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| RESEARCH ARTICLE

Voice Onset Time Contrasts in Tripolitanian Libyan Arabic Stops

Abdurraouf Shitaw
Assistant Professor, University of Tripoli, Faculty of Languages, Department of English Language, Tripoli, Libya
Corresponding Author: Abdurraouf Shitaw**, E-mail**: a.shitaw@uot.edu.ly

| ABSTRACT

This study aims to investigate the duration of voice onset time of single stop consonants in Tripolitanian Libyan Arabic. It also seeks to identify any potential influence of the place of articulation of these stops and the vocalic context on this duration. Four Tripolitanian Libyan Arabic speakers were recorded while producing 39 monosyllabic words with /b/, /t/, /d/, /k/ and /g/ followed by the vowels /i:/,/i/,/a:/,/a/,/u:/,/u/, /e:/ and /o:/. The duration of positive voice onset time was measured from the release burst to the onset of vocal fold vibration. For negative voice onset time, the duration was measured from the initiation of voicing during the hold phase to the release burst. Results of the analysis show that voice onset time in Tripolitanian Libyan Arabic Falls under two categories. While voiceless stops have a positive voice onset time value ranging from 14 ms to 44 ms, voiced stops have a negative voice onset time ranging from –33 to –60. Results have also revealed that voice onset time varies as a function of the place of articulation of the stop and the quality and duration of the following vowel. As the stop's place of articulation moved from an anterior to a posterior point in the vocal tract, the duration of voice onset time seemed to increase. The duration of voice onset time is longer when voiceless stops are followed by a close vowel, compared to when the stop was followed by a non-high vowel. Finally, voice onset time was longer when voiceless stops were followed by the long vowels /i:/ and /u:/. This tendency was not observed when the stops were followed by /a:/.

| KEYWORDS

Plosives, Voice Onset Time, Tripolitanian Libyan Arabic

| ARTICLE INFORMATION

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1. Introduction

Voice onset time (VOT) is probably the most prominent acoustic characteristic of stop consonants. Despite the importance of VOT, there have been only few attempts to explore its patterns in Libyan Arabic in general, and in Tripolitanian Libyan Arabic (TLA) in particular. In this variety of Libyan Arabic, which is spoken in Tripoli, the capital, stop consonants are classified according to their place of articulation into three groups: bilabial /b/, non-pharyngealised alveolars /t/ and /d/, pharygealised alveolars /tˤ/ and /dˤ/, and velar /k/ and /g/. Stop consonants can also be classified according to the state of vocal folds. Here, /t/، /tˤ/ and /k/ are voiceless and /b/, /d/m /dˤ/ and /g/ are voiced. The present paper aims to investigate the VOT durations of non-pharyngealised stops in TLA and to see how these durations vary as a function of the place of articulation of the stop, the quality of the vowel: close vs. nonclose, and vowel length: short vs. long. It is important to note that the VOT of /tˤ/ and /dˤ/ is not investigated in this study, as it is limited only to non-pharyngealised stops in TLA.

2. Literature Review

In phonetics, VOT of stop consonants is usually classified into four categories. When the vibration of the vocal folds is initiated before the release, VOT is referred to as pre-voiced, and it is measured in minus. VOT is referred to as zero when vocal folds vibration starts at the release. When vocal folds vibration starts after the release of up to 25 milliseconds (ms), VOT falls into the short lag category. Finally, VOT is described as having a long lag when vocal folds continue to vibrate after 25 ms and up to 100 ms (MacKay, 1987, pp. 93-94). It has also been said that, based on these categories, languages can be divided into two groups: Those languages in which VOT is over 50 milliseconds for voiceless stops and shorter VOT for voiced ones, and those languages

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in which voiceless stops have short VOTs, less than 30 milliseconds, and negative VOT for voiced stops (Kessinger and Blumstein 1997 and Alghamdi, 2004:25).

