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Acoustic Analysis of Iraqi Arabic Simple Vowels

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Abstract

Objectives: The study aimed at mapping IBA simple vowels as they are produced by Iraqi speakers. The study also aimed to identify the effect of gender on the pronunciation of Iraqi Arabic simple vowels. The study attempted to compare between the vowel chart proposed in this study and other Iraqi and Arabic vowel charts proposed in the literature.

Methods: A quantitative method was adopted in this study. Thus, 10 Iraqis were asked to read stimuli, and their voices were recorded using high quality smart phones. The recordings were analyzed via PRAAT, and the frequencies obtained were descriptively and statistically processed.

Results: The chart showed a clear tense-lax dichotomy where each short vowel has a long counterpart except for /ee/. Moreover, the results showed significant differences in vowel formants based on gender variable. Female speakers tend to produce vowels at higher levels, while males tend to produce vowels in more front positions. The results also revealed differences between Iraqi variant in one hand, and Maslawi and other Arabic varieties on the other hand.

Conclusions: Iraqi speakers showed a good ability to map vowels in distinct places. Biological differences in male and female vocal apparatuses are behind differences in the pronunciation of vowels. It is recommended that the vowel chart offered here can be used as a reference for teachers of English pronunciation at various levels as it indicates to difficulties Iraqi EFL leaners encounter in the pronunciation of English vowels that are mostly resulting from L1 transfer.

Keywords: Acoustic analysis, Iraqi Arabic vowels, Iraqi speakers, vowel mapping, gender.

دراسة صوتية لأصوات العلة البسيطة في اللهجة العر اقية العربية

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ملخّص

الأهداف: هدفت الدراسة إلى تحديد مواقع حروف العلة البسيطة للّهجة العراقية البغدادية كما نطقها متحدثون عراقيون. كما هدفت الدراسة إلى التعرف على أثر الجنس في نطق حروف العلة العربية البسيطة. حاولت الدراسة المقارنة بين مخطط حروف العلة المقترح في هذه الدراسة ومخططات حروف العلة في اللّهجات العراقية والعربية الأخرى المقدمة في الدراسات السابقة.

المنهجية: تم إعتماد الأسلوب الكمي في هذه الدراسة. وعليه طُلب من 10 عراقيين قراءة مجموعة كلمات، وتم تسجيل أصواتهم باستخدام الهواتف الذكية عالية الجودة. تم تحليل التسجيلات عبر برنامجPRAAT ، وتمت معالجة الترددات التي تم الحصول عليها بشكل وصفي وإحصائي.

النتائج: أظهر الرسم البياني ثنائية واضحة بين الاصوات الطويلة والقصيرة حيث يكون لكل صوت علة قصير نظير طويل باستثناء /ee/. علاوة على ذلك، أظهرت النتائج فروق ذات دلالة إحصائية في أصوات العلة على أساس متغير الجنس. حيث مالت المتحدثات الإناث إلى إنتاج أصوات العلة ترددات أعلى، بينما مال الذكور إلى إنتاج أصوات العلة في مواضع أمامية أكثر. كما كشفت النتائج عن وجود إختلافات بين اللهجة البغدادية من جهة واللهجة العراقية المصلاوية وبعض اللهجات العربية الأخرى من ناحية أخرى.

الخلاصة: وخلصت الدراسة إلى أن المتحدثين العراقيين أظهروا قدرة جيدة على رسم حروف العلة في أماكن متميزة. الاختلافات البيولوجية في الأجهزة الصوتية للذكور والإناث هي وراء الاختلافات في نطق حروف العلة. يمكن استخدام مخطط أصوات العلة المقدم هنا كمرجع لمعلمي نطق اللغة الإنجليزية على مستويات مختلفة لأنه يشير إلى الصعوبات التي يواجهها الطلاب العراقيون في نطق أحرف العلة الإنجليزية والتي تنتج في الغالب عن تأثير اللغة الأولى.

الكلمات الدالة: التحليل الصوتي، أصوات العلة في اللهجة العراقية، متحدثين عراقيين، رسم اصوات العلة، الجنس

Introduction

Arabic is a Semitic language that belongs to the Afro-Asiatic language family. This language is spoken in 22 Arab countries, whose people can use Modern Standard Arabic (MSA) as their official language (Bassiouney, 2017). It is also spoken in other non-Arab states such as Chad, Eritrea, Israel, Tanzania, and Western Sahara, whose people use MSA as a semi-or second official language. All Muslim countries such as Iran, Pakistan and Afghanistan, and all Muslim communities in non- Muslim countries such as Macedonia, Ethiopia, Tanzania and Sweden also need to use Arabic when practicing Islam rituals (Alsaawi, 2020).

Arabic speakers recognize and first acquire a variety of regional, local, and sub-local Arabic from their parents, environment, and community. They mainly use it in their daily oral communication and activities (Altoma, 1969; Jastrow, 2007). They formally learn Standard Arabic when they start schooling at around six. The age of onset of language is very important because it helps determine the type of language acquisition a person develops. If a child acquires another language after the age of 6, this may be described as early second language acquisition or normal second language acquisition. Standard Arabic speakers use it in formal situations, e.g. public authorities, books, official written communications and the media, but do not use it in their daily oral communications and activities.

It can be concluded from how Arabic speakers learn and use the language that Standard Arabic is not considered the mother tongue of the Arab peoples. It is rather a second language for them. Their true mother tongue can be one of the varieties of Arabic to which they are exposed and learn first in their childhood. This situation has been described by (Ryding, 2005, p. 5) as "Diglossia".

IBA is considered one of the least analysed Arabic accents, as there are a few studies that focused on this accent in general and its vowel system in particular (Al Abdely, 2016). On the other hand, so many studies examined Modern Standard Arabic (MSA) and other Arabic accents. These studies provided extensive accounts of the vowel systems of MSA and other Arabic accents; however, most of these studies were not based on acoustic measures. The very early description of Arabic vowels offered by Gairdner (1925) cited in (Al Abdely, 2016, 76) approximately reflects "the physical positions indicated by mediaeval Arabic philologists like Sibawayh, (d. late 8th c.) and Ibn Jinni (10th c.)". However, these descriptions "are perception-based and closely related to tongue positions".

