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L2 Learners' Pronunciation of English Phonetic Sounds: An Acoustic Analysis with Software *Praat*

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Abstract

Pronouncing English sounds correctly is not an easy task for second language (L2) learners because of the influence of their mother tongue. Empirical studies, based on first language (L1) interference, have investigated L2 learners' pronunciation problems. However, these studies rarely focused on students' development in pronunciation, and their results lack validity and reliability because of their mere employment of L2 English teachers as pronunciation assessors. The present study, using the acoustic software *Praat* as the instrument and taking a native speaker as the comparison, investigated Chinese L2 English learners' problems and improvement in pronouncing the English sounds that do not have exact counterparts in Chinese. Data analysis revealed that the participants manifested different degrees of pronunciation accuracy with the target English sounds; their mispronunciations of consonants were mainly due to lacking voicing, wrong manners, and wrong places of articulation, while their mispronunciations of vowels were attributed to their improper tongue position, mouth opening, and diphthongization; and that higher-proficiency students tended to have greater pronunciation accuracy. The findings were discussed with reference to the literature, and pedagogical implications were provided at the end.

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1 Introduction

Pronunciation is an important aspect of language learning because it is closely associated with learners' spoken communicative competence. However, English pronunciation is one of the most difficult skills to acquire (Gilakjani, 2016). Particularly, L1 interference mainly accounted for EFL learners' difficulties in pronouncing English sounds and their mispronunciations (Begum & Hoque, 2016; Zheng & Liu, 2018).

Empirically, studies have investigated the pronunciation problems experienced by EFL learners in countries such as Japan, Thailand, Bangladesh, Albania, Turkey and China (Begum & Hoque, 2016; Ercan, 2018; Nuhiu, 2013; Peng, 2017; Wei & Zhou, 2002; Wu et al., 2020), as well as the factors causing mispronunciations. However, they (Peng, 2017; Wu et al., 2020), mainly focused on students of the same proficiency level, and could not inform the development of students' pronunciation. In addition, methodologically, existing studies (Zhou, 2021) mainly invited EFL teachers to judge participants' pronunciations, which might lead to unreliable results.

In light of the deficiencies, the present study, using the acoustic software *Praat* as the instrument and taking a native speaker as the comparison, investigated L2 learners' problems and development in pronouncing English phonetic sounds in the Chinese EFL context. Hopefully, the study would help gain insight into L2 learners' pronunciation of English phonetic sounds and proffer implications for pronunciation teaching and learning.

2 Literature Review

2.1 Language transfer and L2 speech learning model

Language transfer is defined as the influence resulting from the similarities and differences between the target language and any other language that has been previously acquired (Odlin, 1989). Language transfer can be divided into positive transfer and negative transfer (Weinreich, 1953). When the target language and the mother tongue are similar, positive transfer may occur in learning the target language. On the contrary, when the target language and the mother tongue are different, negative transfer or interference may take place in learning the target language. Positive transfer can promote learners' mastery and use of the L2, while negative transfer will interfere with learners' L2 learning.

Language transfer also takes place at the level of pronunciation. Learners usually transfer their mother tongue's pronunciation habits and rules to L2 (Zheng & Liu, 2018). Positive transfer of EFL learners' pronunciation from their mother tongue can facilitate their English pronunciation acquisition, whereas negative transfer accounts for their pronunciation problems. The degree depends on how great the similarities or differences are between the mother tongue and the L2. For instance, the negative transfer of Chinese pronunciation always surpasses the positive transfer because more differences than similarities exist between English and Chinese in their pronunciation.

Theoretically, Flege (1995), introduced the Speech Learning Model (SLM), and Flege & Bohn (2021), further proposed its revised version (SLM-r) to predict L2 speakers' perception and production of L2 segments based on the degree of phonetic similarity between an L2 segment and a segment in their native language. In SLM, Flege (1987, 1988, 1995), argued that L2 phones could be classified as "identical", "similar", or "new" regarding learners' L1. Particularly, "new" L2 phones have no counterpart in L1 and differ acoustically from sounds in L1, such as French /y/ for native speakers of English, whereas "similar" L2 phones differ systematically from an easily identifiable counterpart in L1, such as /t/, which is found in both French and English, but it is implemented as a short-lag stop with dental place of articulation in French, and as a long-lag stop with alveolar place of articulation in English (Flege, 1987). Furthermore, acquiring an "identical" L2 sound will be relatively easy due to its function of positive transfer, whereas the acquisition of a "similar" L2 sound is more difficult than a "new" one. For the "new" L2 sounds, successful acquisition can be achieved as L2 learners can discern the phonetic dissimilarity between L2 sounds and L1 sounds, and thus will form a new L2 category as their L2 experience increases. For the "similar" L2 sounds, however, difficulty in acquisition may be expected, due to a higher degree of phonetic similarity between L2 and L1 sounds, and hence it is less likely to establish a new L2 category even for advanced L2 learners (Calis & Dikilitas, 2012; Hashemian & Heidari, 2013; Spahiu & Kryeziu, 2021).

The present study would employ language transfer, SLM and SLM-r as the theoretical rationale to examine how L2 learners' English pronunciation in the Chinese EFL context is influenced by their mother tongue. For this purpose, studies on L2 English learners' pronunciation problems including those conducted in the Chinese EFL context will be reviewed.

2.2 Studies on L2 English learners' pronunciation problems

Some studies, drawing on the notion of language transfer, have investigated the pronunciation problems of L2 English learners in countries other than China. Wei & Zhou (2002), based on their six years of oral English teaching experience in Thailand, found that it was difficult for Thai L2 English learners to pronounce aspirated /p/ and /k/ or voiced /m/ and /n/ in English because the final consonants in Thai are always unaspirated and unvoiced. Othata (2004, cited from Ercan, 2018) pointed out that Japanese L2 English learners tended to add a vowel at the end of English words that end in consonants as in the word "bath"/basu/ because in Japanese a vowel is often put to the end of every consonant-ending word. Begum & Hoque (2016), observed that L1 interference caused tertiary-level students' problems in producing English pronunciations in Bangladesh. O'Connor (2003, cited from Ercan, 2018) reported that many of the pronunciation problems (/p/ and /b/, /θ/ and /ð/) of Arabic L2 English learners were due to their L1 transfer. Nuhiu (2013), found that Albanian students tended to pronounce the voiceless English sound /θ/ with a dental [t̪] or with /f/ and the voiced English sound /ð/ with a dental [d̪] because of the negative transfer of Albanian mother tongue since the Albanian language does have dental fricatives. Ercan (2018), found that Turkish L2 English learners had problems with the pronunciation of the English consonants (e.g., /ð/, /w/, /θ/, /ŋ/) that do not exist in the Turkish sound system. Frederick (2005, cited from Ercan, 2018), reported that Spanish L2 English learners mainly replaced /v/ with /b/ due to their native language interference, since in Spanish both letters /v/ and /b/ are pronounced as /b/.