English and Arabic are two distinct languages. They differ in many phonetic and phonological aspects. One of these is the timing of voicing in stops. Lisker and Abramson (1964) identified different VOT durations in English stop consonants. They stated that the English voiceless stops /p/, /t/, and /k/ have longer VOT values. /b/, /d/, and /g/, on the other hand, are produced with short VOTs or with pre-voicing in some instances. Docherty (1992) confirms these findings that /p/, /t/ and /k/ have a long positive VOT lag ranging from 30-100ms and /b/, /d/ and /g/ have a short positive VOT lag ranging from 0-25ms.

On the other hand, many studies have focused on VOT of stops in different Arabic dialects. Amongst the available literature is Rifaat (2003: 791), who investigated the voicing categories of Colloquial Egyptian Arabic and found that a negative VOT value characterises voiced stops, while a positive VOT value is associated with voiceless stops. Moreover, Alghamdi (2006) investigated the duration of VOTs of voiceless stops in Saudi Arabic. He found that the duration of VOT for /t/ ranged from 21-78 ms and that for /k/ was 21- 55 ms. Bellem (2007) investigated the duration of VOT for /b/, /t/, /d/, /k/and /g/ in Baghdadi Arabic. Results of his study revealed that the value of VOT was -41 ms, 31 ms, -47 ms, 39, and 47 ms, respectively. In the same year, he conducted another study on Saudi Arabic stops /b/, /t/, /d/ and /k/ and concluded that the duration of VOT was -36 ms, 35 ms, -66 ms and 44 ms, respectively. Another study on the acoustic properties of Iraqi Arabic was conducted by Alsiraih (2020), who found that voiceless stops have a positive VOT value and voiced ones have a negative VOT value. The same pattern has been observed in Saudi Arabic (Mitleb, 2009) and Palestinian Arabic (Tamim, 2017).

Despite the general agreement that voiceless stops in Arabic dialects have positive VOTs and voiced ones have negative VOTs, some results are not in agreement with such conclusions. For example, AlDahri (2010) conducted an experiment to investigate the values of /t/and /d/ in Modern Standard Arabic (MSA). The study revealed that the range of VOT for /d/ was 12-22 ms, and for /t/, the value was 38-93 ms. In addition, AlDahri (2012) conducted another study to investigate the value of VOT of /b/, /t/, /d/ and /k/ in Modern Standard Arabic (MSA) and Classical Arabic (CA) stops. His results showed that the value of VOT was 14 ms for /b/, 50 ms for /t/, 15 ms for /d/, and 53 ms for /k/ in MSA, and 13 ms, 36 ms, 17 ms and 37 ms, respectively for CA. This means that both groups of stops, voiceless or voiced, have positive VOT values, which is contrary to English and some Arabic dialects.

Regarding Libyan Arabic, there needs to be more acoustic studies. There have been only a few attempts to investigate VOT in Libyan Arabic. Laradi's (1983) thesis on Pharyngealization in Libyan Arabic is among the available literature. In her description of stops in TLA, she stated that voiceless non-emphatic stops in TLA can be aspirated, and voiced stops can become devoid. Kriba (2010) investigated the acoustic parameters of emphasis in Libyan Arabic, the dialect spoken in Zliten. One of his findings is that /t/ has a VOT value of 35 ms, and it is slightly aspirated. Shitaw (2014) investigated the timing relations of two-stop consonants in TLA. He found that the duration of VOT for /t/ is 21ms, and for /k/, it is 39 ms. As for /b/, /d/ and /g/, the average VOT duration was -38 ms, -47 ms and -60 ms. It is worth mentioning that the duration of VOT, positive and negative, becomes longer as the place of articulation moves back. Another finding is that VOT becomes shorter in fast articulation rate.

Elbakay and Zaglom (2018) investigated VOT of stops in Alkhomsy Libyan Arabic (KLA), the dialect spoken in Khoms. Results of this study showed that KLA stops have short lags for voiceless plosives and pre-voicing for voiced plosives. For TLA, Ghummed (2021) conducted a study to compare VOT in TLA and English. His Results revealed that the VOT durations were significantly shorter in TLA than in their English counterparts. Finally, Marwan (2022) investigated the influence of place of articulation, vocalic context and gender on the values of VOT in TLA. The results showed that VOT in TLA falls in the category of short lag for voiceless stops and pre-voicing for voiced stops. The results also confirm the influence of place of articulation, the vocalic context and gender on the values of VOT.

