The acquisition of VOT of [b d g] in the context of Saudi Learners of English

by

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Abstract:

There wereseveral research studies conducted on the VOT of voiceless stops of L2 English but little has been devoted to the acquisition of voiced stops of English by native Arabic speakers in particularadult Saudi learners. This study explored how stops were produced within the context of certain vowels; the focus was put on native Arabic speakers in general then on Saudi learners of English whose VOT was compared with English native speakers. In this respect, 20 Saudi learners of English and 20 monolinguals (10 English and 10 Arabic monolinguals) had been selected to take part in this study. The results showed that the vowel following a stop did not have any effect on the learning of VOTunlike what was predicted in Johnson and Babel (2010). Although the learning appears less rudimentary as only two participants have learnt [b] but none of them had learnt [g] or [d], there were signs of learning among the participants. The path of learning showed that English coronal stops appeared to be the most difficult for the learners.

Key words: voiced stops, VOT, pre-voicing, acquisition, L2 phonology

اكتساب المتعلمين السعوديين لوقت بدء الصوت (VOT) في اللغةالإنجليزية

هناك العديد من الدراسات التي تطرقت إلى خاصية وقت بدء الصوت (VOT) **في الحروف الوقفية المهموسة (الغير صائتة)** (Voiceless stops) **ولكن توجد ندرة في الدراسات على إكتساب الأصوات المجهورة (الصائتة)** (Voiced) **من قبل متعلمي اللغة الإنجليزية العرب وخصوصاً المتعلمين السعوديين. هذه الدراسة تبحث كيف يتم نطق تلك الأصوات وذلك في سياق مجموعة من حروف العلة** (Vowels) **التي تليها في النطق مباشرة. تمت مقارنة آداء نطق الأصوات للمتحدثين الإنجليز مع آداء نطق الأصوات للمتعلمين. شارك في الدراسة ٢٠ متعلم للغة الإنجليزية و١٠ متحدثين أصليين انجليز، و ١٠ متحدثين أصليين عرب. نتائج الدراسة أشارت إلى أن حرف العلة الذي يلي وقت بدء الصوت مباشرة، ليس له أي دور في عملية إكتساب تلك الأصوات، خلاف ما وجدته**

بعض الدراسات من إن هناك دور كبير لحرف العلة في تحديد مدة وقت بدء الصوت. بالرغم من محدودية ما تم إكتسابه من قبل المتعلمين، إلا أن هناك مؤشرات تدل على أن التعليم قائم ومستمر ولكن الأصوات الوسطية (coronal stops) تبدو أنها هي الأكثر صعوبة.

1. Introduction

It is commonin the field of phonetics, phonology and second language acquisition to analyze stop soundssuch as [t] or [g]by measuring their voicing onset time(VOT). VOT is detected in the acoustic signal of a sound, i.e. the sound waves which travel through the air when it is uttered. From that signal it is possible to measure the time between the burst/plosion of stops (e.g. when the lips open to say the [b] in *be*),and the onset of voicing, i.e. vocal cord vibration, for the following vowel (Lisker and Abramson, 1964). If the voicing of the following vowel initiates more than 30 ms after the burst (VOT > +30ms), the duration is called 'long lag' and if the duration between the burst of the stop and the onset of the following vowel is shorter than 30 ms it is called 'short lag' (ibid). A third type of stop is called 'pre-voiced'(Lisker and Abramson 1964),which is produced if the vocal folds start vibrating before the burst. The duration of pre-voiced stops is in that casemeasured in negative VOT values.

Someof the languages of the world only have stops withshort and long lag VOT but there are many languages which have stops with negative VOT (pre-voicing). Arabic is a language which has pre-voiced stops such as [d, g]as well as stops with positive VOT such as [t, k], whileEnglish only has short lag stops like [d, g]and long lag stopslike [t, k][1], all with positive VOT.

