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An Acoustic Analysis of the English Plosive Sounds (/p/ and /b/) Pronounced by Students in the Department of English at Sirte University

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Abstract

This study aims to investigate whether Libyan Arabic (LA) learners are able to distinguish between the English plosive sounds (/p/ vs. /b/). In addition, it aims to find out whether the learners' first language (L1) interferes with their production of the target sounds. Data were collected from five LA learners, enrolled in the Department of English, Sirte University. The students produced five English minimal pairs, containing the English stops /p/ and /b/, and five LA words with the Libyan Arabic stop consonant /b/ in an initial position. The participants were also asked to record the same words embedded in fixed carrier phrases in both English and Libyan Arabic. The voice onset time (VOT) values of English stops /p/ and /b/, and the LA consonant sound /b/ were measured using Praat software. In total, there were 300 tokens targeted for analysis. The findings showed that the participants were able to distinguish between /p/ and /b/ in their productions. This provides evidence against the general assumption that Arab learners have difficulty with English voiceless sound /p/. However, the results obtained from this study showed that some participants had difficulties with the pronunciation of the English voiced sound /b/, which they produced with positive values (i.e. values similar to those of its voiceless counterpart /p/). In addition, the statistical analysis of the data revealed no significant effect of the students' L1 on their production of the target sounds. The results obtained from the current study are expected to provide valuable recommendations for EFL teachers and material writers.

Keywords

Instrumental Analysis, English Stops, VOT, Pronunciation, Libyan Arabic Learners

تحليل صوتي للاصوات الانجليزية (\p\ و \b\) من قبل طلاب اللغة الانجليزية في جامعة سرت

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الملخّص

تهدف هذه الدراسة إلى التحقق مما إذا كان المتعلمون الليبين للغة الانجليزية قادرين على التمييز بين الاصوات الانفجارية (/b/ /p/)في اللغة الانجليزية. كما تهدف إلى تحديد تأثير لغة المتعلمين الأم على نطق هده الاصوات. تم جمع البيانات من 5 متعلمين للغة الانجليزية مسجلين في قسم اللغة الإنجليزية، جامعة سرت، والذين قاموا بتسجيل كلمات وجمل تحتوي على الاصوات الانجليزية المستهدفة(/p/ و/b) والصوت الساكن /b/ الموجود في اللهجة الليبية. تم إجراء تحليل صوتي لقياس قيمة وقت بدء الصوت (VOT) باستخدام برنامج Praat. بالمجمل كان هناك 300 تسجيل مستهدف للتحليل. أظهرت النتائج أن المشاركين تمكنوا من التمييز بين /p/ و/b/، مما قدم دليلاً يعارض الافتراض السائد بأن المتعلمين العرب يواجهون صعوبة في نطق الصوت الإنجليزي/p/. ومن ناحية اخرى، أظهرت نتائج هذه الدراسة أن بعض المشاركين يواجهون صعوبات في نطق الصوت الإنجليزي المسموع /b/، حيث قاموا بنطقه بقيم إيجابية (أي قيم مماثلة لقيمة نظيره الغير المسموع /p/). كما كشفت النتائج عن تأثير كبير للغة الأولى للمتعلمين على نطقهم للأصوات المستهدفة. من المتوقع أن تكون الدراسة الحالية ذات قيمة، لا سيما لمتعلمي اللغة الإنجليزية كلغة أجنبية.

الكلمات المفتاحية:

التحليل الصوتي، اصوات اللغة الإنجليزية التوقفية، النطق، المتعلمون الليبيون، VOT.

1. Introduction

Differences between first language (L1) and second language (L2) sound inventories are believed to be the primary cause of the challenges that L2 learners encounter when pronouncing certain sounds. L2 learners often struggle with producing the target sound contrasts, leading to notable inconsistencies in pronunciation. For example, it is well-known that Arabic learners have difficulties in differentiating English /p/ from /b/ because Arabic does not utilize aspiration as a phonemic feature. Accordingly, Arabic learners may have difficulty perceiving and producing the

voicing contrast that characterizes English voiceless stops (Al-Damen et al, 2025). Libyan Arabic (LA) learners are no exception. As with the majority of other Arabic dialects, Libyan Arabic sounds system does not contain the voiceless stop sound /p/; however, it includes its voiced counterpart /b/. As with most Arab learners, LA speakers face difficulty when learning a second language (L2) that contains a /p/ sound, such as English. In other words, it has been observed that LA learners tend to produce English /p/ as /b/ due to the absence of this sound in their L1 (Garib, 2014). Several studies have investigated the articulation of English /p/ by speakers of other Arabic dialects (for example, Flege and Port, 1981; Khattab, 2002).

There are not many studies related to the pronunciation of /p/ and /b/ by LA learners of English. Hence, this study aims to contribute to the existing literature by providing additional insights. It particularly aims to determine whether LA speakers of L2 English can distinguish in their production between the voiceless stop /p/ and the voiced stop /b/, using VOT as a measurement of voicing. In addition, it attempts to find out if participants' L1 affect their pronunciation of the target sounds.

1.1 The Objectives of the Study

This paper is conducted in order to:

1. Determine the VOT values of the English voiceless stop /p/ and voiced stop /b/ as pronounced by Libyan Arabic learners of English.

2. Find out whether the Libyan students understudy can distinguish between /p/ and /b/ in their pronunciation, and to what extent.

3. Find out whether learners' L1 affects the pronunciation of English /p/ and /b/.

1.2 Study Questions

The following research questions were formulated to achieve the purpose of this study:

1. What are the VOT values of the English plosive sounds /p/ and /b/ as pronounced by the Libyan Arabic learners of English?