To sum up, TLA and English stops differ in their VOT patterns. While English has a two-way voicing distinction between short and long lags, TLA has a two-way voicing distinction between pre-voicing and short lags. The influence of the place of articulation of the stop and the vocalic context on the value of VOT is also evident across all dialects.

2.1 Factors Influencing the Duration Of VOT:

Many factors, such as the place of articulation of the stop, vowel quality and duration, gender of the speaker, speaking rate, the position of the stop within the word, stress, and the number of syllables in a word, can influence the duration of VOT. It is only possible to discuss some of these factors in detail due to length constraints. The following sections will review and discuss the influence of place of articulation and the vocalic context. Other factors will also be mentioned and briefly discussed.

2.1.1 *The Influence of Place of Articulation on VOT:*

The main reason behind the variation in VOT duration is related to the place of the constriction. In general, the duration of VOT increases as the place of articulation moves from an anterior place of articulation to a posterior one (Lisker and Abramson 1964, 1967). This means that VOT for /p/ is the shortest, then the /t, which is shorter than that for /k/. Docherty (1992) carried out an experiment on the timing of voicing in British obstruents. His findings confirmed the previous findings by Lisker and Abramson (1964) that the short-lag VOT in /b/ was significantly shorter than that for /g/. Docherty (1992) concluded that longer VOT durations are related to velar stops. In addition, Abdelli-Beruh (2009) carried out an experiment to investigate the relationship between short-

lag VOT and place of articulation, closure duration and voicing in post-voiced in Parisian French. She found that the average short-lag VOT duration is longer in velar stops. Yavaş (2009) investigated the influence of place of articulation and vocalic context on the duration of VOT of English stops. He found a correlation between the place of articulation and VOT. His results agree with the results of previous studies, which found that the duration of VOT is longer in velar stops. In Arabic, Mohammad and Bader (2022) examined the influence of place of articulation, gender and the vocalic context on the duration of VOT for /b/, /d/, /g/, /t/ and /k/ in Najdi Arabic. They found that as the place of articulation moves back, the value of VOT increases. The same results have been confirmed for Mosuli (Rahim and Kasim (2009) and for Libyan Arabic (Elbakay & Zaglom, 2018; Marwan, 2022).

There are numerous answers to why the place of articulation determines VOT. According to Klatt (1975), the volume of the cavity relative to the place of constriction is one of these reasons. Moreover, the velocity of the articulators and the size of the contact area between the articulators can also affect the duration of VOT (Cho & Ladefoged, 1999). In addition, the rate at which the intra-oral pressure decreases after the release of the stop is also crucial to VOT duration (Lisker and Abramson 1967, Abdelli-Beruh 2009:67). The size of the contact area between the articulators forming the constriction can also affect the value of VOT (Stevens, 1999). However, there is a weak correlation between VOT and interarticulator phasing (Löfqvist, 1992, p. 15). Other factors besides interarticulator phasing include the glottis opening, the amount of transglottal pressure and airflow, and vocal folds tension.

Although it is apparent that the place of articulation affects the value of VOT, some studies reported different findings. Docherty (1992), for example, did not find any significant difference between the duration of VOT for /d/ and /g/. Along the same lines, Allen *et al.* (2003) found no difference in VOT duration between alveolar and velars when followed by low vowels. Finally, Mitleb (2009:135) found no difference between the VOT values of /t/ and /k/. Their results could be influenced by speaker variability or the vocalic context. In short, the influence of place of articulation on VOT is observed and confirmed; however, it is variable. As Ladefoged and Maddieson (1990:622) conclude, it is not easy to explain this variation because it could be determined by many factors.

