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Perception of Mandarin fricatives by native speakers of Taiwan Mandarin and Taiwanese

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This perception study examines bilingual Taiwan Mandarin (Guoyu) and Taiwanese listeners' perception of Mandarin fricatives. Two female talkers and two groups of listeners, one from Taiwan and the other from China, were recruited. The participants listened to fricative pairs such as /sa/, /fa/ and then rated the similarity. The results show that bilingual listeners have difficulty in distinguishing the contrast between Mandarin /s/ and /ʂ/ no matter which talker they listened to. They also perceive /x/ and /f/ to be similar when listening to the stimuli produced by a bilingual talker. The results show that the lack of the retroflex fricative /ʂ/ and labiodental /f/ in Taiwanese influence how these bilingual listeners perceive Mandarin fricatives. [1]

1. Introduction

Fricatives sound like a stream of noise because fricatives are produced by air being forced through a narrow gap in the oral cavity (Ladefoged 2005) and this is where the noise comes from. According to Li (2008:25), the place of articulation of fricatives means "the narrowest constriction made by the tongue toward the ceiling of the vocal tract in the mid-sagittal plane. Take English for example; the /s/ in soup is an alveolar fricative which means that the narrowest constriction for this fricative is made in the alveolar ridge. Though, fricatives sound like a stream of noise, depending on the place of articulation, the frequency of the noise can help listeners distinguish which fricative they hear: the shorter the front cavity in front of the constriction, the higher the frequency of the noise. To distinguish fricatives with different places of articulation, frequency of fricative noise and formant movement of the adjacent vowels are often used.

Several previous studies examine cross linguistics perception show that listeners have more difficulty in discriminating fricatives that are not phonemic in their native languages. For example, Johnson and Babel (2010) explored whether listeners' fricative

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inventory will influence their perception of fricatives of non-native language. They recruited English and Dutch speakers and tested their perception of English fricatives. English has more voiceless fricatives than Dutch as shown in the table 1. The results show that Dutch speakers rated English /s/-/ɵ/, /s/-/ʃ/, /ɵ/-/ʃ/ to be more similar than English speakers. The lack of a dental and post-alveolar fricative in Dutch made Dutch listeners perceive the English fricatives /ɵ/ and /ʃ/, to be similar to adjacent fricatives such as /s/.

	Labiodental	Dental	Alveolar	Post-alveolar	Velar	Glottal
Dutch	f		s		x	h
English	f	ɵ	s	ʃ		h

Table 1. Fricatives of Dutch and English in IPA

Similarly, Aoyama et al. (2008) examined Japanese speakers' perception of English fricatives and the author focused only on English /ɵ/ which is not phonemic in Japanese. The result also shows that Japanese speakers have difficulty in discriminating /s/ and /ɵ/. The authors concluded that listeners are influenced by their native language inventory when perceiving fricatives of other languages. When there is a lack of fricatives in certain places of articulation in a listeners' native language, they perceive the fricative they do not have to be similar to the neighboring fricative in the target language.

	Labiodental		Interdental		Alveolar		Post-alveolar		Palatal	Glottal
English	f	v	ɵ	ð	s	z	ʃ	ʒ		h
Japanese					s	z			ɕ	h

Table 2. Fricatives of Japanese and English in IPA

Lastly, Tsao et al. (2006) explored Mandarin and English speakers' perception of Mandarin fricative-affricates [ɕ]-[tɕ], [ɕ]-[tɕ^{h}] contrast. The authors indicated though

English speakers have contrast in the same place of articulation, aspiration is not used in contrasting fricatives. Therefore, they reported that English speakers performed poorly in discriminating the Mandarin fricative-affricate contrast.