2. Can the Libyan Arabic (LA) students distinguish between /p/and/b/ in their pronunciation, and to what extent?

3. Is there any effect of the learners' L1 in the pronunciation of English plosive sounds /p/ and /b/?

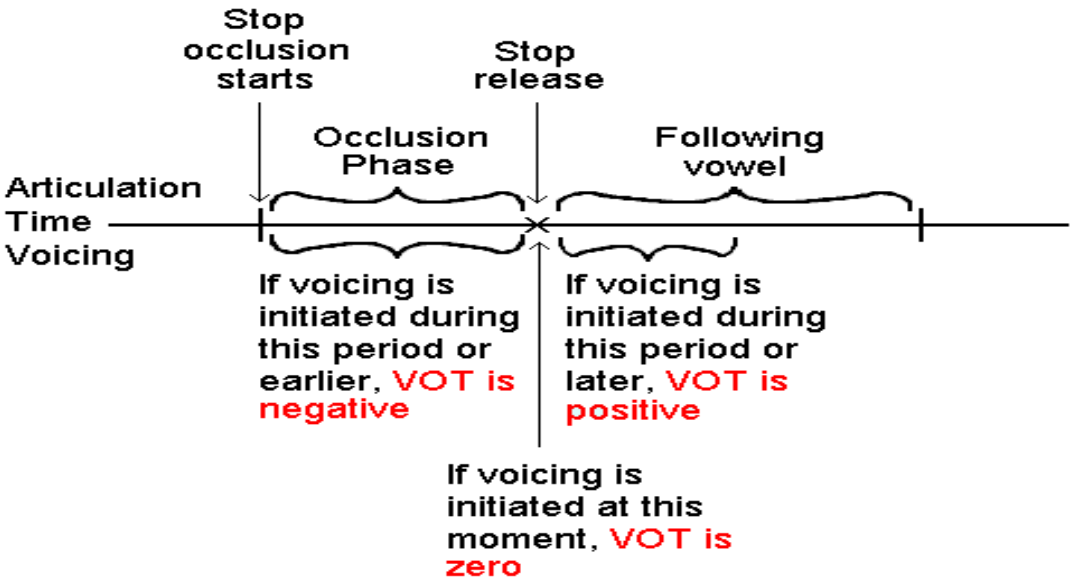
2. Review of the Literature

2.1 Voice Onset Time (VOT) as a measurement of voicing.

Voice Onset Time (VOT) is considered as one of the most widespread acoustic tools for identifying voicing in stop sounds (Al-Damen et al, 2025). VOT is measured by the pause between the release of the full closure of the vocal tract and the beginning of regular vibrations. In other words, Voice onset time (VOT) can be recognized as the duration between stop release and the beginning of the vowel (Weismer, 1979; cited in Adam, 2012). In languages with a contrast between voiced and voiceless stops, differences in VOT are the distinctive auditory feature used to distinguish between them (Lisker and Abramson, 1964). VOT manifests the temporal relation between the release of the stop sound and the onset of voicing as can be shown in Figure 2.1 below.

VOT values can be interpreted in three different ways: negative VOTs occur when the vibrations begin before the release and it is called 'voicing lead'; positive VOTs occur when the vibrations start after the release and it is called 'voicing lag', and zero VOT which occur when release and voicing occur simultaneously (Lisker and Abramson, 1964, Adam, 2012).

Figure 2.1 A Graphic Display of the VOT (Adam, 2012: 301)



In their investigation, Abramson and Lisker (1964) showed that voiced stop sounds have shorter VOTs than voiceless ones, as "voiced" indicates that the vibrations occupy longer portion of the sound, leading to a short period before the burst of the sound. In other words, the period of time before the onset of voicing is short in length thus the VOT value of this sound is negative. On the other hand, voiceless sounds have longer VOTs as there is a longer period of time between the burst of the consonant and the beginning of voicing.

Figure 2.2 the Voiced Plosive Sound /b/ on Praat

Figure 2.2 is a further illustration of a word with sound /b/ presented in the acoustic waveform and spectrogram. The section, which is highlighted in the figure, shows the limits from which the measurement of VOT is taken for this sound. It is clear from the figure that the English voiced /b/ has a negative VOT value because it shows voicing before the burst (Garib, 2014).

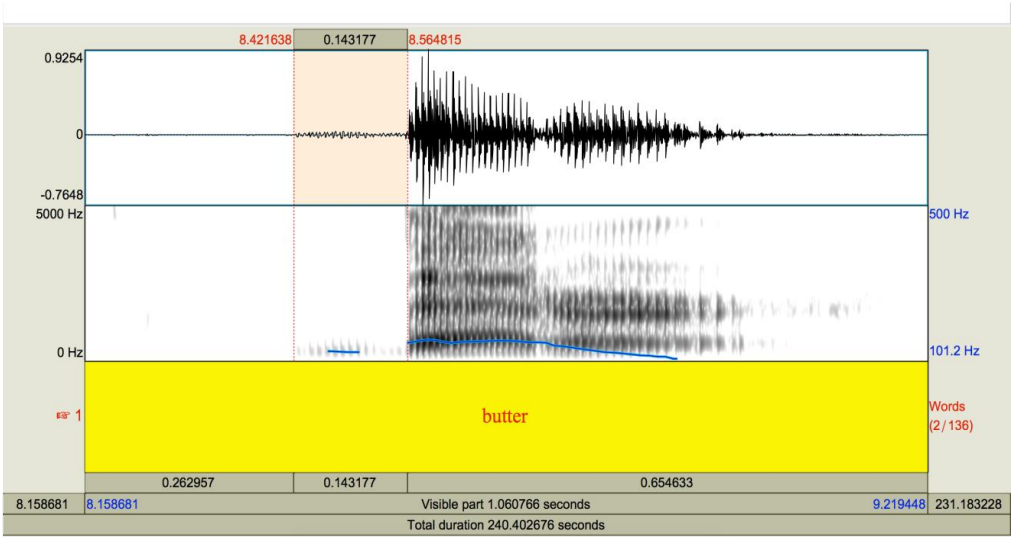
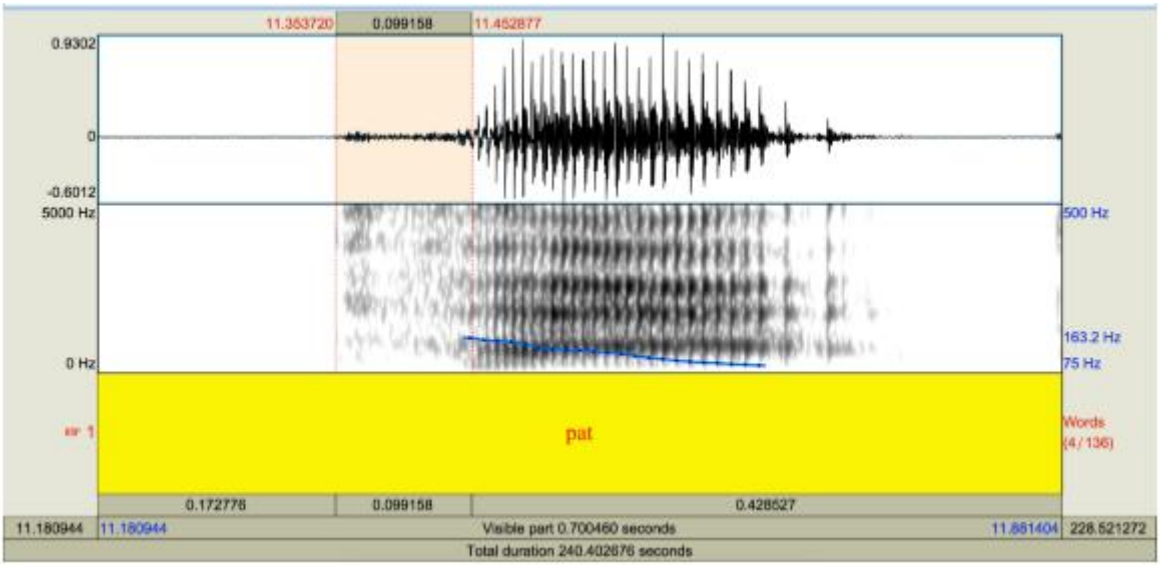


