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CROSS-DIALECTAL VARIATIONS IN THE IRAQI ARABIC VOWEL SYSTEM: A SOCIOPHONETIC STUDY

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Abstract

This paper provides an acoustic description of the three Arabic vowels /i/, /a/ and /u/, and their long counterparts /i:/, /a:/ and /u:/ as produced by speakers of the two Iraqi *qəltu* dialects spoken in Hīt (Hīti Iraqi Arabic) and Mosul (Mosuli Iraqi Arabic), from now onwards referred to as HIA and MIA, respectively. It examines temporal and spectral acoustic characteristics between and within these two speech communities, and compares the results to relevant previous studies that have been conducted on several Arabic dialects, including Iraqi Arabic (IA) (Al-Ani, 1970). No previous acoustic analyses of this type have been conducted on HIA and MIA. Hence, this paper attempts to build on previous studies on temporal and spectral characteristics of Arabic vowels. In addition, it is expected to provide an empirical evidence to the universal as well as language-specific features of vowels and relates such evidence to regional and gender factors. Furthermore, it investigates to what extent regional and gender differences in vowel duration correlates with the spectral variations. In terms of vowel duration contrasts, MIA showed slightly greater short to long vowel duration ratio (1:2.4) than HIA (1:2.2). Gender seems to be an influential factor in Hit than in Mosul in terms of such variations. HIA men produced longer /a/, /u/ and /a:/ with statistical significance, while gender -related duration variations in MIA were statistically significant only /i/. As for the spectral differences, it has been found that MIA vowels are lower and more retracted than their cognates in HIA. Both dialects varied in F2 rather than in F1. Results show with statistically significant values that the effect of vowel quality on vowel duration is clearly greater in HIA than in MIA.

Introduction

Arabic, which is a Semitic language, is the official language in the eighteen countries that make up the Arab world, extending from Iraq in the east to Mauritania in the west. Approximately 250 million people in the eighteen Arab countries and other Arabic-speaking communities in Africa, USA, Europe and Asia speak it currently. Instead, there are various dialects used in informal situations. Standard Arabic (SA) is used in education and media, but not an everyday-life variety in these countries (Watson, 2011: 1). Instead, Colloquial Arabic is the spoken alternative in these regions. SA has thirty-six phonemes, six of which are vowels, two diphthongs and twenty-eight consonants. The six vowels are the short, /i/, /u/, and /a/ and their long counterparts /i:/, /u:/, and /a:/, respectively.

A great deal of recent research has focused on phonetic variation among Arabic vowels from different dialects. A number of researchers have reported that due to linguistic and extralinguistic factors, some Arabic dialects have a larger number of vowels than others. Cowell (1964) claims that Syrian Arabic has eleven vowels; five long and six short. IA has been reported to have nine vowels: five long vowels, /i:/, /u:/, /a:/, /o:/, /e:/ and four short vowels, /i/, /u/, /a/, /o/ (Erwin, 1963, 2004; Ghalib, 1977).

Previous studies on Arabic tend to agree that the temporal differences among vowels are accompanied by spectral variations. In terms of temporal differences, long vowels were found to be approximately twice as long as their short counterparts. Al-Ani (1970) reported that in IA, the ratio between short vowels and their long versions is 1:2.4. Hassan (1981) study showed that IA long vowels are almost twice as their short counterparts, 1:1.8. A recent study has been conducted by Almbark and Hellmuth (2015), who examined variation in quantity and quality in eight Arabic dialects in North Africa, Egypt, the Levant, Iraq, and the Arab Gulf. In these dialects, the short/long vowel ratio ranged from 1:1.7 in Egyptian Arabic to 1:2.6 in Moroccan Arabic, while the ratio between short and long vowels in IA was 1: 2.4.

The first research question of the present study is to investigate whether the temporal differences between short and long vowels in HIA and MIA are correlated with spectral differences. In order to provide

sociophonetic variations, differences were examined to explain variations between and within both speech communities.

