The Perception of Mandarin Sibilant Fricatives by American English Speakers Learning Mandarin

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Abstract

This study examines the perception and identification of Mandarin sibilant fricatives by American English (AE) speakers who are learning Mandarin. The researcher investigates whether AE speakers who are learning Mandarin can identify Mandarin sibilant fricatives and whether their performance is affected by the types of L2 phones, the amount of L2 experience, and linguistic contexts. This study uses OpenSesame (Mathôt et al, 2012) to conduct an identification experiment. The results show that AE speakers learning Mandarin can identify Mandarin sibilant fricatives, and that the types of L2 phones, the amount of L2 experience, and linguistic contexts play important roles in the identification of Mandarin sibilant fricatives by AE speakers who are learning Mandarin.

Keywords: Equivalence Classification, L2 perception, Mandarin sibilant fricatives, English learners of Mandarin

INTRODUCTION

Literature Review

Over the years, researchers have examined L2 learners' perception and production of L2 phones. Flege (1987) proposed the concept of "Equivalence Classification" (EC) in L2: L2 learners tend to classify similar phones of the L2, which share the same or similar phonetic properties with their native phones, into their native phonetic spaces. Therefore, it is harder for them to differentiate between those L2 phones and their native phones because the two have been categorized as "the same", which means that they are in the same phonetic space. However, L2 learners do not tend to classify brand new phones of the L2 into their native phonetic spaces. An example of this is the high front rounded vowel [y] in Mandarin, which has no English equivalent. As a result, it is easier for them to differentiate between those L2 phones and their native phones because the two are not in the same phonetic space. Based on this idea, Flege (1987) claimed that L2 learners should produce brand new L2 phones authentically or native-like, but not similar L2 phones due to difficulty caused by the differentiation. To test this, he compared the F2 values of the new French vowel /y/ and the similar French vowel /u/ produced by native English speakers learning French with those of French monolinguals. The results indicated that native English speakers learning French did not differ from French monolinguals in producing the French /y/, but they did differ from French monolinguals in terms of producing the French /u/.

The findings from another study conducted by Bohn and Flege (1992) further tested the hypothesis that similar L2 phones remained foreign-accented even after lengthy exposure to the L2 due to the EC. However, new L2 phones were produced more

authentically with extended L2 experience. They measured the spectral and temporal characteristics of the English vowels produced in /bVt/ words by three groups: two groups of L1 German speakers with different English language experience, and one L1 English control group. The same tokens were also judged for intelligibility in a labeling experiment. The results showed that more L2 experience did not help L1 German speakers produce similar English vowels more native-like (English /i, ɪ, ɛ/ vowels which have counterparts in German) but that it did help them produce new English vowels more authentically (English /æ/ which has no counterpart in German).

Both studies examined the EC with respect to L2 production; L2 learners produce new L2 phones more authentically than similar L2 phones and more L2 experience helps the productions of new L2 phones but not similar L2 phones. However, what is still unclear is whether or not the EC can be applied equally to L2 perception.

In addition, the EC did not work well for L2 production as argued by one study that was concerned with the productions of Mandarin voiceless fricatives by L1 Thai learners (Kitikanan & Al-Tamimi, 2012). In this study, three Thai learners of Mandarin and two native Mandarin speakers participated in a picture-naming task. The auditory analysis showed that it was easier for L1 Thai learners to produce Mandarin labiodental and dental/alveolar fricatives [f] and [s]. The author claimed the reason for this was that they had similar counterparts in Thai. However, it was much harder for L1 Thai learners to produce Mandarin alveolo-palatal and retroflex [ɕ] and [ʂ], and the author claimed that this was because they did not have similar counterparts in Thai. Therefore, the results challenge the EC and make additional L2 research necessary in order to test it further, especially with respect to fricatives.

Except the EC, which has been challenged by L2 research on fricatives, investigations into the perceptions of Polish sibilant fricatives by AE listeners has revealed that AE listeners relied solely on the vocalic transition information and ignored fricative noises when categorizing Polish alveolo-palatal and retroflex sibilant fricatives [ɕ] and [ʂ] (McGuire, 2007). Thus, more L2 research specifically with regard to L2 learners' and not just listeners' is needed in order to test the influence caused by linguistic contexts, in this case, consonants in isolation versus consonants combined with vowels.

As a result, it would be of great interest to investigate the perception of L2 phones by L2 learners to further test the EC and the influence caused by linguistic contexts. This current study is a preliminary investigation on how AE speakers learning Mandarin identify Mandarin sibilant fricatives.