The studies on Chinese L2 English learners' pronunciation problems can be divided into two strands. One strand (Liao, 2020; Wang & Yang, 2015), based on the existing literature or researchers' teaching experience, summarized Chinese L2 English learners' pronunciation problems and the factors causing their problems. For instance, Liao (2020), after reviewing the existing literature, reported that there were mainly three pronunciation problems among Chinese non-English major students: failure to correctly pronounce English sounds that are not found in Chinese like /θ/ and /ð/; negative transfer of Chinese local dialects (e.g., English learners from Northeast China have difficulty in recognizing English sounds /v/ and /w/, as in the northeast dialect, people tend to substitute /v/ with /w/.); and difficulties of identifying strong and weak forms of the English words and phrases. Wang & Yang (2015), based on their English teaching experiences, attributed Chinese vocational school students' pronunciation problems (e.g., failure to distinguish between long and short vowels) to their mother tongue's interference.

The other strand of studies, the data-based empirical ones (Peng, 2017; Wu et al., 2020), examined Chinese L2 English learners' problems with English pronunciation. Following his comparison of the phonetic features of the Changsha dialect in China and those of Received Pronunciation, and using questionnaires and pronunciation tests, Peng (2017), found that in Changsha, secondary vocational school students' mispronunciations were mainly due to the negative transfer of Changsha dialect. By comparing Chinese English major freshmen's mispronunciations with General American and Received Pronunciation, Wu et al. (2020), reported that their participants mainly had three pronunciation problems: replacing a sound with a similar one (e.g., using the voiced alveolar fricative /z/ to substitute the voiced dental fricative /ð/), failure to distinguish voiceless from voiced consonants, and shortening diphthongs. Although the authors examined the phonetic differences of English and Chinese consonants, they failed to design a test that, as far as possible, covered all the English sounds not shared by Chinese. Different from Wu et al. (2020), the present study designed a test that covered all the English sounds that do not exist in Chinese.

In addition, the current studies are limited in two other aspects. First, some of them (Zhou, 2021), invited Chinese teachers of English to judge students' pronunciations. This might result in invalid or unreliable judgment. Second, the current studies (Wang & Yang, 2015; Wu et al., 2020), only focused on students of the same proficiency level, either freshmen or vocational school students. They didn't include learners of different proficiency levels, and could not reveal whether learners at the higher proficiency level would have better pronunciations.

In light of the deficiencies identified above, the present study investigated different proficiency levels of Chinese L2 English learners' pronunciation of the English phonetic sounds that Chinese does not share by using the acoustic software *Praat* as the instrument and taking a native English-speaking teacher as the comparison. The study particularly addressed three research questions (RQs).

1) What pronunciation problems do Chinese L2 English learners have with English sounds that do not exist in Chinese?
2) What factors lead to Chinese L2 English learners' pronunciation problems?

3) To what extent do Chinese L2 English learners develop their English pronunciation as their English proficiency increases?

3 Materials and Methods

3.1 Participants

Twenty-nine English major students and one teacher participated in the study. The students, including ten males and nineteen females, were recruited from a university (anonymously known as G) in Guangdong province, China. They were composed of twelve freshmen and seventeen sophomores, representing two proficiency levels. They willingly participated in the study after receiving our invitation through WeChat, a widely used communication platform in China. Most of them were familiar to the first two authors. Compared with the freshmen, the sophomores had studied English one year longer, taken about 200 more English lessons, and had more English pronunciation and oral English training in university. The sophomores' pronunciation should be better than that of the freshmen. Thus, the freshmen and the sophomores were respectively taken as the lower-proficiency group and the higher-proficiency group. For convenience, each participant was assigned a symbol. For example, participant Y1-S1 refers to student No. 1 from Year 1.

Apart from student participants, JC, a male native English-speaking teacher from Britain was selected as the standard for assessing student participants' pronunciation. JC, in his early thirties, received both his bachelor's and master's degrees in modern languages and linguistics in Britain. He had worked in University G as a teacher of phonetics, English writing, English debating, linguistics, and second language acquisition for at least six years. He willingly accepted our invitation to participate in the study. We believed that JC was a perfect comparison for the student participants.

3.2 Data elicitation instrument

By comparing the standard sounds of Chinese (Lee & Zee, 2003), and the Received Pronunciations of English (Roach, 2004), we first identified the English sounds that Chinese does not share. They include thirteen English consonants: /b/, /d/, /g/, /v/, /θ/, /ð/, /z/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, /r/ and /h/, and nine English monophthongs: /ɪ/, /ʊ/, /e/, /ɜ:/, /ʌ/, /ɔ:/, /æ/, /ɒ/ and /ɑ:/. The thirteen consonants and the nine vowels constitute the target sounds of the study.

The target consonants are highlighted in italic bold and listed in Table 1 together with their phonetic transcriptions, place of articulation, and manner of articulation. Presented in Table 2 are the target vowels highlighted in italics bold, their phonetic transcriptions, and their features in terms of position of the tongue, tongue height, and lip rounding.

Table 1
Target consonants and their places and manners of articulation

target consonants	phonetic transcriptions	place of articulation	manner of articulation
birthday	/b/	plosive	bilabial
da***d***	/d/	plosive	alveolar
gift	/g/	plosive	velar
whi***ch***	/tʃ/	affricate	palato-alveolar
fri***dge***	/dʒ/	affricate	palato-alveolar
room	/ɹ/	liquid	alveolar
van	/v/	fricative	labio-dental
thank	/θ/	fricative	dental
fa***th***er	/ð/	fricative	dental
shone	/ʃ/	affricate	palato-alveolar
lei***s***ure	/ʒ/	affricate	palato-alveolar
handed	/h/	fricative	glottal
friend***s***	/z/	fricative	alveolar

Table 2
Target vowels and their articulatory properties

target vowels	phonetic transcriptions	position of tongue	tongue height	lip rounding
y***e***sterday	/e/	front	mid	close-mid
b***ir***thday	/ɜː/	central	mid	open-mid
d***a***d	/æ/	front	low	near-open
g***i***ft	/ɪ/	near-front	high	near-close
f***a***ther	/ɑː/	back	low	open
s***u***n	/ʌ/	back	mid	open-mid
f***our***	/ɔː/	back	mid	open-mid
b***oo***ks	/ʊ/	back	high	near-close
j***o***gging	/ɒ/	back	low	open

To elicit the target sounds, we then created a text covering the target sounds. The text consists of eight sentences as presented below.

> Yesterday was my birthday. My dad gave me a gift which was a fridge and I placed it on the right side of the room. It was delivered by a van. I thanked my father. Today, the news said the sun shone brightly. In my leisure time, I handed my friends some ice cream from the fridge. Four of them were reading books. Then we hailed a taxi and went jogging.