With respect to stops, the languages of the world are often categorisedon the basis of their aspiration as well as voicing contrasts, yielding 'voicing' and 'aspiration' languages (Simon, 2011). According to this classification, Arabic is a voicing

[1] **We overlook in this account the fact that in RP English there is a variant of /k/ etc. which occurs in restricted environments with short lag VOT, and unaspirated (as in *skin*).**

language and English is an aspiration language. Thismeans that,in Arabic, stops like [g] and[k]are typically discriminated by the phonetic feature [± voiced][2], i.e. negative versus positive VOT. In English,however, these stops all have positive VOT and are instead discriminated by the feature [± spread glottis] (Kager et al., 2007, Honeybone, 2005), i.e. presence of aspiration following the burst with long lag stops such as [k], versus absence of it with short lag [g] etc.

As a result of the above state of affairs in Arabic and English, the VOT difference between the languages is more marked for the stops [b d g] than for[t k][3]. While in both languages stops like [k] have positive and usually long lag VOT, with aspiration, stops such as [g], though not aspirated in either language, have negative VOT in Arabic but positive short lag VOT in English. Hence the latter might be argued to present more of a VOT learning challenge (Table 1).

Table 1. Summary of relevant differences between English and Arabic stops.

Language	English	Arabic	English	Arabic
Stops	[p t k]	[t k]	[b d g]	[b d g]
Vocal cord vibration during stop	n	n	n	y
Aspiration after burst of stop	y	y	n	n
VOT polarity	+	+	+	-
VOT type	High Long lag	Low Long lag	Short lag	Pre-voiced
Phonological categorisation	Voiceless		Voiced	

[2] Arabic also has emphatic stops which are different from non-emphatic stops but the current discussion is only focused on the non-emphatic stops of Arabic, since they are closer to English stops.

[3] /p/ is missing in Saudi Arabic, which makes for a striking difference from English. However, the present paper is only concerned with /b d g/.

A review of the existing literature shows that there is a considerablebody of studieson the acquisition of English stop consonants (Cho &Ladefoged, 1999;Yeni-Komshian et al, 1977;Flege& Port, 1981, Mitleb, 2009), including a few concerning Arabic learners (Alghamdi, 1990;Khattab 2002). There has however been less research on the acquisition by Arabic learners of the VOT ofthe stops of English, particularly those such as [b d g]where inter-lingual VOT differences are greatest. The current study is an attempt to fill this gap. It aims to analyze the acquisition of VOT of English [b d g]by a group of adult Saudi learners of English. It also studies the influence of the immediately following vowel on the acquisition of VOT of the preceding stop because there are many studies which have found influence of the vowel on the acquisition of consonants of L2 (Johnson and Babel, 2010).

Section 2 of the paper now describes the objectives of the study. Research methodology will be explained in detail in section 3 and the resultspresented in section 4. Section 5 is discussion, followed by the conclusion.

2. Objectives of the Study

The current study has two main objectives:

1. **To study the acquisition of the VOT of English [b d g]by adult Saudi learners of English.**
2. **To study the influence of the immediately following vowel on the acquisition of VOT of the preceding stops.**

The above two objectives will be achieved by measuringthe VOTof stops produced by advanced adult Saudi learners of English at their current stage of acquisition, and comparing it with that of monolingual speakers of each language. We are particularly interested to know if the Saudi learners transfer their L1 VOT (pre-voicing) or have developed a separate category for L2 stops. If they developed a range of VOT for English [b d g] different from that inL1, then what is the range of VOT values of the newly established category? Is it like that of native speakers of English or different from them?

3. Methodology

The details of the participants and research instruments used for the data collection and analysis are described in the following sections.

3.1. Participants

20 male adult Saudi learners of English living in the UK,together with 10 male Arabic native speakers from Saudi Arabia and 10 male native speakers of English from England,were selected for the study. The Saudi and English native speakers were monolinguals. The Saudi learners of English and the native speakers of English were selected from the same town in England with the intention that the VOT of the learners shouldbe judged against the VOT ranges of the kind of native speakers to whom they had been predominantly exposed during their stay in the UK. Similarly, the Arabic monolinguals were selected from the same area of Saudi Arabia which the learners came from. Thus, the Arabic monolinguals and the learners spoke as L1 the same dialect of Saudi Arabic.

