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The Influence of Bilingualism on the Production of Plosive Sounds in L1 (Arabic) and L2 (English): Acoustic Analysis of the Duration of Preceding and Following Vowels

Abstract

This paper used the plosives' duration of preceding (DoPV) and following (DOFV) vowels to investigate the effect of bilingualism on the pronunciation difficulties for Arabic as an L1 and English as an L2. The subjects were divided into three groups; Arabic-English bilinguals who speak Arabic as an L1 (N: 15), Arabic monolinguals (N: 15), and English native monolinguals (N: 5). The participants had a reading test as they produced the target words in carrier sentences with five repetitions. The results showed that the plosives' DoPV and DoFV for L1 and L2 had complicated interactions categorised into four types. 1- a unidirectional impact of L1 on L2, 2. a unidirectional impact of L2 on L1, 3. bidirectional effect, and 4. Free L1-L2 interference. The outcomes additionally revealed that the bilinguals faced production difficulties that included similar and dissimilar Arabic and English plosives. Besides, the bilinguals succeeded in producing DoPV in a native-like way for dis/similar plosives. Consequently, this paper assumed that the pronunciations' difficulties are not necessarily associated with the dis/similarity in the context of L1-L2 interaction. This paper helps Arabic-English bilinguals in developing their pronunciation by highlighting the plosives' pronunciation complexity.

Keywords: acoustic analysis, language interference, plosives, bilingualism, pronunciation difficulties, preceding vowel, following vowel

1. Introduction

The acquisition of the native sound system of the second language is one of the most challenging concerns connected to L2 learning difficulties. There are two fundamental hypothesises regarding the relationship

between sounds' dis/similarity and pronunciation difficulties. The first one was the Contrastive Analysis Hypothesis (CAH). The hypothesis assumed that the L2 sounds that differ from L1 sounds are more challenging to be achieved, while those sounds that are familiar in L1 should be more manageable. This hypothesis means that the CAH suggested that these new L2 sounds that do not belong to L1 could create learning obstacles (Lado 1957). By contrast, the other hypothesis, the Speech Learning Model (SLM) (Flege 1995) declared that identical L2 sounds that belong to the L1 and L2 sound systems are more challenging while learning new L2 sounds are easier.

Although the L1–L2 language interaction is considered a complicated process, these influences were categorised into four divisions which are ranged between accentedness and nativeness (Antoniou et al. 2011). First, due to the effect of the L1 on the L2, some L2 sounds are pronounced with a foreign accent that differs from the L2 native monolingual speakers. This effect apparently occurs in the case of the sequential acquisition of languages. In such cases, L1 plays the role of language "filter", which means that L2 is learned through L1 (Flege 1987). Second, both L1 and L2 influence each other. In this case, bilinguals have a foreign accent in both languages, leading to a "language interference" (Antoniou et al. 2011; Dmitrieva, Jongman, and Sereno 2010). The third division is the influence of L2 on L1 with no effect of L1 on L2, which usually happens in the cases of bilinguals who gain a high fluency of L2, especially in the dominant L2 context (Flege, MacKay, and Piske 2002). And finally, the fourth division is the zero L1-L2 interaction. In this case, bilinguals are able to pronounce sounds of both L1 and L2 in an exact native like-way (Antoniou et al. 2010).

The voice onset time (VOT) is a well-known acoustic cue that was utilised in research on bilingualism and even multilingualism (Wrembel 2011; Llama, Cardoso, and Collins 2010) to investigate "nativeness" and "accentedness" in both language production and perception of plosives. Several studies focused on how Arabic-English bilinguals produce the L1 and L2 sounds. Some of them examined vowels (Al-Hamadi 2012; Hubais and Pillai 2017; Khalil 2014), while others centred on consonants, especially plosives that were produced by Arabic-English bilinguals (Alkhudidi, Stevenson, and Rafat 2020).

However, some studies focused on the acoustic analysis of Arabic-English using Praat in training English teachers. They analysed the voice onset time to improve the native-like accuracy of plosive pronunciation in the segmental level, in addition to the suprasegmental level, by measuring the duration of stressed syllables (Nagamine 2011). In addition to using it as an audio-visual tool to improve the pronunciation (Kadhim 2018).

This paper used a different acoustic cue of plosives, which is the plosive's Duration of The Preceding Vowel (DoPV), to examine the degrees of the language interference between plosives of Modern Standard Arabic (MSA) and English as pronounced by bilinguals whose L1 is Palestinian Arabic and they learn English as an L2. Also, this paper evaluates the CAH and SLM theories and tries to answer the question of how dis/similarity relates to the production difficulties over the two languages.

As presented in Table 1, plosives in Arabic consisted of plain and emphatic counterparts /tˤ, dˤ/, but they do not include the voiced velar /g/ and the voiceless bilabial /p/. Besides, it is important to notice the difference between the /t/ and /d/ in Arabic and English, as they differ in the place of articulation. In other words, these two sounds are alveolars in English, but they are dental-alveolars in Arabic (Kopczynski and Meliani 1993). Consequently, /b/ and /k/ are similar plosives in the two languages, /t/, /d/ are not fully similar, due to the difference in the place of articulation, /p/, /g/ are dissimilar English sounds, and finally, /q/, /tˤ/, and /dˤ/ are dissimilar Arabic plosives.

Table 1. The plosives in the MSA and English consonant inventories. (voiceless sounds to the left in the cell).

		Bilabial	Dental-alveolar	Alveolar	Velar	Uvular
Arabic	plain	- b	t d		k -	q -
	emphatic		tˤ dˤ			
English		p b		t d	k g	

2. Methodology

This part describes the criteria employed to choose the subjects and explain the method applied to collect and analyse the data.

2.1. Subjects

A total of 35 participants volunteered to be engaged in the production test. They were grouped according to their language status; 1- An experimental group of Arabic-English bilinguals who speak Arabic as an L1 (N: 15, 7 females), 2- a control group of Arabic monolinguals (N: 15, 7 females), and 3- a control group of American English native monolinguals (N: 5, 3 females). Their ages were ranged between 20 and 30 years when the data were collected. During the interview and through the questionnaire, all of them reported no hearing difficulties or health problems.

