A sociophonetic analysis of Farsi vowel systems among heritage speakers and immigrants of Persian ethnicity in Oklahoma

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This study investigates the variation of the Farsi vowel formants – F1 and F2 – among Persian-American heritage and immigrant speakers in Oklahoma, a topic which has been under-investigated. The participants were a group of 20 Persian adult immigrants (ten males and ten females) and 20 US-born Persian-American heritage speakers of Farsi (ten males and ten females). Data were gathered in the form of acoustic audio recordings of a 150-word word list carefully pronounced by the participants. A lexicon was created for the purpose of forced alignment, and vowel formants were extracted using DARLA. The vowel plots showed substantial similarity among all participants to the Farsi monolingual speakers’ in Iran regarding the back vowels /u/, /o/ and /ɒ/. However, the front /i/ and /e/ sounds were a bit more back than that of the monolinguals. In regard to /æ/, both groups of female Persian immigrants and female Persian heritage speakers showed similarity to that of the monolinguals; however, male Persian immigrants and male Persian heritage speakers had a relatively raised /æ/.

1 Introduction

“Phonetics and phonology remain among the least understood properties of heritage languages” (Polinsky 2018: 162). This study is a phonetic investigation of immigrant and heritage Farsi, which is understudied (Sedighi 2010, 2018). It focuses on the vowel system – first and second formants – of Farsi produced by heritage speakers of Persian ethnicity born and raised in Oklahoma and that of their Persian parents’ generation of immigrants.1

To the best of my knowledge, no other study has been done which has focused on the Farsi vowel system among a Persian-American ethnic group in the United States. This ethnic group has its own cultural practices and social network. Impressionistically speaking, Farsi heritage speakers sound different from Farsi monolinguals or even sequential bilinguals of Farsi and English. This was also asserted by the Persian parents of the heritage speakers of Farsi in Oklahoma (Dokhtzeynal and Sheikhhahaie 2020). The motivation behind the present study was to determine if this difference is found in the vowel system of heritage speakers of Farsi. This study investigates the existence of variation between and among the participants in terms of vowels based on cultural practice and ethnic orientation (Nagy et al. 2014) and social network (Milroy and Milroy 1985).

1 It is worth noting that in the literature related to the Farsi language, this language is either termed as Farsi or as Persian. For the purpose of consistency throughout the present paper, I use the term Farsi for the language and the term Persian for the ethnicity that uses Farsi.

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1.1 Heritage language speakers

Van Deusen-Scholl (2003: 222) defines heritage speakers as people “who have been exposed to another language in the home and have either attained some degree of bilingual proficiency or have been raised with a strong cultural connection to a particular language through family interaction.” Polinsky (2008: 40) emphasizes the importance of “understanding the nature of incomplete acquisition” to understanding acquisition. Polinsky (2008: 40) also mentions that “heritage speakers [can] provide a crucial missing link between competent L1 learners, balanced bilinguals, and possibly L2 learners.” These speakers have varying degrees of proficiency in their heritage language. They should not be compared to the language which is spoken by fully-competent speakers or the language which is spoken in the media or literature (Polinsky and Kagan 2007).

However, several studies investigate the phonetics/phonology of heritage speakers compared to the language spoken in the homeland. Tse (2016a, 2016b, 2016c, 2017) shows that the phonemic inventory of the Cantonese heritage speakers in Toronto is similar to the Cantonese in Hong Kong. Cheng (2017) finds that heritage Korean speakers in California are not participating in the ongoing Seoul Korean sound change. Kang and Nagy (2016) find that Korean heritage speakers in Toronto from an older generation than Cheng’s (2017) Californian speakers participate in the sound change in progress in Korea, but the younger generation in Toronto are leveling off or perhaps reversing the process.

Most relevant to the current study is Godson’s (2003, 2004) work which looked at the vowel production of ten Armenian heritage speakers, ten Armenian immigrants and one Armenian monolingual speaker. Godson’s (2003, 2004) findings found that the heritage speakers’ production of Armenian /i/, /e/ and /æ/ was closer to the English counterparts than those produced by the immigrants, but heritage speakers’ production of the back vowels /o/ and /u/ was quite similar to that of the immigrant group. To the best of my knowledge, the present study is the first work on the phonetics and phonology of Persian-American heritage speakers in the United States. It compares the vowel production of Persian immigrants to the US with that of the monolinguals of Farsi in Iran and the vowel production of Persian heritage speakers to that of their parents’ immigrant generation, since they were exposed only to their parents when acquiring Farsi and not Farsi speakers in Iran.