A Typological Comparison of English and Mandarin

In general, American English has two voiceless sibilant fricatives, the alveolar sibilant fricative [s] and the postalveolar sibilant fricative [ʃ]. However, Mandarin Chinese has three voiceless sibilant fricatives, those being alveolar sibilant fricative [s], retroflex sibilant fricative [ʂ], and alveolo-palatal sibilant fricative [ɕ]. Mandarin alveolar sibilant fricative [s] should be considered a similar/shared L2 phone for AE learners of Mandarin while Mandarin retroflex [ʂ] overlaps with English postalveolar [ʃ] in terms of spectral properties. As a result, it should also be considered a similar/shared L2 phone. Mandarin alveolo-palatal [ɕ] should be considered as a new L2 phone to AE learners of Mandarin.

It is also important to note that the vowel contexts are complementary for [s] and [ʂ] in relation to [ɕ]. More specifically, [s] and [ʂ] appear in the environment of [ɨ], [u] and [a]. On the other hand, [ɕ] appears in the environment of [i], [y] and [ja], which means it occurs in a fronted vowel environment.

Limitations on Acoustic Measurements

Generally speaking, there are no reliable acoustic cues with regard to the measure of Mandarin sibilant fricatives. Concerning English sibilant fricatives, [s] has a higher first spectral moment/spectral mean value (the frequency of average energy distribution) than [ʃ] (Jongman, Wayland, & Wong, 2000, p. 1256). However, with regard to Mandarin sibilant fricatives, [s] has the highest spectral mean value. Nevertheless, the difference between [ʂ] and [ɕ] is still not clear. Some research found [ɕ] has a higher spectral mean value than [ʂ] (Lee, 2011, p.1181), but some contrasting research has found that it has a lower spectral mean value than [ʂ] (Lee, 2011, p. 1178). Thus, spectral mean value is not a reliable acoustic cue to differentiate Mandarin sibilant fricatives although it is a reliable acoustic cue for English ones. As a result, we cannot rely on spectral mean value to determine whether or not the production is Mandarin [ʂ] or [ɕ], which poses a challenge to conduct a production study. Moreover, it is important to conduct a perception study in order to test the EC on the L2 perception. Thus, this current study focuses on perception, specifically identification of Mandarin sibilant fricatives by AE speakers who are learning Mandarin.

RESEARCH QUESTIONS & HYPOTHESES

Research Questions

1. Can American English speakers who are learners of Mandarin identify Mandarin sibilant fricatives?
2. Do AE speaking learners of Mandarin identify new L2 phone [ɕ] more accurately than similar/shared L2 phones [s] and [ʂ]?
3. Do AE speaking learners of Mandarin enrolled in 300- and 400-level Mandarin classes identify new L2 phone [ɕ] but not similar/shared L2 phones [s] and [ʂ] more accurately than learners enrolled in 100- and 200- level classes of Mandarin?
4. Do linguistic contexts affect the identification of Mandarin sibilant fricatives by AE speakers who are learning Mandarin?

Hypotheses

1. AE speakers who are learners of Mandarin can identify Mandarin sibilant fricatives. Previous literature has shown that even AE listeners of Polish can successfully perceive Polish voiceless alveolo-palatal and retroflex sibilant fricatives [ɕ] and [ʂ], which are similar to Mandarin voiceless alveolo-palatal and retroflex sibilant fricatives (McGuire, 2007).
2. AE speaking learners of Mandarin identify new L2 phone [ɕ] more accurately than similar/shared L2 phones [s] and [ʂ] because L2 learners acquire new L2 phones more authentically or native-like than similar/shared L2 phones based on the EC (Flege, 1987).

3. AE speaking learners enrolled in 300- and 400- level Mandarin classes will outperform those enrolled in 100- and 200- level Mandarin classes on new L2 phone [ɕ] but not similar/shared L2 phones [s] and [ʂ], which is supported by previous literature that more L2 experience can only help L2 learners better acquire new L2 phones but not similar/shared L2 phones (Bohn & Flege, 1992).
4. Vowel contexts help AE learners of Mandarin better identify Mandarin sibilant fricatives compared to Mandarin sibilant fricatives in isolation because previous literature has shown that vocalic cues help L2 listeners better acquire L2 phones (McGuire, 2007).