3.3 Data collection procedure

Data collection was conducted through WeChat and lasted one day. Although audio in WeChat has been compressed and reduced, and the quality of sounds may be affected, it is acceptable considering the pandemic policies (see Guan & Li, 2021; Zhang et al., 2021). We sent our invitation and the elicitation task to two student WeChat groups. The students who agreed to participate in the study were required to complete the elicitation task by reading aloud the sentences at an appropriate speed, recording their reading and sending the recordings to us. It turned out that within one day, we received twenty-nine voluntary recordings and the twenty-nine students constituted the participants of the study. All participants completed the task as required, and they took an average of thirty seconds to record the sentences. Besides, JC willingly accepted our invitation and sent his recording to us through E-mail. After receiving the participants' recordings, we converted each participant's recordings to MP3 format and saved them to our computers for analysis (Cheng, 2011; Mak, 2011; Du & Jackson, 2018; Widanta et al., 2016; Yu & Lee, 2014).

3.4 Data analysis

Participants' recordings were analyzed in terms of answering the three RQs. For RQ1, we judged the accuracy of each target sound produced by the participants by comparing it with that produced by JC with the help of *Praat*, an acoustic-phonetic software that is capable of analyzing and visualizing pronunciation details such as spectrograms, pitch, and formants (Boersma & Weenink, 2020). In light of Lin & Wang (1992), formant figures and spectrograms were respectively used to judge participants' pronunciation of vowels and consonants.

Specifically, regarding vowels, the authors compared the formant figures of student participants and those of JC. Formant refers to the frequency range where vowel sounds are at their most distinctive and characteristic pitch (Lin & Wang, 1992). There are mainly four formants associated with vowels' pronunciation, but among the four formants, the first and the second are the most important. Thus, we mainly used the first and the second formants. The first formant (F1) is related to tongue height. The lower the tongue is, the higher F1 is, and vice versa. The second formant (F2) is associated with the front-back position of the tongue and the openness of the mouth. The frontier the tongue is, the higher F2 is, and vice versa (Lin & Wang, 1992). Further, if both formants' differences between the participants and JC were less than 200, the participants' pronunciation would be identified as correct. If either difference was over 200, the participants' pronunciation would be recognized as incorrect.

Take the vowel /ɔː/ in "four" as an example. Formant statistics of JC's, participant Y1-S1's and participant Y1-S10's pronunciation of /ɔː/ in "f***our***" are shown in Table 3. For JC, his F1 and F2 were 486.743724 and 759.824412.

Similarly, participant Y1-S1's F1 and F2 were 348.686212 and 639.361920. The differences between JC and Y1-S1 for F1 and F2 were 138.057512 and 120.462492, both being less than 200. Thus, the pronunciation of Y1-S1 was identified as correct. Differently, the participant Y1-S10's F1 and F2 were 676.303340 and 1305.310312. The difference between JC and Y1-S10 for F1 was 189.559616, less than 200. However, Y1-S10's F2 was 545.485900, higher than that of JC. A higher F2 meant that Y1-S10 pronounced /ɔ:/ with fronter tongue location. Hence, Y1-S10's pronunciation was recognized as incorrect.

Table 3
Formants of JC's, participant Y1-S1's and participants Y1-S10's pronouncing of /ɔ:/ in "f***our***"

Participants	Time_ms	F1_Hz	F2_Hz
JC	25.542184	486.743724	759.824412
Y1-S1	24.841358	348.686212	639.361920
Y1-S10	19.741850	676.303340	1305.310312

Note: "Time-ms" represents the time in milliseconds and it is the time that participants used to pronounce the sound. Hz refers to Hertz, a unit for measuring the frequency of sound waves.

In terms of consonants, we first identified the errors by perceptual judgment. Next, we compared student participants' and JC's spectrograms of the target consonants to provide acoustic evidence for the mispronunciation. Particularly, if vertical striations were found in the participants' spectrograms with the help of *Praat*, their pronunciations would be deemed as correct (Ladefoged & Johnson, 2015). Take the voiced consonant /d/ as an example. Figure 1 presents the spectrograms of /d/ in "dad" by JC, Y2-S4 and Y1-S10. As depicted in the left graph of Figure 1, vertical striations were found in JC's spectrogram. Similarly, vertical striations were also found in the participant Y2-S4's spectrogram (middle graph of Figure 1). Thus, Y2-S4's pronunciation was identified as correct. However, in the spectrogram of participant Y1-S10 (right graph of Figure 1), no vertical striations were found. In this case, Y1-S10's pronunciation was recognized as incorrect. After the first two authors assuredly judged each target consonant sound, their rating results were compared. The interrater agreement was 92.31%. The disagreed sounds were reexamined and a consensus was reached on all of them.

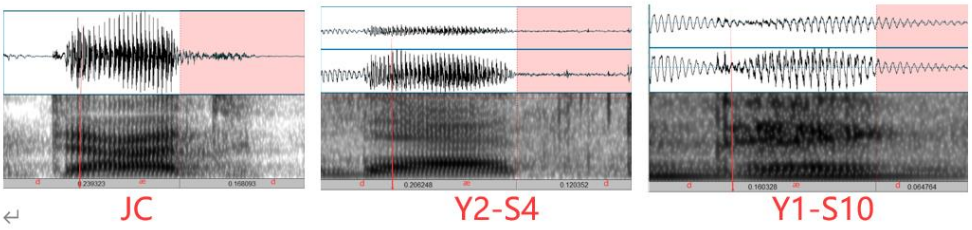

Figure 1. Spectrograms of /d/ in "da***d***" by JC (left graph), Y2-S4 (middle graph) and Y1-S10 (right graph)

In order to answer RQ2, student participants' mispronounced English consonants and vowels were reexamined in terms of what was wrong. With regard to consonant pronunciation, we totally detected three reasons, namely, lack of voicing, wrong manner of articulation, and wrong place of articulation. The interrater agreement reached 100%. As for vowel pronunciation, three reasons were identified: wrong tongue locations (being too front and/or too high), openness of the mouth being too wide and not round, and improper diphthongization. The interrater agreement was 93.87% with a consensus being achieved on all disagreed items. In response to RQ3, the lower-proficiency and the higher-proficiency groups were compared in terms of their pronunciation accuracy rates to detect the development.

4 Findings

4.1 Students' mispronounced sounds

4.1.1 Mispronounced consonants

Table 4 demonstrates student participants' rates of correct pronunciations of the targeted consonants. In general, the rates for /b/, /g/, /h/, /ʃ/, /ɹ/, /dʒ/, /tʃ/, /θ/, /v/, /ʒ/, /d/, /ð/ and /z/ are arranged from the highest to the lowest, showing students' different rates of correctness with the consonants. Specifically, all participants pronounced /b/, /g/ and /h/ correctly; the majority of participants (over 50%) correctly pronounced /ʃ/, /r/, /dʒ/, /tʃ/, /θ/ and /v/; less than half of participants correctly pronounced /ʒ/, /d/ and /ð/; and only five participants (17.24%) correctly pronounced /z/. To sum up, not all the English consonants that Chinese does not have posed difficulties to the participants, and the difficult English consonants posed different degrees of challenge to the participants.