(Amir et al., 2014) state that variances between MSA and its dialects are noticed at all linguistic levels including the phonetic and phonological levels. (Mitchell, 1990) states that the Arabic vowel system including Classical Arabic (CA) and MSA has three vowels, which are open and close front, and close back and any changes from short to long vowels are based on the implementations of these three vowels. (Abdul-Kadir & Sudirman, 2011) add that the three Arabic vowels are “ya” [jaaʔ], “alif” [alif], and “waw” [waw]. In other words, the vowel system of Arabic contains six vowels, short vowels /a, i, u/ and long vowels /aa, ii, uu/ (Alghamdi, 1998). These vowels differ between speakers of vernacular dialects. A vowel in MSA can be realized in Iraqi dialects differently with different acoustic features. The vowel sound /a/ in final position of the word /tawiil**a**/ (long, female) is pronounced as /i/ in Maslawi accent. Such an example urges researchers to conduct studies that describe the vowel system of these Iraqi accents individually, and may be to trace the impact of these differences on Iraqis when learning a foreign language like English.

This research investigates the vowel system of IBA, and it is confined to examine the monophthongs of that Iraqi variant as it represents the most widely spoken dialect in Iraq. Accordingly, one of the criteria adopted in the selection of participants in this study was that they should be native speakers of Baghdadi Arabic; hence, speakers of other Iraqi accents were excluded. Moreover, speakers who use Baghdadi Arabic as a secondary accent were also eliminated. The study of sound description is an important part of phonetics. (Ladefoged & Johnson, 2010, pp. 6-7; Ladefoged & Johnstone, 2006, p. 6) give four motives for the desire to describe speech sounds acoustically: First, acoustic description is useful to explain the confusion that occurs between speech sounds. Second, speech sounds are better described by their acoustic structure instead of their articulatory movements. Third, acoustic phonetics helps perceive how speech sounds are synthesized and recognized by computers. Fourth, the most effective way of studying speech data is achieved by analysing a permanent recording since x-rays or photographs are difficult to get in order to know what the speaker is doing during his speech.

The importance of this research lies in the fact that it tries to draw a chart that depicts Iraqi simple vowels as they are produced by Baghdadi speakers. This chart is going to be formulated based on the articulation of natives rather than on the perception of these sounds. The pronunciation of the study participants will be acoustically examined to measure the quality of Iraqi vowels. This requires extracting the F1 and F2 values for these vowels, and then representing them in a chart that shows their positions. Such study can be replicated by other researchers as it employs a clear set of procedures. This study will hopefully offer a reference for researchers, who are interested in studying this particular accent as it has not been acoustically examined before. The chart depicted in this study will also be used for comparison with vowel descriptions offered in previous studies that targeted the vowel system of other Arabic varieties.

Literature Review

There are 22 Arabic countries, in which Arabic is the official language; yet, every country has its own cultural background, especially: Egypt, Iraq and Lebanon. Arabic is one of the most common languages in the world. (Amir et al., 2014) reveal that it is "spoken by 250×10^6 (250.000.000) native speakers over large parts of the world, mainly around the Mediterranean in north Africa and middle East". (Alotaibi & Hussain, 2010) illustrate that the huge number of Arabic speakers makes it the second most spoken language in the world.

However, the Arabic language spoken over these large areas is not exactly the same in terms of pronunciation, spelling, vocabulary, and even grammar. The most noticeable difference among dialects, according to (Nydell, 2002, p. 186), occurs in pronunciation and vocabulary, although there are grammatical discrepancies too. Generally speaking, most Arabic dialects differ from MSA in the number of sounds they have. MSA has a rather limited vowel system with three short and three long vowels only (Holes, 2004), while other different Arabic language variants show different sets of vowels.

Iraqi Dialects

The idea that there are dialectal differences among various dialects of Arabic in one hand and MSA on the other hand has been well supported in previous studies. Vowels in MSA show different acoustic features in many Arabic dialects. (Alghamdi, 1998) implemented an exciting spectrographic examination of Arabic vowels where he examined Arabic vowels as produced by speakers who speak Saudi, Sudanese, and Egyptian dialects. Alghamdi concluded that there are phonetic variations in how Arabic speakers realize the vowels of MSA. Hence, the vowel system of each Arabic dialect can be examined and acoustically analysed to draw its own vowel chart. More interestingly, Arabic dialects have their own variants that belong to the prototype dialect, but definitely differ from it in some phonetic aspects.

Iraqi Arabic is one of the dialects of Arabic that is spoken in Iraq; however, there are more than one dialect spoken in Iraq such as Maslawi, Baghdadi, Bedouin and southern dialects. Actually, scholars have different perceptions of Iraqi dialects as some believe that there are only two dialects in Iraq. (Ani & Salmān, 1970; Blanc, 1964; Palva, 2009) all report that there are two language variants in Iraq. These variants basically differ in the realization of the Arabic letter "qaaf" القاف. The variety that retains the pronunciation of "qaaf" as it is pronounced in MSA is called the "Qeltu Dialect", while the one that changes it into "gaaf" is called the "Gelet Dialect".

Based on Khoshaba (2006, p. 3) Iraqi Arabic is different from MSA as Iraqi dialect has 3 consonants more than the MSA and 3 additional long vowels compared to the standard ones. Al-Khalesi (2006) illustrates that the MSA has only 3 short and three long vowels (a, i, u) and (aa, oo, uu) respectively, while the Iraqi dialects have five long vowels (aa, ee, ii, oo, uu), and four short vowels (a, i, o, u). Khoshaba (2006, p. 34) confirms that "there are two additional vowels in the Iraqi dialect compared with those of classical Arabic. They are longer than the classic sounds, though they have the same written form". Unlike MSA, the Iraqi dialects do not add a vowel to the end of words, and they end words with consonants rather than vowels. Al Abdely et al. (2016, p. 4) explains that "Iraqi Arabic (IA) has nine vowels", and it "has a richer vowel system compared to Classical Arabic and Modern Standard Arabic, which has only six vowels".

Baghdadi Arabic, the dialect under investigation in this study, is the most popular form of Gelet dialect. The other variant, Qeltu" is mostly spoken in the northern part of Iraq, and it is frequently called Maslawi Arabic. Baghdadi dialect is spoken in the middle area and in some cities around Baghdad. However, Maslawi Arabic is spoken by people who live in Mosel and the regions around it. Some dialects of south Iraq have different varieties in specific linguistic technique such

as the dialects of city centre of Basra and its districts. In Iraqi Arabic, especially the dialects of Iraq, a few researchers have investigated the different varieties in the region of Iraq (Weeden, 2008).