1.2 Farsi heritage speakers of Persian ethnicity

Sedighi (2010, 2018), from an educational point of view, holds that since the most important point that middle-class Persian immigrant families have in mind regarding their children’s future is their education and job; they neglect the importance of their children’s acquisition of their heritage language and rarely take it into consideration. She also believes that heritage language has been paid attention to among other ethnic groups since they have a longer history of residence in the U.S., but Farsi heritage language has been severely under-investigated. Farsi heritage speakers do not use their heritage language because they do not need it when communicating with their peers, but when they are older and have been detached from their Persian culture and language, they hold their parents responsible for not paying attention to their learning their heritage language (Sedighi 2010).

1.3 Farsi

Modern standard Farsi, which is used in Iran, is an Iranian language within the Indo-Iranian branch of the Indo-European language family (Windfuhr 2009). More than 30 million speakers speak Farsi as their first language (Lewis et al. 2009). Farsi is the official language of Iran with Tehrani dialect as its standard dialect. This language is not bound to Iran as the only geographical region. It is also spoken in countries such as Tajikistan and parts of Afghanistan. The inventory of the Farsi vowel system contains three long vowels which are /i/, /u/ and /o/ and three short vowels which are /e/, /o/ and /æ/ (Miller 2012). This inventory also contains two diphthongs which are /ej/ and /ow/ (Miller 2012).
A sociophonetic analysis of Farsi vowel systems of Persian heritage and immigrant speakers

Figure 1. Vowel system of modern standard Farsi (Miller 2012)

The existence of diphthongs in Farsi is a matter of debate. Majidi and Ternes (1999) believe that Farsi has only 6 monophthongs and no diphthongs. Yaesoubi (2010) maintains that Farsi has two diphthongs /ej/ and /ow/. Hakimi (2012), from a phonemic viewpoint, considers diphthongs in Farsi nothing but sequences of a vowel and a consonant. However, the existence of diphthongs in Farsi is immaterial to the present study and only the six monophthongs will be measured.

1.4 Acoustics of Farsi vowels

Several studies have focused on the acoustic features of vowels – first and second formants – in Farsi (Ansarin 2004; Aronow et al. 2017; Esfandiari et al. 2015; Ghaffarvand Mokari et al. 2017; Mohammadi et al. 2011). Ghaffarvand Mokari et al. (2017) reported the F0, F1, F2, and F3 and the duration of the Farsi vowels of 28 male and 25 female Farsi monolinguals with Tehrani dialect. The measurements from this study were used as the basis of comparison for the immigrant generation’s Farsi vowel system. It was chosen because it systematically investigated the vowel systems of monolinguals of Farsi of both genders, whereas other studies used only women, TV-recorded data, or a small number of speakers.

Although many studies have extensively researched the vowel system of Farsi monolinguals and a few the vowel system of bilingual speakers of Farsi and English, none of these studies have considered the vowel system of Persian heritage speakers whose dominant language is English and their variation from that of their parents, if any.

2 Methods

2.1 Research Questions

This study addresses two research questions: (1) Does the Farsi vowel system of heritage speakers differ from that of their parents and modern standard Farsi? If so, how? (2) What social factors contribute to variation among heritage speakers’ Farsi vowels?

2.2 Participants

The participants in the present study are 20 immigrant adults (ten males and ten females) of Persian ethnicity and 20 US-born Persian-American heritage speakers of Farsi (ten males and ten females) whose parents are both Iranians who immigrated to the United States before or shortly after the Islamic revolution in Iran, which took place in 1979. They all live in cities such as Oklahoma City, Tulsa and Norman, Oklahoma. The US-born heritage speakers are all within the age range of 18–35, and the immigrants’ age range is over 35. The US-born heritage speakers speak Farsi with varying degrees of proficiency. Some of them were able to read the orthography of Farsi and some of them were not. When referring to the participants individually, pseudonyms are used. The heritage speakers all have different levels of interaction with their heritage culture and attend the Persian cultural events with varying degrees.
2.3 Procedure

Before beginning the study, I attended several Persian cultural events in the participants’ hometown where they gathered with their families and friends. After we got to know each other, I asked them to voluntarily participate in my study.