Several production studies which focus on Taiwanese show that Taiwanese speakers' production of Mandarin fricatives are influenced by Taiwanese. The first study that examined Taiwanese speakers' production of Mandarin fricatives is Peng (1993). Peng recruited 10 Taiwanese people who learned Mandarin as a second language (L2) and differed in their Mandarin proficiency. She found that her participants tend to use Taiwanese /h/ for Mandarin /x/. Furthermore, due to the lack of a labial fricative in Taiwanese, these participants produced the labialized /h/ for the labio-dental fricative /f/. Similarly, Lin (2008) and Yang (2008) also researched Taiwanese speakers' production of Mandarin /f/. Though these two studies examined the phenomenon from a sociolinguistic perspective, they also found that Taiwanese speakers tend to produce Mandarin /f/ as [h ^{w}]. Although /f/ and /h/ are not adjacent fricatives in terms of place of articulation, they are both non-sibilants. It might be the reason why Taiwanese speakers use labialized /h/ to mimic the labial feature of /f/.

	Labiodental	Dental	Retroflex	Palatal	Velar	Glottal
Mandarin	f	s	ʂ	ɕ	x	
Taiwanese		s				h

Table 3. Fricatives of Mandarin and Taiwanese in IPA

2. Research questions and predictions

The above cross-linguistic studies show that the lack of certain fricatives in one's native language will influence listeners' perception. However, there is relatively less research examining bilingual speakers' perception of one of their native languages. The study aims to answer the following research questions:

(1) Which Mandarin fricative contrasts are more difficult for bilingual listeners of Taiwan Mandarin/Guoyu and Taiwanese to discriminate?

(2) Do talkers' dialectal differences influence bilingual listeners' perception of Mandarin fricatives?

The predictions based on previous literature are (1) Bilinguals will perceive [f] to be similar to [x] because there is no labiodental fricative in Taiwanese and these two non-

sibilants will be perceived to be more similar than other sibilants. (2) Bilinguals will perceive [s] to be similar to [ʂ] because of the lack of a retroflex fricative in Taiwanese.

3. Methodology

3.1 Participants

Two talkers and two groups of listeners participated in the study. One talker was a bilingual Taiwanese and Taiwan Mandarin (Guoyu) speaker from southern Taiwan and the other talker was a monolingual Mandarin (Putonghua) speaker from northern China. The bilingual listeners were all from southern Taiwan (*N*=22, 7 male and 15 female, mean age=35). The other group of listeners (*N*=20, 5 male and 15 female, mean age=30) were all from China but recruited in the States. They are graduate students in a major middle west university. The monolingual listeners serve as a comparison group in order to compare their result with bilingual listeners.

3.2.Stimuli

The stimuli are five Mandarin fricatives combined with the low front vowel /a/ in tone one. They are /fa/,/sa/, /ʂa/, /ɕia/ and /xa/ (The stimuli are presented in IPA). For historic reasons, /ɕ/ cannot be combined with other vowels without /i/. Therefore, this stimuli is different from other four. Each talker produced a fricative plus /a/ 10 times. Then the stimuli were paired by randomly selecting from the 10 repetitions. The stimuli pairs are pairs such as /fa/-/fa/ or /sa/-/xa/. There are a total of 15 fricative pairs: 5 of them as "same" pairs and 10 of them as "different" pairs. The stimuli were blocked by a talker and each block contains 125 stimuli pairs.

3.3 Procedures

The experiment was run on Praat (a phonetic analysis software). All listeners listened to the block produced by the Putonghua talker first and then the Guoyu talker. The listeners used a five-point Likert scale : 1(the same), 2(very similar), 3(similar), 4(different), 5(very different) to rate the stimuli pair. Every participant listened to the stimuli pair only once and their reaction time was not recorded.