Method

Speakers

In this study, twelve speakers were recorded, six (3 male and 3 female), speakers from each dialect with no reported speech or hearing difficulties. The sample size were calculated as follows:
12 speakers (6m/6f) x 2 dialects x 6 vowels x tow tokens for each vowel = 288 tokens; 144 per dialect).

The mean age for male speakers is 36.3 years, and for female speakers 33.5 years at the time they were interviewed. For ease of investigating gender differences, equal numbers of male and female speakers for each dialect were included. All twelve speakers were born in, and grew up in the two speech communities under investigation and are therefore native speakers of their dialects.

Data collection and sample size

The data in this study were collected from parallel controlled read speech. The twelve speakers produced the six vowels in /hvd/ context embedded in a carrier sentence /qu:l……. marte:n/ 'Say……twice'. The total of 288 tokens were analysed. Recordings took place in a quiet room at the participants' homes using a battery-operated and AC adapter-powered TASCAM DR-40 audio recorder. Audio files were recorded at 44.1 KHz 16 bit as wav files and saved on an external hard drive.

Acoustic measurements for duration

For word duration, the start and end times of the 288 /hvd/ words were labelled manually using textgrids in PRAAT (Boersma and Weenink, 2008) at zero crossings at the start point of the word onset (i.e. /h/) and the end point of its coda (i.e. /d/). For vowel duration, the start and end points of each of the vowels were labelled manually by looking at the waveform and spectrogram in PRAAT. Three tier intervals were created; one for phrase, one for word, and one for vowel (see Figure 1). On the phrase tier, the whole carrying phrase was labelled, starting from /ʔ/ of the word /qu:l/ and ending with /n/ of the word /marte:n/. On the words tier, the start and end of the word containing the target vowel were labelled. The start and end of the target vowel were labelled on the vowels tier. The measurements were taken from the words and vowels tiers. Both word and vowel durations were extracted using a PRAAT script developed by Leendert Plug of the University of Leeds and available online at: http://www.personal.leeds.ac.uk/~lnplp/duration_measure.script.