2.2. Stimuli

In the acoustic analysis, the DoPV and DoFV were measured for a total of 6676 tokens. These tokens were represented as the following:

1 – For the bilingual experimental group: 3,900 tokens (2 acoustic cues * 15 subjects* (7 Arabic plosives + 6 English plosives) * 5 repetitions * 2 word-positions)

2 – For the Arabic monolingual control group: 2,176 tokens (2 acoustic cues * 13 subjects * 7 plosives * 5 repetitions * 2 word-positions; medial and final)

3 – For the English monolingual control group: 600 tokens (2 acoustic cues * 5 subjects * 6 plosives * 5 repetitions * 2 word-positions).

The stimuli included all Arabic and English plosives in the word-medial and final positions for the DoPV, and the word-initial and medial positions for the DoFV. These plosives were inserted in a (CVC) syllable with the same following and preceding vowels /ɪ/, in meaningful words. The participants read these words with five repetitions in the carrier sentences (I say...) for English words and (Aqūlu kalɪmata ...) for Arabic words.

2.3. Data Collection and Analysis

The production test took place at the Islamic University of Gaza's sound production studio. The process took about (15–20) minutes for every subject. The test was monitored on an LCD screen, and an AKG C414 microphone was installed on a stage at mouth height, almost 20 mm to the right of the mouth, to

minimise the airflow turbulence. The plosives tokens were selected, normalised, and acoustically analysed in the Praat software 6.0.25 (Boersma and Weenink 2019). The spectrogram parameters were set to standard values with a window duration of 5 ms, a dynamic range of 50 db, and a maximum frequency of 5000Hz, and the DoPV measures were selected manually by Praat in both of the word-medial and the final positions.

2.4. Statistical analysis

The SPSS software program was used for the statistical analysis, where an independent sample t-test was conducted to assess if there were any statistically meaningful differences between the bilingual and monolingual groups in the mean of the DoPVs; the critical p-value was set at 0.05. The means, standard deviations, and ranges were also measured.

3. Results of Duration of Preceding Vowel

This part displays and discusses the difference in the DoPV's for Arabic and English plosives among the native monolinguals and the bilinguals.

3.1. Duration of Preceding Vowel for Similar Plosives

Beginning with similar plosives /b, t, d, k/, which exist in the consonant inventories of English and Arabic, the results showed that the DoPV of these sounds in word-medial position were either influenced by the L2 or exhibited a bi-directional L1-L2 effect. In other words, the Arabic voiced similar plosives which produce by bilinguals were significantly shorter than those produced by Arabic monolinguals for /b/ (p = 0.037, MD = 18 ms) and /d/ (p < 0.0001, MD = 20 ms). In contrast, the differences in the DoPV for these sounds in English between monolinguals and bilinguals were not significant (p; /b/ = 0.802, /d/ = 0.06). On the other hand, the voiceless similar plosives exhibited a bidirectional effect. In other words, Bilinguals had a significantly shorter DoPV for these sounds /t/ (p = 0.015, MD = 13 ms) and /k/ (p = 0.01, MD = 11 ms) than those of Arabic monolinguals. But they produced these sounds in English with longer DoPV than those of English monolinguals (/t/, p < 0.0001, MD = 21 ms. /k/; p = 0.048, MD = 8 ms). Table 2 presents the means of the DoPV of similar word-medial plosives, the subjects' number, the standard deviation, and the lowest and highest values of the DoPV. Also, Figure 1 demonstrates the means' differences in the DoPV for both bilinguals and monolinguals in both languages.

Table 2. Descriptive information about the DoPV for similar Arabic and English plosives in word-medial position.

plosives	Language	Mono/bilinguals	N	Mean	Std. Deviation	Minimum	Maximum
b	Arabic	Monolingual	12	75	14	57	101
	Arabic	Bilingual	15	56	26	9	89
	English	Bilingual	16	69	23	10	104
	English	Monolingual	15	72	33	7	157

| plosives	Language	Mono/bilinguals	N	Mean	Std. Deviation	Minimum	Maximum
t	Arabic	Monolingual	13	74	13	52	94
	Arabic	Bilingual	15	61	13	37	94
	English	Bilingual	16	73	17	46	105
	English	Monolingual	15	52	8	39	65
d	Arabic	Monolingual	13	74	15	49	100
	Arabic	Bilingual	16	55	11	31	70
	English	Bilingual	16	75	19	39	101
	English	Monolingual	15	62	16	36	94
k	Arabic	Monolingual	13	64	9	48	86
	Arabic	Bilingual	15	53	11	35	73
	English	Bilingual	15	62	11	45	80
	English	Monolingual	15	55	9	44	73
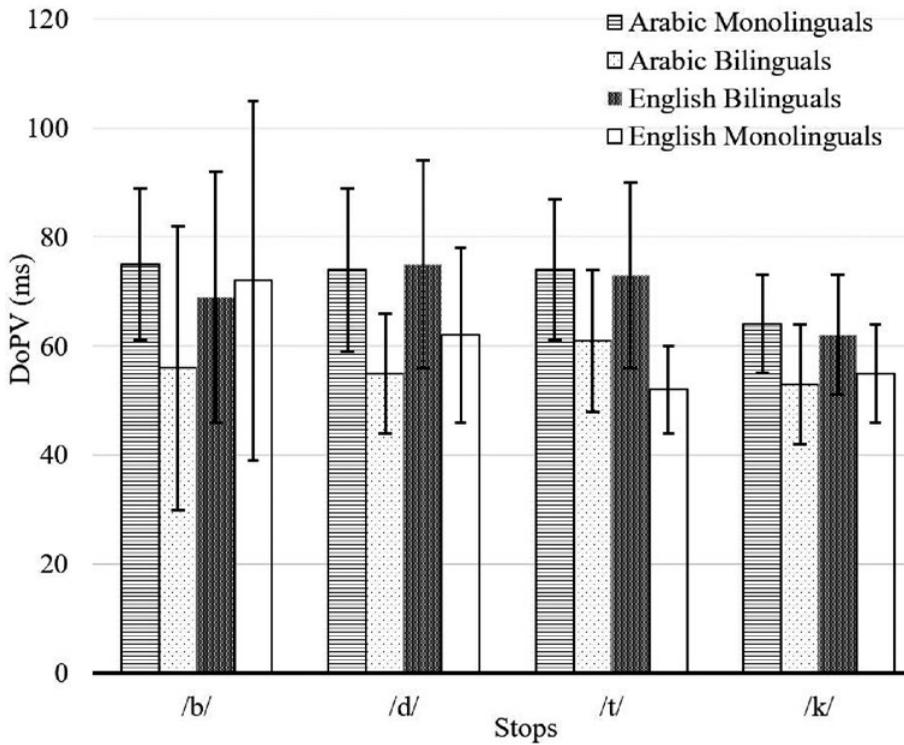
Figure 1. The DoPVs of similar Arabic-English plosives in word-medial position for monolinguals and bilinguals.