After obtaining written consent, participants were fitted with an Audio-Technica – PRO 8HEx – head-mounted microphone to allow freedom of movement during the interview. The interviews were recorded in .WAV format with sampling rate of 44.1 kHz using a Marantz PMD660 professional audio-recording device. The elicitation of data was done in two stylistic formats, through semi-structured interviews conducted in Farsi and through the reading of a wordlist. The wordlist was in the form of Microsoft PowerPoint slides containing the words in Farsi orthography and their closest translation in English for those heritage participants who could not read the Farsi orthography. The words were presented to the participants one at a time on each slide. In case of mispronunciation or mistake, the participants were allowed/asked to read the words again. All the recordings were done in a study room at a library with no peripheral interfering noise.²

2.4 Interview

I conducted a sociolinguistic interview in Farsi with a list of questions about the participants’ views on Persian culture and language and asked them whether they read books in Farsi, listen to Farsi music or watch Farsi movies. I also asked the heritage speakers about their memories of travelling to Iran with their parents and whether they have attended any cultural events in Iran. Moreover, I asked questions off the topic which the participants were discussing or were interested in. I also allowed them to ask me questions to keep the conversation going as long as possible to have enough naturally produced language in an informal conversational style to analyze for discourse and acoustic features in future work.

2.5 Wordlist

The wordlist that I designed for this study consisted of 150 Farsi words and phrases which included the 6 vowels in the phonetic inventory of Farsi in different phonetic environments. The phonetic environments were as follows:

- word-final position in CV words
- before/after all consonant phonemes in CVC words
- before/after all consonant phonemes in CVCC words

2.6 Demographic information

The participants were asked to answer a list of demographic questions at the end of our interview. The demographic information form asked for their name, contact information, age, place of birth, profession, education, the people who are the participants’ close friends/associates and their ethnicity, the people they were in touch with before they went to elementary school, family members and the language(s) they use to communicate with them. The other questions in the demographic information form were aimed at determining the cultural score of the participants to determine their level of engagement with the Persian/Iranian culture. The questions consisted of the type of food they eat – e.g., American, Iranian, etc., the reading/listening materials that they read or listen to and the language of the materials, the language(s)

² The recordings were all copied onto two password-protected computers and on two password-protected external hard drives.
in which they communicate, the materials that they watch or the music that they listen to and the language of the materials, and finally the cultural events they attend – e.g., American events, Persian events, etc. However, these network scores had no clear effect on the vowel production so they will not be discussed further in this paper.3

2.7 Analysis

Due to the lack of a forced aligner for Farsi, a pronouncing dictionary of Farsi words used in the wordlist was created using English orthography and a modification of Arpabet (Shoup 1980). The dictionary was used to time-align the recordings to Praat (Boersma and Weenink 2019) TextGrids using Penn Phonetics Lab Forced Aligner – P2FA (Yuan and Liberman 2008). The aligned files were manually hand-corrected to make sure that the vowel boundaries were correct. The aligned files were then uploaded to the DARLA web interface (Reddy and Stanford 2015) to extract vowel formants using the semi-automated feature, which includes FAVE-Extract (Rosenfelder et al. 2014) and the Vowels R package (Kendall and Thomas 2010). The vowels occurring in phonetic environments before /l/, /r/ and nasal sounds were filtered out and excluded from the results due to the possible effects these sounds can have on vowel formant values. For each participant, DARLA provided a spreadsheet containing information about each vowel, including the previous and the following sounds, the mean F1 and F2 values across vowel duration, and F1 and F2 values at 20%, 35%, 50%, 65% and 80% of vowel duration. For the purpose of the present study, the 35% and 80% F1 and F2 values were chosen in order to check for possible glides in Farsi vowels and to check for possible effects from the participants’ English diphthongs on their Farsi vowels. Measurements from participants’ English vowels were taken from Dokhtzeynal (2020), who conducted a study on the English vowel system of the same Persian immigrants and Farsi heritage speakers who participated in the present study. Formant values for monolinguals were taken from Ghaffarvand Mokari et al. (2017). They collected 252 tokens for males and 225 tokens for females in their study. They also calculated the formant values “by averaging the values at central 40% of the vowel duration for each token” (Ghaffarvand Mokari et al. 2017: 11). All vowels from all speakers were plotted together in NORM (Thomas and Kendall 2007) using the Labov ANAE, Telsur G normalization method. It also should be mentioned that the values for F1 and F2 extracted from Ghaffarvand Mokari et al. (2017) did not include the offglide. This could be due to the fact that Farsi vowels are believed to be monophthongs and not diphthongs according to the literature (Majidi and Ternes 1999). The number of vowel tokens analyzed for Persian immigrant males and females are shown in table 1 below. The number of vowel tokens analyzed for female and male heritage speakers of Farsi are shown in table 2.

