective preconsonantal vowel duration ratios for statistical analyses.

Two linear mixed models (LMM) were applied respectively to the consonant and preconsonantal vowel duration ratios using the lme4 package 1.1.26 (Bates et al., 2015) in R 3.6.3 (R Core Team, 2020), with Group (four levels: 1MC, 2MC, 3MC, NIT), Context (two levels: in isolation, in carrier-sentence) and their interaction as fixed factors, and Subject and Item as random intercepts. The assessments of the main effects of the fixed factors were performed with the Type II Wald chi-squared tests using the car package 3.0.10 (Fox & Weisberg, 2019). Post-hoc pairwise comparisons with FDR (false discovery rate) correction were conducted using the emmeans package 1.5.3 (Lenth, 2020).

RESULTS

Consonant Duration Ratios

Table 2 lists the duration values of the consonants produced by the 1MC, 2MC, 3MC and NIT groups and their geminate to singleton consonant duration ratios. For a visual representation of the consonant duration ratios, see Figure 2. As Table 2 and Figure 2 show, both in isolation and in the carrier-sentences, all of the four groups had longer durations for geminate than for singleton consonants. However, the NIT group had greater consonant duration ratios than the other three groups. Besides, in terms of duration value, the singleton consonants produced by the 1MC, 2MC, 3MC groups were consistently much longer than those of the NIT group, while the four groups' geminate consonants had durations that did not differ to a great extent both in isolation and in the carrier-sentences.

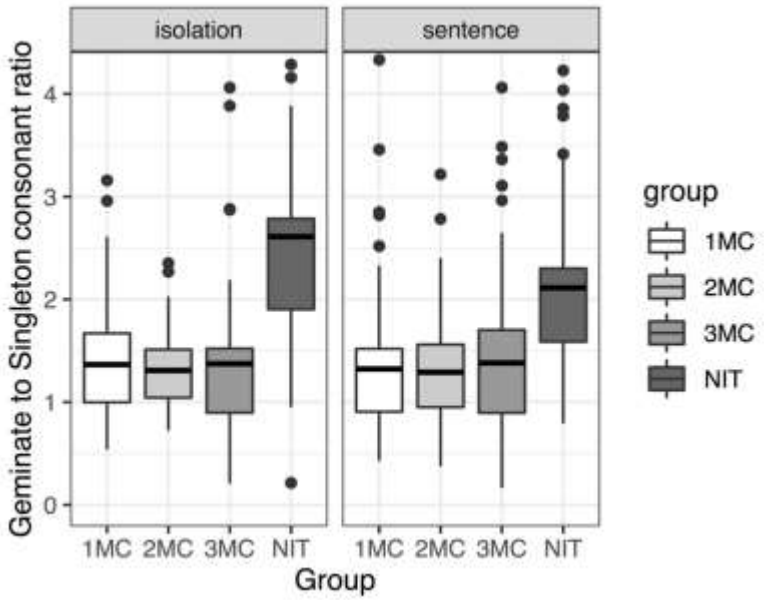
Table 2

Mean consonant durations (ms; SDs in parentheses) and mean geminate to singleton consonant duration ratios (G:S ratio; SDs in parentheses) of the 1MC, 2MC, 3MC and NIT groups

	In isolation			In carrier-sentence		
	Singleton	Geminate	G:S ratio	Singleton	Geminate	G:S ratio
1MC	131.2 (41.7)	171.6 (66.9)	1.37 (0.53)	100.3 (55.3)	122.7 (64.1)	1.32 (0.68)
2MC	143.4 (45.0)	182.3 (58.7)	1.31 (0.35)	105.0 (39.6)	128.2 (53.2)	1.29 (0.52)
3MC	140.0 (75.8)	169.5 (78.0)	1.37 (0.83)	106.7 (46.8)	134.3 (71.5)	1.38 (0.72)
NIT	80.5 (28.0)	183.5 (43.2)	2.61 (1.48)	69.6 (22.4)	133.3 (33.0)	2.11 (0.93)

Figure 2

Distribution of the geminate to singleton consonant duration ratios of the 1MC, 2MC, 3MC and NIT groups



For the statistical analyses, the consonant duration ratios were first normalized using the bestNormalize package 1.7.0 (Peterson & Cavanaugh, 2020). After fitting the LMM, the visual diagnostics of the histogram and the plot of residuals showed no drastic violations of the assumptions of normality and homoscedasticity.

