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VOT-Analysis: The Production of Stops by Agrammatic Palestinians

Hisham Adam

American University of the Middle East-Kuwait

P. O. Box: 220, Dasman 15453, Kuwait

E-mail: hisham.al-adam@aum.edu.kw/hishamadam3@hotmail.com

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Abstract

The aim of this paper is to study the VOT characteristics of Palestinian Broca's aphasics and to compare them with those of normal speakers. The acoustic analysis has revealed aberrations in the VOTs of plosive sounds in speech of Broca's aphasics, by exhibiting an overlap between the places of articulation of the stops under examination /t/ and /d/. In contrast, the normal speakers demonstrate full normal VOT distributions for voiced and voiceless stops. Broca's aphasics were unable to maintain the normal voicing distinction for Arabic stop consonants. In addition, they revealed different patterns of VOT distribution with the tendency towards greater prevoicing for voiced stops.

Keywords: Voice Onset Time (VOT), Palestinian Arabic, Aphasia

1. Introduction

Numerous studies have studied voicing contrasts in stop sounds using voice onset time (VOT) because of its critical attribution to the voiced-voiceless phonetic distinction (Keating, 1984). Voice onset time (VOT) can be defined as the duration between stop release and the beginning of the vowel (Weismer, 1979). In this context, it manifests the temporal relation between the release of the stop sound and the onset of voicing as can be shown in the below figure.

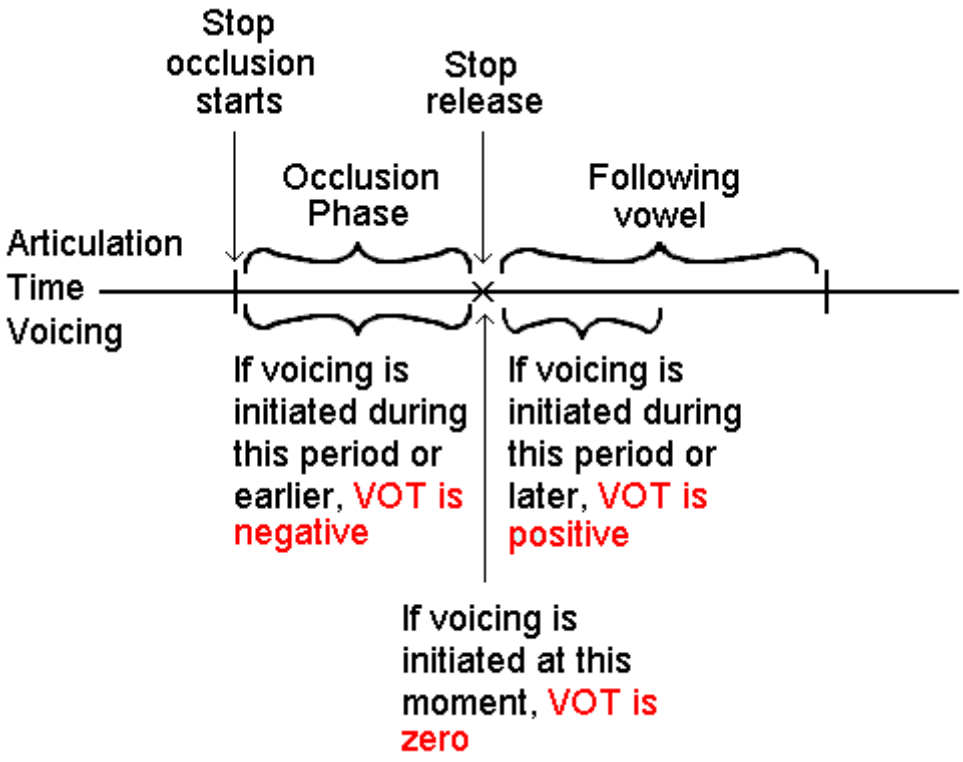

Figure 1. An Illustration of the Voice Onset Time

Voice Onset Time values have three ranges: VOT before the release are stated as negative and called "voicing lead," while VOT values after the release are considered as positive and called "voicing lag." However, if release and voicing occur simultaneously, the VOT is zero. In their investigations, Kent and Read (2002) and Lisker and Abramson (1964) showed, for example, that the voiced stops /b/, /d/, and /g/ show relatively short VOTs (-20 ms to +20 ms), while the voiceless stops /p/, /t/, and /k/ have relatively long VOTs.