2.1.2 The Influence of Vowel Quality on VOT:

The second factor that affects the duration of VOT is the vocalic context. Klatt (1975) measured the duration of VOT in word-initial consonant clusters. He concluded that the duration of VOT is longer when the stop is followed by a high vowel compared to contexts where the stop is followed by mid and low vowels. In addition, Ohala (1981) reported that the duration of VOT for /p/ in /pi/ was longer than that of /p/ in /pa/. Finally, whether it is tense or lax can affect the duration of VOT. Weisruer (1979) states that VOT is longer when the following vowel is tense than when it is lax.

In investigating the influence of the vocalic context on the duration of VOT in Arabic dialects, Rahim and Kasim (2009:39) conducted a spectrographic study on the duration of VOT in Mosuli Arabic. Their results have shown that voiceless stops have a longer VOT before a close vowel than before a non-close vowel. However, voiced stops were not influenced by the vocalic context. In another study on the Ghamidi dialect, Alghamdi (2004) found that when /t/ and /k/ were followed by the vowel /a/, the average duration of VOT was 25 ms and 30 ms, respectively. The influence of the vocalic context has also been partially confirmed for KLA. In their study on the dialect, Elbakay and Zaglom (2018) pointed out that vowel height significantly affected VOT duration, with VOT values increasing before high vowels and decreasing when the stop preceded low vowels.

With regard to front vs. back vowels, Yeni-Komshian et al. (1977) investigated VOT for /b/, /t/, /d/ and /k/ in Lebanese Arabic when followed by the vowels /i/, /u/ and /a/. When followed by the vowel /i/, VOT for /t/ and /k/ was 30 ms, and for /b/ and /d/, VOT was -40 and -40, respectively. When followed by /u/, VOT for /t/ and /k/ was 25 ms and 30 ms, and for /b/ and /d/, VOT was -75 ms and -70 ms respectively. Finally, when followed by /u/, VOT for /t/ and /k/ was 20 ms and 25 ms, and for /b/ and /d/, VOT was -80 ms and -60 ms, respectively. These results confirm that whether the vowel is front or back does not have any significant effect on VOT durations.

2.1.3 The Influence of Vowel Length

Mitleb (2009) conducted a study to examine the influence of the vocalic context on the duration of VOT in Jordanian Arabic. He found that when followed by a short vowel, the duration of VOT was 37 ms for /t/, 10 ms for /d/, 59 ms for /k/ and 15 ms for /g/. When followed by a long vowel, the duration of VOT was 46 ms for /t/, 23 ms for /d/, 60 ms for /k/ and 20 ms for /g/. In addition, Mohammad and Bader's (2022) findings have also shown that VOTs of voiceless stops in the vicinity of short vowels were shorter than when a long vowel followed the stop.

2.1.4 Other Factors that Influence VOT

There are other factors that can lead to variations in VOT duration. These factors include the age and gender of the speaker, speaker variability, speech rate, the position of the stop, the voicing of consonants in the vicinity of the stops, the number of syllables within the word, and stress. Regarding the speaker's age, it has been found that by the increase in age, VOT values become more variable (Sweeting and Baken 1982). The physiological differences between males and females, including the shape of the glottis and the size of the vocal tract, have also been found to affect the value of VOT. These physiological differences include (Simpson, 2001), the thickness of the vocal folds, and variations in speaking styles (Mattingly, 1966; Shue & Iseli, 2008, p. 4493). The influence of gender on VOT has been noted by Swartz (1992), whose results showed significant differences between

males and females, particularly in /t/ and /d/. Longer VOTs produced by females have been reported by Whiteside and Irving (1997), Ryalls *et al.* (1997), and Whiteside *et al.* (2004). However, other results showed no significant difference between the values of VOTs of males and females (e.g. Smith's 1979).