METHODOLOGY

Participants

Participants consisted of 2 undergraduate students of Indiana University who had previously registered for Chinese language 100 or 200 level courses, both of which were female with a mean age of 19 years old. In addition to speaking English and Mandarin Chinese, both participants identified themselves as beginning Spanish learners. One of the participants also identified herself as an advanced Vietnamese learner. Since both learners were beginning learners who still need to master the basic language skills in modern Chinese —they will be referred to as low level AE learners of Mandarin.

Additional participants consisted of 2 undergraduate students of Indiana University who had previously registered for Chinese language 400 or 500 level courses, one of which was male and another was female with a mean age of 22 years old. In addition to

English and Mandarin Chinese, the female participant identified herself as a beginning Spanish learner. Since both learners were advanced learners who had mastered basic language skills and were trained to understand and appreciate Chinese literary genres and prose—they will be referred to as high level AE learners of Mandarin.

There were 2 native Mandarin speakers serving as a control group, both were female with a mean age of 32 years old. In addition to Mandarin, both identified themselves as advanced English learners. One of them identified herself as a beginning French learner. One of the participants was a graduate student at Indiana University and the other was a visiting scholar at Indiana University.

All participants were recruited through flyers distributed by the researcher.

Variables

There were three independent variables. The first variable was language group, which includes high level learners, low level learners and native speakers. The second variable was the fricative type, which includes the alveolar [s], the retroflex [ʂ] and the alveolo-palatal [ɕ]. The final variable was the linguistic contexts. More specifically, there were four contexts: sibilant fricatives in isolation, sibilant fricatives combined with a [ɨ] or [i] vowel, sibilant fricatives combined with a [u] or [y] vowel, and sibilant fricatives combined with a [a] or [ja] vowel. The dependent variable was the identification accuracy rate.

Stimuli

Four female native Mandarin speakers were asked to produce three Mandarin sibilant fricatives combined with three vowel contexts ([ɨ]/[i], [u]/[y], and [a]/[ja]). In addition to CV stimuli, fricative-only stimuli were also spliced from the productions of full CV-structure syllables using Praat (Boersma & Weenink, 2016). Native Mandarin speakers were not asked to produce the three Mandarin sibilant fricatives in isolation because it seemed unnatural and hard to do so. The speakers were recorded using a Marantz PMD 660, ElectroVoice Cobalt 9, at a sampling rate of 44.1 kHz. There were a total of 144 tokens elicited (3 sibilant fricatives × 4 linguistic contexts × 3 repetition × 4 female native speakers).

Procedure

The identification experiment was presented using OpenSesame and was conducted in the recording room of the Phonetics & Phonology Lab at Indiana University. Participants read a consent form prior to participating in the study. The identification experiment consisted of two parts; a practice session and an experiment session. During the practice session, there were no illustrations of 's'[s], 'sh' [ʂ] or 'x' [ɕ] played for participants since they have been trained in their language classes on these three phones and all tokens were judged to be good representations by native Mandarin speakers. In addition, participants were given detailed instructions that read as follows: "You will hear one of the three Chinese consonants 's'[s], 'sh' [ʂ] or 'x' [ɕ] produced in isolation and combined with different vowels. After hearing each one, you will need to decide which one it is. If

you think it is ‘s’[s], press S in keyboard, if you think it is ‘sh’ [ʂ], press L in keyboard, if you think it is ‘x’ [ɕ], press B in keyboard.” ‘s’, ‘sh’ and ‘x’ are Pinyin symbols corresponding to [s], [ʂ] and [ɕ]. They were used because AE learners have learned Pinyin symbols, in which Mandarin Chinese uses several letters corresponding to specific sounds rather than IPA. In addition, the correspondences between the target sounds and the buttons in keyboard were presented to the participants on a screen in case they forgot which button to press.

The practice session consisted of 12 randomized tokens. Participants were allowed to ask questions as the practice session was designed to help participants become familiar with the study. After the practice session, the experiment began. There were 4 tasks in this experiment part. Task 1 contained 3 Mandarin sibilant fricatives in isolation. Task 2 contained 3 Mandarin sibilant fricatives combined with a vowel [ɨ] or [i]. Task 3 contained 3 Mandarin sibilant fricatives combined with a vowel [u] or [y]. Task 4 contained 3 Mandarin sibilant fricatives combined with a vowel [a] or [ja]. There were 36 randomized tokens in each task. During the experiment session, participants saw instructions similar to those in the practice session. In addition, there were correspondences between the target sounds and buttons on the keyboard presented on screen. After completing the experiment, participants were asked to complete a language background questionnaire.