Many studies have shown that VOTs vary with place of articulation. For example, It has been found that bilabial stops have the shortest VOT, alveolar stops have intermediate VOT mean values; and velar stops, on the other hand, are produced with the longest VOT (John et al., 2010) . Many factors can affect VOT patterns and values, including physiological factors like age, lung volume, and pathological conditions, such as hearing impairments (Catherine et al., 2010). Moreover, different linguistic variables, such as speech rate, phoneme environment, syllable structure, and vowel height, influence VOT patterns and distributions.

2. VOT in Arabic

In fact, numerous studies have investigated VOTs in many other languages compared to Arabic. For example, in their comprehensive study, Keating et al. (1983) report on VOT in 51 languages, and more recently Cho and Ladefoged (1999) investigated VOT in 18 languages (Cho & Ladefoged, 1999). In general, most existing studies concentrate on English. However, VOT patterns in Arabic have been less documented, which is not the case in English. It is nevertheless undeniable that differences between the distribution of VOT values in Arabic and English are predictable. In this regard, based on Figure 2, a comparison of the VOT distributions of speakers in the two languages demonstrates that the VOT range of the Arabic voiceless stops is within the range of the English voiced stops, whereas the voiced Arabic stops and voiceless English stops occupy the end of the continuum.

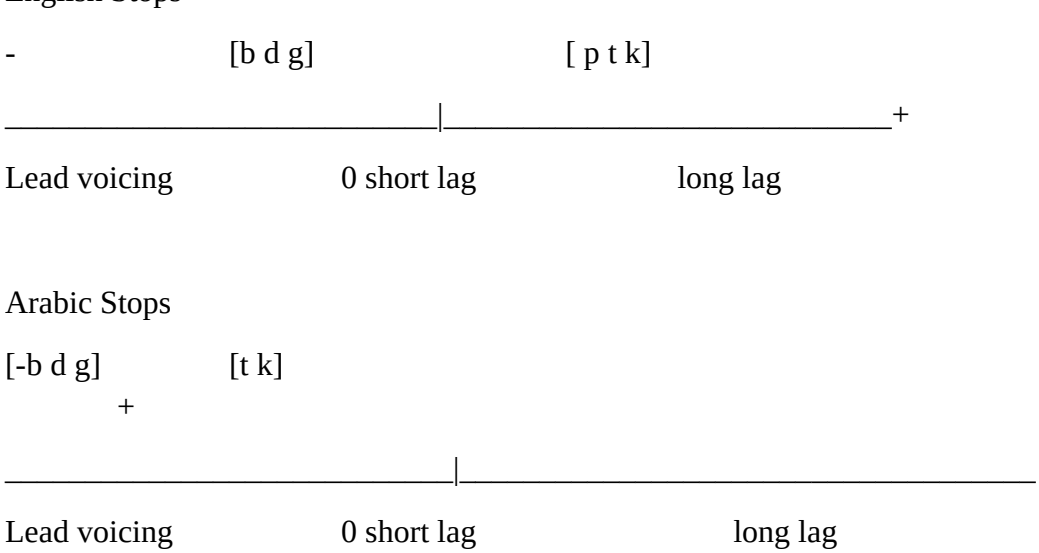

Figure 2. VOT distributions

3. Neurolinguistic VOT Studies on Aphasia

Wide range of studies on agrammatism found that Broca's aphasic speech is characterized by the omission or substitution of function words (see Goodglass, 1993; Mortenet al., 2010 for reviews). They also demonstrate a reduction in sentence length and syntactic complexity in language production. Moreover, their speech demonstrates expressive deficits, but with relatively good comprehension abilities. Speech is slow, labored, and monotonous. Broca's aphasics generally find it more difficult to produce consonants than vowels.