In word-final position, however, the DoPV for similar sounds were represented in L1 effects on L2 or a bidirectional L1-L2 influence. The bilinguals produced significantly shorter DoPV for the Arabic plosives /t/ (p = 0.001, MD = 26 ms), /d/ (p = 0.034, MD = 23 ms), and /k/ (p = 0.044, MD = 11 ms) comparing to the Arabic monolinguals. But the differences in the DoPV were not significant between the bilinguals and the English monolinguals for these sounds (p; /t/ = 0.686, /d/ = 0.608, /k/ = 0.303). However, /b/ in Arabic and English was affected, as bilinguals produced the Arabic /b/ with significantly shorter DoPV comparing to Arabic monolinguals (p = 0.011, MD = 28 ms), and they also produced the English /b/ with significantly shorter DoPV comparing to English monolinguals (p = 0.003, MD = 41 ms). Table 3 gives the means of the DoPV of similar word-final plosives, the subjects' number, the standard deviation, and the minimum and maximum values of the DoPV. Likewise, Figure 2 displays the means' differences in the DoPV for both of the bilinguals and monolinguals in both languages.

Table 3. Descriptive information about the DoPV for similar Arabic and English plosives in word-final position.

| plosives	Language	Mono/bilinguals	N	Mean	Std. Deviation	Minimum	Maximum
b	Arabic	Monolingual	11	102	25	67	140
	Arabic	Bilingual	15	74	24	38	120
	English	Bilingual	16	125	23	91	181
	English	Monolingual	15	166	44	106	251
t	Arabic	Monolingual	13	98	22	63	122
	Arabic	Bilingual	14	72	15	51	100
	English	Bilingual	16	139	35	93	220
	English	Monolingual	15	134	27	79	176
d	Arabic	Monolingual	12	102	27	56	148
	Arabic	Bilingual	16	79	26	36	138
	English	Bilingual	15	140	46	87	240
	English	Monolingual	14	151	62	79	269
k	Arabic	Monolingual	13	91	11	67	106
	Arabic	Bilingual	16	80	16	61	113
	English	Bilingual	15	111	24	62	162
	English	Monolingual	14	104	11	89	125
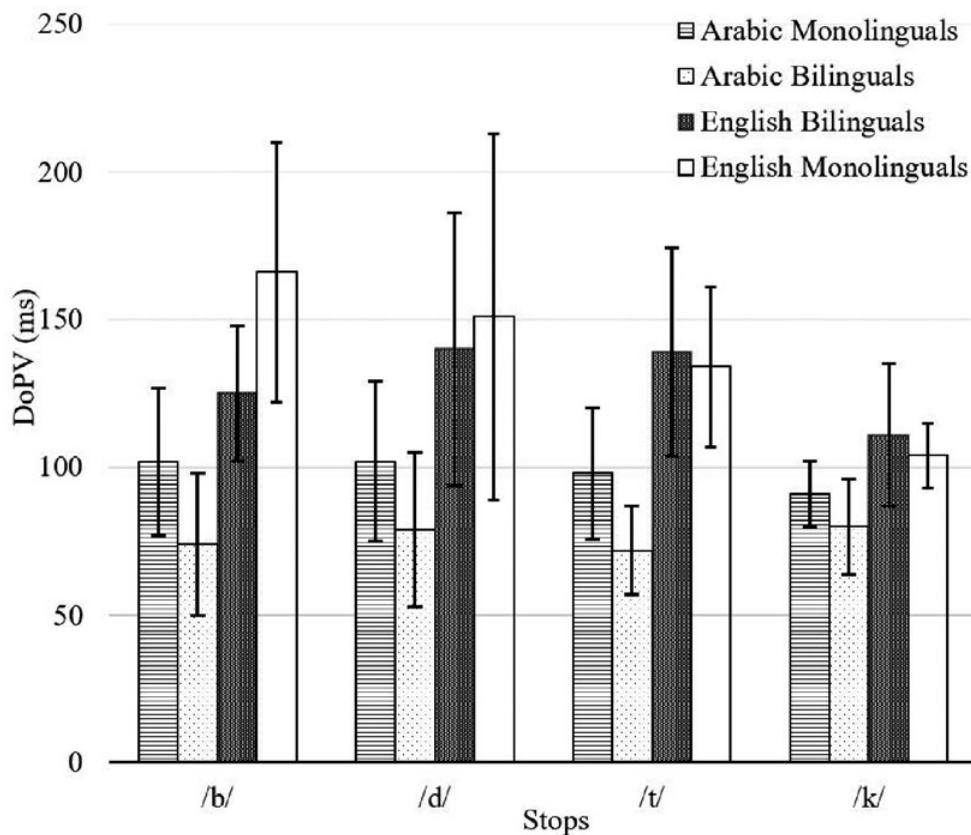
Figure 2. The DoPVs of similar Arabic-English plosives in word-final position for monolinguals and bilinguals.