As Tables 2 and 3 show, learners and monolinguals had a similar mean age. Learners had been in the UK for between one and eight years, so were judged to be advanced learners.

Table 2. Descriptive statistics of the learners

	N	Minimum	Maximum	Mean	Std. Deviation
Stay in the UK in months	20	12.00	96.00	40.75	19.99
Speaking English (hours p/day)	20	1.00	8.00	3.25	1.86
Listening to English (hours p/day)	20	1.00	8.00	4.10	2.29
Age in years	20	22.00	37.00	29.50	3.35

Table 3. Age of the monolinguals

Group	N	Minimum	Maximum	Mean	Std. Deviation
English	10	25.00	45.00	30.90	5.95
Arabic	10	19.00	45.00	29.50	8.11

3.2. Procedure

Written consent was obtained from the participants for the use of the data in research, promising that their identities would remain confidential. A background questionnaire was then used to elicit the participant information about age and length of UK residence reported in 3.1.

A word reading aloud task wasnextadministeredto the participants to elicitthe spoken material from which VOTs could be measured. The participants were asked to read a written list of 27 word stimuli in natural speech. Learners and English monolinguals read the English list, Arabic monolinguals read the Arabic list. Eachlist (Appendix 1) containednine different words, representing the three voiced stops followed by three long vowels articulated in the extremities of the oral cavity. Similar long vowels are found in both English and Arabic: high front unrounded [i:], high back rounded [u:], and low unrounded [ɑ:]. Each of the 9 words was written three times in the list in a random order. In this way, a total of 27 (3 consonants *3 vowels* 3 repetitions)utterances of target words of English were recorded.All the recordings were made using an M-Audio Track II digital recorder.

The dialect of Arabic that the learners and the Arabic monolingual participants speak has [b d g] in its consonant inventory. In writing, the letter used for [g] is the same as that used for the modern standard Arabic [q]:'ق'. The monolingual participants were therefore asked to produce the words in the colloquial style, i.e. using [g] in the way they speak normally, not in the style of modern standard or classical Arabic. The recordings of the Arabic monolinguals were listened to by 3 native

speakers from the same area who confirmed that the pronunciation of the words followed the informal colloquial dialect, not standard or classical Arabic.

3.3 Data Analysis

The recordings were analysed using Praat(Boersma and Weenink, 2012), which assisted in theidentification of the instant of the burst, and the VOT start point, for the initial stop in each utterance. Based on this information, 1080 VOTs (40 * 27) were calculated and entered into SPSS.

In order to assess the reliability of the learner VOT data, Cronbach's alpha was calculated for each stop (across the 9 repetitionsof each per learner). The reliability level was above 80% (Table 4), which is excellentgiven that normally a minimum cut off point of 70% reliability or a Cronbach's alpha value of 0.70 is considered desirable for exploratory research (Larson-Hall, 2010).

Table 4. Internal reliability of the learners' data

Sound	Cronbach's alpha
[b]	0.847
[d]	0.885
[g]	0.804

4. Results

First of all, the effect of the following vowel on the VOT of the preceding consonant was tested usingANOVA. The overall effect of the vowel was not significant (F=2.28, p=.196). Two-way and three-way interaction effects of the vowel with the place of articulation and participant grouping were also non-significant (p>.1). After this discovery of lack of anyeffect of following vowels on stopVOT, the VOT values were for further analyses averaged for each stop across all three vowels.

The learners produced some of the stop utterances pre-voiced and some with short lag VOT. Following the standard method (Lisker and Abramson, 1964), we calculated the zero or positive VOT values and the negative VOT values of the stops separately (Tables 5 and 6).