Figure 2.3 below is an example of a word with the sound /p/ presented in the acoustic waveform and spectrogram. The section, which is highlighted in the figure, shows the limits from which the measurement of VOT is taken for this sound. As shown in the figure, /p/ has a period of noise (i.e., aspiration) between the stop burst and the

beginning of voicing, which means that it has a positive VOT (Garib, 2014) .

Figure 2.3 the Voiceless Plosive Sound /p/ on Praat



Abramson and Lisker (1964) stated that languages are grouped in one of two categories regarding their VOT. In the first group, voiced stops have a negative VOT and voiceless stops have a medium-length positive VOT. In the second group of languages, all VOTs are positive, with voiceless stops having long positive VOTs, and voiced stops having short positive VOTs.

Abramson and Lisker (1964) stated that English belongs to the second language group, with positive VOTs for most voiced and voiceless plosive sounds. They added, based on a research into American English, that while most English voiced stop consonant display positive VOTs, speakers do, occasionally, pronounce some voiced stops with negative VOTs.

Regarding Arabic, past studies were carried out which mainly aimed to generate the VOT values in a variety of Arabic dialects, including Jordanian and Saudi in Alotaibi & AlDahri (2010a), Egyptian in Rifaat (2003), Jordanian in Mitleb (2001), and Modern Standard and Classical Arabic in AlDahri (2012a). These studies conclude that Arabic also belongs to the second group, with mostly positive VOTs. One exception in the literature is the Lebanese dialect, which was studied by Yeni-Komshian et al. (1977). The participants in this study exhibited negative VOTs for /b/ and /d/.

It should be noted that variances between the distribution of VOT values in Arabic and English are expected. Based on Figure 2.4, the VOT distributions of speakers in the two languages were compared and it was found that the VOT values of the voiced Arabic stops and voiceless English stops occur in the end of the continuum, whereas the Arabic voiceless stops is within the range of the English voiced stops (Adam, 2012). It is clear from the Figure 2.4 below that Arabic /b/ is recognized as “lead voicing” in onset/word-initially which means that it is more vibrated. This is because the vibration of the English /b/ usually begins after the stop release; however, the vibration in lead voicing occurs before the stop release of /b/ (Kattab, 2002: 96).

Figure 2.4 VOT Distributions of English and Arabic Stops (Adam, 2012:302)

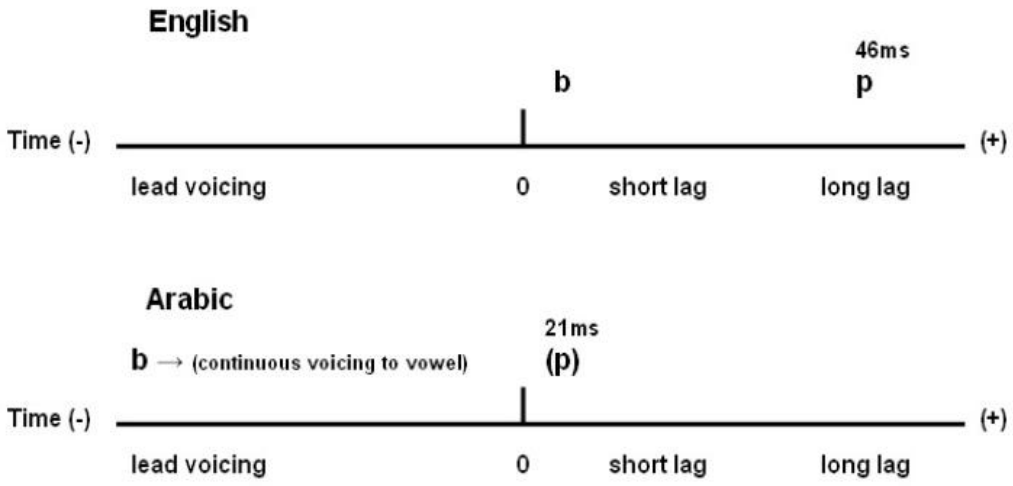
English Plosive Sounds

Arabic Stop Consonants

Taking the above figures into consideration, an explanation has been provided by Garib (2014) of why Arab learners fail to produce the English voiceless /p/ in a native –like manner. Garib argues that even if L2 speaker manages to successfully distinguish the VOT of /p/ and /b/, confusability may continue if the VOT of /p/ is not long enough.

Figure 2.5 is a clear illustration of how Arabic speakers pronounce /p/, but English speakers still perceive it as /b/ because of its way of articulation. Buali (2010) used VOT values from Flege and Port's study (1981, 135). (Note: In the figure, "0" indicates the stop release.)