3.2. Duration of Preceding Vowel for Dissimilar Arabic plosives

For the three Arabic plosives that do not belong to the English sound system /dˤ, tˤ, q/, the results of the independent t-test study showed that the DoPV for all of these plosives were significantly influenced by L2 except the emphatic voiceless dental-alveolar /tˤ/ in word-final position (p = 0.081). The bilinguals produced these sounds with significantly shorter DoPV compared to Arabic monolinguals in word-medial (/q/; p = 0.003, MD = 16 ms. /dˤ/; p = 0.001, MD = 23 ms) and final (/q/; p = 0.037, MD = 17 ms. /tˤ/; p = 0.002, MD = 26 ms. /dˤ/; p = 0.001, MD = 35 ms) positions. Figures 3 and 4 set out the means' differences of DoPV for these sounds. Besides, Table 4 shows the means of the DoPV, the subjects' number, and the standard deviation.
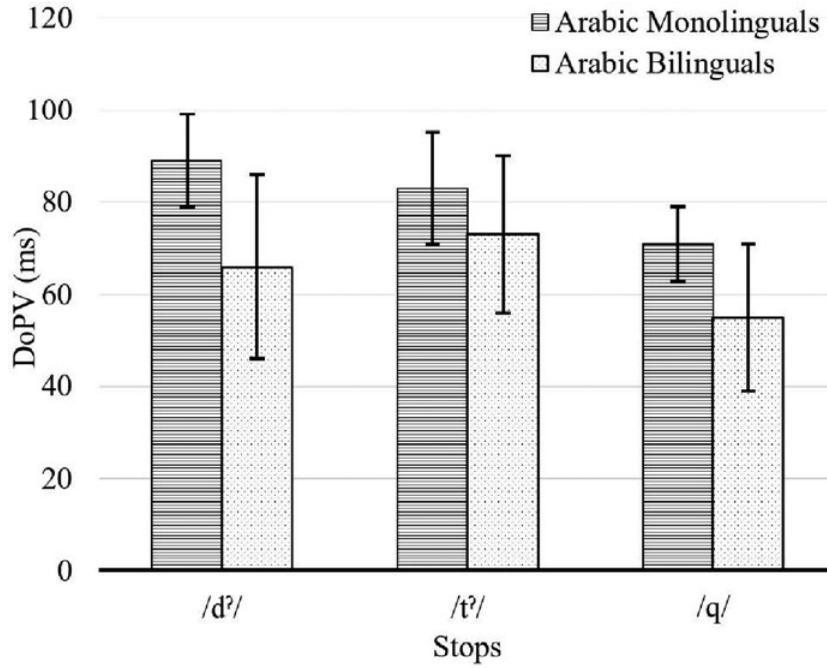
Figure 3. The DoPVs of Arabic dissimilar plosives in word-medial position for monolinguals and bilinguals.
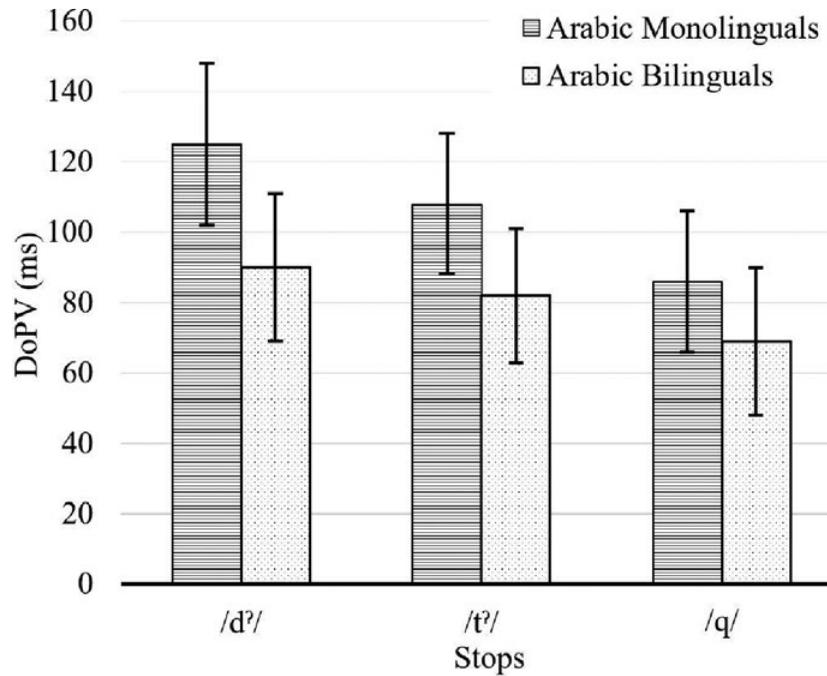

Figure 4. The DoPVs of Arabic dissimilar plosives in word-final position for monolinguals and bilinguals.

Table 4. Descriptive information about the DoPV for Arabic dissimilar plosives in word-medial and final positions.

plosive	Mono/bilinguals	plosives' position	N	Mean	Std. Deviation
tˀ	Monolingual	medial	13	83	12
	Bilingual	Medial	16	73	17
	Monolingual	Final	12	108	20
	Bilingual	Final	16	82	19
dˀ	Monolingual	medial	12	89	10
	Bilingual	Medial	16	66	20
	Monolingual	Final	11	125	23
	Bilingual	Final	16	90	21
q	Monolingual	Medial	13	71	8
	Bilingual	Medial	16	55	16
	Monolingual	Final	13	86	20
	Bilingual	Final	16	69	21

3.3. Duration of Preceding Vowel for Dissimilar English plosives

Although both /p/ and /g/ are dissimilar English sounds, they are not represented the Arabic consonant inventory, the DoPV for these two sounds interacted differently with the bilinguals' sound systems. While the DoPVs of the voiceless bilabial produced by bilinguals were not significantly different from those of native English speaker in both word-medial ($p = 0.449$) and final ($p = 0.395$) positions, the DoPVs for the voiced velar /g/ were significantly longer in the word-medial position ($p = 0.003$, MD = 18 ms) and shorter in word-final ($p = 0.057$, MD = 34 ms) positions. Figures 5 and 6 present the means of DoPV for these plosives in word-medial and final positions for both English monolinguals and bilinguals. In addition, Table 5 displays the means of the DoPV, the subjects' number, and the standard deviation.