Previous Studies

A number of previous studies examined the vowel system of MSA and its various dialects. However, these studies had different aims, targeted different groups of speakers, and adopted different procedures. The majority of these studies examined the vowel system of Arabic dialects to explore its interference in the process of learning a foreign or a second language. Al Abdely and Yap (2016a) and Al Abdely and Yap (2016b) investigated the role of L1 in the process of acquiring L2 vowels. Moreover, these studies made use of existing vowel charts offered by (Al-Khalesi, 2006; Erwin, 2004; Khoshaba, 2006). Almbark (2012), and Almbark and Hellmuth (2015) conducted an acoustic analysis of Arabic vowels; however, she targeted Syrian speakers, who are supposed to show different vowel characteristics compared to Iraqis. The same is true with studies conducted on Sudanese (Hassan, 2014; Mohammad, 2014), and on Saudi Arabian speakers (Nikolova-Simic, 2010), which were concerned with vowel production in relation to various variables. These studies were also interested in identifying the problems these speakers face during their journey in acquiring English vowels.

Most of the accounts provided on the vowel system of IBA were based on the perception of these vowels; hence, they cannot be reliable enough. Researchers started to include vowel production experiments that are acoustically analysed in order to validate the perceptually oriented descriptions of these vowels. A recent study conducted by (Fathi & Qassim, 2020) has acoustically analysed Iraqi Arabic vowels; however, this study targeted the other Iraqi dialect, Qeltu dialect, while the present study targets Iraqi Baghdadi Arabic or what is so called the Gelet Dialect. Fathi and Qassim (2020, p. 694) claim that what triggers them to conduct their study was that it becomes clear to them that "Arabic vowels have received little attention as far as experimental studies are concerned. Little research has been conducted to examine Arabic vowels experimentally".

In addition to the claim made by Fathi and Qassim (2020), the present study is motivated by the need to establish a dialect background of the vowel system of IBA. This system is expected to be of great value to Iraqi EFL learners, Iraqi EFL teachers, researchers and even textbook designers, who are interested in documenting this particular dialect.

Based on the review provided above, it can be concluded that the current study is the first that aims to acoustically describe the Gelet IBA simple vowels. The study fills in the gap identified in the literature as previous studies depended on perceptual accounts of vowels of various Arabic varieties when analysing L1 interference in the acquisition of foreign or second languages. Moreover, previous studies have targeted Arabic varieties such as Syrian, Saudi, Sudanese, etc. Only one study described IA vowels (Fathi & Qassim, 2020); however, it was interested in the other dialect of IA, which is the Qeltu not the Gelet dialect that is being described here. The basic aim of the current study is to offer a vowel chart of IBA that can be used as a reference to learners, teachers, and researchers of IA. The chart will hopefully be of value to learners, teachers, and researchers who are interested in identifying dialectal influence on foreign and second language learning. Such a vowel chart has not been, to the best knowledge of the researchers, offered before.

Method

The main objective of the study is to provide a phonetic description of the Iraqi Arabic vowels as spoken by Baghdadi Iraqi speakers. To this end, the study employed a production test that offers the data necessary for the analysis and depiction of the IBA vowel system. The nature of the study and the aims set to be achieved here require a quantitative method that analyses data numerically, as it is based primarily on measuring F1 and F2 values of the vowels recorded in the production test.

Samples of the Study

The Stimuli

The words used as stimuli in this study were 27 meaningful Iraqi Arabic words. Every Arabic vowel was represented in monosyllable CVC words except for the vowels /i/ and /u/, which were provided in disyllabic words (CVCCV) due to the difficulty of finding single-syllable words for these vowels. Hence, words such as (شرطة, نكته, جبة, دوشك) have been included in the stimuli. The context in which these vowels occur was not limited to specific proceeding and following consonant sounds as it was difficult to choose one context over the other as the surrounding sounds do have an effect on the frequencies of vowels under analysis.

The choice of single-syllable words rather than multi-syllable words was to avoid the distraction that might happen when two vowels are available in the same word. All of the words used in the study were Baghdadi Arabic words that are frequently used in everyday interaction among Iraqi speakers of this language variety. The consonants that precede and follow the target vowels were either stops or fricatives because they provide clear boundaries on the spectrogram. It is worth noting that the symbols used to represent IBA vowels are not IPA symbols. The study rather used a common set of symbols used to represent Arabic sounds. Long vowels, for example, are represented by doubling the sound (Al-Abdely, 2002).

Table 1. Wordlist used in the test

N	Words in Arabic	Words in English	Words Transcribed	Targeted Vowel
1	هيج	Thus	hiitʃ	ii
2	شيش	Piece of iron	ʃiiʃ	ii
3	ديج	cock	diidʒ	ii
4	تلح	Insist	tlih	i
5	يجز	Omit	jdʒiz	i
6	كتله	Tell him	gitla	i
7	زين	Okay	zeen	ee
8	بيش	How much	beeʃ	ee
9	ليش	Why	leeʃ	ee
10	كال	said	gaal	aa
11	خاب	Lose	xaab	aa
12	حاد	Spicy	haad	aa
13	شكد	How many	ʃagad	a
14	جم	They came	dʒam	a
15	حط	He put	hat	a
16	مو	Do you agree?	muu	uu
17	روح	wend	ruuh	uu
18	شوف	look	ʃuuf	uu
19	نكتة	joke	nukta	u
20	شرطة	Police	ʃurta	u
21	جبة	robe	dʒuba	u
22	حوش	yard	hoʃ	O
23	دوشك	bedding	doʃag	o
24	خو	so	Xo	o
25	فوك	Above	foog	oo
26	شلون	how	ʃloon	oo
27	هور	swamp	hoor	oo

The participants of the study

Ten Baghdadi dialect speakers participated in the study, five males and five females, are all educated and range in age from 20 to 30 years old. None of them reported any speech disturbances. All of them were monolinguals with Arabic as their native tongue, and they are learning English as a foreign language at an Iraqi university. There is no particular reason for recruiting EFL learners to be the study informants except for the fact that they were available and willing to participate in the study. Thus, convenient sampling technique was adopted in the selection of the informants. Several selection criteria

such as age, mother dialect, and education level were all taken into consideration in sampling the participants of this study. All of the participants agreed to participate in this study as non-paid informants, and they signed a consent letter that certifies their willingness to participate in this study. They were also assured by the researchers that any information they present in this study will remain confidential and will only be used for the purpose of this study.