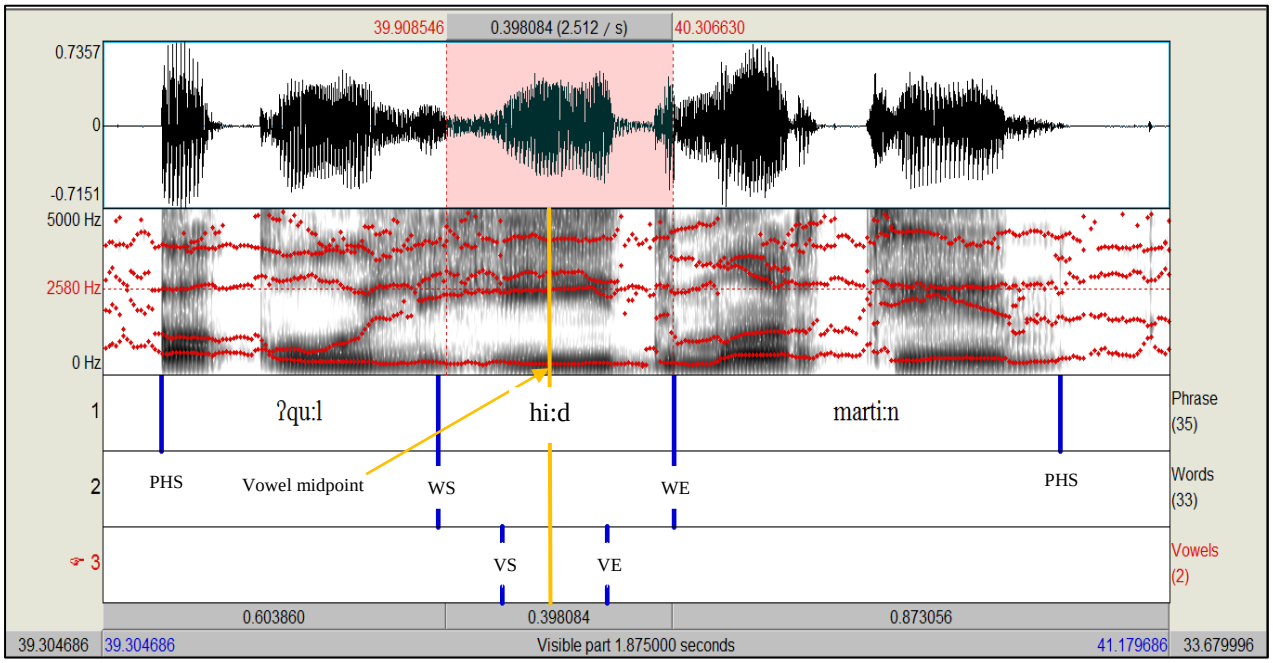


Figure 1. PRAAT photo of an HIA man illustrating labelling procedure, PHS=phrase start, PHE=phrase end, WS=word start, WE=word end, VS=vowel start, VE=vowel end.

The normalised vowel duration and short/long ratio was obtained following the equations below (After Almbark and Hellmuth, 2015):

Vowel duration: Norm Vowel duration= (Vowel duration/ Word duration) * 100

Short/long ratio: Norm long vowel duration/ Norm short vowel duration)

Acoustic measurements for fundamental frequencies

In vowels, F_1 indicates the height of the vowel and is inversely related to it. In other words, the lower in the oral cavity the vowel is produced, the higher its F1 is, but the higher it is produced the lower F1 it has. F2 refers to the frontness of vowels. Higher F2 indicates that the vowel is produced high to the lips, while lower F2 values mean that the vowel is articulated as more advanced in the mouth. According to Kent and Read (1992), F1 ranges between 270Hz and 1030Hz, and F2 ranges between 850Hz and 3200Hz. In the present study, the frequencies of F1 and F2 were taken at midpoint of the target vowel to minimize the co-articulation effects of preceding and following consonants. This was done by placing the curser at the middle of each vowel after activating the 'show frequency' tool on PRAAT. When clicking at the point of the formant frequency, PRAAT draws a horizontal red line at the location of the curser and marks the frequency. Another method is to activate the frequency tool and run show first, second formant. In this study, F1 and F2 values for all target vowels were normalized using the Lobanov Procedure (Adank et al. 2004, Fabricius 2007, Fabricius *et al*. 2009).

Results

This section answers if there is regional or gender variations in the way HIA and MIA speakers use the three vowels under analysis. I first present results related to variations in vowel duration and then we will provide results in spectral values. In both cases, differences were discussed in relation to the variable.

Regional differences in vowel duration

The first research question addresses the differences in vowel duration across dialects. Figure 2 shows the mean normalized durations for HIA and MIA short and long vowels.[1]

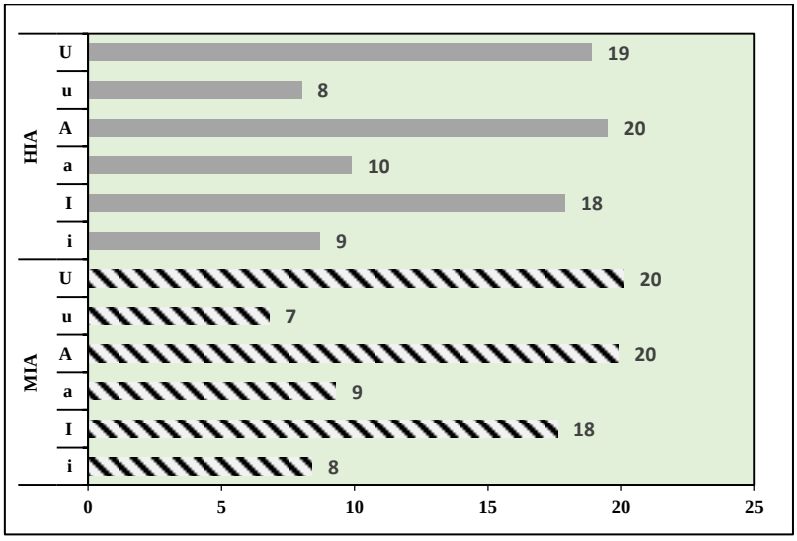


Figure 2. Normalised durations for HIA and MIA short and LONG vowels

As can be seen, the average duration for the long vowels in both dialects is at least twice that of their short counterparts. However, the short/long ratio in MIA is slightly larger (1:2.4) than that in HIA (1:2.2). Overall, the ratio in both dialects is larger than the ratio reported for the BIA dialect as 1:2.0 and 1:1.8 by Al-Ani (1970) and Hassan (1981), respectively.