Figure 2.5 Voicing Characteristics of English and Arabic plosive sounds (Buali, 2010)



In summary, Buali (2010) stated that the mispronunciation of /p/ by Saudi Arabia speakers leads to the "shortening" of the VOT of /p/, resulting in producing /p/ which is closer to zero (2010, p. 8).

2.2 VOT in English and Arabic Languages

2.2.1 Voice Onset Time in English (L2)

English plosive sounds are phonologically divided into two types, voiceless sounds such as /p, t, k/ and voiced sounds such as /b, d, g/. The VOT values of these sounds indicate differences between the voiceless and voiced stops.

Abramson and Lisker (1964) examined the English stops of American speakers. The voiceless stop /p/ in word initially was pronounced with long VOT durations of generally 50 ms or more ('long-lag'). The voiced stop /b/ was pronounced in two different ways: with short-lag, where the stop tended to be produced with VOT durations close to zero, or with pre-voicing, where it tended to have voicing during the stop closure.

2.2.2 VOT in Arabic (L1)

Few studies were conducted which primarily aimed to examine Arabic voicing contrasts.

This section highlights one experiment by Khattab (2000). Khattab studied the VOT values in both languages (i.e. Arabic and English). The main focus was to extract values for the English /p/sound. Khattab found that the Arabic/b/sound had a negative VOT value which ranged from -30 to -57.

Garib (2014) in his study of measuring the VOT values of English /p/ pronounced by Libyan Arabic speakers, he extracted the VOT values for all Libyan Arabic stop consonants (i.e. /b/, /t/, /d/, /g/ and /k/). The results showed that the voiced consonants (/b/, /d/, and /g/) show negative VOT, indicating that these sounds are pronounced with voicing during the stop closure. The voiceless consonants (/t, k/), on the other hand, have positive VOT averages of around 50ms.

2.3 The Effect of the L1 on English production of /p/ and /b/

The differences between the sound structure of English and Arabic is perceived as the main obstacle to achieve acceptable English pronunciation for most Arab students. Some English sounds are not found in the Arabic sound inventory like /p/, /ʧ/, /ʤ/, /ŋ/, and /v/. Even if these sounds appear to be similar to some Arabic consonants like /t/ and /r/ /k/, they are not identical, but different in place of articulation and in manner (Majeed, 1999).

Most Arab speakers perceive /p/ to /b/ as they are two allophones of one phoneme. Alkhuli, (1983) noted that Arab students of English mispronounce /p/ as /b/ and that this is due to the influence of learners' L1, as their tongues get stiff with their L1 sounds. It is found that they continue to commit such errors until the mastery of L2 sounds. Ladefoged (2001) showed that learners' L1 has a significant influence on pronouncing some L2 sounds; where L1 and L2 rules are overlapped. This is known as the interference between L1 and L2. Foreign learners are expected to commit errors. For example, it is widely reported that many L2 learners use /p/ as /b/; others use /s/ for /θ/, and /z/ for /ð/, and /b/ for **/v/.** It is stated that the adults' vocal musculature is fixed to pronounce L2 sounds with an accent. For example, Yule (2009) reported that one of the main problem of English pronunciation is learners' inability to build a new set of sounds corresponding to the sounds of English, and to break down the arrangement of sounds which the systems and the habits of our L1 have strongly built up.

2.4 Theoretical Framework

2.4.1 Contrastive Analysis Hypothesis (CAH)

Contrastive Analysis Hypothesis, suggested by Lado (1957), is an attempt to explain L2 pronunciation difficulties. CAH argues that L1-L2 differences are the main source of difficulty. In other words, comparing L1 and L2 can predict L2 learners' errors. Similar sounds to L1 aid acquisition and learners are expected to attain a native-like production, while non-native features appear when the two languages are different.

2.4.2 Markedness Differential Hypothesis (MDH)

The Markedness Differential Hypothesis (MDH) proposes that difficulty learners face when acquiring new sounds is determined by the degree of differences between L1 and L2, with more marked sounds being harder to acquire. In other words, Eckman (2008) states that the areas of the target language that are different from, and more marked than the L1 are particularly challenging for L2 learners. Research, such as Moulton's (1962) study on voice contrasts in German and English, supports this claim. The MDH predicts the direction of difficulty, which the Contrastive Analysis Hypothesis (CAH) fails to account for.

Brown (1998) argues that acquiring L2 phonetic contrast is successful if the relevant feature distinguishing the segment is already available in learner's L1. He claims that the absence of phonological feature in learner's L1 makes it difficult for him/ her to acquire L2 segments. Brown's study on Japanese speakers of English provides evidence for his assumption. In this study,

he showed that the absence of the coronal feature in Japanese hindered the perception of the /l, r/ contrast, while the presence of phonological features like [*continuant] and [*voice] in Japanese facilitate learners 'perception of other contrasts.

It could be concluded that the current study seems to well-suited to test whether the availability or lack of L1 phonetic features (i.e. voicing) will make it easier or more difficult for Libyan speakers to pronounce English plosive sounds /p/ and /b/.

2.4.3 The Speech Learning Model (SLM)

The Speech Learning Model (SLM), which is proposed by Flege (1995), suggests that producing L2 sounds depends on the degree of differences between L1 and L2 sounds. The model claims that similar sounds are difficult to acquire and produce because they are perceived as equivalent to L1 sounds, whereas 'new' sounds are easier to produce as they are distinct from any L1 category. Equivalence classification of L1 and L2 can block the establishment of phonetic categories for L2 sounds, due to L2 learners' inability to detect phonetic differences (Flege, 1987, 1995).

The SLM aims to provide an explanation of how experienced non-native speakers acquire L2 and change their segmental production overtime. It focuses on changes in phonological representations as L2 learners progress. The SLM assumes L1 and L2 phonetic subsystems are part of a merged system, interacting in the same phonological space (Bohn & Flege, 1995). It also claims that the ability to form new sound categories remains intact throughout life, but decreases with age, allowing L2 sound acquisition through mechanisms used in L1 acquisition.
Henceforth, it can be hypothesized that LA students will have no difficulty in producing English /p/ in a native-like manner because it does not exist in their L1 vocalic system.