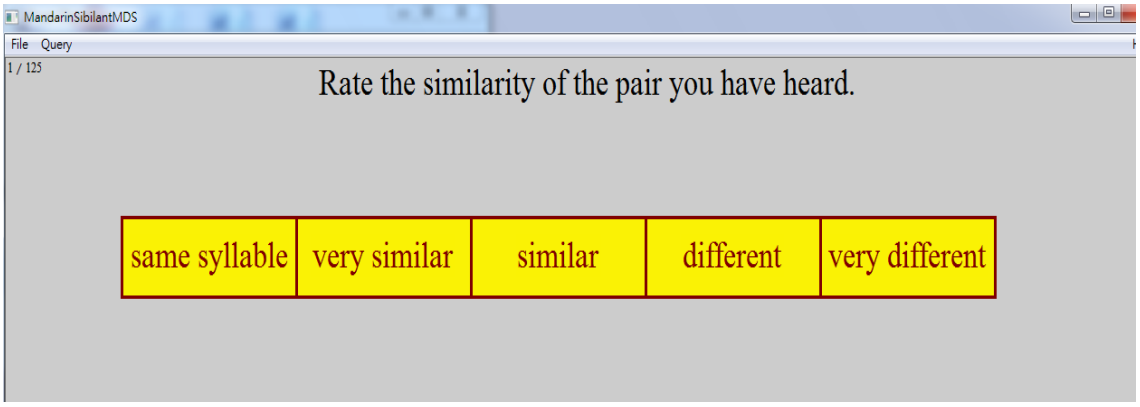

Figure 1. Snapshot of the program

3.4 Data analysis

The data was analyzed by first calculating all listeners' mean rating of the stimuli pairs. Then the data was analyzed by repeated measure of ANOVA. The three independent variables were (1) talker (bilingual of Guoyu and Taiwanese/monolingual of Putonghua), (2) stimuli pair (15 pairs) and (3) language background of the listeners (bilingual/monolingual). One-dimensional plots were also plotted to show the perceptual similarity of the listeners.

4. Results

Figure 2 shows the general patterns of all the results calculated by the mean rating of all participants. There are four lines in Figure 2. Each line represents the result of the two groups listened to the two talkers. The x-axis is the stimuli pairs. The first five pairs are identical pairs and the rest of them are different pairs. The y-axis is the mean rating of the stimuli pair ranging from 1(the same) to 5 (very different). The blue solid line represents the data of bilingual subjects listening to the Putonghua talker's production. The red solid line shows monolingual subjects listening to the Putonghua talker. The light blue dashed line represents the results of bilingual subjects listened to bilingual talker and lastly, the light red dashed line indicates the data of monolingual listeners' response to bilingual talker. The general patterns are pretty similar for both listener groups.