The acoustic measurements differ from those in previous studies on IA and other Eastern Arabic dialects in having larger short/long vowel duration contrasts. While previous studies showed greater duration variations in

[1] From now onwards, in Figures and occasionally elsewhere in the text, short vowels will be written in lower case, while long vowels in upper case e.g. u for /u/ and U for /u:/.

/i(:)/ and less duration variations in /a(a:)/ and /u(:)/ (Almbark and Hellmuth, 2016), duration measurements in this study revealed greater variations across dialects in /u(:)/.

HIA speakers produced slightly longer short vowels than MIA speakers did by 0.010 ms. However, the results of a T-test analysis indicates that there are no sufficient regional variation patterns between the two dialects with no statistical significance ($p > 0.05$). With the exception of /u:/, the analyses for the long vowels indicated that the duration of long vowels is similar in both speech communities. Despite the very small difference in the duration of /u:/ as produced by HIA and MIA speakers, but this difference showed statistical significance ($p < 0.05$).

Gender differences in vowel duration

Figure 3 presents the normalized vowel durations between male and female speakers across both speech communities.

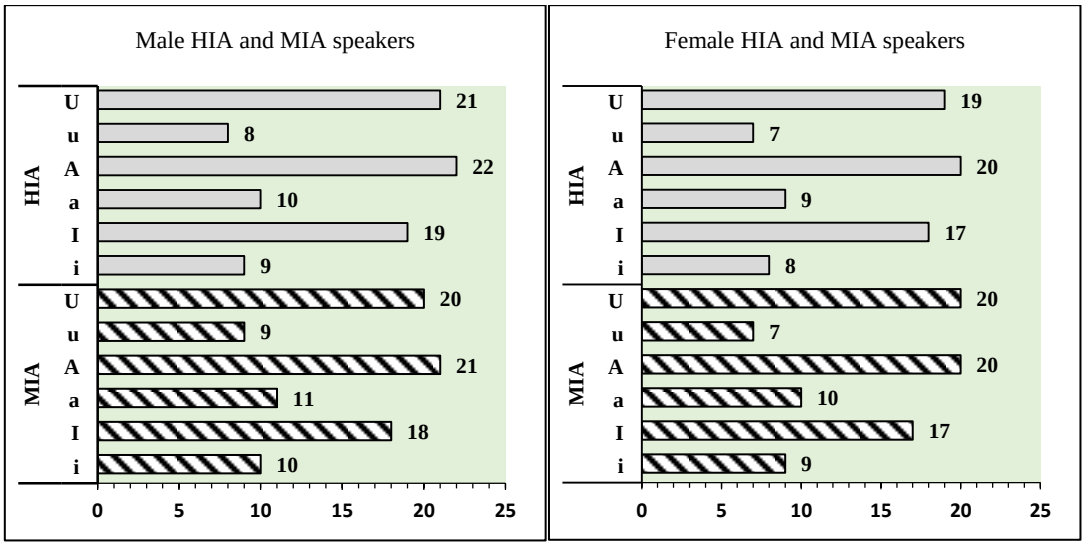


Figure 3. Normalized duration for HIA and MIA vowels by gender

Gender seems to be a more influential factor in Hit than in Mosul in terms of such variations. To establish which vowels varied in duration the most in terms of gender , a one-way ANOVA test was carried out for each vowel separately. The duration measurements per each short and long vowel served as the dependent variable, and the gender served as the independent variable. The analyses showed that the gender differences were only significant for the low vowel /a/ (F: 6.787, $p<0.05$), and its long version /a:/ (F: 6.632, $p<0.05$). The gender differences among HIA speakers were very significant for short as well as long vowels at $p<0.00$. In contrast, despite the noticeable differences between MIA males and females, they were only significant for /i/ $p<0.05$.