Table 5. Descriptive information about the DoPV for English dissimilar plosives in word-medial and final positions.

plosives	Mono/bilinguals	plosives' position	N	Mean	Std. Deviation
g	Bilingual	medial	16	72	19
	Monolingual	Medial	15	54	9
	Bilingual	Final	15	154	33
	Monolingual	Final	15	188	57

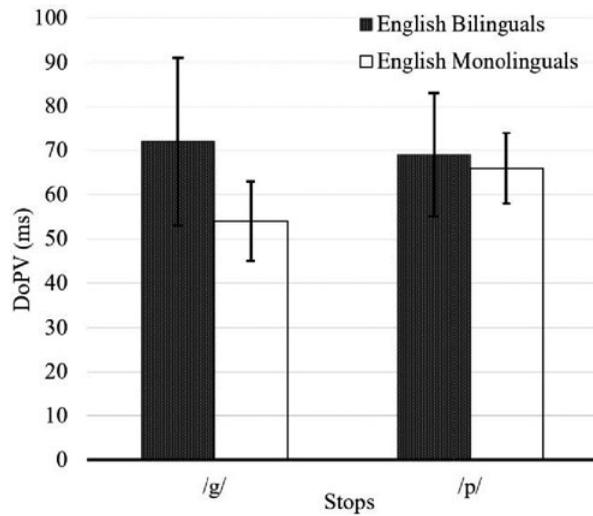| plosives	Mono/bilinguals	plosives' position	N	Mean	Std. Deviation
p	Bilingual	medial	15	69	14
	Monolingual	Medial	15	66	8
	Bilingual	Final	16	104	27
	Monolingual	Final	14	112	23

Figure 5. The DoPVs of English dissimilar plosives in word-medial position for monolinguals and bilinguals.
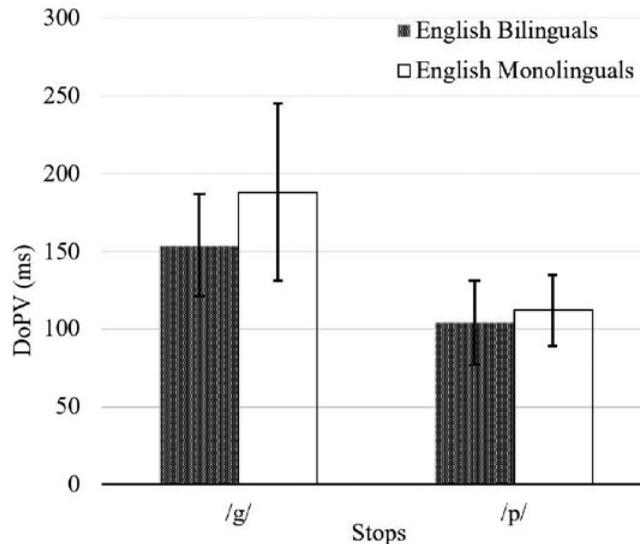

Figure 6. The DoPVs of English dissimilar plosives in word-final position for monolinguals and bilinguals.

3.4. Discussion

The DoPV was influenced by unidirectional effects, either L1 affected L2 (i.e., /g/ in words-medial and final positions), or L2 affected L1 (i.e., /q/ and /dˤ/ in word-medial and final positions). In some cases, the DoPV were influenced by both L1 and L2. In other words, the bilinguals had DoPVs that differed from monolinguals of both Arabic and English (i.e. /k/, /t/ in word-medial position). The last case was the free interaction between L1 and L2. In this case, the bilinguals succeeded to had DoPVs that did not significantly differ from monolinguals of both languages for both Arabic and English plosives. Furthermore, these results accounted for the fact that the pronunciation difficulties were not exclusive for similar or dissimilar plosives but included plosives that belong to both Arabic and English sound systems, besides the plosives that belong to only on sounds system. For dissimilar plosives, bilinguals found it challenging to have a native-like DoPV for some English and Arabic dissimilar plosives. i.e., the Arabic /q/, /dˤ/, and the English /g/ in word-medial position. This kind of difficulty agreed with the CAH (Lado, 1957) which supposes that different sounds are more difficult in pronunciation. However, bilinguals also had difficulties in the DoPV for familiar plosives that belong to both Arabic and English. i.e., /k/, /d/, and /t/ in word-final position. which corresponded to the Speech Learning Model (SLM) (Flege, 1995). The details of the interaction of DoPVs between the Arabic (L1) and the English (L2) in terms of the dis/similarity are set out in Table 6 below.

Table 6. The interaction of DoPV for Arabic (L1) and English (L2) plosives produced by Arabic-English bilinguals.

Plosives' similarity	Plosives' Word-position	L1 affects L2	L2 affects L1	Bi-directional effect	No interaction
Similar plosives	Medial		/d/, /b/ /	/k/, /t/	
Dissimilar Arabic plosives	Medial		/q/, /dˤ/		/tˤ/
Dissimilar English plosives	Medial	/g/			/p/
Similar plosives	Final	/k/, /d/, /t/		/b/	
Dissimilar Arabic plosives	Final		/q/, /dˤ/, /tˤ/		
Dissimilar English plosives	Final	/g/			/p/

4. Results of Duration of Following Vowel

This section presents and discusses the difference in the DoFV for Arabic and English plosives among the native monolinguals and the bilinguals.

4.1. Duration of Following Vowel for Similar Plosives

Starting with similar plosives /b, t, d, and k/ which occur in the consonant inventories of English and Arabic, the results revealed that the DoFV of /b/ /t/, and /k/ in word-initial position were not influenced in both Arabic (/b/; p = 0.986, MD = 0.19 ms. /t/; p = 0.101, MD = 17 ms. /k/; Ar: p = 0.393, MD = 3.9 ms) and English (/b/; p = 0.077, MD = 38.5 ms. /t/; p = 0.948, MD = 1 ms. /k/; p = 0.973, MD = 0.5 ms). However, the DoFV for the Arabic /d/ in word-medial position were influenced by L2 (English). In other words, bilinguals produced a longer DoFV for Arabic /d/ comparing to Arabic monolinguals (p = 0.011, MD = 27 ms), although the differences in the DoFV between bilinguals and English monolinguals were not statistically significant (p = 0.164, MD = 24.9). Table 7 presents the means of the DoFV for similar word-initial plosives, the subjects' number, the standard deviation, and the lowest and highest values of the DoFV. Besides, Figure 7 demonstrates the means' differences in the DoFV for both of the Arabic-English bilingual and Arabic and English monolingual groups in both languages.