2.5 A Review of the Previous Studies Conducted in Arabic Contexts

Flege and Port (1981) examined the production of the voiceless stops (/p/, /t/, and /k/) among Saudi Arabic speakers learning English in the United States. The participants were divided into two groups of six: the first group had lived in the U.S. for less than one year, while members of the second group had resided there for more than a year, with an average stay of 39 months. To provide a basis for comparison, a control group of native American English speakers was also included.
The three groups' productions of the target voiceless stops in word-initial position were recorded within a carrier phrase and analyzed using Praat. Results indicated no significant differences between the two groups of Arabic speakers, including those with less than one year of residence in the U.S. However, a noticeable contrast emerged between the Arabic learners and the native American English speakers.

Another study conducted by Garib (2014) which examined how Libyan Arabic speakers distinguish in their production of English /p/ and /b/. He divided the participants who were 19 into two groups; fifteen speakers of Libyan Arabic and four American English adults. Recorded production of voiceless stops consonants were inserted in minimal pairs and sentences for both groups. In his analysis, he used the Microsoft program Praat. The results revealed that the majority of Libyan Arabic students have successfully distinguished between voiced /b/ and voiceless /p/.

Another study conducted by Olson (2017) who examined the VOT of stops consonants /b/, /p/, /t/, /d/, /k/, /g/, pronounced by Arabic speakers compared to the English speakers. There were two groups of subjects; seven native English speakers and seven native Arabic speakers (six from Saudi Arabia and one from Iraq). The English participants were 1 male 6 females their average age was between 20 and 50 and Arabic speakers were six males and one female all of whose age were in the range of 21- 26.The results show that Arabic speakers tended to have shorter VOTS than English speakers for most stops as Arabic voiced consonants were negative.
Tamim (2017) examined the voicing contrast of the Palestinian dialect stops by measuring the VOT values as produced by the participants using Praat. Eight Palestinian speakers participated in the study (four males, and four females), who speak English as a second language. The results showed that the Palestinian Arabic dialect has short positive VOT values for voiceless stops and negative VOT values for voiced stops.

Abdelaal (2017) examined the VOT values of the English stops generated from 10 Arabic students. His study aimed to provide an acoustic analysis of the English stops produced by Arab learners. The findings showed that the VOT values of some speakers were similar to the native speakers of English. The findings also revealed that the participants were able to distinguish between /p/ and /b/ in term of both aspiration and voicing.

3. Methodology

3.1. Participants

The population of the current study consisted of five students registered in the Department of English at Sirte University. A questionnaire was used to gather general information about the LA participants and their language background. The information received from the participants is summarized in Table 3.1 below

Table 3.1 Details of the Libyan Participants

Student	Gender	Age	No. of years studying English
Student 1	M	24	Seven Years
Student 2	F	20	Five Years
Student 3	F	23	Eight years
Student 4	M	23	Five years
Student 5	F	24	Eight years

3.2 Instrumentation

The research is mainly quantitative. Data were collected through experiments in which all students recorded a list of English and LA words. Students were also given a questionnaire designed to gather background information on the participants, summarized in Table 3.1 above.

3.3 Recording Materials

3.3.1 English items

The English items involved ten words containing the target sounds in an initial position, as shown in Table 3.2 below. The two investigated consonants were placed in a monosyllabic (CVC) context. This structure helps control the surrounding phonetic environment and determine the accurate acoustic values of the sounds being studied (Garib, 2014). The target sounds were elicited in two formats: as minimal pairs and embedded in a fixed carrier phrase “say _____again”. Appendices A and B show the guidelines and the word list as they were presented to the LA students. Furthermore, the words and sentences containing the target sounds were recorded twice by each of the five students. In total, there were 200 tokens targeted for analysis (i.e. 5 students * 5 minimal pairs (10 words recorded as isolated items and in a carrier sentence) * 2 repetitions).

Table 3.2 English target items

/b/	/p/
But	Put
Bark	Park
Bar	Par
Base	Pace
Bat	Pat

3.3.2 Libyan Arabic item

In addition to producing the English pair words and sentences, the LA students were asked to record words containing the LA consonant /b/ to compare their production of English consonants with their L1. The materials included sets of words containing the Libyan Arabic voiced consonant /b/, as illustrated in Table 3.3 below. The five words with the target sound were presented in a monosyllabic context taking the form of CVC and CVCC. As with the English items, the target sounds were elicited in two formats: as isolated words and embedded in an LA carrier phrase (“say _____again”; see Appendices C and D). The LA students were asked to repeat each isolated word and each sentence twice. Therefore, 100 tokens

were targeted for analysis (i.e. 5 students *10 items *2 repetitions).

Table 3.3 Libyan Arabic items

Target Items in LA	Meaning in English	Phonetic Transcription
باب	Door	[bæb]
بيت	House	[beɪt]
بركه	Pond	[bɪrkh]
بقر	Cows	[bʌgr]
بات	Slept over	[bat]

3.4 Data Collection Procedures

Participants were presented with the English and the LA items on six A4-sized sheets and were asked to read them using a normal loudness and speed. They were also given an opportunity to familiarise themselves with word list before recording to ensure that the target words were produced correctly. The English word items were typed in English orthography, whereas Arabic word items were written in the Arabic script. The LA participants were asked to read all materials in their dialect and they managed to do so with no reported difficulty.

The pairs and sentences were recorded using a Panasonic microphone connected to an HP laptop. Recordings were also saved as wav files. The recordings took place at English Department, Sirte University in a quiet room. Each recording session lasted approximately forty five minutes.

3.5 Analysis of Data and Measurement

The study employs an acoustic analysis using the phonetic software Praat (Boersma & Weenink, 2014) in order to extract the measurements (in seconds) for the target consonant stops /p/and /b/. Following the method Abramson & Lisker (1964), the VOT for /b/ was measured by selecting the onset of voicing before the burst until the realease of the burst, as illustrated in Figure 2.2 above. The VOT for /p/ was measured from the release of the burst until the beginning of the following vowel, as illustrated in Figure 2.3 above.