As for speech rate, previous studies on English voicing have demonstrated that the duration of VOT varies as a function of articulation rate (Miller & Baer, 1983). A decrease in articulation rate results in an increase in VOT duration (Pind 1995: 293). However, some studies reported no significant influence of speech rate on the value of VOT (e.g. Kessinger and Blumstein 1997)

The position of the stop in an utterance has also been said to influence the duration of VOT. Lisker and Abramson (1964) stated that VOT for words produced in isolation was longer than when these words were embedded in a sentence. How many syllables in a word can affect the duration of VOT. For example, the duration of VOT of stops in monosyllabic words was found to be longer by 8% than the duration of VOT of stops in disyllabic words (Klatt, 1975) observed that. Another factor influencing VOT duration is the voicing of neighbouring segments. Weisruer (1979) noticed that when the stop in the coda position was voiced, the VOT value of the onset stop was longer. Finally, stress patterns have been found to influence the duration of VOT. In their study, Lisker and Abramson (1967) found that the value of VOT is longer when the stop occurs in a stressed syllable. In stressed syllables, the value of VOT was even longer. In addition, Lisker and Abramson (1967) noticed that the VOT duration was longer when the following vowel was stressed than when it was unstressed.

3. Methodology

3.1 Participants

Four male participants took part in this study. The age range for the participants is 22-27. All participants were born in Tripoli and have lived there their entire lives. All participants reported no history of speech or listening disorders.

3.2 The Material

The material consists of five lists of frequently occurring monosyllabic words in TLA. All these words contained one of the singleton stops /b/,/t/, /d/, /k/ and /g/ in initial position followed by the vowels /iː/, /i/, /aː/, /a/, /uː/, /u/, /eː/ and /oː/. The total number of tokens is 39 because the phonotactics of TLA do not permit a monosyllabic word starting with /tu/. The words were embedded in the carrier sentence /mat.guː.liːʃ _____ halba/ meaning 'Don't say_____ many times' and written in Arabic on 20 x 5 cm cards. The words were produced five times each in normal conversational speaking rate.

3.3 Acoustic Measurements

In this study, the data was recorded and analysed using Praat software. For voiceless stops, the duration of VOT was measured from the offset of the hold phase (the release burst) to the onset of vocal folds vibration of the following vowel (Lisker & Abramson, 1964; Jannedy, 1995). In voiced stops, VOT was measured from the onset of vocal fold vibration during the hold phase to the release burst.

4. Results

4.1 Results of the Influence Place of Articulation on VOT

stops / Vowels	/b/	/t/	/d/	/k/	/g/
/i/	-48	29	-52	40	-37
/iː/	-53	44	-56	35	-52
/a/	-60	22	-47	37	-39
/aː/	-41	14	-57	30	-55
/u/	-38		-33	40	-40
/uː/	-47	33	-41	43	-47
/eː/	-55	32	-45	40	-52
/oː/	-51	24	-56	39	-56
mean	-49	28	-48	38	-47

Table 1 shows the duration of voice onset time of TLA stops

The first thing to notice about the duration of VOT in Table 1 is that TLA voiceless stops have positive VOT durations, while the voiced stops have negative VOT durations. The average VOT duration for /t/ is 28 ms, and the average VOT duration for /k/ is 38 ms. Apart from the context where /t/ is followed by the close long vowel /i:/, it is evident that VOT for the voiceless stops increases as the point of articulation moves from alveolar to velar. However, all voiced stops do not show the same tendency. The average VOT value for /b/ is -49, followed by /d/ -48 and /g/ has the lowest VOT value of -47. It seems that /b/ has the longest pre-voicing when it is followed by a close vowel, and /g/ has the longest pre-voicing when it is followed by a back vowel. Figure 1 shows the positive VOT for /t/ in the words /tiʃ/ and the negative VOT for /d/ in the word /das/.