Data Collection Method

The data of this study was primarily obtained from a production test that requires participants to read from a sheet of paper that contains the wordlist of Baghdadi Iraqi Arabic words. The reading of participants was recorded using smart phones and the recording was made in quite halls at the English Language Department, Education College for Women, University of Anbar. Good quality microphones were used to attain clear voices and less noise. The recording of each participant was directly checked for voice quality before the participant left the hall. Low quality recordings were done again and the first recording had to be ignored. This happened twice during the recording stage. The recording of each participant was stored in a separate file to be keyed in PRAAT software program and later analysed for vowel frequencies.

Data Analysis Method

In the analysis stage, recordings were recalled in PRAAT to view and edit screen. Then, each vowel in each word was marked. After that the F1 and F2 values were measured at each vowel midpoint. The process of measuring F1 and F2 values were made thirty times for each vowel (30 F1 and 30 F2 values), as each vowel was spoken in three words by ten speakers. Frequency was measured in Hertz (Hz) with 500 Hz as maximum frequency. On the other hand, the average frequency of F2 was about 2300 Hz. as these frequencies are often recommended for human speech. The F1 and F2 values obtained from the acoustic analysis were measured for means, which were later used to map IBA vowels on a vowel chart.

Results

The results obtained from the production test conducted in this study were processed acoustically. After that, the data was presented in various ways to respond to the research questions raised and the aims set in this study. These results are presented in the following sections.

Acoustic Measurements

The results presented in this section are basically extracted from the acoustic analysis performed in this study. The results include measurement of vowel frequencies and how to use them to plot IBA vowels. The effect of gender on these frequencies and consequently on the mapping of vowels is also identified.

Vowel frequency analysis

The files that contain the recording of participants were opened one by one. Each file was divided into tokens, and each token includes a separate word. Each word was later processed in PRAAT to identify the targeted vowel. Here are some screen shots of various vowels as they were identified in PRAAT.

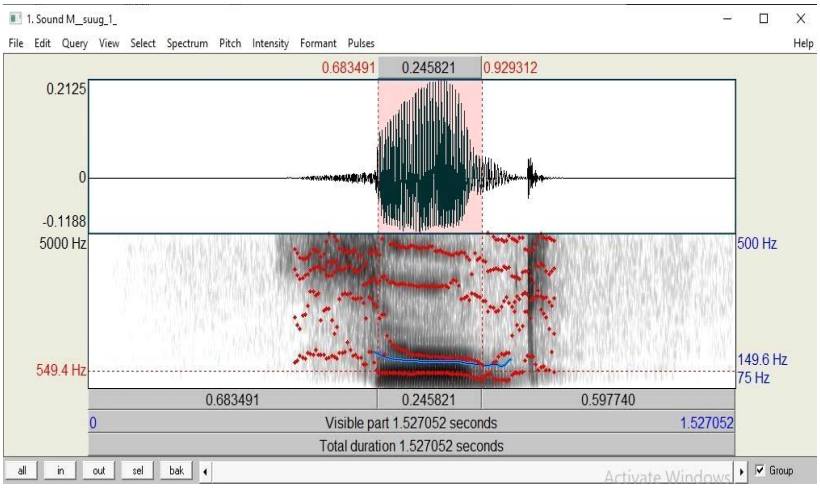

Figure 1. The word (/suug/, market) as pronounced by an Iraqi male speaker

The shadowed area in figure (1) above refers to the vowel /uu/, whose frequencies were measured at its midpoints so that the effect of following and preceding sounds is eliminated. Figure (2) shows the sound wave of the word (dʒam/, they came) as it is pronounced by a female Iraqi speaker. The shadowed area indicates the vowel sound /a/.

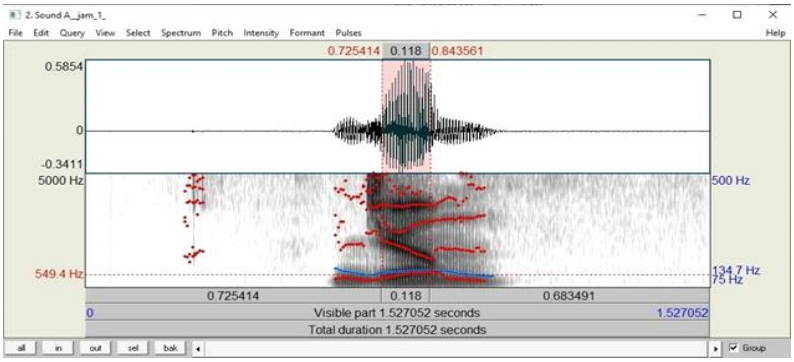

Figure 2. The word (/dʒam/, they came) as pronounced by an Iraqi female speaker

After marking the vowel in each word, F1 and F2 were measured for each participant. The measures of each vowel were taken from the three pronunciations of that vowel as they were embedded in three different words. The mean for each vowel as pronounced by each participant was first calculated. Later, a mean value for each vowel was calculated as it was produced by all participants. Having three words for each vowel to be pronounced by ten different speakers would result in 30 trials for each vowel. That was necessary to obtain a more authentic description of IBA vowels. Table (2) below shows the mean values for each IBA vowel as they were produced by IBA speakers.

Table 2. Overall Formant Frequency means for IBA vowels

Vowels	F1	F2
ee	**448.76**	**2248.1**
a	**654.8**	**1643.63**
aa	**730.2**	**1333.66**
u	**471.33**	**1409.23**
uu	**424.56**	**996.933**
i	**475.63**	**2017.73**
ii	**364.16**	**2480.33**
o	**553**	**1162.93**
oo	**562.43**	**1086.9**

The frequencies obtained in Table (2) above were mapped into a vowel chart via PRAAT to locate IBA vowels in their positions in the vowel space of this particular dialect. The following figure shows the vowel chart of IBA based on the pronunciation of the present study participants.