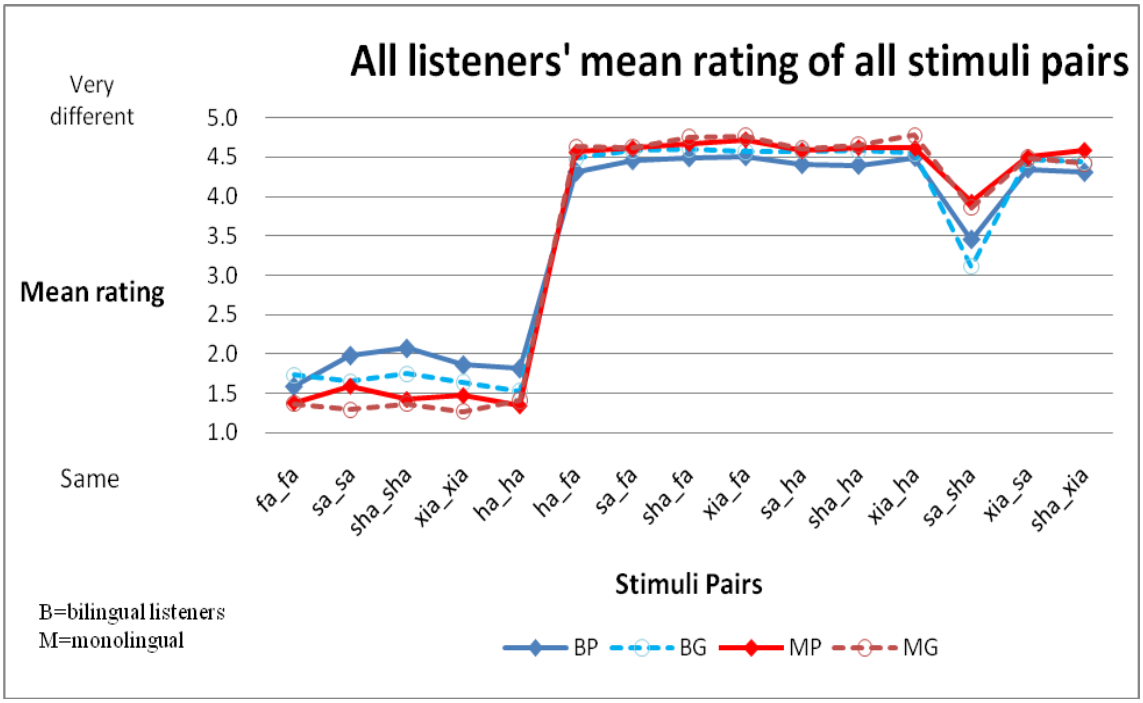

Figure 2. The mean rating of all listeners' response

The results were analyzed in a repeated measures analysis of variance. The between-listeners variable is language background (bilingual of Guoyu and Taiwanese and monolingual of Putonghua) and the within-listeners variables are (1) talker (bilingual of Guoyu and Taiwanese, monolingual of Putonghua) and (2) stimuli pairs (15 pairs). The main effect of stimuli pair was significant (F [14,560]=507.71, p=.00). The stimuli pair by language background interaction was also significant (F[14,560]=5.80, p=.00). The talker by stimuli pair interaction was also significant (F[14 ,560]=4.68, p=.00). Lastly, the three way interaction was also significant (F[14 , 560]=1.92, p=.02). In order to know whether the variation in the first five "same" pairs and the dipping in the sa-sha (the stimuli is represented by Pinyin) pair is significantly different, the researchers separated the pairs into two parts - five same pairs and ten different pairs - and ran a paired T test. The paired T test for the five same pairs showed that although there is variation among the five pairs, they are not statistically different from each other (p>.05). On the other hand, for the ten different pairs, sa-sha pair was the one which was significantly different from all other pairs (p<.003).

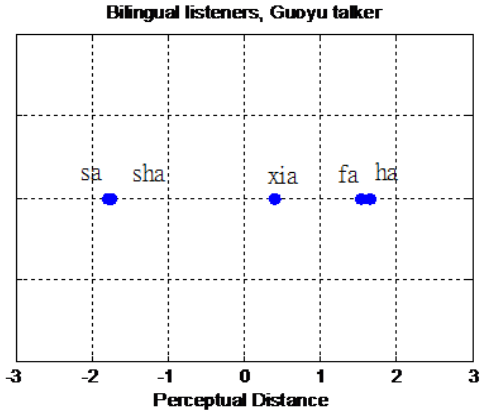

Figure 3. Bilingual listeners, Guoyu talker. (The stimuli pairs are presented in Pinyin).

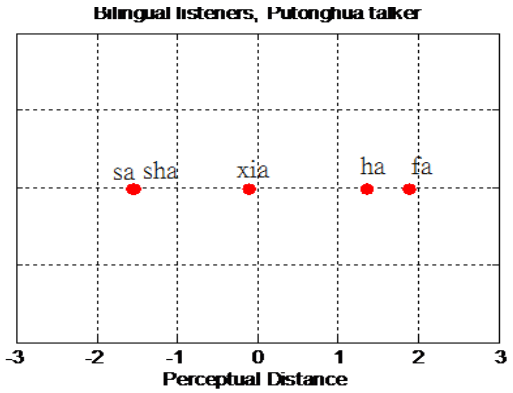

Figure 4. Bilingual listeners, Putonghua talker.

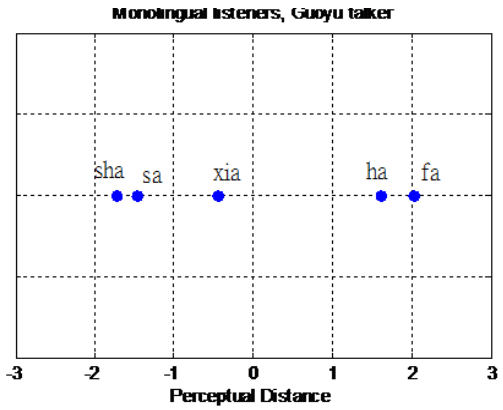

Figure 5. Monolingual listener, Guoyu talker. (The stimuli pairs are presented in Pinyin).