Table 1. Number of vowel tokens from Persian immigrant males and females

| vowel | immigrant females | immigrant males |
|-------|-------------------|-----------------|
| /i/   | 93                | 81              |
| /e/   | 116               | 97              |
| /æ/   | 120               | 120             |
| /ɒ/   | 154               | 137             |
| /o/   | 78                | 61              |
| /u/   | 90                | 66              |

3 The demographic information was collected from the participants on printed forms. The forms were then scanned and the files were saved on a password-protected computer.
Table 2. Number of vowel token for female and male heritage speakers of Farsi

| vowel | female heritage speakers | male heritage speakers |
|-------|--------------------------|------------------------|
| /i/   | 118                      | 98                     |
| /e/   | 103                      | 97                     |
| /æ/   | 119                      | 138                    |
| /ɒ/   | 153                      | 169                    |
| /o/   | 79                       | 77                     |
| /u/   | 101                      | 96                     |

3 Results and discussion

Figure 2. Comparison of Farsi vowels of the immigrant generation against monolingual speakers of Farsi in Iran from Ghaffarvand Mokari et al. (2017)

Vowels of the immigrant generation were compared against those of monolingual Farsi speakers in Iran to look for any effects of their L2 English experience on their L1 Farsi. In figure 2, the red – female – and the green – male – colors are the Farsi vowels of the participants in the Ghaffarvand Mokari et al.’s (2017) study of 53 Farsi monolinguals residing in Iran. The blue – immigrant Persian females – and the orange – immigrant Persian males – colors are the Farsi vowels of the participants in the present study who have all immigrated from Iran to the US and have been residing in Oklahoma for more than 25 years. In the above plot as well as the following plots, IY stands for the vowel /i/, EH for /e/, AE for /æ/, AA for /ɒ/, OW for /o/, and UW for /u/ in Farsi.

As can be observed in figure 2, the F2 of /i/ produced by immigrant females is 278 Hz less than the F2 of /i/ produced by monolingual females and is backer. The F2 of /i/ produced by immigrant males is 445 Hz less than the F2 of /i/ produced by monolingual males and is backer. So, the /i/ produced by immigrant males is backer than the /i/ produced by immigrant females, which is backer than the monolingual F2 values. Similarly, the /e/ produced by immigrant males is 265 Hz backer that of the monolingual males, but
the difference for females is small. However, the difference between the F2 of the immigrant generation and the monolinguals is not much, and these differences could be due to the normalization technique.

The nucleus of the vowel /æ/ produced by immigrant females is very similar to the /æ/ produced by monolingual females. It can be observed that this vowel has a small glide of 89 Hz, which may be too short to be considered a diphthong. The F1 of /æ/ produced by immigrant males is 51 Hz less than that of monolinguals, and it has a very short glide of 40 Hz. So, /æ/ is slightly higher for immigrant males and slightly more diphthongal for immigrant females compared to monolingual speakers.

Both immigrant males and females produce /ɒ/ and /o/ in the same cluster as monolingual speakers of Farsi in their homeland, Iran. /ɒ/ has a short glide of 88 Hz for males and 109 Hz for females, which may be too short to be considered diphthongal in Farsi.

The nucleus for the vowel /u/ produced by immigrant males is close to the nucleus of its counterpart produced by male speakers in Iran. However, its glide is 265 Hz long. The F2 of the nucleus for the vowel /u/ produced by immigrant females is 267 Hz fronter than that of its counterpart produced by female speakers in Iran, but its glide is short at 105 Hz.