Several studies have revealed the crucial role of VOT in both speech production and perception, since it conveys information about the coordination between laryngeal and supralaryngeal mechanisms. In general, as an acoustic cue, VOT serves as "an inferential estimate of speech motor control, requiring fine motor coordination of the respiratory, phonatory and articulatory structures" (Robb et al., 2005:125).

In fact, VOT patterns and values have been widely investigated in aphasia (Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, 1980; Blumstein, Cooper, Zurif, & Caramazza,

1977). Studies of language and speech disorders have shown that neuropathological changes in patients, particularly those with strokes, would affect their ability to establish voicing discriminations. In this regard, research examining VOT in individuals with aphasia has produced mixed results. Some research has established longer VOTs, while other research has established shorter VOTs. Blumstein and Cooper (1980) indicate that the performance of Broca's aphasics on voicing discrimination tasks was quite good; however, they also exhibited overlapping patterns between voiced and voiceless stops. In contrast, Wernicke's aphasia is distinguished by a phonemic deficit. General speaking, studies on aphasia have demonstrated that Broca's aphasic patients exhibit phonetic errors, while Wernicke's aphasics reveal phoneme mistargeting (Sidiropoulos et al., 2010).

In accordance with the patterns found across Broca's aphasics, studies conducted on apraxic patients demonstrated overlapping patterns between voiced and voiceless stops and showed that their VOT values were longer than those of normal speakers (Pazzaglia, et al. 2008). Similar results were obtained by Gandour and Dardarananda (1984), who found voiced and voiceless overlapping in the production of stop sounds by apraxic subjects and their voicing lag was longer than that of normal speakers. In particular, a number of investigations have demonstrated that anterior aphasics show impaired VOT production and overlapping between the stop sounds. For example, Gandour and Dardaranada drew the conclusion that the deficit lies in coordinating between the "abductory and adductory forces at the larynx with upper articulatory events" (Gandour & Dardarananda, 1984:202). It would be expected, on this basis, that those patients would display timing deficits. In contrast to the previous findings, Shewan et al. (1984) indicate that Broca's subjects produce short VOT lead and lag.

In the light of previous results, the aim of this paper is to study the VOT characteristics of Palestinian Arabic aphasics and compare them with those of normal speakers. The Alveolar sounds [d] and [t] were chosen for this study since the voicing cue distinguishes these stops in Arabic. The paper tries to get a picture of Palestinian aphasic patterns by highlighting the similarities and differences that might appear in comparison with normal speakers and non-Arabic aphasics. In general, aphasics' VOT values would be expected to be significantly different to those of normal speakers and VOT duration would be expected to be a crucial cue in voiced/voiceless distinction.

4. Method

4.1 Participants

Five male patients aged 45-70 participated in this study. All spoke Palestinian Arabic as their mother tongue and were from the same region. They were all right- handed and had no significant history of educational problems. Each patient underwent a standardized aphasia assessment and all were diagnosed with mild to moderate Broca's aphasia. In all cases there was no reported neurological surgery, neurological disorders, and no reported previous speech, language, or hearing disorders unrelated to their manifestations.

Five normal speakers served as a control group, roughly matched for age (within 15 months) and gender with the Broca's aphasics, participated in the current study. None of the control

subjects had a history of speech, language, or hearing disorders or had undergone neurological diagnoses or neurological surgery.

4.2 Measurement and Procedure

Spontaneous speech samples of both the aphasic patients and the control group were analyzed. The VOT stimuli and recording measurements were the same for both groups. "Phonolab" software was used to measure VOT values. The VOT for voiceless stops was measured from the onset of the release burst to the highest point of the first periodic cycle. The VOT values were given positive values in terms of voicing lag. For pre-voiced stops, the measurement of VOT was taken from the onset of the first periodic cycle in the closure period to the beginning of the release burst and it was reported as a negative value, as it took place before the stop release that is defined as voicing lead. The initial voiced stop /d/ and the initial voiceless stop /t/ in a non-emphatic context followed by the vowel /a/ were investigated.