The LMM yielded significant main effects on Group ($\chi^2(3) = 82.34$, $p < .0001$) and Context ($\chi^2(1) = 7.37$, $p = 0.0066$), indicating that the participants' consonant duration ratios differed significantly by these two factors. Post-hoc pairwise comparisons revealed that, first, all three learner groups had significantly smaller consonant duration ratios than the NIT group (1MC vs. NIT: $\beta = -1.17$, $SE = 0.17$, $t(43.9) = -7.01$, $p < .0001$; 2MC vs. NIT: $\beta = -1.14$, $SE = 0.17$, $t(42.7) = -6.94$, $p < .0001$; 3MC vs. NIT: $\beta = -1.18$, $SE = 0.17$, $t(42.6) = -7.19$, $p = p < .0001$); second, there were no significant differences across the learner groups (1MC vs. 2MC: $\beta = -0.02$, $SE = 0.17$, $t(44.4) = -0.13$, $p = 0.91$; 1MC vs. 3MC: $\beta = 0.02$, $SE = 0.17$, $t(44.4) = 0.11$, $p = 0.91$; 2MC vs. 3MC: $\beta = 0.04$, $SE = 0.17$, $t(43.2) = 0.24$, $p = 0.91$); third, the participants had larger consonant duration ratios for the words produced in isolation than for those produced in the carrier sentences ($\beta = 0.15$, $SE = 0.06$, $t(712) = 2.65$, $p = 0.0083$). Also, there was no significant interaction between Group and Context ($\chi^2(3) = 6.61$, $p = 0.085$), indicating that the differences in consonant duration ratio between groups did not vary by context.

The results show that, both in isolation and in the carrier-sentences, the Chinese learners were able to produce short-long differences for Italian singleton vs. geminate consonants. Nevertheless, their geminate to singleton duration ratios were always significantly smaller than those of the native Italian speakers. Also, though the Chinese learners had different learning experiences, they performed in a similar fashion in producing Italian geminate to singleton consonant duration ratios.

Preconsonantal Vowel Duration Ratios

The duration values of the preconsonantal vowels produced by the 1MC, 2MC, 3MC and NIT groups and their pre-singleton to pre-geminate vowel duration ratios are shown in Table 3; see Figure 3 for a visual representation of the preconsonantal vowel duration ratios. As Table 3 and Figure 3 show, both in isolation and in the carrier-sentences, only the NIT group had pre-singleton to pre-geminate vowel duration ratios greater than 1. The preconsonantal vowel duration ratios of the other three groups hovered around 1. This means that only the NIT group produced pre-singleton vowels longer than pre-geminate vowels.

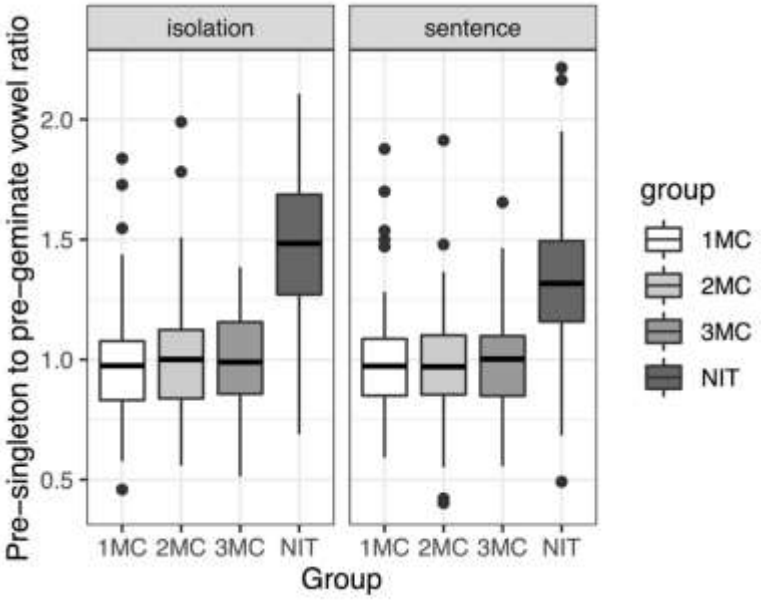
Table 3

Mean preconsonantal vowel durations (ms; SDs in parentheses) and mean pre-singleton to pre-geminate vowel duration ratios (PS:PG ratio; SDs in parentheses) of the 1MC, 2MC, 3MC and NIT groups