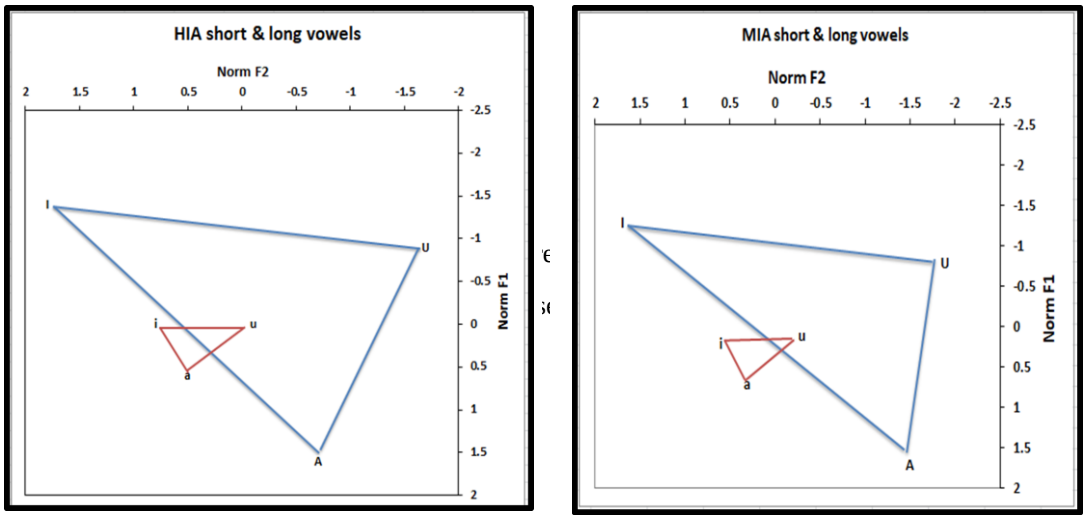
Although statistical analyses indicate that male speakers in both speech communities produced longer vowels than female speakers did, the two speech communities appear to have different gender-related variation patterns in vowel duration. Gender-related variations can be observed across and within dialects. With regard to variations across dialects, HIA male speakers were found to produce longer /i:/, /u:/ and /a:/, but shorter /i/, /u/ and /a/ than their MIA male speakers. However, these differences did not hold any statistical significance for all short and long vowels at $p>0.05$.

In addition, HIA women produced slightly longer /i:/, /u:/ and /a:/, but shorter /i:/, /u:/ and /a:/. A T-test analysis was carried out to establish whether these differences reflect any gender-related variation pattern across dialects. The results showed that the duration differences are statistically significant only for short vowels. An additional test was performed to find out in which vowels HIA and MIA females varied the most. The statistical analysis showed that the differences are very significant only for /i/ and /a/.

As for gender-related variation within dialects, there is more variation among HIA than among MIA speakers, for short rather for long vowels. While gender-related differences among HIA speakers were more significant for /a/ and /u/, the differences between MIA male and female speakers were only statistically significant for /i/. For long vowels, gender-related differences were not significant, except for /a:/, which seem very significant among HIA speakers ($p = 0.000$).

Regional differences in formant frequencies

The first research question in this study is to access whether the temporal differences between short and long vowels are accompanied by spectral differences. Figure 4 shows the distribution of short and long vowels for all speakers according to mean normalized F1 and F2 values.



From the location of vowels, it seems that HIA and MIA have dispersed long vowels. As the formant measurements taken at the midpoint of long vowels show, MIA has higher F1 values, but lower F2 values than HIA for short and long vowels. All short and long vowels in both dialects varied more in terms of F2 than in F1. For short vowels, formant frequencies varied greatly for F2 than in F1 values. All three vowels showed similar differences range in F2. However, the differences in F2 values between both dialects proved significant for /i/ and /a/ at $p<0.05$ and very significant for /u/ at $p<0.005$. While all three vowels exhibited similar differences in F1, they were only significant for /u/ at $p<0.05$.