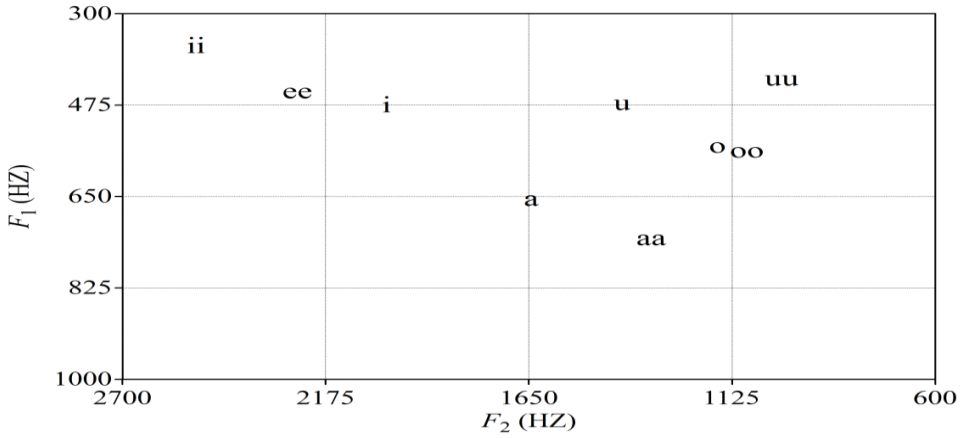

Figure 3. IBA Vowel Chart

As shown in Table (2) and Figure (3) above, the nine IBA monophthongs were distributed throughout the vowel space of this dialect. IBA vowels occupied distinct positions in the vowel chart with no overlap between one vowel and another. Even those vowels, who are supposed to be immediate neighbors such as /i/ and /ii/, /u/ and /uu/, were spectrally distinctive from each other. This means that the difference between short and long vowels in IBA is not only a matter of quantity but a matter of quality as well. More specifically, the difference between short and long vowels in IBA is not just in the duration taken to pronounce the vowel, but also in the specific acoustic features of these vowels. This is similar to the short-long distinction found in English.

The short vowels /i/ and /u/ have higher F1 values than their long counterparts /ii/ and /uu/ respectively, while the short vowel /a/ has a lower F1 value than its long counterpart /aa/. Concerning F2 values, the short vowel /i/ has a lower F2 value than its long counterpart, while the two vowels /u/ and /a/ have higher F2 values than their long counterparts /uu/ and /aa/ respectively. The two dialectal vowels /ee/ and /oo/ have higher F1 values than the high vowels /ii/ and /uu/. When compared with the low vowel /aa/ and its short counterpart /a/, the vowel /ee/ has a lower F1 value. The vowel /oo/, on the other hand, has a lower F1 value than /aa/, but a higher F1 value than the short vowel /a/. The vowel /ee/ has a higher F2 value than all other BIA vowels except the vowel /ii/ which has a higher F2 value than /ee/. The vowel /uu/ has a lower F2 value than all other vowels.

The F2 differences between long vowels and their short counterparts are higher than the F1 differences. The F1 difference is 11 Hz between /i/ and /ii/, 76 Hz between /a/ and /aa/ and 47 Hz between /u/ and /uu/. The F2 difference is 463 Hz between /i/ and /ii/, 310 Hz between /a/ and /aa/ and 413Hz between /u/ and /uu/. Moreover, one can notice a gap starting between F1 and F2. Then it gets tight when we see that F1 and F2 get a little closer to each other. In other words, F1 starts low which means the spoken vowel is high. However, the finish indicator shows that F1 is up a bit. It indicates that the tongue changes from one place to another. F2 starts higher which means it is a forward vowel and goes down toward F1 at the end of its pronunciation.

Gender Variable Effect on IBA Vowels Pronunciation

In order to identify the effect of gender on the participants' production of IBA vowels, two methods were adopted. Both methods got its data from the production test conducted here and the measurement of vowel formants. The results of the production test, which was processed acoustically, were first used to map IBA vowels on the vowel chart. Two vowel charts were drawn based on the production of males (Figure 4) and females (Figure 5). As it can be noticed in Figures (4 and 5) below, female Iraqi speakers have a wider vowel space where some vowels, particularly front vowels, were located far at

the right edge of the vowel chart. The female vowel sounds /i/ and /ii/ are more front than the ones produced by males. However, in terms of height, there is not that big difference. Back vowels are located in similar positions indicating lack of difference between the two groups. Low vowels are almost absent in the female vowel chart with vowels /a/ and /aa/ at mid positions. Female vowel charts shows a lower /a/ and /aa/ compared to males'. The formant frequencies of females are higher than that of males. The formants change the center frequency and bandwidth during speech.

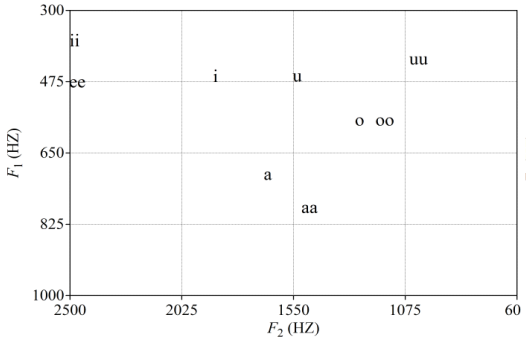

Figure 4. Male IBA Speakers

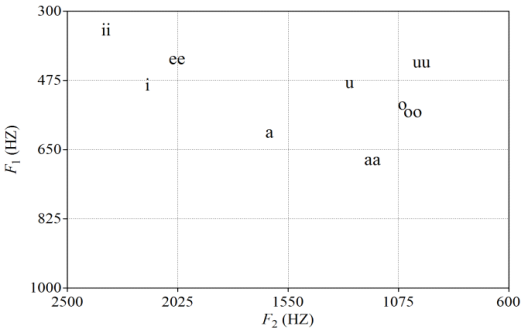

Figure 5. Female IBA Speakers

The above results offer more support to the assumption that adult men and women have different vocal folds sizes; reflecting the male-female differences in larynx size. Adult male voices are usually lower pitched and have larger folds. The differences between female and male voices are associated with complex and multidisciplinary issues. They refer not only to sound (fundamental frequency, resonant frequencies, etc.) and sensory measurements, but also to anatomy and physiology (differences in vocal organs), sociology and even philosophy (construction of gender identity, innate versus learned behavior).

Table (3) below provides a description of IBA vowels based on the acoustic measurements conducted in the present study. The description adopts the three famous criteria often considered in the description of vowels. Other features such as length are not provided as it is beyond the scope of the present study. However, some notes on vowel length can be briefly offered here.