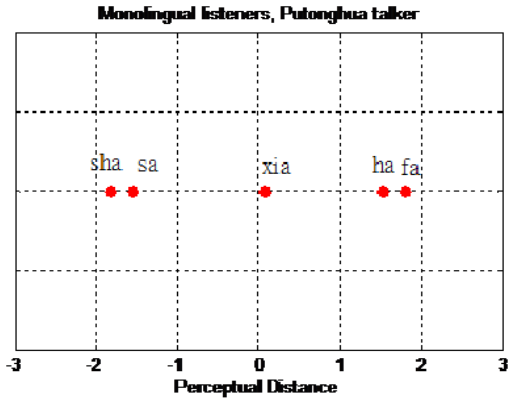

Figure 6.Monolingual listeners, Putonghua talker.

The 4 one-dimensional plots show the perceptual space of the two listener groups. Although there are numbers on the x-axis, this number does not mean the exact distance of the sounds. It only shows the relative distance among the target fricatives. The plots with the blue dots are the results of bilingual listeners while and red dots show the results of the monolingual listeners. The stimuli pairs such as “sha” and “sa” in the plot are presented by Pinyin. Each plot has 5 dots which represent each fricative and vowel combination. Figure 3 shows the result of bilingual participants listening to the bilingual talker. These bilingual listeners perceived "sa" to be very similar to "sha". In other words, they perceived /s/ to be similar to /ʂ/ because the two dots overlapped. Interestingly, they also perceived the "ha" and "fa" produced by the bilingual talker similar to each other, which means they perceived /x/ to be close to /f/. However, when the bilingual subjects

listened to the monolingual speaker, they still perceived "sa" to be close to "sha" but not the "fa" and" ha" pair. The production of sa-sha contrast is clearer when produced by a Putonghua speaker. However, bilingual of Taiwanese and Guoyu still perceived these two pairs to be very similar to each other. On the other hand, the monolingual listeners can distinguish the five fricatives very well. Unlike bilingual listeners, they can separate the "sa" "sha" pair and "fa" "ha" pair very well for both talkers.

5. Discussion

The general pattern for the two groups of listeners is very similar to each other. In Figure 2, although bilingual listeners seem less certain in rating identical pairs than monolingual listeners, the statistical analysis shows that this variation is not statistically different(p >.05). Moreover, in Figure 2, listeners' rating of the sa-sha pair also drops which is different from all other pairs. A paired T test was conducted to test if this dipping is truly different from all other pairs. The statistic test indicated that the rating of the sa-sha pair is significant different from all other pairs. The rating of the ha-fa pair also differs from many pairs but it does not differ from all pairs like the sa-sha contrast. However, on the one-dimensional plot, it shows that the fa-ha pair is rated similarly only by bilingual listeners when they listened to the bilingual talker. It may be the reason why on the general pattern it did not show a clear dipping like the sa-sha pair.

To answer the research questions, the most difficult fricative pair for a bilingual of Guoyu and Taiwanese is the sa-sha pair. The result is further confirmed by the one dimensional plot because the perceptual distance is very close for /s/ and /ʂ/ and it is true no matter which talker they listened to. One possible explanation for the results may be the influence from Taiwanese. Due to the lack of retroflex fricatives in Taiwanese, these speakers had more difficulty in discriminating the two fricatives. The result of this experiment is similar to Johnson and Babel (2010)'s study. In their study, their Dutch listeners perceiving English fricatives not in their native language to be closer to the neighboring sounds. On the other hand, the bilingual listeners also have difficulty in discriminating the ha-fa pair which is the contrast between /x/ and /f/. However, the bilingual listeners only have difficulty distinguishing when the stimuli were produced by the bilingual talker. This is probably because the bilingual talker has a less distinctive fricative category when compared with the monolingual Putonghua talker as shown in figure 7 and 8. The result of this perception study also provides some evidence for Peng (1993)'s production study. The bilingual listeners of Guoyu and Taiwanese perceive /x/ to be close to /f/ due to the lack of a labiodental fricative in Taiwanese. Therefore, they use labialized /x/ to mimic the labial feature of /f/.