Table 5. VOT of English stops produced by the learners with pre-voicing

Sounds	N	Minimum	Maximum	Mean ms	Std. Deviation
[b]	18	-166.75	-33.00	-88.35	35.85
[d]	19	-153.78	-48.89	-100.21	28.25
[g]	19	-125.33	-45.71	-81.94	25.04

Table 6. VOT of English stops produced by the learners without pre-voicing

Sounds	N	Minimum	Maximum	Mean ms	Std. Deviation
[b]	15	.00	40.50	11.84	11.24
[d]	5	20.00	27.00	23.00	2.92
[g]	14	.00	49.00	24.01	19.31

As Table 5 shows, almost all the learners produced all the English consonants [b d g] with pre-voicing on some occasions. On the other hand, Table 6 shows that somewhat fewer produced some tokens withzero or positive VOT, of which some utterances had nativelike short lag VOT. In fact only 5 participants produced some of the repetitions of English [d] without pre-voicing, while 15 learners produced some of the labial stops without pre-voicing and 14 of them produced some of the velar stops without pre-voicing. We will consider further in the Discussion the fact that some utterances were in the long lag range (>30).

Tables 7 and 8 confirm, as we expected (Table 1), that all the monolingual Arabic speaker utterances of [b d g]were pre-voiced while none of the monolingual English speaker utterances were. The learner results for utterance of English [b d g] with zero or

positive VOT are on average descriptively somewhat lower than the mean VOTs of monolingual English speakers.There is however no significant difference between the VOT of the English monolingualsand the VOT of the learners who produced these stops with short lag VOTeither for [b] (Mann-Whitney Z= -1.112, p=.27) or [g] (Z= -.235, p=.81). The findings for [d] cannot be compared in this way because the number of learners who produced [d] without pre-voicing was too low (5) for comparison.

By contrast, the learner results for prevoicing of English [b d g] are in fact descriptively more extremely prevoiced (with greater average negative VOT) than those of monolingual Arabic speakers uttering Arabic words. The pre-voicing in the production of English stops by the learners was also compared with the pre-voicing of the Saudi monolinguals in Arabic stops, using the Mann-Whitney test. The results (Appendix 2) however show that there was no significant difference between the two groups (p>.05).

Table 7. VOT of Arabic monolinguals

Sounds	N	Minimum	Maximum	Mean ms	Std. Deviation
[b]	10	-102.22	-44.56	-68.40	17.24
[d]	10	-107.89	-41.89	-77.42	24.05
[g]	10	-96.22	-35.33	-71.28	21.20

Table 8. VOT of native speakers of English

Sounds	N	Minimum	Maximum	Mean ms	Std. Deviation
[b]	10	8.11	22.11	15.28	4.27
[d]	10	16.33	34.11	25.26	6.01
[g]	10	25.78	41.44	30.89	4.70

Furthermore, some of the learners in fact produced all three repetitions of a particulartarget soundfollowed by a specific vowel of English without pre-voicing(Table 9).

Table 9. Number of learners who produced English stops without pre-voicing in all three repetitions with a specific vowel following

Sounds	[i]	[a]	[u]
[b]	7	5	3
[d]	1	0	0
[g]	2	3	1

It is clear that on this measure, regardless of following vowel,it was English initial [b] that the L2 learners produced most often without pre-voicing. 7 participants produced [b] in 'beep', 5 in the word 'bar' and 3 in the word 'boot' without pre-voicing in all three repetitions. However, only two of them produced [b] without pre-voicingin all 9 trials (3 repetitions*3vowels). Most of the participants produced a specific sound with more nativelike VOTin some of the stimuli but less soin others.