RESULTS AND ANALYSIS

As a whole, American English speakers who are learning Mandarin can identify Mandarin sibilant fricatives, and AE speaking learners of Mandarin identify

similar/shared L2 phones [s] and [ʂ] more accurately than new L2 phone [ɕ]. In terms of L2 experience, high level AE speaking learners of Mandarin outperform low level ones on all three L2 phones. Moreover, vowel contexts help them better identify Mandarin sibilant fricatives.

The data was analyzed by calculating the mean identification accuracy rates given that the sample size was too small (two participants in each language group). Even so, it may serve as a guideline for future research when we extend the sample size. As a result, in this preliminary study, the statistical significance was not examined; however, the mean identification accuracy rates will be reported.

Data from Table 1 and Figure 1 show that AE learners of Mandarin have a mean accuracy rate of 89.1% and native Mandarin speakers have a mean accuracy rate of 95.1%. Although native Mandarin speakers do –at least numerically— outperform AE learners of Mandarin, AE speakers who are learning Mandarin have a relatively high mean accuracy rate that indicates they can identify Mandarin sibilant fricatives.

Table 1. Mean accuracy rate by language group

Language Group	Mean Accuracy Rate
AE Learners of Mandarin	.891
Native Mandarin Speakers	.951

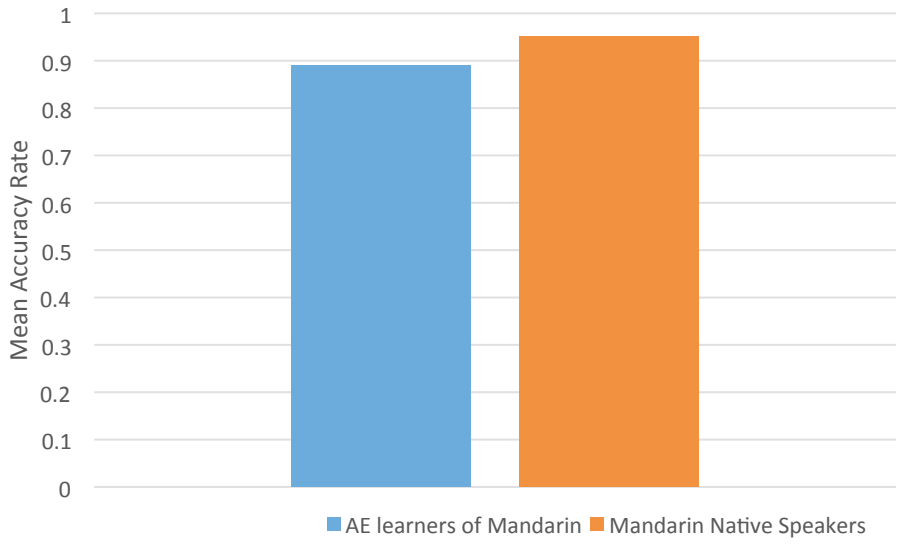

Figure 1. Mean accuracy rate by language group.

Based on the data from Table 2 and Figures 2a, b, c, with respect to new L2 phone [ɕ], AE learners of Mandarin have a mean accuracy rate of 82.3%; however, native Mandarin speakers have a mean accuracy rate of 93.8%, which means they outperform AE learners of Mandarin by 11.5%. In addition, concerning similar/shared L2 phone [s], AE learners of Mandarin have a mean accuracy rate of 92.2%, and native Mandarin speakers have a mean accuracy rate of 99.0%, which means they outperform AE learners of Mandarin by 6.8%. Moreover, regarding another similar/shared L2 phone [ʂ], the mean accuracy rates of AE learners and native Mandarin speakers are the same, that is 92.7%. Thus, compared to new L2 phone [ɕ], AE speakers who are learning Mandarin identify similar/shared L2 phones [s] and [ʂ] more accurately. The results seem to contradict with Flege's concept of the EC, which claims that L2 learners acquire new L2 phones more authentically or native-like than similar/shared L2 phones. However, the prediction made by Flege cannot be applied to L2 perception, at least to L2 identification equally as the

results of the present study show. Thus, this issue will be addressed in the discussion section.