Table 7. Descriptive information about the DoFV for similar Arabic and English plosives in word-initial position

plosives	Language	Mono/bilinguals	N	Mean	Std. Deviation	Minimum	Maximum
b	Arabic	Monolingual	13	133.30	36.87	83.33	197.98
	Arabic	Bilingual	16	133.49	23.43	97.77	182.75
	English	Bilingual	16	112.33	46.27	12.38	176.79
	English	Monolingual	15	150.87	69.30	13.00	259.00
t	Arabic	Monolingual	13	84.98	24.03	41.94	133.52
	Arabic	Bilingual	16	102.39	29.88	66.11	174.99
	English	Bilingual	16	149.22	32.11	91.00	205.66
	English	Monolingual	15	150.26	53.75	89.36	274.07
d	Arabic	Monolingual	13	115.51	28.60	62.62	171.47
	Arabic	Bilingual	15	87.82	24.96	45.46	148.44
	English	Bilingual	15	148.69	44.58	15.12	200.56
	English	Monolingual	15	173.55	50.43	88.84	273.00
k	Arabic	Monolingual	13	49.87	13.69	30.40	70.90
	Arabic	Bilingual	16	45.99	10.41	32.21	66.50
	English	Bilingual	16	155.28	28.59	99.92	229.67

THE INFLUENCE OF BILINGUALISM ON THE PRODUCTION OF PLOSIVE SOUNDS IN L1
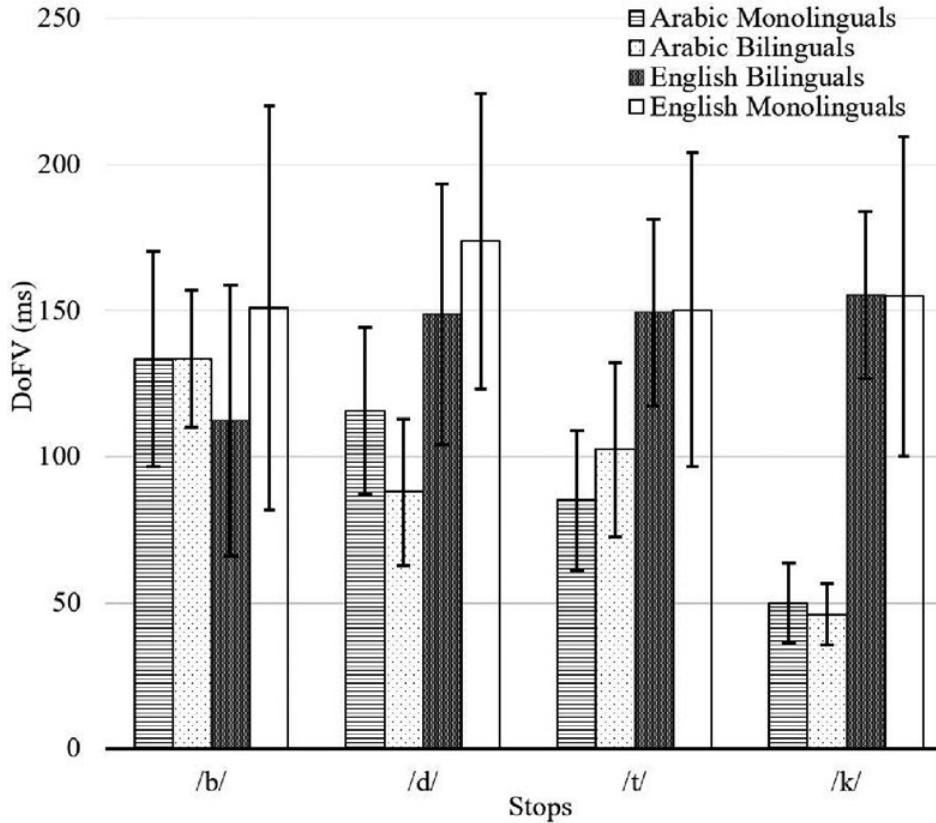

Figure 7. The DoFVs of similar Arabic-English plosives in word-initial position for monolinguals and bilinguals.

Surprisingly, in plosive's word-medial position, /t/ was the only similar plosive that did not influenced by neither L1 nor L2. As bilinguals succeeded to produce DoFVs for Arabic (p = 0.7, MD = 2 ms) and English (p = 0.524, MD = 4 ms) same to native speakers in both languages. While the rest of these similar sounds were influenced by L2; bilinguals pronounced Arabic /b/ (p = 0.004, MD = 117.7 ms), /d/ (p < 0.0001, MD = 27.5 ms), and /k/ (Ar p = 0.003, MD = 13.8 ms) with significantly shorter DoFVs comparing with Arabic monolinguals. At the same time, there were no statistical significant differences in the DoFV for the English final-position plosives /b/ (p = 0. 624, MD = 6 ms), /d/ (p = 0.351, MD = 9 ms), and /k/ (p = 0.213, MD = 13 ms) between the bilinguals and the English monolinguals. Table 8 gives the means of the DoFV for similar word-medial plosives, the subjects' number, the standard deviation, and the minimum and maximum values of the DoFV and Figure 8 illustrates the means' differences in the DoFV for both of the bilinguals and monolinguals in both languages.

Table 8 Descriptive information about the DoFV for similar Arabic and English plosives in word-medial position

| Plosives	Language	Mono/bilinguals	N	Mean	Std. Deviation	Minimum	Maximum
b	Arabic	Monolingual	13	177.06	132.61	85.29	425.09
	Arabic	Bilingual	14	59.34	32.99	6.08	117.67
	English	Bilingual	16	80.17	35.68	33.11	183.00
	English	Monolingual	15	85.73	25.56	52.48	132.20
t	Arabic	Monolingual	13	73.09	16.16	47.19	97.63
	Arabic	Bilingual	15	70.76	15.63	48.45	111.43
	English	Bilingual	16	52.50	17.50	35.09	104.05
	English	Monolingual	14	48.93	11.95	25.70	80.76
d	Arabic	Monolingual	13	98.76	9.29	82.12	113.60
	Arabic	Bilingual	16	71.22	14.93	48.52	107.95
	English	Bilingual	16	87.27	27.73	42.17	139.41
	English	Monolingual	15	78.78	21.49	25.70	107.94
k	Arabic	Monolingual	13	71.15	11.34	48.23	82.17
	Arabic	Bilingual	16	57.38	11.58	44.72	83.04
	English	Bilingual	16	98.90	29.46	56.13	142.51
	English	Monolingual	15	85.65	28.39	47.00	151.01
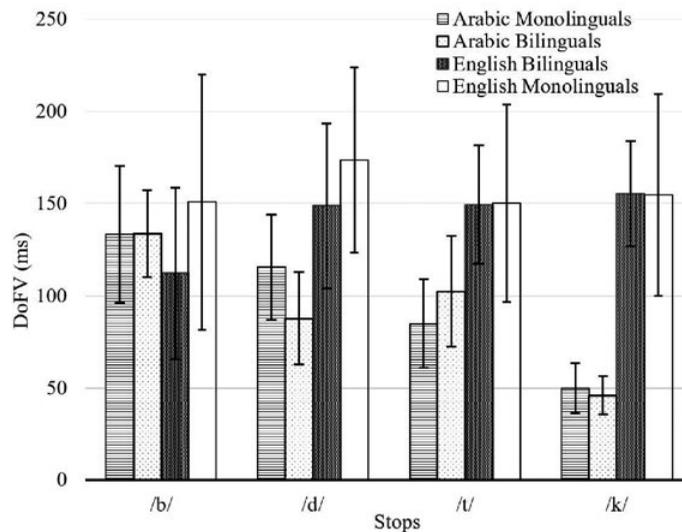
Figure 8. The DoFVs of similar Arabic-English plosives in word-medial position for monolinguals and bilinguals.