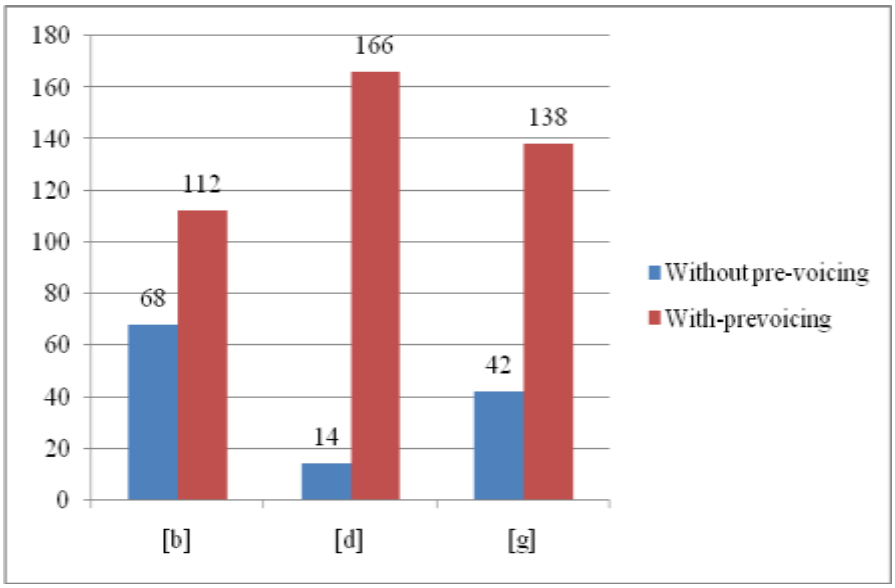
We also counted the total number of trials which were produced without pre-voicing (Table 10).

Table 10. Number of times a sound was produced without pre-voicing by the learners

Sounds	Total (180)	%
[b]	68	38
[d]	14	8
[g]	42	23

There were a total of 180 repetitions (20 participants*3 vowels*3 repetitions) for each of the stops. English [b] was produced without pre-voicing 68 times, [d] 14 times and [g] 42 times as also displayed in Figure 1. As in the analysis displayed in Table 9, once again [b]evidences more non-negative VOTs followed by [g] with [d]showing the most Arabic-like VOT.

Figure 1. The number of times a stop was produced by learners with or without pre-voicing



5. Discussion

One of the study's objectives was to identify the influence of vowels on acquisition of VOT. The results of the ANOVAhowever do not confirm any influence of the following vowel on VOT of [b d g]. These findings are therefore different from Schmidt (1996),Johnson & Babel (2010) and Iverson et al (2008) who found a strong effect of the vowel on the acquisition of L2 sounds.

The mainobjective of the current research was,however,to study the degree of success in the acquisition of VOT of English voiced stops byadvanced adult Saudi learners of English. The VOT results of the voiced stops produced by monolinguals confirmthat Arabic has exclusively pre-voiced stops(see Table 1), while English voiced stops are predominantlyproduced with short lag VOT (with some instances of long lag for [d g], see Table 8). Hence learners' acquisition success is to be seen in how far they manage to shift categorically from the negative to the positive VOT range for English [b d g]. The results show that although quite a number of learners occasionally produced utterances of the English stops

without pre-voicing, most of the learners could not categorically shift their VOT out of the negative VOT range. Only 2 of them produced all repetitions of [b] in the nativelike range, with zero or positive VOT (Table 5).

On the other hand, table 9 shows that rather morelearners produced allthree repetitions of a particular stopfollowed by a particular vowel with non-negative VOT, and Table 10 shows that more than a third of learner utterances of [b] were not pre-voiced. The non-parametric tests also confirm that the average VOT valuesof those stops which were produced with zero or positive VOT werenot significantly different from the VOT values of the native speakers of English. Similarly, the pre-voiced VOTs of the learners when utteringstops of English werenot significantly different from the VOTs of the Arabic monolinguals.

This allshows that the participants are in the process of learning English voiced stop VOT, but for the most part cannot yet be said to be fully nativelike. Sometimes their stops are English-like and sometimes they are Arabic-like. Most of the learners are operating most of the time with what Flege (1995) terms an equivalence classification between L1 and L2 sounds, meaning that they simply identify the L2 sound with their existing L1 sound. This is what is more traditionally referred to as full transfer of L1 into L2. Nevertheless, some of them are fluctuating between L1 and L2 VOT values, showing signs of being in the process of creating a new mental phonetic category for the latter.

At this point it would be interesting to comment on which stop, with which place of articulation, shows greater signs of acquisition than the others, and why. However, in order to assess where acquisition of nativelike VOT performance has really been attained, we need to examine the results in more detail.