Table 2. Mean accuracy rate by fricative type

Fricative Type	Language Group	Mean Accuracy Rate
[ɕ]	AE Learners of Mandarin	.823
	Native Mandarin Speakers	.938
[s]	AE Learners of Mandarin	.922
	Native Mandarin Speakers	.990
[ʂ]	AE Learners of Mandarin	.927
	Native Mandarin Speakers	.927

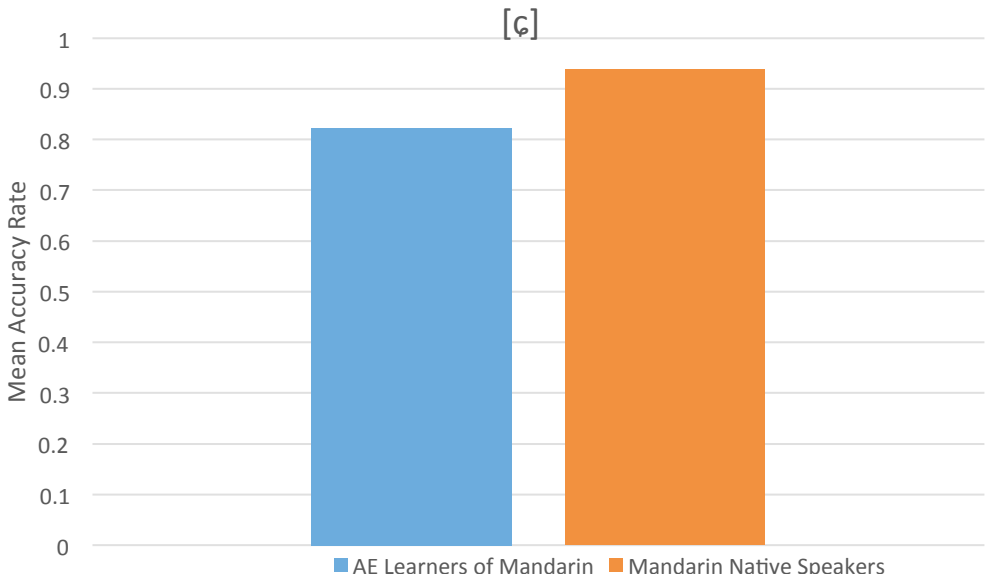

Figure 2a. Mean accuracy rate for [ɕ].

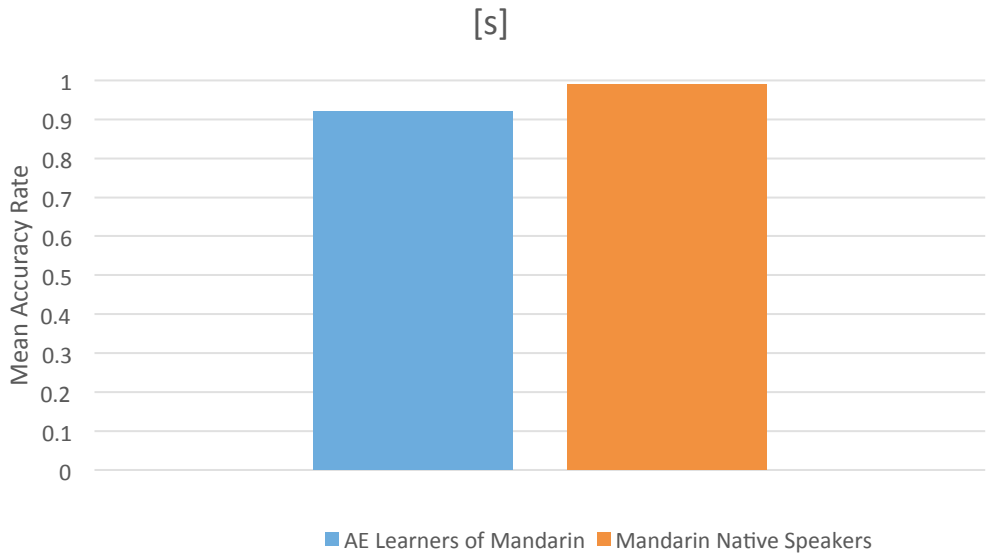

Figure 2b. Mean accuracy rate for [s].