Between-dialect differences exhibited that long vowels in MIA are lower and more retracted than those in HIA. Spectral measurements revealed greater differences in F2 for /a:/. HIA speakers retracted this vowel more than /i:/ and /u:/. However, this great retraction did not show any statistical significance with $p>0.05$ compared to /i:/ and /u:/ which were significant at $p<0.05$. Two One-way ANOVA tests were performed to establish in which vowels both dialects vary the most in their formant frequencies. The first test was performed for to measure F1 in short and long vowels, and the second test was run for F2 in short and long vowels. In both tests, the formant frequencies served as the dependent variable, and dialect served as the independent variable. For F1, the results showed, for long vowels strongest dialectal differences in /i:/ and /a:/ ($p<0.005$) and lower differences in /u/ ($p<0.05$) for short vowels. For F2 frequencies, the vowels in which both the two dialects varied the most were /u/ ($p<0.005$) and /i/ ($p<0.05$).

Gender differences in formant frequencies

Figure 5 presents F1 and F2 values taken at the vowel midpoint for the three male and three female speakers of each dialect.

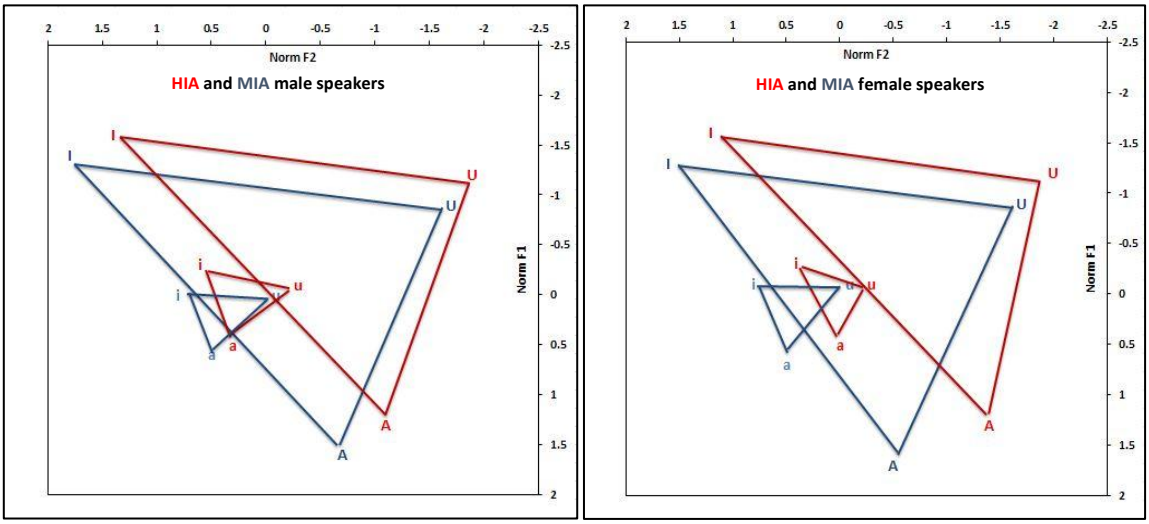


Figure 5. Spectral differences between HIA and MIA by gender

Figure 5 shows that in HIA, male speakers produced higher and more retracted short and long vowels than their MIA peers. Short vowels showed larger differences in F1 than in F2 values with /u/ produced as more retracted than /i/ and /a/. The results of T-test showed no significant differences between HIA and MIA men in the position of short vowels except for /i/ with $p<0.05$. Further, both short vowels also varied in their F2 values with a similar degree of significance. Greater differences in F1 between HIA male and MIA male speakers were noticed in the long vowels /i:/ and /a:/, which proved significant at $p<0.05$ for /a:/, but not for /i:/.