Up to this point we have distinguished only between learner L2 responses that exhibited negative VOT, which are pre-voiced, like in L1 Arabic, and those that exhibited zero or positive VOT. The latter, however, cannot necessarily all be regarded as resembling monolingual native speaker English, and so evidencing acquisition, since (as the maximum values show in Table5) they include some responses that are long lag (>30ms) for [b g]. In fact

the monolingual English data also suggests (Table 8) that while short lag is the predominant response, some English native speakers do in fact produce some instances of [d g] with long lag VOT, but they do not do this for [b]. Hence we additionally created Figure 2 which, in contrast with Figure 1, shows only the numbers of learner utterances that were precisely in the native speaker VOT ranges (i.e. short lag for [b], short or low long lag for [d g]).

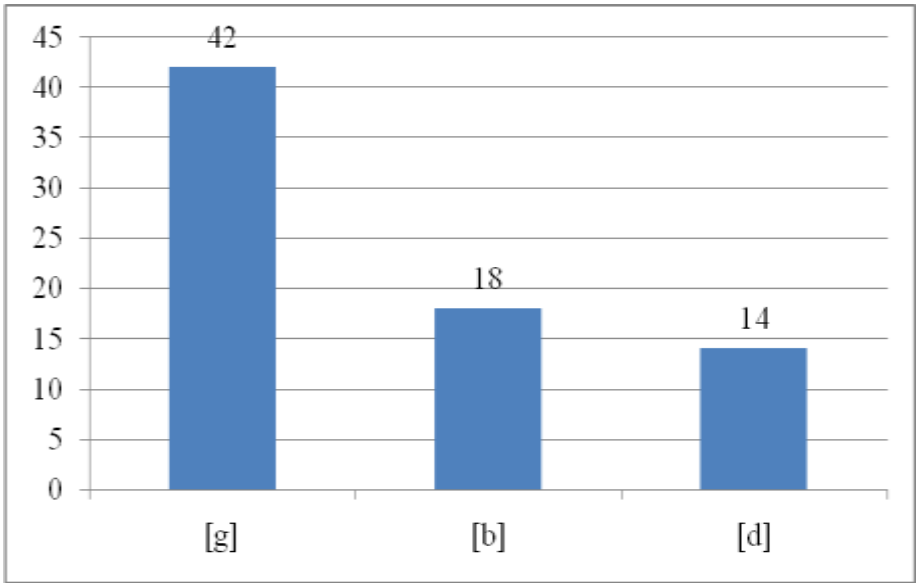
A dramatic difference between the two graphs appears for [b], while the numbers for [d g] remain as before. The data shows that, out of 68 productions by learners of English [b] which were produced without pre-voicing, 41 had zero VOT and only 27 had positive VOT. Out of these 27, [b] was produced with a short lag 18 times, and 9 times with a long lag VOT (up to 41ms). Monolingual English native speakers, by contrast, range only between 8 and 22 ms (Table 8). Thus while Figure 1 suggests superficially that, of the three stops, [b] was produced in the most nativelike way (68 instances, 38% of the possible total), the more careful calculation reflected in Figure 2 shows that in fact only 18 instances were short lag, exactly like those of monolingual English speakers (i.e. 10%).

By contrast, the non-negative VOTs of learners for /d/ are closer to the monolingual NS range for those sounds. The VOT range of [d] of the 5 learners who produced [d] 14 times with non-negative VOTwas between 20 and 27 ms, compared with the monolingual NS range of 16 to 34 ms. Thus, all the learner instances can be regarded as nativelike (8% of the possible maximum). In addition, the non-negative VOTs of learners for /g/ are also in a range closer to the monolingual NS range for those sounds.[g] was produced by learners 42 times with positive VOT, ranging up to 49 ms, while the NS utterances ranged upto 41 ms. Thus, as with [d], all 42 learner non-negative VOT responses (23%) can be seen as nativelike.