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4.2. Duration of Following Vowel for Dissimilar Arabic Plosives

For the three Arabic plosives that do not exist in the English sound system /dˤ, tˤ, q/, the results revealed that the DoFV for these in word-initial and word-medial positions witnessed the same effect. As the voiceless emphatic /tˤ/ were influenced by L2, because the bilinguals produced /tˤ/ with significantly shorter DoFV comparing to the Arabic monolinguals in both word-initial ($p = 0.0001$, MD = 92.8 ms) and medial ($p = 0.023$, MD = 18.4 ms) positions. But bilinguals succeeded in producing the DoFV for both/dˤ/ and /q/ in a native-like way. In other words, there were no statistically significant differences in the DoFV for /dˤ/ between the bilinguals and the Arabic monolinguals in plosives' word-initial ($p = 0.082$, MD = 25.4 ms) and medial ($p = 0.123$, MD = 12.7 ms) positions. In addition, the differences in the DoFV for /q/ were not significant too between the bilinguals and the Arabic monolinguals in plosives' word-initial ($p = 0.266$, MD = 8 ms) and medial ($p = 0.08$, MD = 15 ms) positions. Figures 9 and 10 demonstrate the means' differences of DoFV for these Arabic similar plosives. Besides, Table 9 shows the means of the DoFV, the subjects' number, and the standard deviation.
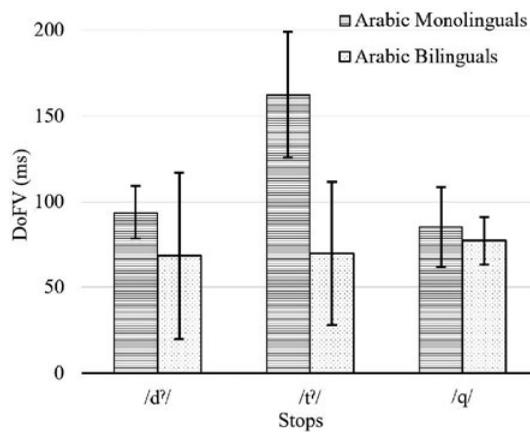

Figure 9. The DoFVs of Arabic dissimilar stops in word-initial position for monolinguals and bilinguals.
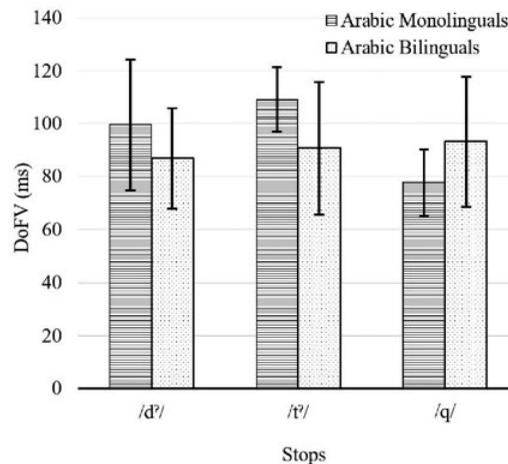

Figure 10. The DoFVs of Arabic dissimilar plosives in word-medial position for monolinguals and bilinguals.

Table 9. Descriptive information about the DoFV for Arabic dissimilar plosives in word-medial and final positions.

Plosives	Mono/bilinguals	Plosive's position	N	Mean	Std. Deviation
tˤ	Monolingual	Initial	13	162.53	36.68
	Bilingual	Initial	16	69.76	41.77
	Monolingual	Medial	13	109.09	12.17
	Bilingual	Medial	16	90.72	25.20
dˤ	Monolingual	Initial	13	93.79	15.45
	Bilingual	Initial	16	68.39	48.53
	Monolingual	Medial	13	99.57	24.60
	Bilingual	Medial	16	86.89	19.00
q	Monolingual	Initial	13	85.22	23.38
	Bilingual	Initial	16	77.26	14.03
	Monolingual	Medial	10	77.69	12.43
	Bilingual	Medial	16	93.15	24.74

4.3. Duration of Following Vowel for Dissimilar English Plosives

Bilinguals succeeded in producing both of the English voiceless bilabial /p/ and voiced velar /g/ in same to native English monolinguals regarding the DoFV with no significant differences in both word-initial (/p/; $p = 0.103$, MD = 26 ms. /g/; $p = 0.185$, MD = 25.5 ms) and word-medial (/p/; $p = 0.137$, MD = 18 ms. /g/; $p = 0.179$, MD = 22 ms) positions. Figures 11 and 12 present the means of DoFV for these plosives in word-initial and medial positions for both English monolinguals and bilinguals. In addition, Table 10 displays the means of the DoFV, the subjects' number, and the standard deviation.

Table 10. Descriptive information about the DoFV for English dissimilar plosives in word-medial and final positions.