The relationship between vowel height and duration

It has been reported that low vowels are longer than high vowels (Escudero et al, 2009). This is because physiologically, low vowels require more jaw opening resulting in more time than high vowels. IA follows this tendency where low short and long vowels have been seen to be significantly longer than high short and long vowels (Hassan, 1981).

The second research question is whether HIA and MIA follow the cross-linguistic trend, according to which low vowels are longer than high vowels. Table 1 is subdivided into two main columns; (A) for HIA and (B) for MIA vowels. In both columns, the table shows that for all contexts, low vowels are significantly longer than high vowels.

Table 1. Mean normalized duration of low and high vowels along with level of statistical significance

HIA			MIA		
Context	Duration	Significance	Context	Duration	Significance
/hid/	9	**p<0.01**	/hid/	8	p>0.05
/had/	10		/had/	9	
/hi:d/	18	p>0.05	/hi:d/	18	p>0.05
/ha:d/	20		/ha:d/	20	
/hud/	7	**p<0.01**	/hud/	6	**p<0.01**
/had/	10		/had/	9	
/hu:d/	19	p>0.05	/hu:d/	20	p>0.05
/ha:d/	20		/ha:d/	20	

From the duration measurements presented in Figure 3, one can expect an effect of vowel height on duration, and Table 1 confirms this expectation. However, the differences between low and high vowels were statistically significant only for the short vowels. The effect of vowel quality on vowel duration is clearly greater in HIA than in MIA supported by statistical significance values. Overall, only in short vowels is the effect of vowel F1 values on its duration statistically significant. In both dialects, no effect of vowel quality on vowel duration in long vowels can be observed despite the fact that there were greater differences in F1 between /a:/ on one hand and /i:/ and /u:/ on the other hand shown in Figure 3 above.

In order to test gender -related variation patterns in both dialects, an independent sample T-test was carried out in SPSS. The results showed greater gender variations in HIA than in MIA. Except for those between /i:/ and /a:/, males varied more in front than in back vowels; the two low vowels /u/ and /u:/ were statistically shorter than the high vowels /a/ and /a:/ ($p<0.05$), while /i/ proved very significantly shorter than /a/ ($p<0.01$). In contrast, female speakers only significantly varied in the differences between short back vowels; /u/ proved very significantly shorter than /a/ ($p<0.01$). In MIA, there were significant differences only among females. Only in back vowels the duration between low and high vowels reached statistical significance. Only the duration difference between /u/ and /a/ reached statistical significant ($p<0.05$), where the former was found to be shorter than the latter.

Conclusions

This study examined acoustic characteristics of vowels in the two Iraqi *qəltu* dialects HIA and MIA. It attempted to find a correlation between vowel quality and quantity, i.e. in vowel duration and in F1 and F2. The two dialects showed spectral and temporal differences. In terms of vowel temporal contrasts, MIA showed slightly greater (1:2.4) duration ratio than HIA (1:2.2). In addition to the fact that male speakers in both speech communities used longer vowels than their female peers, the two speech communities showed different gender -related variation patterns in vowel duration. Gender seems to be an influential factor in Hit than in Mosul in terms of such variations. Further, gender -related vowel duration differences were more significant among HIA speakers than among MIA speakers. HIA men produced longer /a/, /u/ and /a:/ with statistical significance, while gender -related duration variations in MIA were statistically significant only /i/.

As for the spectral differences, MIA revealed lower and more advanced than their cognates in HIA with higher significant values for short than for long vowels. Both dialects varied in F2 the most and in F1the least. For short vowels, the differences in /u/ were more significant, while for long vowels both dialects varied more significantly in /a:/.

The acoustic measurements showed that both dialects have slightly dispersed long vowels. There has been a clear effect of vowel quality on duration, clearer for short vowels in HIA than in MIA supported by statistical significance values. In this dialect, while men varied more significantly in /i/ and /a/, women differed in /u/ and /a/ the most. While /u/ and /u:/ were statistically shorter than /a/ and /a:/, /i/ proved very significantly shorter than /a/.

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