Table 4
Rates of participants' correct pronunciation of target consonants

Target sounds	Examples	Participants (N)	No. of correct pronunciation	Rate of correct pronunciation
/b/	***b***irthday	29	29	100.00%
/g/	***g***ift	29	29	100.00%
/h/	***h***anded	29	29	100.00%
/ʃ/	***sh***one	29	28	96.55%
/ɹ/	***r***oom	29	27	93.10%
/dʒ/	fri***dge***	29	23	79.31%
/tʃ/	whi***ch***	29	20	68.97%
/θ/	***th***anked	29	19	65.52%
/v/	***v***an	29	16	55.17%
/ʒ/	lei***s***ure	29	12	41.38%
/d/	da***d***	29	12	41.38%
/ð/	fa***th***er	29	9	31.03%
/z/	friend***s***	29	5	17.24%

4.1.2 Mispronounced vowels

Table 5 demonstrates the rates of student participants' correct pronunciation of the target vowels. In general, the rates for /ɜ:/, /e/, /ʊ/, /ɔ:/, /ʌ/, /ɪ/, /æ/, /ɑ:/ and /ɒ/ are arranged from the highest to the lowest, showing students' different rates of correctness with the vowels. Specifically, all participants pronounced /ɜ:/ correctly; the majority of participants (over 70%) correctly pronounced /e/, /ʊ/, /ɔ:/ and /ʌ/; and only approximately half of the participants correctly pronounced /ɪ/, /æ/, /ɑ:/ and /ɒ/. In short, not all the English vowels that Chinese does not have posed difficulties to the participants, and the difficult English vowels posed different degrees of challenge to the participants.

Table 5
Rates of participants' correct pronunciation of target vowels

Target sounds	Examples	Participants (N)	No. of correct pronunciation	Rate of correct pronunciation
/ɜ:/	b***ir***thday	29	29	100.00%
/e/	y***e***sterday	29	27	93.10%
/ʊ/	books	29	24	82.76%
/ɔ:/	four	29	24	82.76%
/ʌ/	sun	29	21	72.41%
/ɪ/	gift	29	17	58.62%

/æ/	dad	29	17	58.62%
/ɑ:/	father	29	17	58.62%
/ɒ/	jogging	29	16	55.17%

4.2 Factors causing mispronunciations

4.2.1 Reasons for the mispronunciation of consonants

The study found that participants' mispronunciations of the target consonants were mainly caused by three reasons: lack of voicing, wrong place of articulation, and wrong manner of articulation, as presented in Table 6.

Table 6
Reasons for participants' consonant mispronunciations

Reasons	Mispronounced consonants	No. of mispronounced consonants	Rate of incorrect pronunciation	Substitutes of consonants
lack of voicing	/dʒ/	5	17.24%	/ʃ/
	/ʒ/	15	51.72%	/ʃ/
	/d/	17	58.62%	/t/
	/ð/	20	68.97%	/t/
	/z/	24	82.76%	/s/
wrong place of articulation	/θ/	9	31.03%	/s/, /f/
	/v/	12	41.38%	/w/, /b/
	/ð/	20	68.97%	/t/
wrong manner of articulation	/dʒ/	5	17.24%	/ʃ/
	/v/	12	41.38%	/w/, /b/
	/ð/	20	68.97%	/t/

a) Lack of voicing

The study found that some participants tended to pronounce voiced consonants like /dʒ/, /ʒ/, /d/, /ð/ and /z/ as voiceless, especially when these consonants are in the middle or at the end of a word. As shown in Table 6, 5, 15, 17, 20 and 24 participants respectively substituted the voiced consonants /dʒ/, /ʒ/, /d/, /ð/ and /z/ with the voiceless consonants /ʃ/, /ʃ/, /t/, /t/ and /s/. The differences were observed in the spectrograms of the participants' pronunciations of these sounds. Take the voiced consonant /d/ in "da***d***" as an example. In the spectrogram of JC (left graph of Figure 2), vertical striations (periodic) were found, indicating that JC pronounced /d/ with vibration. But in the spectrogram of participant Y1-S10 (right graph of Figure 2), there were no vertical striations (periodic), suggesting that participant Y1-S10 mispronounced the voiced consonant /d/ in a voiceless manner.

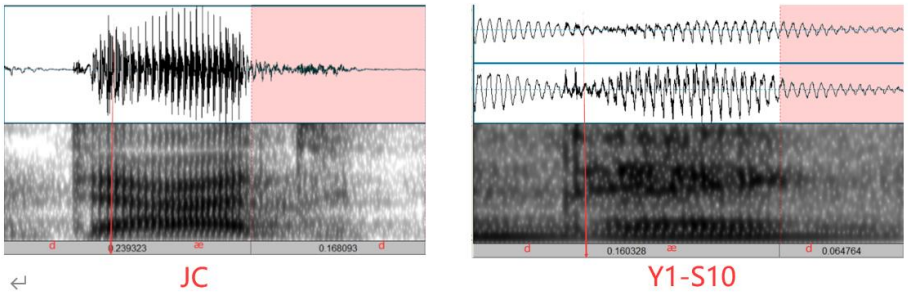

Figure 2. Spectrograms of /d/ in "da*d*" by JC (left graph), and Y1-S10 (right graph)

b) Wrong place of articulation

The participants mainly mispronounced three consonants, i.e., /v/, /θ/ and /ð/ by using the wrong places or wrong speech organs of articulation. As indicated in Table 6, twelve participants pronounced the labio-dental /v/ by using

the wrong places of articulation (eleven of them pronounced it as the bilabial /w/ and one pronounced it as the bilabial /b/). In terms of the dental /θ/, nine participants pronounced it at the wrong places of articulation (four of them pronounced it as the alveolar /s/ and five as the labio-dental /f/). As for the dental /ð/, twenty participants pronounced it as the alveolar /t/. Take the labio-dental fricative /v/ in "***v***an" as an example. If participants correctly pronounced it, random noise patterns, especially in higher frequency regions, could be found in their spectrograms (Ladefoged & Johnson, 2015). A random noise pattern was found in the spectrogram of JC (left graph of Figure 3). However, generally, regular cyclic waves, instead of random noise patterns, were found in the spectrogram of participant Y1-S7 (right graph of Figure 3), showing that participant Y1-S7 did not pronounce /v/ correctly.

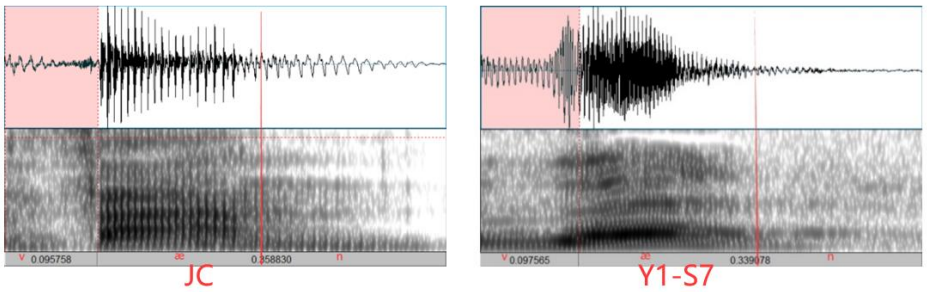

Figure 3. Spectrograms of /v/ in "*v*an" by JC (left graph), and Y1-S7 (right graph)

c) Wrong manner of articulation

As presented in Table 6, the participants mainly pronounced three consonants, i.e., /ð/, /v/ and /dʒ/ with wrong manners of articulation. Twenty participants pronounced the fricative /ð/ as the plosive /t/. Among the twelve participants, eleven pronounced /v/ as the glide /w/ and one as the plosive /b/. For the affricate /dʒ/, five participants pronounced it as the fricative /ʃ/. Take the fricative /ð/ in "fa***th***er" as an example. Random noise pattern was found in the spectrogram of JC (left graph of Figure 4). However, generally regular cyclic waves, other than random noise pattern were found in the spectrogram of participant Y1-S7 (right graph of Figure 4), indicating that participant Y1-S7 did not pronounced /ð/ correctly.