5. Results and Discussion

As illustrated in table 1, the normal speakers exhibited no overlap between all the places of articulation for the stop consonants. This is evidence of the fact that normal speakers show full voicing lead for the voiced stops and voicing lag for the voiceless stops, indicating a control of time programming for production of the targeted phonemes.

Subjects	[t]	[d]
Normal speakers	20	10

Table 1. VOT Average Duration (ms) for Normal Speakers

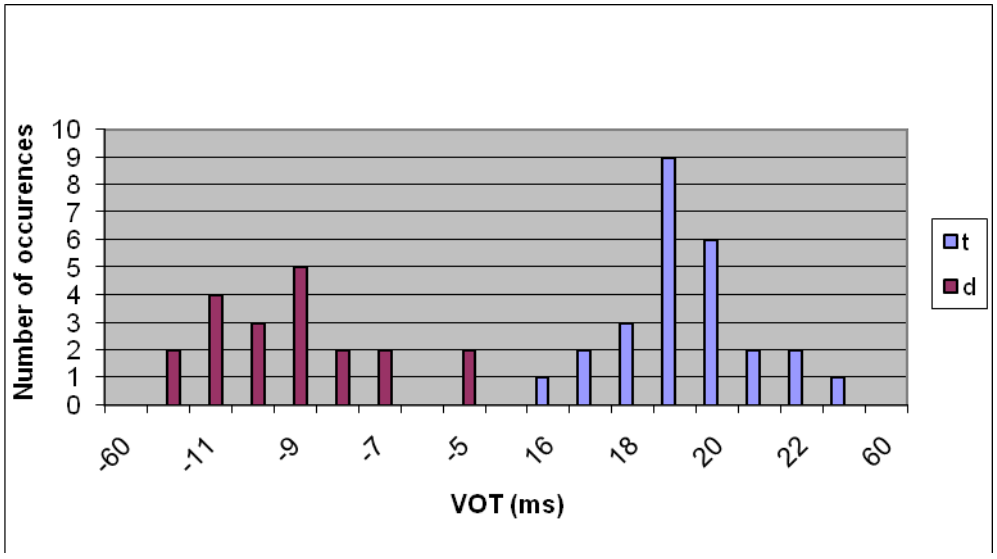

Figure 3. VOT distribution of the stops [t] and [d] for the control group.

However, as figure 4 illustrates, in contrast to the results of normal speakers as shown in figure 3, the aphasic subjects displayed overlapping between [t] and [d]. In figure 4, for example, it is clear that the VOT values for [t] and [d] overlapped. Therefore, [t] is sometimes produced in the voicing lead and [d] in the voicing lag, which is inconsistent with normal patterns. Furthermore, the findings show that the aphasic subjects exaggerated with aspiration of the voiceless stop [t] and produced it with higher VOT values.

Significantly, these aphasic patients reversed the pattern found in other studies (Baum, et al., 1990), where the VOT of Broca's aphasics for voiceless aspirated stops is shorter than for normal speakers, producing long VOT for these consonants in the current study (Blumstein & Cooper, 1980).