Figure 3. Comparison of Farsi vowels of heritage speakers against those of their parents’ immigrant generation

Polinsky and Kagan (2007) and Polinsky (2018) believe that the point of comparison for heritage language speakers should be the variety they are exposed to and not the standard language spoken in the homeland country. In the same vein, figure 3 compares the heritage speakers’ Farsi vowels – female in red, male in green – to those of their parents’ generation of immigrants from figure 2 – females in blue, males in orange.

As can be observed in figure 3, the nucleus of the vowel /i/ produced by male heritage speakers is very close to the nucleus of the vowel /i/ produced by immigrant males. The glide for male heritage speakers is 57 Hz long, which is longer than that of immigrant males, but still not considered a diphthong in Farsi. The nucleus of the vowel /i/ produced by female heritage speakers is also very close to the nucleus of the vowel
/i/ produced by immigrant females. The glide for female heritage speakers is about 157 Hz long, which is longer than that of immigrant females, but still not considered a diphthong. The /e/ vowel produced by heritage speakers is lower in comparison to that of the immigrant generation, but this is not a great difference and no noticeable glide can be observed on the vowel /e/.

The nucleus of /æ/ produced by female heritage speakers is very close to that of immigrant females. The length of the glide is approximately the same at about 100 Hz. The nucleus of /æ/ produced by male heritage speakers is a little higher compared to that of immigrant males. However, the length of the glide is approximately the same at about 25 Hz.

Both male and female heritage speakers produce the back vowels in the same cluster as immigrant males and females. Therefore, there is not a big difference between their F1 and F2. The vowel /o/ has a short glide of 100 Hz for male heritage speakers and 138 Hz for female heritage speakers. Only the vowel /o/ produced by male heritage speakers has a glide of 55 Hz. The vowel /u/ has a glide of 268 Hz for male heritage speakers, approximately the same as immigrant males and it has a glide of 159 Hz for female heritage speakers, approximately the same as the immigrant females. However, these glides cannot be considered diphthongal in Farsi.

Overall, the nuclei of all three back vowels are in the same cluster and very similar in terms of their F1 and F2 between both generations and genders. The length of their glides is also similar between generations.

**Figure 4.** Comparison of Farsi vowels of male (left) and female (right) heritage speakers against their English (Dokhtzeunal 2020)

To have a clear picture of whether the Farsi vowels have been affected by English vowels or not, the Farsi and English vowels of all male heritage speakers and all female heritage speakers have been normalized and plotted separately. Figure 4 shows the English vowels (red color) of the male/female heritage speakers as well as their Farsi vowels (blue color). Four vowels are pronounced similarly in both languages: /i, æ, d, o/ (FLEECE, TRAP, LOT/THOUGHT, GOAT in figure 4). English /o/ (GOAT) is slightly fronter compared to Farsi /o/, as is typical for Oklahoma English (Tillery and Bailey 2008). Farsi /e/ is in a position distinct from both English /ɛ/ and /e/ (DRESS and FACE in figure 4), so it does not appear to have been affected by either English vowels. Similarly, Farsi /u/ is completely distinct from the fronted English /u/ (GOOSE). Dokhtzeunal (2020) observed that the English /æ/ produced by these heritage speakers is backed and lowered compared to that of European-American Oklahoma English. This could be an effect of Farsi /æ/ on their English /æ/ or have some other reasons to it.
4 Conclusion and future work

The results of this study show that the six Farsi vowels of Persian immigrants and heritage speakers in Oklahoma are not affected by their English vowels. There is no statistically significant support to these results and they are based on descriptive means. The Immigrants’ vowel systems were very similar to those of monolingual Farsi speakers in Iran, and second-generation Persian-American heritage speakers’ vowel systems were very similar to those of their immigrant parents’ generation. Therefore, the accent that native Farsi speakers perceive in heritage Farsi might have a different source. In future work, other constituents such as consonants, prosody, and morpho-syntax should be examined.

Speech style and social network strength may also play roles in heritage Farsi pronunciation. Future work will analyze the more casual conversational speech collected during the interviews for this study, which will be facilitated by the creation of a forced aligner for Farsi. The analysis of the spontaneous speech may reveal different or similar patterns. Future studies may also involve collecting data from the large Persian ethnic communities in Los Angeles or Toronto, which may show tighter social networks than the communities in Oklahoma.

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