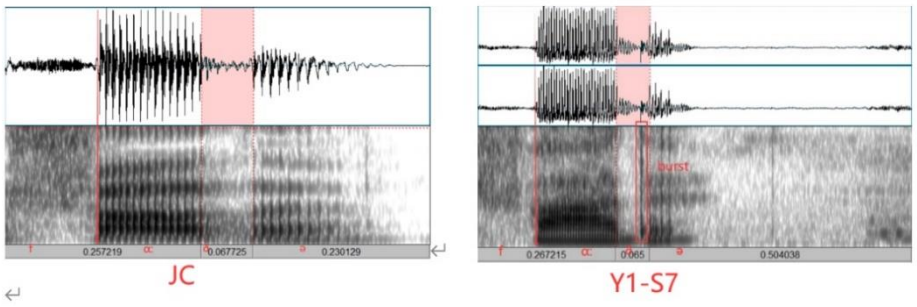

Figure 4. Spectrograms of /ð/ in "fa*th*er" by JC (left graph), and Y1-S7 (right graph)

4.2.2 Reasons for the mispronunciation of vowels

The study found that the participants' mispronunciations of vowels were mainly attributable to three reasons: the tongue location being too front or too high, the openness of the mouth being too wide and not round, and improper diphthongization, as presented in Table 7.

Table 7
Reasons for participants' vowel mispronunciations

Reasons		Mispronounced vowels	No. of mispronounced vowels	Rate of incorrect pronunciations	Substitutes of target vowels
Wrong tongue locations	too front	/ɪ/	11	37.93%	/i/
		/æ/	12	41.38%	/e/
		/ɑ:/	12	41.38%	/a/
	too high	/ʌ/	3	10.34%	/e/
Mouth opening being too wide and not round		/ʊ/	5	17.24%	/u///ʌ/
Improper diphthongization		/ɒ/	4	13.79%	/ou/

Note: /i/, /e/ and /a/ are all Chinese Pinyin.

a) Tongue location being too front or too high

The results showed that the participants pronounced /ɪ/, /æ/ and /ɑ:/ with too front tongue locations (Table 7). Specifically, eleven participants' pronunciation of the front vowel /ɪ/ was similar to the Chinese Pinyin "i" in "衣 (yi)". Twelve participants pronounced the front vowel /æ/ in a way similar to the pronunciation of the phoneme /e/ in "bed" or the Chinese Pinyin "e" in "叶(ye)". Twelve participants pronounced the back vowel /ɑ:/ in a way similar to the pronunciation of the Chinese Pinyin "a" in "啊(a)". Take the vowel /ɑ:/ in "f***a***ther" as an example. As presented in Table 8, Y1-S3's F2 (1663.967130) was much higher than that of JC (1125.569564), meaning that Y1-S3 pronounced /ɑ:/ with frontier tongue location.

Table 8
Formants of JC's and the participant Y1-S3's pronouncing /ɑ:/ in "f***a***ther"

Participants	Time_ms	F1_Hz	F2_Hz
JC	13.309891	676.439161	1125.569564
Y1-S3	15.309328	1114.696370	1663.967130

Three participants pronounced the vowel /ʌ/ with too high tongue location (Table 7). Take participant Y1-S2's pronunciation as an example. As shown in Table 9, Y1-S2's F1 (301.341568) was much lower than JC's (599.631918), with a formant difference of 298.29035, meaning that Y1-S2 pronounced /ʌ/ with higher tongue location, similar to the pronunciation of the Chinese Pinyin "e" in "鹅".

Table 9
Formants of JC's and participant Y1-S2's pronunciation of /ʌ/ in "s***u***n"

Participants	Time_ms	F1_Hz	F2_Hz
JC	17.402092	599.631918	1286.185825
Y1-S2	14.899978	301.341568	1262.484706

b) The openness of the mouth is too wide and not round

Five participants mispronounced the vowel /ʊ/ (Table 7). As displayed in Table 10. Y1-S8's F2 (1581.540634) was much higher than JC's (965.828532), with a formant difference of 615.712102, indicating that the openness of Y1-S8's mouth was wider and not round since the formant statistics of a vowel will be lowered if it is a vowel with round lips, except F1 (Lin & Wang, 1992).

Table 10
Formants of JC's and the participant Y1-S8's pronouncing /ʊ/ in "b*oo*k"

Participants	Time_ms	F1_Hz	F2_Hz
JC	26.902317	452.325323	965.828532
Y1-S2	32.300877	389.940309	1581.540634

c) Improper diphthongization

Four participants pronounced the monophthong /ɒ/ as the diphthong /ou/. Take participant Y1-S7's pronunciation as an example. As displayed in Figure 10, F2 was varying when Y1-S7 pronounced /ɒ/. In general, the line of F2 was going up, which meant that the number of F2 was increasing, signifying that the openness of the mouth was becoming smaller and the participant was pronouncing a diphthong.

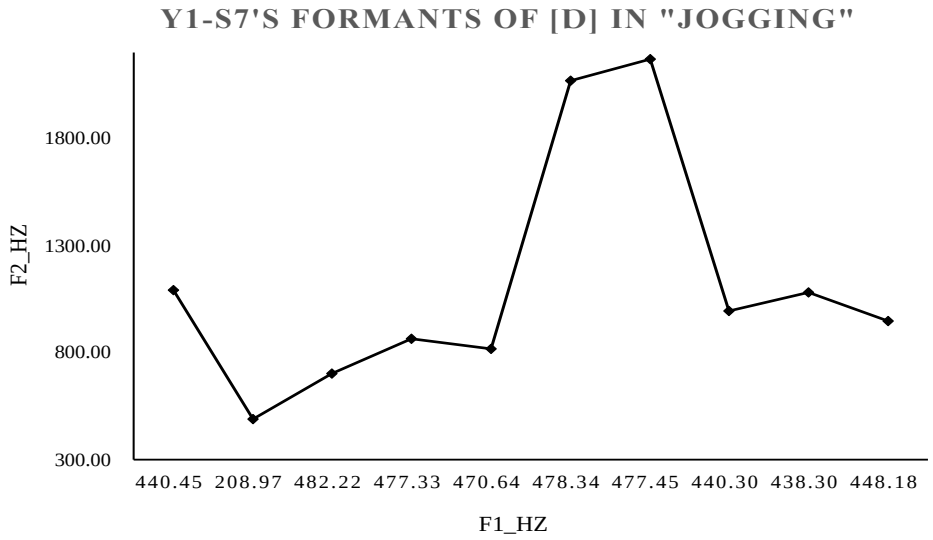

Figure 5. Graph of the spectrogram of participant Y1-S7's pronunciation of /ɒ/ in "j*o*gging"