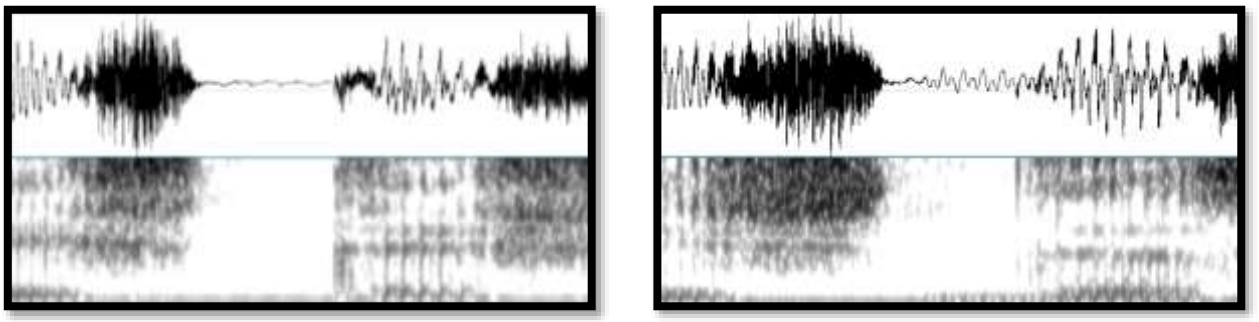

Figure 1: The duration of VOT of /t/ in the word /tiʃ/ (left) and the duration of pre-voicing of /d/ in the word /das/ (right).

4.2 Results of the Influence of Vowel Quality on VOT

Results of the influence of vowel quality on VOT are shown in Table 2. The average VOT duration for /t/, when followed by a close vowel, is 36.5 ms and when /k/ is followed by the same vowel, the average duration of VOT is 37.5 ms. It is worth mentioning that when /t/ preceded the close vowel /i:/, VOT duration was significantly higher than when /k/ preceded the same vowel. Figure 2 shows the duration of VOT in the word /ti:r/ and the duration of pre-voicing of /t/ in the word /ta:b/ (right).

stops / Vowels	/b/	/t/	/d/	/k/	/g/
/i:/ and /i/	-50.5	36.5	-54	37.5	-44.5
/a:/ and /a/	-50.5	29	-52	33.5	-47
/u:/ and /u/	-42.5	33	-37	40.5	-43.5
/e:/	-55	32	-45	40	-52
/o:/	-51	24	-56	39	-56

Table 2: Results of the influence of vowel quality on VOT

When followed by a close vowel, the average VOT duration for /b/, /d/ and /g/ was -50.5, -54 and -44.5 ms, respectively. On the other hand, when /t/ precedes a nonclose vowel, the average VOT duration is 29 ms and when /k/ precedes the same vowel, the average duration of VOT is 33.5. When followed by a nonclose vowel, the average VOT duration for /b/, /d/ and /g/ is -50.5, -52 and -47, respectively. Before a back vowel, the average VOT duration for /t/ is 33ms, and for /k/, it is 40.5 ms. When followed by a back vowel, the average VOT duration for /b/, /d/ and /g/ is -54ms, when it is followed by a close vowel is -42.5, -37 and -43 respectively.

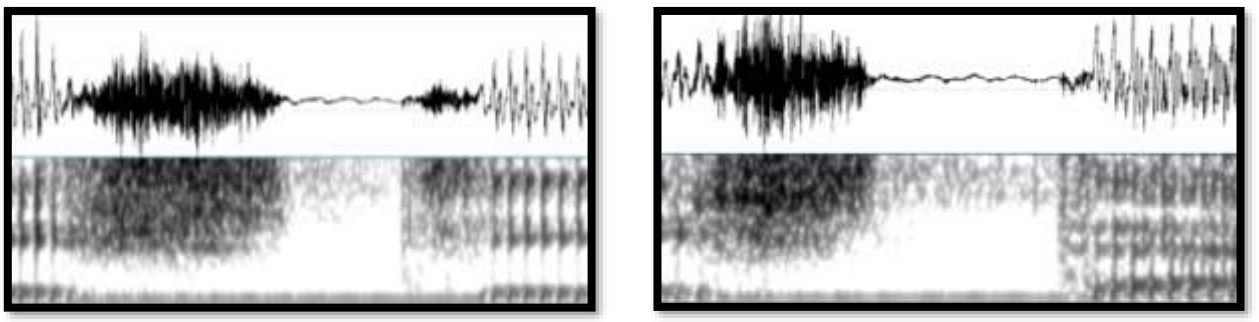

Figure 2: The duration of VOT of /t/ in the word /ti:r/ (left) and in the word /ta:b/ (right).