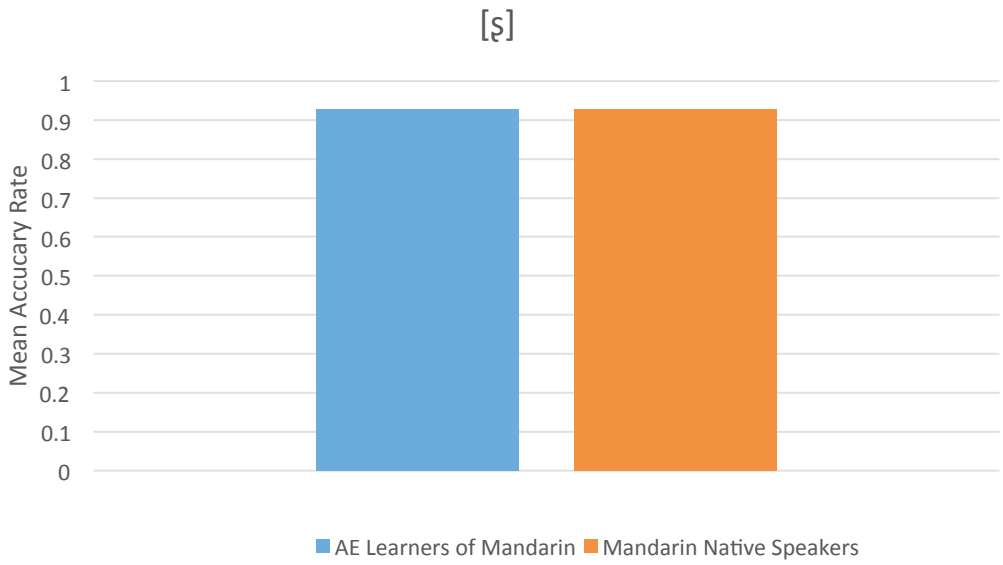

Figure 2c. Mean accuracy rate for [ʂ].

Table 3 and Figures 3a, b, c, present data with regard to new L2 phone [ɛ], low level AE learners of Mandarin have a mean accuracy rate of 77.1%, while high level learners have a mean accuracy rate of 87.5%, which shows that they outperform low level participants by 10.4%. For similar/shared L2 phone [s], low level AE learners of

Mandarin have a mean accuracy rate of 89.6%, and high level participants have a mean accuracy rate of 94.8%, which indicates that they outperform low level learners by 5.2%. For another similar/shared L2 phone [ʂ], low level AE learners have a mean accuracy rate of 87.5%, but high level learners outperform them by 10.4%, that is, 97.9%. The results show that more L2 experience does help L2 learners to better identify not only new L2 phones but also similar/shared L2 phones.

Table 3. Mean accuracy rate by language group and fricative type

Fricative Type	Language Group	Mean Accuracy Rate
[ɕ]	Low Level AE Learners of Mandarin	.771
	High Level AE Learners of Mandarin	.875
[s]	Low Level AE Learners of Mandarin	.896
	High Level AE Learners of Mandarin	.948
[ʂ]	Low Level AE Learners of Mandarin	.875
	High Level AE Learners of Mandarin	.979

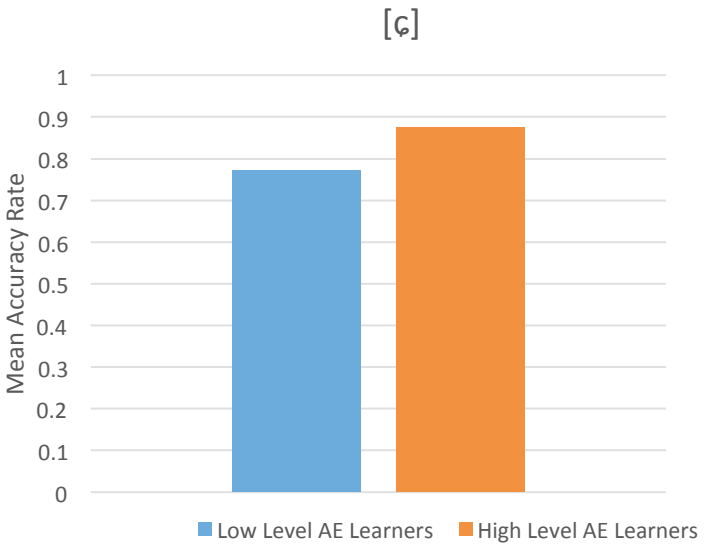

Figure 3a. Mean accuracy rate for [ɕ] by language group.