4.2.3 Participants' pronunciation development

Table 11 and Table 12 display the rates of the two proficiency groups' correct pronunciation of consonants and vowels respectively. Comparisons reveal that both groups obtained high rates of correctness with consonants /b/, /g/, /h/, /ʃ/ and /r/, showing that despite their proficiency difference, both groups pronounced these sounds correctly. Yet, the high-proficiency group achieved higher rates of correctness with consonants /ʒ/, /θ/, /v/, /dʒ/ and /tʃ/ than the low-proficiency group, showing participants' progress in pronouncing these sounds. Additionally, almost all participants obtained relatively low rates of correctness for consonants /d/ and /z/, but the high-proficiency group still performed better than the low-proficiency group, showing participants' slight improvement. One exception was the consonant /ð/, for which the high-proficiency group's rate of correctness was lower than that of the low-proficiency students, suggesting that /ð/ should be especially difficult for the participants to pronounce correctly. In short, the participants have generally improved their pronunciation as their English proficiency increased, but participants of higher proficiency still have difficulties in pronouncing some consonants.

Table 11
Correctness rates of Y1 and Y2 participants' consonant pronunciations

Target sounds	Examples	Y1 Correct rate	Y2 Correct rate
/b/	***b***irthday	100.00%	100.00%
/g/	***g***ift	100.00%	100.00%
/h/	***h***anded	100.00%	100.00%
/ʃ/	***sh***one	91.67%	100.00%
/ɹ/	***r***oom	91.67%	94.12%
/ʒ/	lei***s***ure	25.00%	52.94%
/θ/	***th***anked	50.00%	76.47%
/v/	***v***an	41.67%	64.71%
/dʒ/	fri***dge***	75.00%	82.35%
/tʃ/	whi***ch***	66.67%	70.59%
/d/	da***d***	33.33%	47.06%
/z/	friend***s***	8.33%	23.53%
/ð/	fa***th***er	33.33%	29.41%

Regarding vowels, comparisons indicate that both groups obtained high rates of correctness with vowels /ɜ:/, /e/, /ʊ/ and /ɔ:/, showing that despite their proficiency difference, both groups pronounced these sounds correctly. Yet, the high-proficiency group achieved higher rates of correctness with vowels /ʌ/, /ɑ:/ and /æ/ than the low-proficiency group, suggesting the participants' progress in pronouncing these sounds. In addition, both groups got relatively low rates of correctness for the vowel /ɪ/, but the high-proficiency group still performed better than the low-proficiency group, showing participants' improvement. One exception was the vowel /ɒ/, for which the high-proficiency group's rate of correctness was lower than that of the low-proficiency students, suggesting that /ɒ/ should be especially difficult for the participants to pronounce correctly. In sum, the participants have generally improved their pronunciation as their English proficiency increased, but participants of higher proficiency still have difficulties in pronouncing some vowels.

Table 12
Correctness rates of Y1 and Y2 participants' vowel pronunciations

Target sounds	Examples	Y1 Correct rate	Y2 Correct rate
/ɜ:/	b***ir***thday	100.00%	100.00%
/e/	y***e***sterday	100.00%	94.12%
/ʊ/	b***oo***ks	83.33%	82.35%
/ɔ:/	f***our***	83.33%	82.35%
/ʌ/	s***u***n	58.33%	82.35%
/ɑ:/	f***a***ther	33.33%	76.47%
/æ/	d***a***d	41.67%	70.59%
/ɪ/	g***i***ft	50.00%	64.71%
/ɒ/	j***o***gging	58.33%	52.94%

5 Results and Discussions

The study, using the software *Praat* and taking a native English-speaking teacher as the standard, investigated Chinese EFL learners' pronunciation of thirteen English consonants and nine English vowels that Chinese does not share. Data analysis revealed that the participants manifested different degrees of pronunciation accuracy with the target sounds; their mispronunciations of the consonants were mainly caused by lacking voicing, wrong manner of articulation and wrong place of articulation while those of the vowels were mainly attributed to the wrong location of the tongue, the mouth being opened too wide but not round, and improper diphthongization; and the higher-proficiency group tended to have greater pronunciation accuracy than the lower-proficiency group (Cavus, 2016; Derwing et al., 2006; Flege et al., 1997; Wang et al., 2003).

5.1 Participants' mispronunciations and their reasons

Concerning the rates of participants' correct pronunciations, the findings that all participants correctly pronounced target sounds /b/, /g/, /h/ and /ɜ:/, can help support the prediction of SLM, which argued that the acquisition of a "new" L2 sound is easier than a "similar" one since it is easier for L2 learners to form a new L2 category for the L2 sound whose phonetic differences they can distinguish (Flege, 1987; Flege & Bohn, 2021).

However, most of the "new" English sounds that the Chinese does not share posed difficulties and different degrees of challenge to the participants. For example, the majority of participants (over 50%) correctly pronounced /ʃ/, /r/, /dʒ/, /tʃ/, /θ/ and /v/, whereas only nine (31.03%) and five (17.24%) participants correctly pronounced consonants /ð/ and /z/ respectively. According to SLM, the above "new" L2 sounds should be relatively easy for Chinese learners to acquire. However, in the current study, they did pose different degrees of challenge to the participants. One plausible account may be that only using IPA symbols to compare the similarities and differences of sounds in two languages may be insufficient (Yang et al., 2022). Although IPA provides a set of symbols to transcribe sounds in all languages, specific phonetic details depend on the actual language use and can vary from language to language. Moreover, IPA symbols were generally created by professional phoneticians who are inevitably more sensitive than average language learners in terms of detecting subtle phonetic differences, which may lead to disparities between IPA symbols and actual language use (Yang et al., 2022). For instance, phonetic sounds/θ/ and /ð/ transcribed by two different symbols in IPA are categorized as "new" L2 sounds for Chinese learners according to SLM. However, in this study, several participants mispronounced /θ/ and /ð/ as /f, s, ð/ and /t/ respectively. One possible account may be that /θ/ is audibly similar to /f/, in that they are both voiceless fricative and differ from each other merely by one factor (place of articulation), that is, /θ/ is dental while /f/ is labio-dental. Thus, while /θ/ and /f/ are represented as different IPA symbols, they also share some phonetic similarities, which may confuse learners in actual language performance, at least for Chinese learners, if they lack sensitivity to these phonetic details. In other words, the phonetic similarities resulted in participants' difficulties in pronouncing some English sounds. Hence, our findings were also consistent with the SLM and SLM-r, which claimed that the acquisition of a "similar" L2 sound is more difficult than a "new" one, since it is less likely to establish a new L2 category due to a higher degree of phonetic similarities between L2 and L1 sounds (Flege, 1987; Flege & Bohn, 2021).