	In isolation			In carrier-sentence		
	pre-singleton	pre-geminate	PS:PG ratio	pre-singleton	pre-geminate	PS:PG ratio
1MC	189.8 (51.9)	198.9 (52.7)	0.97 (0.24)	154.4 (40.7)	161.1 (39.0)	0.97 (0.23)
2MC	167.8 (52.9)	176.8 (62.7)	1.00 (0.23)	155.0 (48.3)	167.7 (60.0)	0.97 (0.21)
3MC	147.0 (38.4)	152.5 (39.5)	0.99 (0.21)	145.4 (41.1)	151.6 (46.5)	1.00 (0.29)
NIT	149.5 (37.1)	103.7 (28.2)	1.48 (0.33)	119.3 (39.2)	90.0 (19.3)	1.32 (0.31)

Figure 3

Distribution of the pre-singleton to pre-geminate vowel duration ratios of the 1MC, 2MC, 3MC and NIT groups.



For the statistical analyses, the preconsonantal vowel duration ratios were first normalized using the bestNormalize package 1.7.0 (Peterson & Cavanaugh, 2020). After fitting the LMM, the visual diagnostics of the histogram and the plot of residuals showed no drastic violations of the assumptions of normality and homoscedasticity. The LMM yielded significant main effects on Group ($\chi^2(3) = 127.92$, $p < .0001$), Context ($\chi^2(1) = 6.13$, $p = .013$) and their interaction ($\chi^2(3) = 9.92$, $p = 0.019$).

Table 4 summarizes the results of the post-hoc pairwise comparisons. No significant between-group differences were found across the 1MC, 2MC and 3MC groups both in isolation and in the carrier-sentences. Moreover, all of the three groups were significantly different from the NIT group. Regarding the within-group analysis, only the NIT group performed differently in the two reading contexts (i.e., in isolation vs. in the carrier-sentences).

Table 4

Results of the post-hoc pairwise comparisons for preconsonantal vowel duration ratios

	Estimate	*SE*	*df*	*t* ratio	*p* value
In isolation					
1MC vs. 2MC	–0.10	0.17	86.6	–0.61	0.91
1MC vs. 3MC	–0.06	0.17	88.3	–0.37	0.91
2MC vs. 3MC	0.04	0.16	81.1	0.24	0.98
1MC vs. NIT	–1.48	0.17	84.8	–9.01	<.0001
2MC vs. NIT	–1.38	0.16	77.8	–8.56	<.0001
3MC vs. NIT	–1.42	0.16	79.2	–8.80	<.0001
In carrier-sentence					
1MC vs. 2MC	0.003	0.16	82.5	0.02	0.98
1MC vs. 3MC	–0.07	0.16	80.8	–0.46	0.91
2MC vs. 3MC	–0.08	0.16	78.8	–0.49	0.91

1MC vs. NIT	–1.05	0.16	81.0	–6.46	<.0001
2MC vs. NIT	–1.05	0.16	79.1	–6.53	<.0001
3MC vs. NIT	–0.98	0.16	77.3	–6.08	<.0001
In isolation vs. In carrier-sentence					
1MC	0.01	0.12	711.0	0.05	0.98
2MC	0.11	0.12	708.0	0.96	0.68
3MC	–0.01	0.12	708.2	–0.07	0.98
NIT	0.44	0.11	707.3	3.88	0.0002

The results show that, first, while the native Italian speakers alternated between short vowels before geminate consonants and long vowels before singletons both in isolation and in the carrier-sentences, the Chinese learners showed no difference in pre-singleton and pre-geminate vowel durations. Second, the duration differences between the pre-singleton and pre-geminate vowels produced by the native Italian speakers were more evident in isolation. Third, the Chinese learners' learning experience did not affect their production of Italian preconsonantal vowel durations.