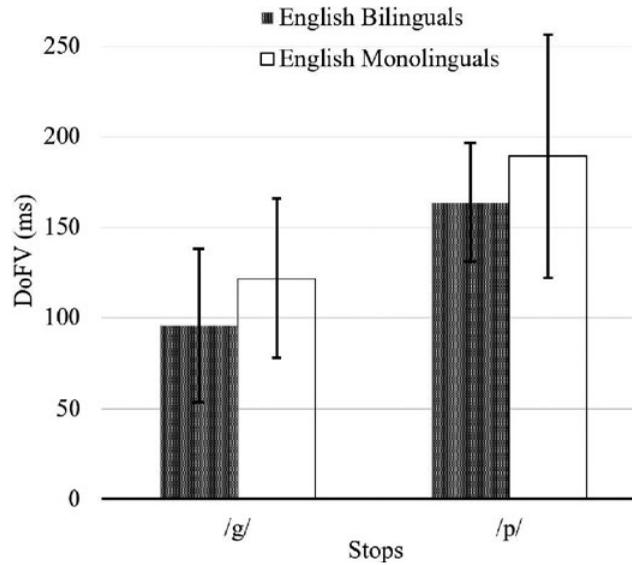| Plosives	Mono/bilinguals	Plosive's position	N	Mean	Std. Deviation
g	Bilingual	Initial	16	95.83	42.54
	Monolingual	Initial	15	121.95	43.92
	Bilingual	Medial	16	163.80	32.74
	Monolingual	Medial	15	189.30	67.20
p	Bilingual	Initial	16	163.80	32.74
	Monolingual	Initial	15	189.30	67.20
	Bilingual	Medial	16	95.83	42.54
	Monolingual	Medial	15	121.95	43.92

Figure 11. The DoFVs of English dissimilar plosives in word-initial position for monolinguals and bilinguals.

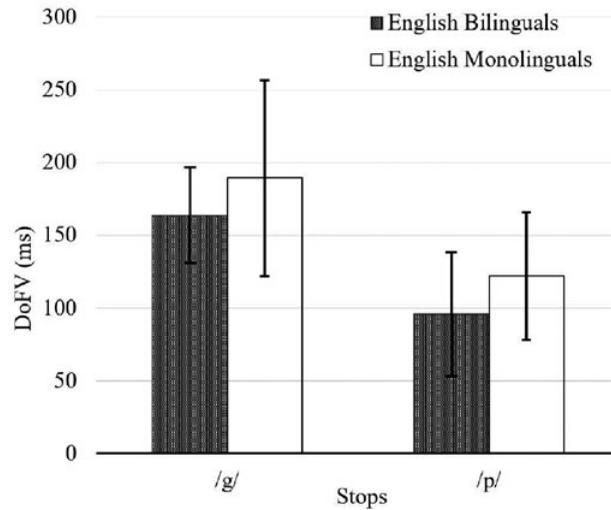Figure 12. The DoFVs of English dissimilar plosives in word-medial position for monolinguals and bilinguals.

4.4. Discussion

The DoFV exposed to unidirectional effects, either L1 affected L2 (i.e., //tˀ/ and /d/ in word-initial position), or L2 affected L1 (i.e., /d/, /b/, /k/, and /tˀ/in word-medial positions). It is worth mentioning that the DoFV were not influenced by both L1 and L2 together. In other words, the bilinguals had no L1-L2 bidirectional effect in the DoFV. However, there was a free L1-L2 interaction, which means that bilinguals succeeded to acquire DoFVs that did not significantly differ from monolinguals of both

languages for both Arabic and English plosives (i.e. /b/, /t/, /k/, /dˤ/, /q/, /p/, and /g/ in word-initial position). The results also showed that the pronunciation difficulties occurred in similar plosives that belong to both Arabic and English sound systems (i.e., /d/, /b/, and /k/ in word-medial position), which agreed with the Speech Learning Model (SLM) (Flege 1995).

For dissimilar plosives, although bilinguals face some DoFVs' difficulties in their L1 sounds that were influenced by their L2 (i.e., /tˤ/ in word-initial position), the results disagreed with the CAH (Lado 1957), as the bilinguals succeeded to produce a native-like DoFV for all of the English dissimilar plosives /p/ and /g/ in both initial and medial positions. The details of the L1-L2 interaction in terms of DoFV between the Arabic (L1) and the English (L2) considering the dis/similarity are illustrated in Table 11 below.

Table 11. The interaction of DoFV for Arabic (L1) and English (L2) plosives produced by Arabic-English bilinguals.

Plosives' similarity	Plosives' Word-position	L1 affect L2	L2 affect L1	Bi-directional effect	No interaction
Similar plosives	Initial	/d/			/b/, /t/, /k/
Dissimilar Arabic plosives	Initial	/tˤ/			/dˤ/, /q/
Dissimilar English plosives	Initial				/p/, /g/
Similar plosives	Medial		/d/, /b/, /k/		/t/
Dissimilar Arabic plosives	Medial		/tˤ/		/dˤ/, /q/
Dissimilar English plosives	Medial				/p/, /g/

5. Conclusion

In this paper, we used the DoPV and DoFV as an acoustic cue to evaluate the "accentedness" and "nativeness" of plosives as pronounced by Arabic-English bilinguals for Arabic (L1) and English (L2). The complex interactions for English and Arabic plosives were classified into four different levels that vary within the range of "accentedness" and "nativeness", which agreed with the suggestion of (Antoniou et al. 2011). The findings indicated that the DoPV and DoFV for plosives of Arabic (L1) and English (L2) interacted in a complicated way that could be divided into four influences. 1- a unidirectional effect of L1 on L2, 2. unidirectional effect of L2 on L1. 3. a bidirectional influence between L1 and L2, and 4. No L1-L2 interaction. The results also indicated that the pronunciation difficulties covered both similar and dissimilar plosives in both L1 and L2 in all word positions. Similarly, the plosives in which bilinguals succeed to have a native-like DoPV also represented both similar and dissimilar sounds. Thus, this paper concluded that pronunciation difficulties do not have to be correlated to the dis/similarity in the context of language interaction. This study offers an evaluation for Arabic-English bilinguals in their stops production. It helps them improve the nativelikeness pronunciation in both Arabic (L1) and English (L2) by highlighting the pronunciation difficulties. It is also hoped that it would help the Palestinian Ministry

of Education improve new curriculum models to integrate special L2 pronunciation training into English and Arabic learning in Palestinian schools and universities to enhance students' pronunciation and overall language intelligibility.

Acknowledgement

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