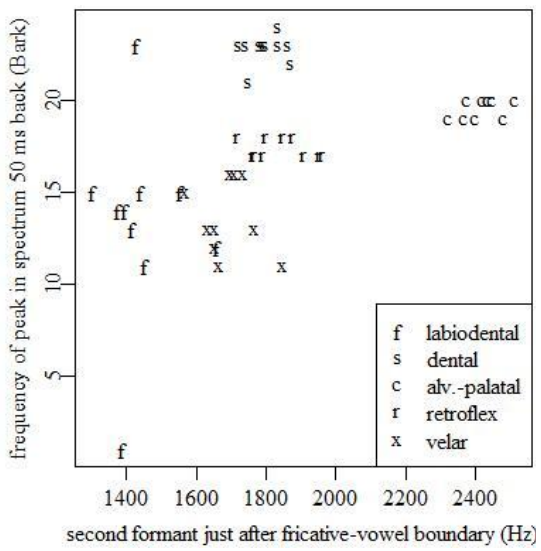

Figure 7. Plot of Guoyu talker's second formant after the fricative-vowel boundary.

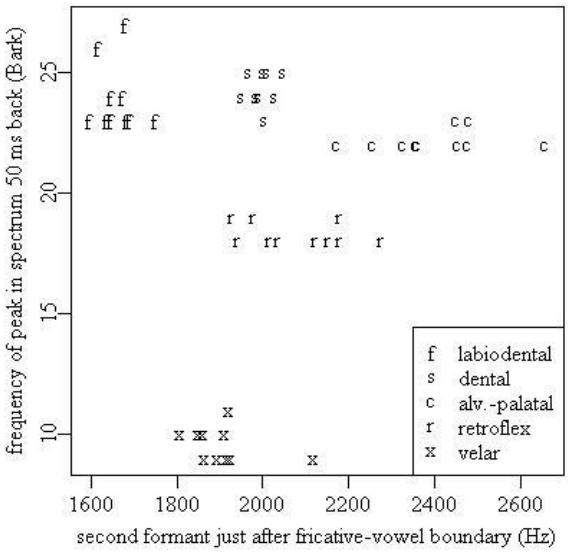

Figure 8. Plot of Putonghua talker's second formant after the fricative-vowel boundary.

6. Conclusion

The current experiment aims to investigate bilingual Guoyu and Taiwanese speakers' perception of one of their native language, Guoyu, and see if there is any influence from Taiwanese. The research questions are (1) which Mandarin fricative contrast is most difficult for the Guoyu and Taiwanese speakers and (2) whether talker's dialectal difference will influence listeners' rating of the Mandarin fricatives. Two groups of listeners were recruited. One group of Mainland Chinese/Putonghua speakers were recruited to serve as control group. The results show that the most difficult Mandarin fricative pair is the sa-sha pair. The monolingual Putonghua listeners can distinguish the contrast well but not the bilingual Guoyu and Taiwanese listeners. On the other hand, for the ha-fa contrast, bilingual listeners have difficulty in discriminating the contrast produced by the bilingual talker only. The findings match the results of previous perception studies that listeners have more difficulty in discriminating fricatives that are not phonemic in their native languages. They will also perceive those "non-phonemic" fricatives to be similar to the neighboring fricatives. Future research can examine these bilingual talkers' fricative space to see if or how they make a distinction between the fricatives and if there are any differences when they produce Guoyu and Taiwanese fricatives.

7. Limitations

There are some limitations of this study. First, the bilingual data was collected in southern Taiwan. Although the participants are more homogeneous, it may not reflect the larger population in Taiwan. On the other hand, the monolingual data was collected in the States. The subjects are less homogeneous and they also speak English. Lastly, the blocks were not counter-balanced when presented to the listeners. It may be better if they are counter-balanced to eliminate any potential order effects.

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