The Windows computer package 'SPSS' was also used to analyze whether the LA participants were able to distinguish between the two target consonants in their productions. In addition, SPSS was employed to determine if the participants' L1 influenced their productions by compared their L2 productions of voiced /b/ and voiceless /p/ with their production of the closest LA equivalent, the consonant /b/.

4. Results and Discussion

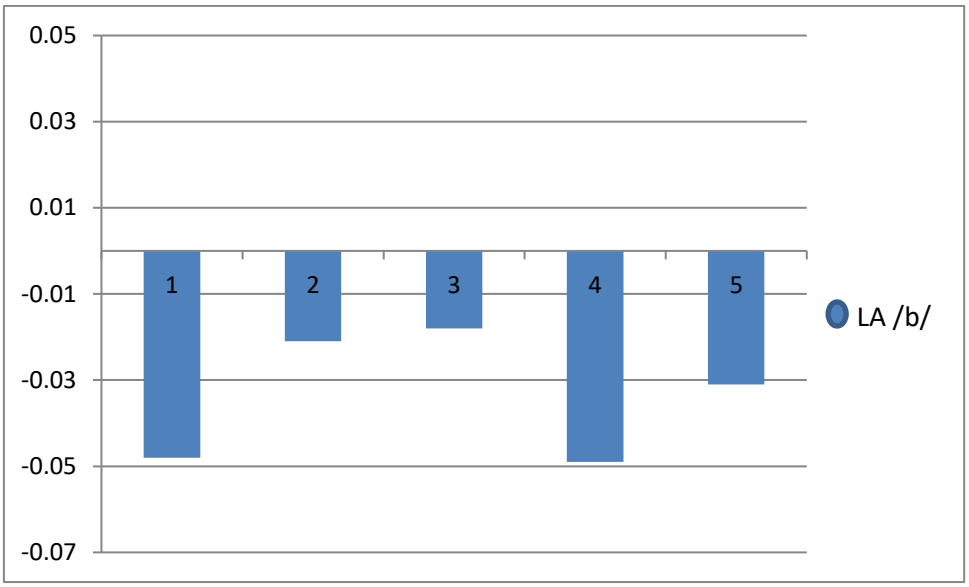
4.1 The VOT values of Libyan Arabic /b/

In this section, the VOT values and standard deviation (SD) of the LA stop consonant /b/are derived across all the LA participants. Table 4.1 displays the mean VOT values and the standard deviation for the LA stop as produced by the students. The phonologically voiced consonant /b/ exhibited negative VOT for all participants, showing that this sound is pronounced with voicing during the stop closure. As seen in Graph 4.1 below, lonely minor variations were found among the subjects. The data confirmed that all participants produce LA with negative VOT values. This finding is in line with those of Buali (2010) for Saudi Arabic and Kattab (2000) for Lebanese, both of whom reported that /b/ has a negative VOT value in their production experiments.

Table 4.1 the VOT values and SD of LA /b/

Student 1	Student 2	Student 3	Student 4	Student 5	Mean	value of standard deviation
-48ms	**-21ms**	**-18ms**	**-49ms**	**-31ms**	**-33ms**	**0.013**

Graph 4.1 the VOT values of the LA /b/



4.2 The VOT values of the L2 Sounds as produced by LA students

4.2.1 The VOT values of the English /b/:

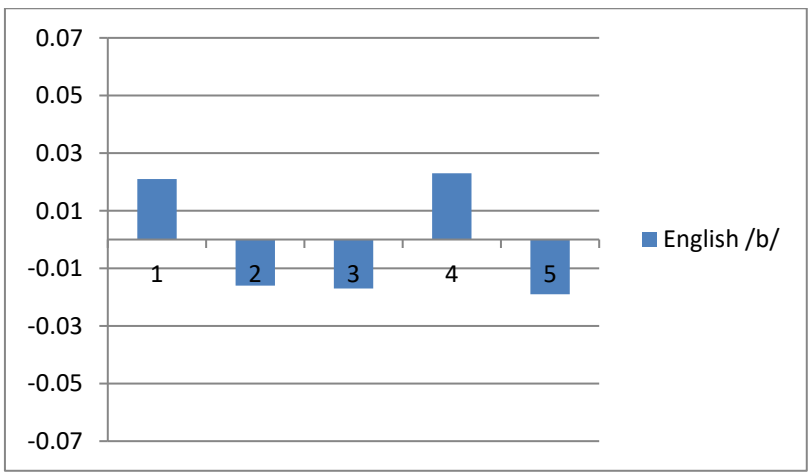
The VOT value of the English voiced stop /b/ is 16ms. In the literature, this sound has a negative VOT value. Table 4.2 below shows that three participants out of five produce this sound with negative value which corresponds with Abramson and Lisker's (1964) findings. However, two participants produce this sound with positive VOT value which means they produce it with close values of the English /p/ (i.e. with positive VOT)

Table 4.2 the VOT Values and Standard deviation of the English stop /b/

Student 1	Student 2	Student 3	Student 4	Student 5	Mean	value of Standard deviation
21ms	**-16ms**	**-17ms**	**23**	**-19ms**	**-16ms**	**0.019**

In the graph 4.2 below, three students (S2, S3, and S5) had a negative VOT of -16ms, -17ms and -19ms, respectively. The mean value was 16ms. This is on the contrary to Khattab's (2000) study who reported that the VOT values for the /b/ sound, as produced by young monolingual Lebanese speakers, ranges from (-30ms –57ms).