Concerning the front vowel /e:/, the average VOT duration for /t/ and /k/ was 32 ms and 40 ms. When /b/, /d/ and /g/ were followed by the same vowel, the average VOT duration was -55, -45 and -52, respectively. As for the back vowel /o:/, the average VOT duration for /t/ and /k/ was 24 ms and 39 ms. When /b/, /d/ and /g/ were followed by the same vowel, the average VOT duration was -51, -56 and -56, respectively.

4.3 Results of the influence of Vowel duration on VOT

Table 3 shows the influence of vowel duration on the duration of VOT.

TLA Stops	TLA Vowels					
	/i/	/i:/	/a/	/a:/	/u/	/u:/
/b/	-48	-53	-60	-41	-38	-47
/t/	29	44	22	14		33
/d/	-52	-56	-47	-57	-33	-41
/k/	35	40	37	30	40	43
/g/	-37	-52	-39	-55	-40	-47

Table 3: The influence of vowel duration on the duration of VOT

When /t/is followed by the long close vowel /i:/, the value VOT is 44ms compared to 29ms when it is followed by the short vowel /i/. The same pattern is observed with /k/ where its VOT is longer when the long vowel /i:/ follow it. Figure 3 shows the duration of VOT of /k/ in the word /kis/ and /ki:s/.

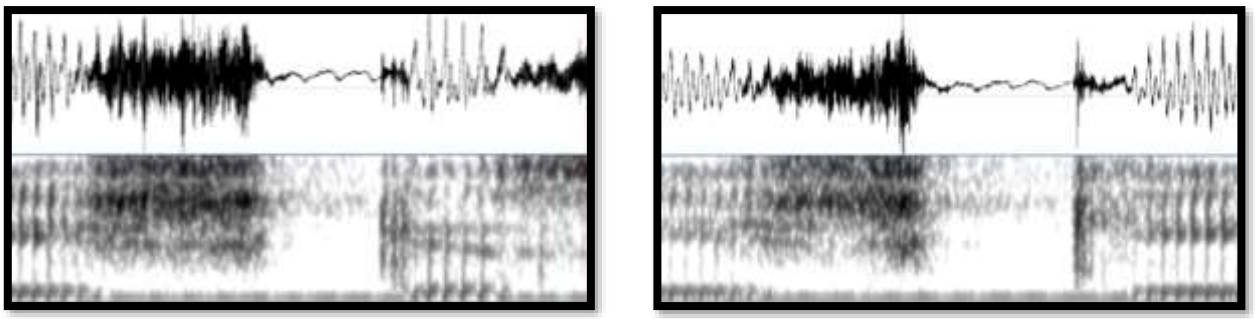

Figure 3: The duration of VOT of /k/ in the word /kis/ (left) and the duration of pre-voicing of k/ in the word /ki:s/ (right).

As for /b/, /d/ and /g/, the duration of pre-voicing is -53, -56 and -52 ms, which is longer when these stops are followed by the short vowel /i/. When /t/ it is followed by the long open vowel /a:/ the value VOT is 14ms compared to 22ms when it is followed by the short open vowel /a/. This contradicts what has been observed with the high vowel /i:/. The same pattern is observed with /k/ where its VOT is longer when it is followed by the short vowel /a/. As for /d/ the duration of pre-voicing is also shorter when it is followed by the long vowel /a:/. The duration of pre-voicing in /b/ and /g/is also shorter when it is followed by the long vowel /a:/. When /k/is followed by the long back vowel /u:/, the value VOT is 43ms compared to 40ms when followed by the short vowel /u/. The same pattern is observed in /b/, /d/ and /g/, where the duration of pre-voicing was -47, -41and -47 ms, which is longer than when these stops are followed by the short back vowel /u/.