On the more careful calculation, then, the order of nativelikeness of VOT does not show labial [b] as top, followed by velar [g] thencoronal [d] (Figure 1), but rather velar [g] top, followed by

labial [b] then coronal [d] (Figure 2). Under both approaches [d] emerges as the least nativelike, i.e. most difficult to acquire. An explanation we might suggest for this is that in L1 Arabic of the participants' dialect(Table 7) it is [d] that has the most negative mean VOT (-77 ms) while [b] and [g] have similar slightly less negative mean VOTs (respectively -68 and -71ms). Hence perhaps it is not surprising that learners who clearly are experiencing a strong L1 transfer effect succeed in producing [b g] with positive VOT of a nativelike range slightly more often than [d]. They simply have to move their VOT a greater distance in order to improve their utterance if L2 [d] than the other two stops.

Figure 2. Number of times the learners produced voiced stops with strictly nativelike VOT



Looking now more closely at the VOT production of [b], there is another factor that may be at play. [b],as we have seen,was produced in 4 different ways: prevoicedlike L1, positive short lag like L2 monolinguals, with zero VOT, and with positive low long lag VOT not found in monolingual English production. A reason for this exceptional range, most of which is not nativelike,could be that Arabic does not have a [p] consonant alongside [t k]. Thus while learners may restrict the VOT range they use for English [d g] because they are familiar with the need to reserve the longer

positive values for [t k], they do not experience this constraint so strongly for [b].

Arab learners can and do acquire [p], despite its absence in L1, because they are aware in general termsof the contrast between voiced and voiceless stops in other articulatory positions. Brown (2000)for instance notesthat L2 learners can acquire a new sound if the relevant contrast type exists in their L1. However, Arab learners experience well-known persistent problems in distinguishing between [p b] while they are doing this, as reflected for instance in written production mistakes such as 'gab' (for 'gap') and 'bazel' (for 'puzzle'). Hence it is quite explicable that even relatively advanced learners such as our participants might tend to produce [b] with a long lag VOT more appropriate to [p]. We conclude that the overall learning of English VOT by the participants was poor. The findings of this study are however similar to those of studies of learners with other L1s. Shimizu (2011) for example found a high rate of pre-voicing of English voiced stops by Thai learners whose L1, like Arabic, has pre-voicing. One of the important reasons that L2 learners of English do not produce nativelike VOTs for voiced stops is that they transfer to L2 English their L1 VOT, which in many languages is pre-voiced(Bell-Berti and Raphael, 1995).

Some native speakers have been reported as also sometimes pre-voicing the voiced stops of English (Simon, 2009, Docherty, 1992), although no participants in our study did this. Suchpre-voiced stops are perceived as correct by listeners (native speakers of English), or at least sufficiently understandable so the communication process is not disrupted. Consequently, the learners have no strong motivation for learning correct VOT for voiced stops.

6. Conclusion

The researcherreached the conclusion that theSaudi learners of English had not fully learnt the VOT of English [b d g]. They predominantly produced them with negative VOT like their L1 voiced stops. But there wasevidence that the learning process is occurring among the learners. Overall the production of [g b]

wasmore nativelikein some of the repetitions than that of [d]. There was some production of English voiced stops with zero VOT, but this also showed improvement as the learners had at least suppressed pre-voicing. Two of the learners hadeven learnt to produce [b] with non-negative VOT all the time. Thus we might argue that further improvement among the Saudi learners might occur, although it would likely require many years more of immersion in the L2 context.

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Appendix 1

A: Stimuli for English stops
Beep, deal, geese,
Bar, dark, guard,
Boot, do, goose

B: Stimuli for Arabic stops

بير باب بوك
ديك دور دار
قال قول قيل

Appendix 2

The comparison of VOT between the learners who produced pre-voiced utterances of English /b d g/ and the Arabic monolinguals' utterances of Arabic /b d g/.

	[b]	[d]	[g]
Mann-Whitney U	**58.00**	**57.00**	**75.0**
Wilcoxon W	**229.00**	**247.00**	**265.00**
Z	**-1.534**	**-1.744**	**-.918**
Asymp. Sig. (2-tailed)	**.125**	**.081**	**.359**
Exact Sig. [2*(1-tailed Sig.)]	**.133[a]**	**.085[a]**	**.377[a]**