Provided that the aim of the study is provide a description of IBA vowels, the overall males and females frequencies are used to describe IBA vowels. Mean values for the formant of each vowel that were used to draw the chart provided in Figure (3) are adopted in the description.

Table 3. Description of Iraqi Arabic simple vowels

Simple vowels	Description
a	Unrounded, mid, central
a:	Unrounded, mid, central
i	Unrounded, high, front
ii	Unrounded, high, front
u	Rounded, high, back
uu	Rounded, high, back
o	Rounded, mid, back
o:	Rounded, mid, back
e:	Unrounded, high, front

To identify the effect of gender variable on the pronunciation of IBA simple vowels, F1 and F2 mean values for male and female IBA speakers were compared using a series of independent samples T.Tests. The purpose was to show any significant differences in the vowel formants as produced by IBA speakers based on their gender. More specifically, 18 independent samples T.Tests were conducted on F1 and F2 means for each vowel, and the results are illustrated in table (4) below.

Table 4. Results of independent samples T.Tests

Vowel	Mean Difference	Std. Error Difference	Sig.
F1 ee	-54.3333	19.3512	.009
F2 ee	-441.800	59.500	.000
F1 a	-95.73333	60.15806	.123
F2 a	-29.53333	157.71752	.853
F1 aa	-107.86667	24.04011	.000
F2 aa	-295.20000	39.55357	.000
F1 u	20.80000	28.59436	.473
F2 u	-249.26667	81.78239	.005
F1 uu	9.66667	17.99372	.595
F2 uu	-43.20000	39.63326	.285
F1 i	25.66667	45.43924	.577
F2 i	272.80000	94.32848	.007
F1 ii	-26.20000	18.75048	.173
F2 ii	-353.53333	67.06353	.000
F1 o	-33.06667	22.20633	.148
F2 o	-212.13333	55.88806	.001
F1 oo	-13.93333	33.12712	.677
F2 oo	-148.33333	56.55776	.014

The significant values typed in red color refer to the formants that show statistical significant differences based on gender variable, while those types in blue color refer to insignificant differences between the male and female groups.

Discussion

Vowel Formant Frequency (Vowel Quality)

As it was illustrated in Figure (3), two long vowels, /ii/ and /uu/ were produced with a higher tongue body position than their short counterparts /i/ and /u/ respectively as indicated by the low F1 values compared to those of /i/ and /u/ (see Table 2). The long vowel /aa/, on the other hand, was lower than its short counterpart /a/ with F1 (730 Hz) and (654 Hz) respectively. The big differences in F2 between the long vowels and their short counterparts indicate a qualitative difference between the long vowels and their short counterparts. The long vowel /ii/ is more forward in vowel space than its short counterpart /i/. This is clearly seen in the high F2 value of /ii/, which is lower than that of /i/. Conversely, the two long vowels /aa/ and /uu/ were in more back positions compared to their short counterparts /a/ and /u/ respectively, since /aa/ and /uu/ have lower F2 values than their short counterparts.

For vowels in this dialect, the vowel /ee/ has a higher F1 value than the vowels /ii/ and /uu/. But its F1value was less than that of vowel /aa/ and its short counterpart /a/. The vowel /oo/ was produced with lower tongue body position is produced by the vowels /ii/ and /uu/ and their short counterparts due to the high value of F1. When compared with the vowel /a:/ and its short counterpart /a/, the vowel /a:/ is produced higher than the vowel /oo/, and for the F2 values of the vowels /ee/ and /oo/, the vowel /e:/ has a higher F2 value than all other vowels except the vowel /ii/ indicating that it is more introverted than all other vowels except for the vowel /ii/ which is more introverted than /e:/. As for the vowel /oo/, it is more regressed than all

other vowels due to the lower value of F2 (1086 Hz), and this could be due to the lip- rounding effect.

The Baghdadi vowels have been accordingly drawn on a spectrogram (Figure 3). One advantage of having a language schema such as this chart is that it can be used for educational purposes. The Iraqi Baghdadi vowels chart can be used to teach English vowels. (Ladefoged & Johnson, 2011) state that students' first language vowels can be used as reference points to compare with the vowels of the taught language. This chart is also beneficial to researchers, who are interested in acoustic features of Arabic dialects in general, and IBA in particular.

As far as IBA vowels quantity (though its investigation is beyond the scope of this study), one can notice that IBA speakers are very much aware of length difference between lax and tense vowels as they produced each pair of short-long vowel in a distinct position with clearly different F1 and F2 formant values. This may well justify Iraqi EFL learners' ability to discriminate between long and short vowels. This ability was reported in previous studies such as (Al-Abdely & Yap, 2016; Alzahrani, 2014; Munro, 1993), who all found out that duration cues are very important tools Arab EFL learners' employ in order to perceive and later produce the vowels of L2.

Gender Variable Effect

Comparison between male and female IBA speakers was made so as to find out any significant differences in the vowel formants of IBA that can be attributed to gender difference. The results of this comparison were first illustrated in figures (4 and 5) that map IBA vowels as produced by male speakers (figure 4) and female speakers (figure 5). Having a look at the two figures, one can notice that there are several differences in the vowel formants and vowel positions that can be gender dependent. According to Cartei et al. (2012, p. 1) "men's vocal tract being on average 18 cm, compared to women's 15 cm", and this difference in vowel tract length is negatively correlated to formant frequencies. Thus, "male speakers produce lower Fi values". This idea has been supported by Rogers (2014), who states that any differences in the shape of the spectrograms of males and females, they belong to the differences between the vocal tract shapes of the male and female speakers.

The fact that males produce lower formant values is well supported in Figure (4) above, where the vowels produced by males are clearly higher in the vowel chart compared to females. These high vowels are the result of low F1 frequencies shown by males in the production of most vowels, specially /ee/, /ii/, /a/, and /aa/. The vowel chart drawn based on males' frequencies almost have no low vowels, while the one mapped based on females' have /a/ and /aa/ as low vowels.

Male IBA speakers produced vowels with lower F2 values compared to female IBA speakers. This means that females should show a tendency to have more front vowels than males. This is clearly noticed in having more front vowels in females' chart compared to males'. The vowels /ii/ and /ee/ are located in more front position in females' chart compared to their counterparts in the males' chart. In the same vein, vowels such as /o/, /oo/, /a/, and /aa/ were located in more back vowels in males' chart compared to females" chart, and this is also due to lower F2 formants shown by males. However, the vowel /u/ and /uu/ show no clear differences in the two charts.