Graph 4.2 the VOT Values of the English /b/



4.2.2 VOT of the English /p/:

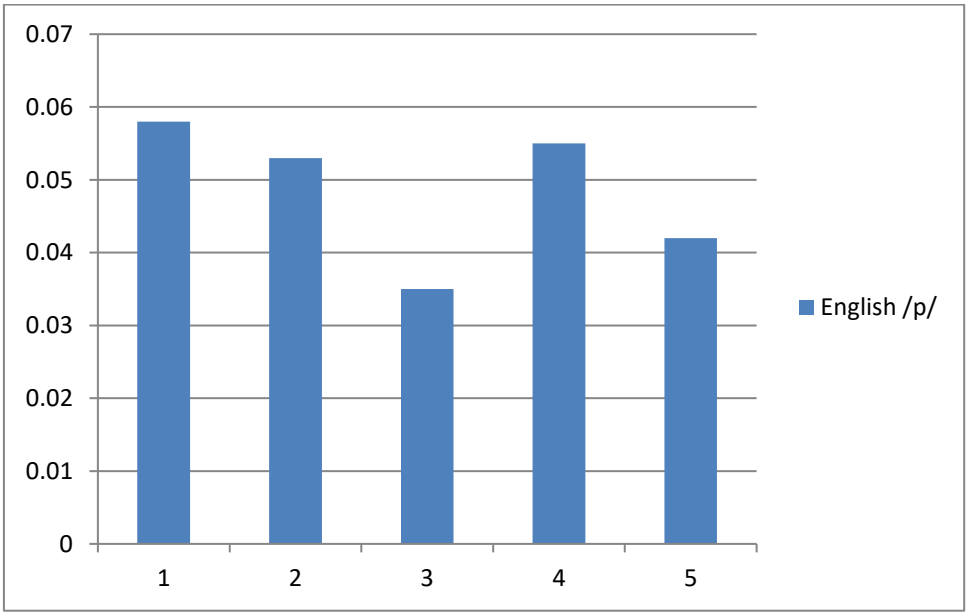
Table 4.3 and Graph 4.3 below show both the mean values of the VOT of English stop /p/ which was 48ms and the standard deviation which was 08ms. This is lower than the value found by Lisker and Abramson's (1964**).** The VOT values of the subjects (S3, S5) were found to be below (45ms) and they had the lowest VOT value among the participants; 35ms, 42ms, respectively.

The VOT values of /p/ (i.e.48ms) is close with Ladefoged and Cho's (1999) study who reported that the VOT values of the aspirated sound /p/is about 50 ms with American native speakers. The study showed that Libyan learners have no problem in pronouncing this sound. In other words, the findings of the current study showed that LA participants were able to produce the English voiceless sound /p/ in a native-like manner which is in contradiction of the widespread assumption that most Arab learners produce low or negative VOT values for the voiceless sound /p/.

Table 4.3 the VOT Values and Standard deviation of the English stop /p/

Student1	Student2	Student3	Student4	Student5	Mean	value of Standard Deviation
58ms	**53ms**	**35ms**	**55ms**	**42ms**	**48ms**	**0.008**

Graph 4.3 the VOT values of the English voiceless stop /p/



4.3 Combined LA (L1) production and L2 English production Results

In this section, the average VOTs for the English stops /p/ and /b/ as produced by LA participants compared to their productions of LA stop sound /b/ are combined in order to find out if there is an interference of participants' L1 on their productions of English /p/ and /b/. Table 4.4 and Graph 4.4 provide these results. For LA students, /p/ had a positive VOT value of about 48sms, while /b/ had a negative VOT value of about -16ms. On average, LA students exhibit a difference of about 70ms of the VOT values between English /p/ and /b/ which was slightly higher of the difference found in Garib (2014). As for LA /b/, the participants had a negative VOT of -33ms which was higher compared to their production of its English equivalent /b/ (i.e. -16ms).

Table 4.4 L2 English /p/ and /b/ productions combined with L1 (LA) /b/ production

	Average	SD
L2 /p/	48ms	0.008
L2 /b/	-16ms	0.019
L1 /b/	-33ms	0.013

Graph 4.4 L2 English production of /b/ and /p/ compared to LA (L1) production

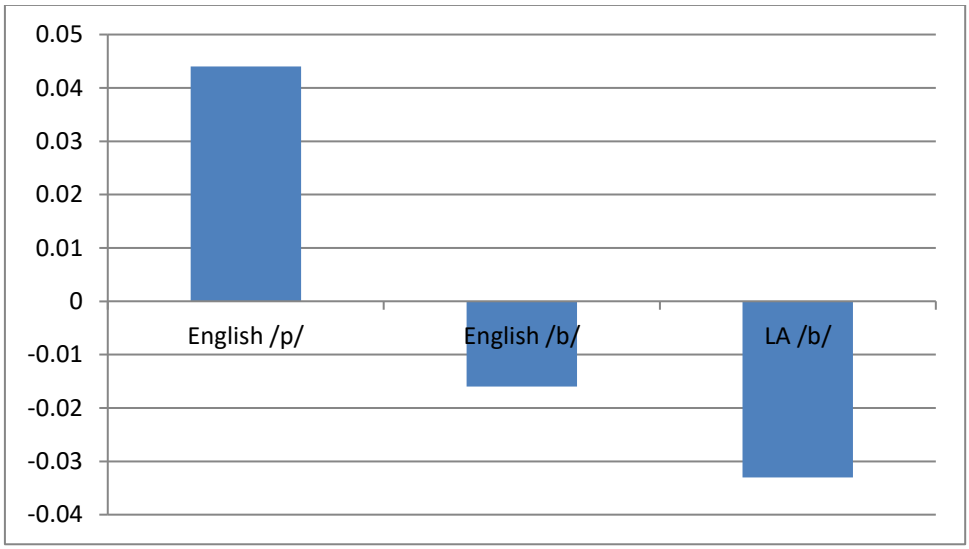


Table 4.5 below shows the statistical results. The P value of the sample's productions of L2 /p/ and L2 /b/ is extremely low (p=0.0002), suggesting strong evidence that the study sample manage to successfully distinguish between the two sounds in their production. Regarding the effect of their L1 /b/ production on L2 /b/ production, the paired t – test results ((t7) =-1.65) revealed no significant evidence of the L1 interference in their L2 production.

Table 4.5 paired t-test results: L2 /p/, L2/b/, and L2 /b/, LA /b/

Effect	Paired t -test	p- Value
L2 /p/ and L2 /p/	t(4)=13.42	p=0.0002
L2 /b/ and L1 /b/	t(7)=1.65	p=0.143

4.4 Discussion

This study attempts to identify the Voice Onset Time (VOT) of English stop consonants pronounced by Libyan Arabic students. It was conducted primarily to determine whether LA learners are able to distinguish between English stops /p/ and /b/. Bearing in mind the second research question, the findings showed that the majority of the LA students made a significant distinction in their production of the target sounds. This result is akin to previous studies (e.g Garib, 2014; Abdelaal, 2017), which reported that their participants successfully differentiated between the two sounds in their production. Moreover, the findings of this study indicated that the distinction between voiceless/p/ and voiced /b/, as produced by LA students, is large on average, as shown in Graph 4.4.This indicates that some students have successfully managed to achieve a clear distinction in the pronunciation of the English /p/ and /b/.