Participants' other mispronunciation was lacking voicing for voiced English consonants. For example, most participants mispronounced the voiced consonants /d/, /ð/ and /z/ in a voiceless manner. Voicing is an important distinctive feature for English consonants, but not Chinese since almost all the consonants in Mandarin Chinese are voiceless. This difference would cause difficulty for Chinese EFL learners to pronounce voiced English consonants due to the influence of their previous pronunciation habits, that is, no voicing for consonants. This finding was in agreement with that of Wu et al. (2020), which also reported that Chinese EFL learners always transferred their Chinese pronunciation habits to English.

Regarding target vowels, most of them also posed different degrees of challenge to the participants. For example, over 70% of the participants correctly pronounced /e/, /ʊ/, /ɔ:/ and /ʌ/, whereas only approximately half of the participants correctly pronounced /ɪ/, /æ/, /ɑ:/ and /ɒ/. This finding was in accordance with a suggestion by James (1985), that nearly all L2 phonetic errors involve sounds that do not occur in L1. Moreover, this finding also helped confirm Trubetzkoy's (1969, cited from Flege, 1987) hypothesis that the establishment of a L1 phonology would cause L2 learners' failure to perceive the acoustic features of L2 that are phonemically irrelevant in L1, and hence their attempts to produce acoustic features of L2 resulted in articulatory inaccuracies. However, this finding seemed not to support SLM's prediction given that the above vowels by their IPA transcriptions are "new" L2 sounds for Chinese learners and should be relatively easy to acquire according to SLM. Nevertheless, in the current study, they did pose different degrees of challenge to the participants. One reasonable explanation could be that symbol-based comparison may be inadequate and inaccurate (Flege et al., 1997). Transcription practices and symbolization may vary across languages, and vowels transcribed using the same IPA symbol may differ systematically. Another possible account may be that authentic linguistic performance is also influenced by other factors such as L1 interference. The finding that some participants mispronounced /ɪ/, /æ/ and /ɑ:/ as the Chinese Pinyin "i" in "衣", "e" in "鹅" and "a" in "啊", can help explain this point. Since /ɪ/, /æ/ and /ɑ:/ do not have corresponding counterparts in Chinese, participants would unconsciously deploy their familiar L1 sounds for easier pronunciation. Researchers (Flege & Bohn, 2021; Lado, 1957), have consistently pointed out that L1 interference is inevitable in the process of

L2 learning, and that L2 learners always substitute L2 sounds with L1 sounds because the L2 sounds are automatically linked to sounds in the L1 phonetic inventory.

5.2 Participants' development in pronunciation

The study found that the participants made different degrees of improvement in pronouncing the target English sounds. Particularly, higher-proficiency learners gained higher pronunciation accuracy rates for consonants /ʒ/, /θ/, /v/, /dʒ/, /tʃ/, /d/, /z/ and vowels /ʌ/, /ɑ:/, /æ/, /ɪ/ than lower-proficiency learners. This should be attributed to the higher-proficiency learners' longer-term of English learning. The sophomores have received more language input, including pronunciation input (e.g., more oral training and practice in class) than the freshmen. Based on the new phonetic input, learners would gradually revise their former phonetic systems, decreasing the negative transfer of L1 with their L2 experience increasing. This finding was also consistent with SLM's (Flege, 1995), prediction that L2 learners would gradually discern L1-L2 phonetic influence and form new phonetic categories for certain L2 sounds as their L2 experience increases.

However, no obvious progress was found in sophomores' pronouncing of the consonants /b/, /g/, /h/, /ʃ/, /r/ and the vowels /ɜ:/ /e/, /ʊ/, /ɔ:/, since both the lower-proficiency and the higher-proficiency participants got almost similar high accuracy rates, showing that the pronunciation of the nine sounds had reached the "ceiling effect". In contrast, the high-proficiency group's correctness rates for the consonant /ð/ and the vowel /ɒ/ were lower than those of the low-proficiency students. One plausible account for this phenomenon could be that successful acquisition of L2 sounds maybe not only related to learners' length of English-language learning and instruction at school but also associated with other factors such as learners' use of English in daily life, the native language of English-language teachers, learning motivations, interests and so on (Bohn & Bundgaard-Nielsen, 2009). Moreover, even though the higher-proficiency learners have longer-term of English learning than the lower-proficiency learners, the quality of L2 input that L2 learners receive also matters, which may exert an important influence on phonetic-level learning (Flege & Bohn, 2021).

6 Conclusion

By using the acoustic software *Praat* as the instrument and taking a native speaker as the hallmark, the present study identified Chinese L2 English learners' mispronounced English sounds and the factors causing their mispronunciations. This study also found that higher-proficiency learners showed higher accuracies for some English sounds but not for others.

The findings of the study provide implications for English pronunciation teaching and learning. First, English-pronunciation teachers are suggested to precisely understand students' common pronunciation problems, so that they can make more specific pronunciation teaching plans. For example, for those difficult sounds, teachers should take more effective measures and provide more opportunities for students to do practice. Second, it is necessary to teach students basic phonetic knowledge, such as voicing and aspiration, so that students are more conscious of the specific phonetic details of some sounds. Third, teachers can demonstrate different ways of pronouncing the same word, including correct and incorrect ways, and encourage students to distinguish them. Fourth, teachers can also use the acoustic software *Praat* to help distinguish similar sounds. Apart from teachers' efforts, learners should clearly know their own pronunciation problems, so that they can pay more attention to those difficult sounds and reduce the interference of their mother tongue. Learners also need to do as much practice as possible in order to gradually improve their English pronunciation.

The study is limited in several ways. First, the sample size is small, so the findings of the study should not be generalized. Second, the self-designed pronunciation elicitation text did not consider the location of some sounds like the word-ending location of /b/ and /g/. In future studies, a more representative, larger sample size and more comprehensive locations of sounds could be included. Lastly, the judgment of the accuracy of participants' consonant pronunciations and the identification of participants' mispronunciations with consonants may not be completely accurate and valid. But we took a native English-speaking teacher as a comparison to increase the credibility of the study. Future studies could invite native speakers to help judge the accuracy of students' pronunciations.

Despite its limitations, the study has made contributions to the field. The study found that not all English sounds that are not shared by Chinese created difficulties to Chinese L2 English learners and the difficult sounds posed

different degrees of challenge. The study also identified the reasons for students' mispronunciation of English sounds and found that more instruction and learning are conducive to the improvement of students' pronunciation.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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References

Begum, A., & Hoque, M. A. (2016). English Pronunciation Problems of the Tertiary Level Students in Bangladesh: A Case Study. *Journal of Arts, Science & Commerce, VII*, 50-61.

Boersma, P., & Weenink, D. (2020). Praat: doing phonetics by computer (6.1. 16).

Bohn, O.-S., & Bundgaard-Nielsen, R. L. (2009). Second language speech learning with diverse inputs. In T. Piske & M. Young-Scholren (Eds.), *Input matters in SLA* (pp. 207-218). Clevedon, England: Multilingual Matters.