Based on the results of the independent samples T.Tests, seven vowels show significant differences in F2 values between males and females. These vowels are /ee/, /aa/, /u/, /i/, /ii/, /o/, and /oo/. The differences were in favour of females, who produced vowels with higher formants compared to males; hence, their vowels were located in lower positions compared to men. Only the vowels /ee/ and /aa/ show significant difference in F1 values based on gender. Thus, /ee/ was more front in females' chart, while /aa/ was more back in males' chart. It is worth noting here that F1 formant refers to the horizontal axes of vowel mapping, where higher F1 formant means more front vowels and lower F1 formant means more back vowels. Moreover, the vowels /a/ and /uu/ show no significant differences at all as they are located in almost the same positions in the two charts.

Though gender effect on the pronunciation of vowels has been reported in numerous studies, this study does not only confirm that effect on the pronunciation of this particular sample (which has not been examined before), but also shows exactly how this effect is manifested in the pronunciation of IBA vowels. The results of the T.Test conducted in this study inform about significant gender effect for some but not all of the vowels investigated. Moreover, gender difference was present in terms of one of the vowel formants but not for the other. This means that gender difference, which is well

supported in the related literature, is not active in the pronunciation of all vowels. Such a study can be replicated on different Iraqi samples to validate the frequencies obtained, the charts depicted, and the gender differences identified. Moreover, According to Johnson et al. (1993), variations in vocal tract size between males and females may not result in differences in pronunciation i.e. variations are not only found between, but also within genders. Such conclusion indicates that gender effect on pronunciation is not always a foregone conclusion.

IBA and Other Arabic Varieties Vowel Systems

This section casts light on some Arabic varieties' vowel systems, particularly simple vowels, as they were acoustically described in previous studies and compare them with the one offered in the current study. It might be convenient to start with the vowel chart of Modern Standard Arabic (MSA), which has been extensively investigated by researches such as Al Ani (1990), Alghamdi (1998), Huthaily (2003), and Kalaldeh (2018).

In MSA, six simple vowels have been always reported in the literature; three short and three long vowels. According to Huthaily (2003, p. 28), these six vowels refer to the "classical triangular Proto-Semitic vowel system". Huthaily (2003) indicates differences between three pairs of short/long vowels using different symbols for each short vowel and its corresponding long vowel. The long high front vowel /i/, for example, is located in a more frontal position than its short counterpart that is symbolized as /ɪ/. MSA vowel chart by Huthaily (2003, p.30) is presented below.

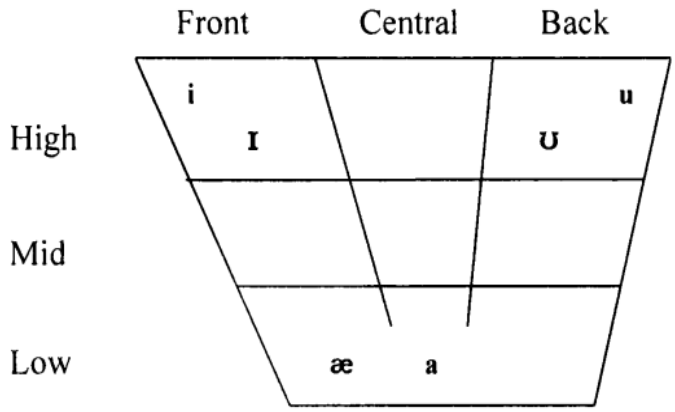

Figure 6. MSA vowels (Huthaily, 2003)

Vowel systems of various Arabic varieties may show the same number of vowels for MSA; yet, some differ from that of MSA. Some varieties show wider vowel space with more simple vowels, while some others show more limited vowel space with fewer simple vowels. Alghamdi (1998) analysed the vowel systems of three Arabic varieties: Saudi (SA), Sudanese (SuA), and Egyptian (EA). For these varieties, He reported six vowels which are very much similar to that of MSA; however, their exact locations in the vowel chart were somehow different from MSA and among each other. The vowel charts proposed by Alghamdi (1998) are presented below.

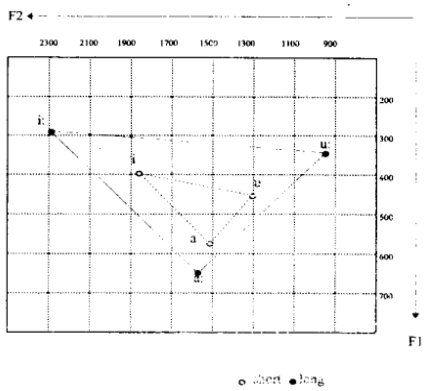

Figure 7. SA Chart

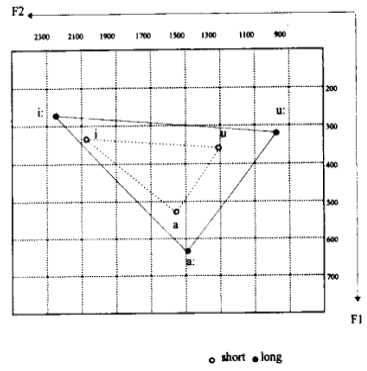

Figure 8. SuA Chart

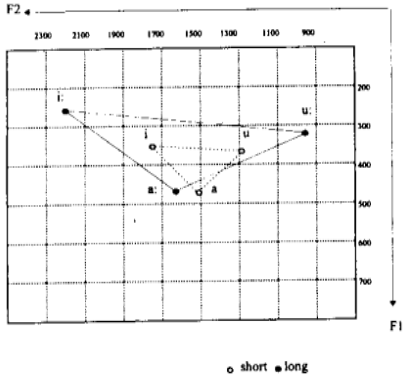

Figure 9. EA Chart

Almbark and Hellmuth (2015) provided an acoustically generated vowel chart of Syrian Arabic (SA), in which 8 vowels have been identified as phonological vowel categories with three allophonic categories as it illustrated in figure (10) below.