It should also be noted that the low overlap and greater stability of the VOT values of this sound suggest that LA students are developing category formation. In other words, it appears that LA participants are beginning to form separate phonetic categories, which is in line with the predictions of the Speech Learning Model (SLM). SLM posits that gradual exposure to L2 enables learners to differentiate L2 sounds from L1 counterparts (Flege, 1995). Al-Damen et al. (2025) reported in their study that intermediate learners were able to produce more native-like patterns, proposing early stages of L2 category formation. According to them, this success in attaining native-like production is attributed to increased L2 experience and exposure. This finding appears to align with participants' background of the current

study, as most of them had been exposed to English for several years.

In order to further confirm this result, a paired-sample t-test was carried out to compare the VOT values of both sounds productions. The findings was (p=0.0002), which is statistically significant (*p-value is significant at 0.05.) This shows that the LA students were able to distinguish between /p/ and /b/ in their production.

The acoustic analysis of English consonant stops pronounced by the LA students revealed some remarkable insights. All participants produced the English stop /p/ with a positive value. The mean VOT value of this sound was 48 ms which is remarkably close to the values found in Ladefoged and Cho (1999) (50ms) and Flege and Port (1981) (46ms) for native English speakers. Furthermore, these results are consistent with Khattab's (2000) study, which reported that the VOT values range from 40ms to 90 ms among bilingual learners. This study's results contradict the widespread assumption that most Arab learners tend to produce /p/ with low VOT values

Interestingly, it appears that the LA learners in this study, particularly two participants, had difficulty producing the English voiced stop /b/ rather than its voiceless counterpart /p/. This finding provides further support for the Speech Learning Model (SLM) proposed by Flege (1995). In his model, Flege argues that L2 speakers have difficulty in acquiring and producing sounds that have equivalents in their L1, which in this case is /b/. In this study, two of the five participants failed to produce the English voiced stop /b/ in a native like-manner (i.e. with negative VOT). On the contrary, they produced it with positive values (i.e. values similar to those of its voiceless counterpart /p/). Flege (1987, 1995) asserted that sounds that are phonetically similar to those in the L1 are difficult to acquire and produce because a speaker perceives them as equivalent. On the other hand, sounds that have no counterparts in the L1 are easier to produce because they are significantly different from any L1 category. In this regard, it is could be stated that some LA participants failed to establish phonetic classifications for L2 due to 'equivalence classification', which might explain why they failedto perceive the phonetic distinctions between L1 and L2 sounds.

Abdelaal (2017:11) further stated that most Arab learners might have problems pronouncing this sound because of the teaching methods applied in the Arab world. He argued that Arab learners might fail to produce this sound successfully and this may be attributed to the fact that some teachers instruct their students to produce the /b/sound either too much or too little aspiration.

The present investigation also shows that LA has negative VOT values for its only voiced bilabial /b/, a finding akin to the averages reported for a number of other Arabic dialects, such as Buali (2010) for Saudi Arabic, Kattab (2002) for Lebanese, and Adam (2012) for Palestinian. Although the mean value of the LA /b/ was slightly lower than that found for Saudi Arabic participants, a difference which could be attributed to dialectal variation. In other words, differences between Arabic dialects may affect the VOT values (Adam, 2012).

The participants' pronunciation of the English /b/ and LA /b/ showed greater variability; the highest standard derivation of English /b/ was 19ms, compared to 13 ms for LA /b/. This suggests that the participants exhibited more inconsistency in their pronunciation of English /b/. This is not surprising, as students vary in their level of English pronunciation.

A paired-samples t-test was conducted to compare the VOT values of the English voiced /b/ and the LA voiced /b/. This test is aimed to determine whether the participants' L1 sound influenced their pronunciation of the equivalent L2 sound. The result was not statistically significant (p=0.143) which indicates that there is was no effect of the students' L1 on their pronunciation of the English voiced stop /b/ because the VOT values of English //b/and LA /b/ are found to be very relatively distant in the spectrogram wave. This, in turn, provides an answer of the third research question which was proposed to find out if there is an effect of the L1 on students' productions of English stops. The results showed that there was not a significant L1 influence.

5. Conclusion

The current study aimed to investigate the Voice Onset Time (VOT) values of English stop consonants pronounced by Libyan Arabic students in the Department of English at Sirte University.

The primary objective was to determine whether Libyan Arabic (LA) speakers could distinguish between the English voiced stop /b/ and voiceless stop /p/ in their production. The results indicated that the LA participants successfully differentiated between the two sounds. However, the findings also revealed that LA speakers experienced difficulties with the voiced stop /b/, rather than its voiceless counterpart /p/. Furthermore, the study revealed that the participants' L1 had not a significant influence on their second language L2 productions.

5.1 Pedagogical Implications

The current study offers valuable recommendations for English pronunciation teachers in the Libyan context. To minimize pronunciation difficulties, teachers should consider the challenges students may face when pronouncing English sounds and employ various strategies to address them. Teachers can enhance learners' pronunciation of voiced and voiceless stops by incorporating articulatory explanations, perceptual training and visual feedback into their instruction. In addition, integrating activities like delayed imitation, structured repetition tasks, and spectrogram analysis into pronunciation classes can help learners develop an acoustic awareness of the differences between L1 and English sounds inventories, ultimately enhancing their pronunciation skills.

5.2 Recommendations for Further Research

It is strongly recommended that future research be conducted with more participants from different age groups and of both genders to increase generalizability and findings validity. Further studies are also advised to investigate students' language experiences as a factor in producing L2 sounds. One limitation with this study is the lack of data from native English speakers, which would have allowed for a clear and valuable comparison between their productions of the target sounds and those of the LA productions.

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