5. Discussion

The first thing to notice from the results is that /t/ and /k/ have positive VOT values, and /b/, /d/ and /g/ have negative VOT values regardless of the vocalic context. These results are in line with previous findings on VOT in Arabic dialects such as Colloquial Egyptian Arabic (Rifaat, 2003), Palestinian Arabic (Tamim, 2017), Iraqi Arabic (Alsiraih, 2020) and Khomsy Libyan Arabic (Elbakay & Zaglom, 2018). However, these results are not in agreement with Bellem, who found out that /g/ has a positive VOT and AlDahri (2010), who found that /d/ in MSA and CA has a positive value as well. As for the value of VOT, these results are in line with Shitaw's (2014) results for /k/, but the VOT duration was longer for /t/, which is in agreement with Kriba (2010).

Results of the influence of place of articulation on the duration of VOT confirm previous findings that as the place of articulation moves back in the vocal tract, the duration of VOT becomes longer (e.g. Lisker and Abramson (1964), Docherty (1992), Abdelli-Beruh (2009), Yavas (2009), Mohammad and Bader (2022), Rahim and Kasim (2018), ElBakay and Zaglom (2018), and Maran (2022).

Our results on the influence of vowel quality on the duration of VOT agree with previous findings that VOT is longer when the stop is followed by a high vowel (e.g., Klatt, 1975; Elbakay and Zaglom, 2018). Unlike Rahim and Kasim, who found that this pattern does not hold for voiced stops, in our results, the duration of pre-voicing was longer when the stop was followed by a high vowel. In addition, the results of the influence of vowel duration and vowel extension and retraction don't confirm previous finding that the duration of VOT is longer when the stop is followed by a long vowel (Mitleb 2009 and Mohammad and Bader 2022), and when it is followed by a back vowel (Yeni-Komshian et al., 1977). Finally, the assumption that VOT is higher before a close vowel than a nonclose vowel holds for voiceless stops and the pre-voicing in /d/. It does not show the same tendency in / g /and remains the same for /b/.

Unlike English stops, which are characterised by having a short and long lag (Docherty, 1992), TLA has pre-voicing VOT duration for voiced stops and a short-long lag for voiceless plosives. This means that TLA stops do not exactly fall under the two categories of pre-voicing and short lag. Our findings are in agreement with Flege (1979:9), who pointed out that the Arabic language does not fall into either of these classifications.

6. Conclusion

The current study has investigated VOT for non-emphatic stop consonants in TLA. In monosyllabic words, the stops /b/, /t/, /d/, /k/, and /g/ were recorded, followed by the /iː/,/i/,/aː/,/a/,/uː/,/u/, /eː/ and /oː/. The aim of the study is to investigate the value of VOT and if there is any influence of place of articulation of the stop and the vocalic context on the value of VOT. Results have shown that TLA has a two-way voicing distinction for its stops: positive short lag for voiceless stops and a pre-voicing for voiced ones. Voiceless velar stops have the longest VOT value compared to voiceless alveolar, which is produced in the front part of the vocal tract. The mean VOT values of the voiceless stops are higher when they are followed by long vowels than when the stop is followed by a short vowel.

In this study, the following limitations can be identified. These include the size of the sample, the influence of other factors on the duration of VOT, restricting the study to nonpharyngealised stops and relying only speech recordings.When it comes to the number of particpants, it was only four. The study should have recruited more participants from different parts of Tripoli to make the results representative. In addition, the study did not investigate the influence of other factors such as gender, age, the number of syllables within the word and the articulation rate on the duration of VOT. Taking all these variable into consideration could lead to more comprehensive conclusions. Another limitation is that the study was limited to investigating the duration of VOT of non-pharyngealized stops. Investigating the duration of VOT of the pharyngealized stops /tˤ/ and /dˤ/in TLA could provide more insights into the influence of pharyngealization on the duration of VOT. Finally, in addition to acoustic analysis, the study could have utilized other instruments such as laryngeal imaging to provide more precise results and credible conclusions.

Thus, the current results are by no means thorough and future research can focus on the influence of age, gender, articulation rate and pharyngealization on the duration of VOT. In addition, future research can investigate the duration of VOT in other varieties of Libyan Arabic other that TLA.

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