Calis, E., & Dikilitas, K. (2012). The use of translation in EFL classes as L2 learning practice. *Procedia-Social and Behavioral Sciences*, *46*, 5079-5084. https://doi.org/10.1016/j.sbspro.2012.06.389

Cavus, N. (2016). Development of an intellegent mobile application for teaching English pronunciation. *Procedia Computer Science*, *102*, 365-369. https://doi.org/10.1016/j.procs.2016.09.413

Cheng, D. (2011). New insights on compliment responses: A comparison between native English speakers and Chinese L2 speakers. *Journal of Pragmatics*, *43*(8), 2204-2214. https://doi.org/10.1016/j.pragma.2011.02.003

Derwing, T. M., Thomson, R. I., & Munro, M. J. (2006). English pronunciation and fluency development in Mandarin and Slavic speakers. *System*, *34*(2), 183-193. https://doi.org/10.1016/j.system.2006.01.005

Du, X., & Jackson, J. (2018). From EFL to EMI: The evolving English learning motivation of Mainland Chinese students in a Hong Kong University. *System*, *76*, 158-169. https://doi.org/10.1016/j.system.2018.05.011

Ercan, H. (2018). Pronunciation problems of Turkish EFL learners in Northern Cyprus. *International Online Journal of Education and Teaching, 5(4), 877-893*.

Flege, J. E. (1987). The production of "new" and "similar" phones in a foreign language: evidence for the effect of equivalence classification. *Journal of Phonetics 15*, 47-65.

Flege, J. E. (1988). The production and perception of foreign language speech sounds. In W. H (Ed.), *Human communication and its disorders: A review.* (pp. 224–401). Norwood, NJ: Ablex.

Flege, J. E. (1995). Second-language speech learning: Theory, findings, and problems. In W. Strange (Ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research* (pp. 233-277). Timonium, MD: York Press.

Flege, J. E., & Bohn, O.-S. (2021). The Revised Speech Learning Model (SLM-r). In R. Wayland (Ed.), *Second Language Speech Learning* (pp. 3-83): Cambridge University Press.

Flege, J. E., Bohn, O.-S., & Jang, S. (1997). Effects of experience on non-native speakers' production and perception of English vowels. *Journal of Phonetics*, *25*, 437-470.

Flege, J. E., Frieda, E. M., & Nozawa, T. (1997). Amount of native-language (L1) use affects the pronunciation of an L2. *Journal of phonetics*, *25*(2), 169-186. https://doi.org/10.1006/jpho.1996.0040

Gilakjani, A. P. (2016). English Pronunciation Instruction: A Literature Review. *International Journal of Research in English Education, 1*.

Guan, Y., & Li, B. (2021). *Usability And Practicality of Speech Recording by Mobile Phones for Phonetic Analysis*. Paper presented at the 2021 12th International Symposium on Chinese Spoken Language Processing, Hong Kong.

Hashemian, M., & Heidari, A. (2013). The relationship between L2 learners' motivation/attitude and success in L2 writing. *Procedia-Social and Behavioral Sciences*, *70*, 476-489. https://doi.org/10.1016/j.sbspro.2013.01.085

James, A. R. (1985). Phonetic transfer and phonological explanation: Some theoretical and methodological issues. In E. Kellerman & M. Sharwood (Eds.), *Cross-Language Influence in Second Language Acquisition*. Oxford: Pergamon Press.

Ladefoged, P., & Johnson, K. (2015). *A Course in Phonetics (Seventh Edition)*. Beijing: Peking University Press.

Lado, R. (1957). *Linguistics across Cultures*. Ann Arbor: The University of Michigan Press.

Lee, W.-S., & Zee, E. (2003). Standard Chinese (Beijing). *Journal of the International Phonetic Association*.

Liao, C. (2020). Pronunciation problems of the non-English majors and teaching strategies. *Journal of Fujian Radio & TV University*.

Lin, T., & Wang, L. J. (1992). *A Course in Phonetics*. Beijing: Peking University Press.

Mak, B. (2011). An exploration of speaking-in-class anxiety with Chinese ESL learners. *System*, *39*(2), 202-214. https://doi.org/10.1016/j.system.2011.04.002

Nuhiu, M. (2013). Difficulties of Albanian speakers in pronouncing particular English speech sounds. *Social and Behavioral Sciences, 70 (2013) 1703 – 1707*.

Odlin, T. (1989). Language Transfer: Cross-Linguistic Influence in Language Learning. *Cambridge University Press*.

Peng, C. (2017). *A Study on the Strategies of Segmental and Phonematic Problems among English Learners in Changsha Aera.* (MA). Shanghai Normal University

Roach, P. (2004). British English: Received Pronunciation. *Journal of the International Phonetic Association*.

Spahiu, I., & Kryeziu, N. (2021). Grammatical mistakes of Albanian students in learning English as a foreign language. *Linguistics and Culture Review*, *5*(S3), 814-822.

Wang, L., & Yang, H. (2015). The Analysis of Common Errors in Higher Vocational Student English Pronunciation and Countermeasures. *Journal of Liaoning Higher Vocational Education, 17(4)*.

Wang, M., Koda, K., & Perfetti, C. A. (2003). Alphabetic and nonalphabetic L1 effects in English word identification: A comparison of Korean and Chinese English L2 learners. *Cognition*, *87*(2), 129-149. https://doi.org/10.1016/s0010-0277(02)00232-9

Wei, Y., & Zhou, Y. (2002). Insights into English Pronunciation Problems of Thai Students. *The Annual Meeting of the Quadruple Helix, 12p.*

Weinreich, U. (1953). Language in Contact: Findings and Problems. *The Hague: Mouton.*

Widanta, I. R. J., Sitawati, A. R., Aryana, I. R., & Ardika, I. D. (2016). Learning center with self-directed learning: a foundation for TOEFL learning activity. *International Journal of Linguistics, Literature and Culture*, *2*(4), 64-71.

Wu, C., Pan, Q., & Cao, D. (2020). Visualizing mismatches in pronunciation among EL2 Chinese learners at segmental level. *Theory and Practice in Language Studies, 10 (11),1388-1394*.

Yang, Y., Chen, X., & Xiao, Q. (2022). Cross-linguistic similarity in L2 speech learning: Evidence from the acquisition of Russian stop contrasts by Mandarin speakers. *Second Language Research, 38*, 3-29.

Yu, S., & Lee, I. (2014). An analysis of Chinese EFL students' use of first and second language in peer feedback of L2 writing. *System*, *47*, 28-38. https://doi.org/10.1016/j.system.2014.08.007

Zhang, C., Jepson, K., Lohfink, G., & Arvaniti, A. (2021). Comparing acoustic analyses of speech data collected remotely. *The Journal of the Acoustical Society of America, 149*(6), 3910–3916.

Zheng, T., & Liu, Q. A. (2018). Influence of Negative Transfer of Mother Tongue on Chinese English Learners' Pronunciation. *Theory and Practice in Language Studies, 8 (11), 1478-1484.*

Zhou, C. (2021). *Study on Grade One of Junior High Students' English Pronunciation Competence and Measures to Improve.* (MA). Kashi University.