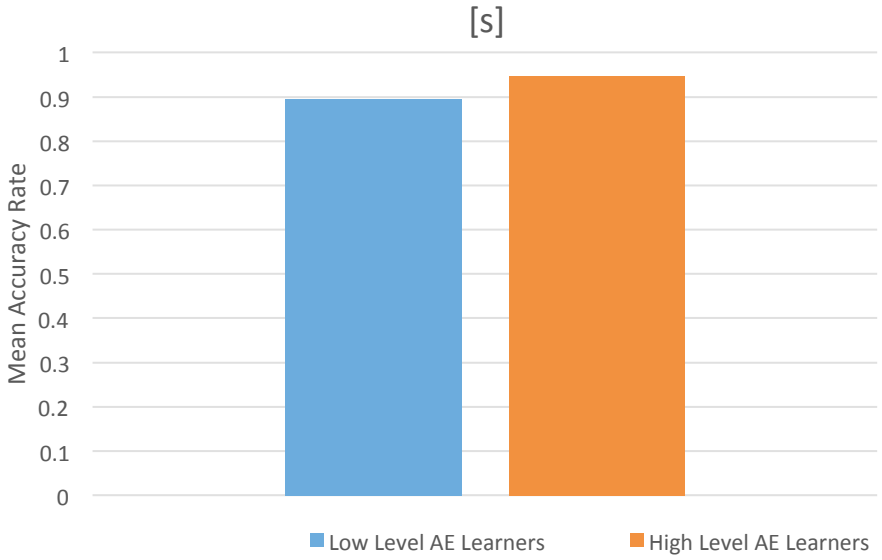

Figure 3b. Mean accuracy rate for [s] by language group.

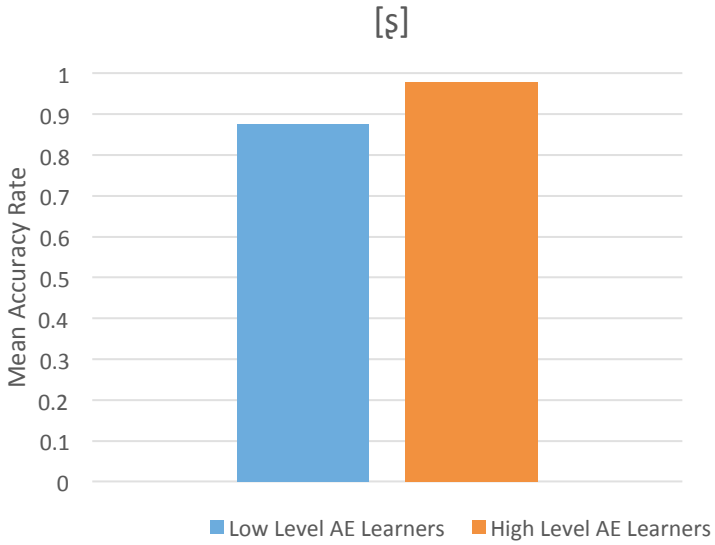

Figure 3c. Mean accuracy rate for [ʂ] language group.

Data from Table 4 and Figure 4 illustrate that AE learners of Mandarin have a mean accuracy rate of 77.8% when these three sibilant fricatives are in isolation. However, when we compare them to the environment of isolation, the mean accuracy rates increase by 15.3%, 16.0%, and 13.9% when these three sibilant fricatives are in the vowel contexts of [ɨ] / [i], [u] / [y] and [a] / [ja] respectively. These results indicate that vowel

contexts do help –at least numerically— AE learners of Mandarin better identify Mandarin sibilant fricatives.

Table 4. Mean accuracy rate by linguistic contexts

Linguistic Contexts	Language Group	Mean Accuracy Rate
isolation	AE Learners of Mandarin	.778
[ɨ] / [i]	AE Learners of Mandarin	.931
[u] / [y]	AE Learners of Mandarin	.938
[a] / [ja]	AE Learners of Mandarin	.917

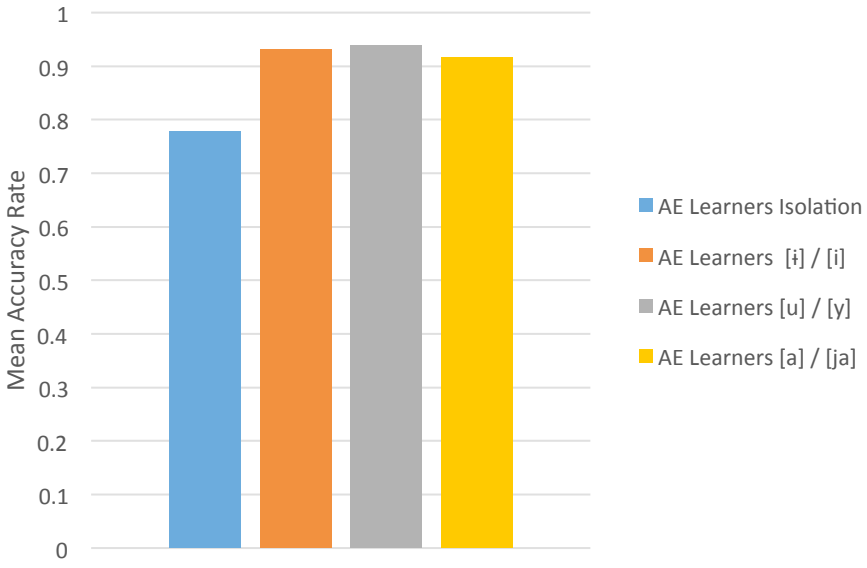

Figure 4. Mean accuracy rate by linguistic contexts.