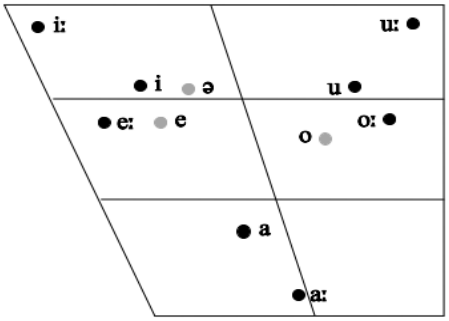

Figure 10. SA Vowels in black and allophones in grey (Almbark & Hellmuth, 2015)

The eight vowels identified in this study look similar to the ones identified in the present study in terms of acoustic features reflected in their mapping on the vowel chart. However, the IBA vowel /o/ is not found in Syrian vowel system. Furthermore, some Syrian Arabic vowels such as /ee/ and /aa/ tend to be a bit lower than their IBA counterparts.

Ahmed (2008) conducted a perception and production study of Libyan vowels, in which he acoustically described the vowel system of the one of the basic dialects spoken in the capital, Tripoli. The number of simple vowels identified in this variety was eight vowels. In addition to the six vowels of MSA, this study acknowledged the existence of two extra vowels: /e:/ and /o:/. The vowel chart presented in the current study shows an extra vowel, /o/, which has not been identified in Ahmed's study. Moreover, the location of some vowels are also different between the studies. The vowel /i/, for example, is found in a lower and more central area in IBA compared to that of Libyan, which is higher and more front to be much closer to its long counterpart /ii/.

Several studies such as Al-Tamimi and Ferragne (2005), Khalil (2014), and Al Mahmoud (2021) acoustically described selected vowels in Moroccan and Jordanian, Egyptian, and Najdi Arabic varieties respectively. However, none of these studies attempted a description of the vowel system of the dialects they investigated. They rather aimed at different objectives such as comparing the vowels of these Arabic varieties with French or General American English. Results obtained in the above mentioned studies indicate that how Arabic vowel system varies across different Arabic variants. This conclusion finds great support in numerous studies such as Alghamdi (1998), Saadah (2011), Nikolova (2012), and Alqarni (2018), which all provided different acoustic accounts of the Arabic varieties they analyzed.

It can be noticed that the number of vowels identified in this study is 9, which is bigger than that of MSA (6 vowels), and some other Arabic varieties (maximum 8). Erwin (2004) assumed that vowels in Iraqi Arabic have a wide variation,

and this may justify the more detailed vowel chart found in this study. As for vowels' location in the vowel space, variations between Arabic varieties and IBA are also observed. Due to space limitation, one brief comparison between IBA vowels (the current study) and Qatari Arabic (Al-Mazrouei, Aisha & Vladimir, in print) is provided below.

The number of vowels identified in Qatari Arabic (QA) is limited to six vowels mapped on the vowel space as illustrated in Figure (11) below.

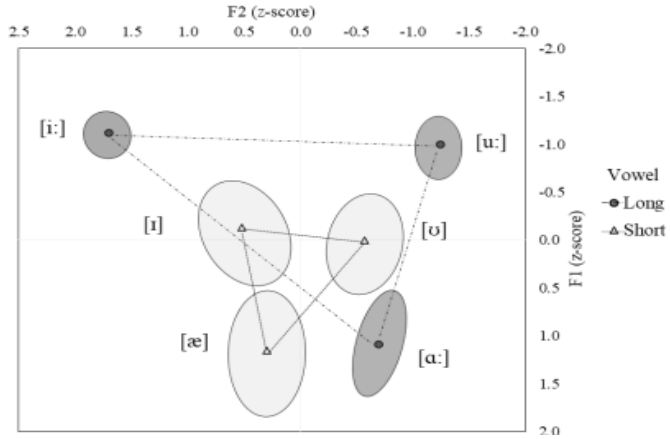

Figure 11. QA vowel chart (Al-Mazrouei, Aisha & Vladimir, in print)

The vowels that are identified in both IBA and QA are not located in the same positions in the vowel chart. More specifically, the short long vowels /a/ and /a:/ of QA are located at very similar vowel height level, while the other two pairs /u/-/u:/, and /i/-/i:/ are significantly different in terms of vowel height and vowel advancement. The long-short IBA vowels mapped in the current study are located at significantly different positions in terms of vowel height and vowel advancement, where the pairs /i/-/i:/, and /u/-/u:/ are distinguished in terms of vowel advancement, while their vowel height is almost similar. The other pair /a/-/a:/ is very well distinguished in vowel height and vowel advancement as well. Moreover, QA short vowels seem to be more centralized compared to ABI short vowels.

Conclusions

This study presented a phonemic depiction of the IBA vowels as they were produced by native male and female speakers of this dialect. The IBA chart presented in this study revealed Iraqi speakers' good ability to discriminate between long and short vowels. Moreover, speakers also provided vowel formants that reflect their ability to distinguish one vowel from another. The only pair of vowels that were located near each other was the /o, oo/ pair, which were produced with very similar formants. This pair should take much attention from learners and teachers so that unnecessary overlap could not happen.

The significant differences identified between male and female speakers stresses the need for considering a vowel chart that is drawn based on the pronunciation of both male and female speakers. This study suggests that the chart illustrated in Figure 3 is more suitable for education and research purposes as it merges vowel formants produced by both groups. Furthermore, the vowel chart presented in this study to show IBA vowels is different from the vowel chart presented in Fathi and Qassim (2020, p. 701) that shows the vowel chart of the other basic dialect in Iraq (Maslawi Iraqi Arabic). Maslawi dialect, according to Fathi and Qassim (2020) realizes eight vowels rather than 9, and these eight vowels are located in different positions compared to IBA vowel chart. IBA vowel system proposed in this study confirms the assumption that the vowel systems of Arabic varieties differ considerably or marginally in terms of the number of vowels realized and the position of these vowels in the vowel space of each variety.

This result invites researchers to conduct more studies on the acoustic features of vowels in IBA and other Iraqi dialects. Further studies are necessary to validate the findings presented in this study. The results of the present study can be used for comparison with other similar studies to validate the data obtained. A further study may work on IBA vowels as they

are produced in more restricted setting such a BVH setting to eliminate any possible influence of various preceding and following sounds on the formant of the vowel in between. Learners as well as teachers and textbook designers are encouraged to take the findings of this study into consideration when teaching foreign languages' vowel systems so that learners can see differences between his/her mother tongue's vowel system and that of the foreign language being learned. This may create a more conscious foreign or second language acquisition process.

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