DISCUSSION

The present study set out to investigate how L1 Mandarin Chinese learners with different learning experiences produce Italian singleton vs. geminate consonants and preconsonantal vowels.

Regarding our first research question that addresses how L1 Mandarin Chinese learners produce Italian singleton vs. geminate consonant contrast, the results suggest that although Chinese learners are not familiar with consonant length contrast through their L1 phonology, they do succeed in making short-long differences for Italian singleton vs. geminate consonants in production. There are a few plausible explanations for this. First, the duration differences between Italian singleton consonants and their geminate counterparts are over the threshold of the Just Noticeable Difference (JND) for segment duration (Payne, 2005; see Klatt (1976) and Lehiste (1970) for JND). Therefore, it may not be too difficult for Chinese learners to perceive the duration differences between Italian singleton and geminate consonants, and to apply the perceived differences to their production. Second, the orthographic form of Italian words may give Chinese learners a clue that Italian geminate consonants should be produced longer than the corresponding singleton ones. Third, it is possible that Chinese learners' Italian language instructors may give extra pedagogical attention to the production of Italian consonant length contrast, so that even the learners with only one year of learning experience manage to produce short-long differences for Italian singleton vs. geminate consonant contrast.

However, L1 Mandarin Chinese learners' significantly smaller geminate to singleton consonant duration ratios as compared to native Italians' show that they fail to approximate the L2 norms in producing Italian consonant length contrast. A closer inspection of the duration values shows that, contrary to our expectations, Chinese learners have smaller consonant duration ratios not because they produce shorter geminate consonants, but because they produce much longer singletons as compared to native Italian speakers. Since in Italian consonant length is inversely related to speaking rates (Pickett et al., 1999), we argue that this is because Chinese learners' slower speaking rates lengthen both their singleton and geminate consonants. Thus, in terms of duration value,

Chinese learners get closer to native Italian speakers in the production of geminate but not singleton consonants. However, will these longer singletons be perceived as geminates by native Italian listeners as is reported for L2 Japanese (Minagawa-Kawai & Kiritani, 1998)? Will these lengthened geminates be perceived as "true" geminates by native Italian listeners? To answer these questions, a perception experiment that involves native Italian listeners as raters is in order.

As for the second research question addressing whether L1 Mandarin Chinese learners can produce duration differences in preconsonantal vowels, our data show that unlike native Italian speakers that shorten pre-geminate vowels, Chinese learners produce Italian pre-geminate vowels as long as the corresponding pre-singleton ones. As stated before, Italian pre-geminate vowels are short because they are in closed syllables, and pre-singleton vowels are long because they are in open syllables. In fact, in Mandarin Chinese, as in Italian, vowels are short in closed syllables and long in open syllables (Duanmu, 2007). This fact therefore implies that Chinese learners do not consider the first syllables in Italian geminate words closed. In other words, they do not consider Italian geminate consonants ambisyllabic as native Italian speakers do, but treat them simply as a whole that acts as the initial part of the subsequent syllable. In this way, L1 Mandarin Chinese learners treat the first syllables of both Italian geminate and singleton words as open syllables, and therefore make no difference in preconsonantal vowel durations.

Concerning the third question, which addresses the effects of L1 Mandarin Chinese learners' L2 Italian learning experience on their production of Italian consonant length contrast, our results indicate that Chinese learners with different learning experiences perform similarly in producing Italian singleton vs. geminate consonants and preconsonantal vowels. In other words, even when their learning experience increases, L1 Mandarin Chinese learners show no/little improvement in acquiring Italian consonant length contrast. This is quite unexpected, yet in line with Lee & Mok (2018) who found that beginning and advanced Cantonese-speaking learners of Japanese did not show significant differences in their acquisition of Japanese quantity contrasts. Though we are unsure about the reason, this fact does imply that for Chinese learners the mastery of Italian consonant length contrast represents a difficulty that might not be easily reduced with an increased learning experience.

The study leaves several avenues for future research. In addition to those mentioned above, future research needs to explore the perception of Italian consonant length contrast by L1 Mandarin Chinese learners. This will undoubtedly contribute to a comprehensive understanding of L1 Mandarin Chinese learners' acquisition mechanisms of Italian consonant quantity contrast.

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