DISCUSSION AND CONCLUSION

As a whole, this study intends to test the EC proposed by Flege (1987) with regard to L2 perception by using an identification task, in which AE speakers who are learning Mandarin were asked to identify Mandarin sibilant fricatives. The results show that AE

learners of Mandarin can identify Mandarin sibilant fricatives because they have a relatively high mean accuracy rate, 89.1%, which is much higher than chance level 33.3%[1]. There is a consistency with regard to L2 perception of sibilant fricatives across linguistically. The reason is this result expands the conclusion concerning the perception of Polish sibilant fricatives [ɕ], [ʂ] by AE listeners to a new data set, that is, L2 perception of Mandarin sibilant fricatives [ɕ], [s], and [ʂ] by AE learners, in which the target language, Mandarin, belongs to Sino-Tibetan language family not Indo-European language family.

In addition, the results in the present study show that AE speaking learners of Mandarin identify similar/shared L2 phones [s] and [ʂ] more accurately than new L2 phone [ɕ], which contradicts with Flege's EC that predicts L2 learners acquire new L2 phones more authentically than similar/shared L2 phones. These results seem to show that the EC, which is proposed to explain L2 production in previous literature cannot be applied to L2 identification equally. When we consider the identification of L2 phones, L2 learners can map similar/shared L2 phones into their existing/native phonetic spaces. As a result, their knowledge with regard to their native phones can help them better identify similar/shared L2 phones. With regard to new L2 phones, L2 learners must establish new phonetic spaces for them, and can rely on nothing to identify them. Thus, L2 learners can identify similar/shared L2 phones more accurately than new L2 phones. However, it is a different situation when we consider the L2 production, in which the EC may cause problems for L2 learners to produce similar/shared L2 phones but not new L2

[1] Since there are three Mandarin sibilant fricatives, the chance level is 1/3=.333

phones due to the difficulty raised by differentiation between similar/shared L2 phones and their native phones.

Moreover, when we consider the influence of L2 experience, the results show that more L2 experience helps L2 learners on both new L2 phones and similar/shared L2 phones, which does not agree totally with the findings by Flege and Bohn that suggested more L2 experience can only help L2 learners better acquire new L2 phones but not similar/shared L2 phones. Flege and Bohn's findings can be explained by considering the way of producing new L2 phones, more L2 experience can help L2 learners establish and become familiar with the new phonetic spaces that they create, and thus, help the productions of new L2 phones more authentically. However, since L2 learners already have existing/native knowledge on similar/shared L2 phones, extended L2 experience can not necessarily help the productions of similar/shared L2 phones. Thus, similar/shared L2 phones remain accented even after lengthy L2 exposure. But, the results from the current study indicate that more L2 experience can help the perception of both new L2 phones and similar/shared L2 phones. The reasons why extended L2 experience can also help L2 learners to acquire similar/shared L2 phones with respect to perception is not clear. These questions open avenue that future research can explore.

With regard to the effect of the phonological environment, having a vowel context does help AE learners of Mandarin better identify Mandarin sibilant fricatives, which is consistent with the findings on Polish sibilant fricatives by AE listeners. The reason can be that the vowel contexts help L2 learners to recall real Mandarin words that help them identify which sibilant fricative it is. This shows the consistency with regard to the effects of vowel effects cross linguistically.

LIMITATIONS AND FUTURE RESEARCH

This current study is a preliminary investigation on how AE learners of Mandarin acquire Mandarin sibilant fricatives from the perspective of perceptual identification, which tests the EC in terms of L2 perception and also contributes to previous existing L2 research on the L2 perception of sibilant fricatives.

Future research could expand the current research by including more participants in each language proficiency group. With this increased simple size, a relevant statistical analysis can be done to find the significance level. Furthermore, other perception tasks such as assimilation or discrimination tasks can also be designed to see if there is a difference among different perception task designs.

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