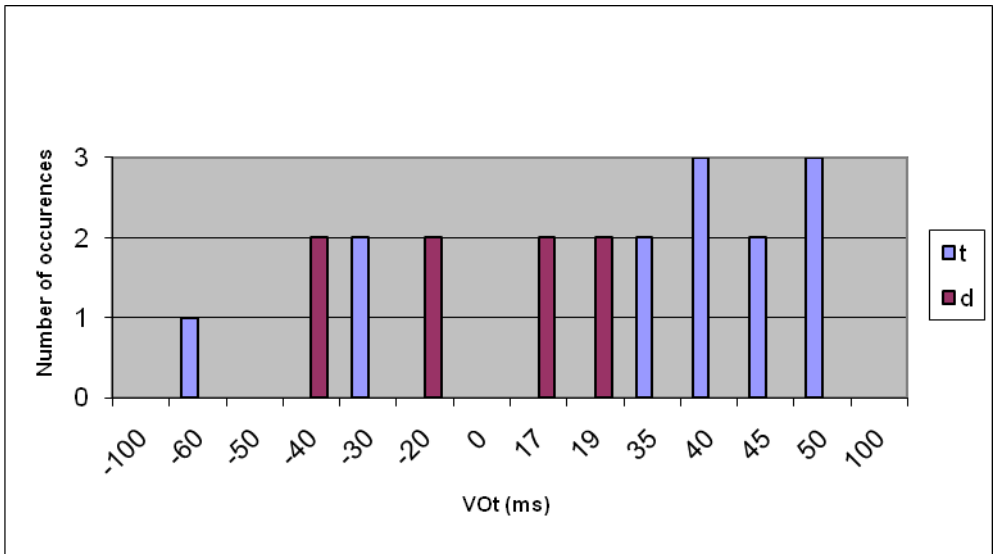

Figure 4. VOT distribution of the Stops [t] and [d] for Broca's Aphasics.

In this regard, it is important to point out that these overlapping errors shed light on the nature of production deficits in Broca's aphasia. In this regard, this finding would seem to suggest that the deficit of Broca's aphasic patients is phonetic rather than phonological, also reflecting patterns of timing difficulties. This also emphasizes the fact that Broca's aphasics exhibit temporal deficits in the control mechanism of the articulation process, in particular, how to integrate the articulatory movements (Daprati et al., 2010). Consequently, this overlap implies that those patients have problems in integrating the multiple articulatory aspects of the speech process, an implication that has also been noted in other studies (Blumstein, 1991).

The acoustic analysis in the current study indicates that VOT is a reliable acoustic cue for voicing contrast, reflecting the timing complexity of the supralaryngeal–laryngeal coordination mechanism. This means that Broca's aphasics have difficulty maintaining a timing control between the laryngeal and supralaryngeal articultory sequences. Thus, there is a notable overlap between the voiced and voiceless stop, indicating impaired temporal coordination of laryngeal and supralaryngeal movements.

The present findings are in line with those found in other studies, indicating that Broca's aphasics are characterized by an overlap between voiced and voiceless stops (Baum et al., 1990). However, the results of other investigations involving other languages are inconsistent with the results of the current study. For example, Itoth et al. (1982) reported that Thai aphasics produce shorter voicing leads for fully voiced stops than normal speakers, while our aphasics exhibit longer voicing leads. Furthermore, Blumstein et al. (1977) indicates that the aphasics' performance on the voiceless aspirated English stops shows no definite trends, some producing shorter voicing lags with others producing longer voicing lags. In contrast, interestingly, the aphasics who participated in this study produced longer voicing lags for [t] compared to normal speakers.

6. Conclusion

On the whole, the Broca's aphasic subjects who participated in this study exhibited remarkable deficits in VOT production compared to normal speakers. Their VOTs are in general higher than those of normal speakers. Overlapping between the voicing lags and voicing leads was notable. Some results of this study have confirmed previous studies. However, in spite of some consistencies with other studies, Arabic aphasics display particular patterns that are not found in other languages, like exhibiting longer voicing leads. The results also emphasized the effectiveness of VOT as a tool to help researchers and clinicians distinguish stop consonants according to voicing and place of articulation.

References

Bartha, L., & Benke, T. (2003). Acute Conduction Aphasia: An Analysis of 20 Cases. *Brain and Language, 85,* 93-108. http://dx.doi.org/10.1016/S0093-934X(02)00502-3

Baum, S., Blumstein, S., Naeser, M., & Palumbo, C. (1990). Temporal Dimensions of Consonant and Vowel Production: An Acoustic and CT Scan Analysis of Aphasic Speech. *Brain and Language,* 39, 33-56. http://dx.doi.org/10.1016/0093-934X(90)90003-Y

Blumstein, S. (1991). Phonological aspects of aphasia. In M.T. Sarno (Ed.), *Acquired aphasia.* San Diego, CA: Academic Press. Second edition. http://dx.doi.org/10.1016/B978-012619322-0/50008-7

Blumstein, S., Cooper, W., Goodglass, H., Statlender, S., & Gottlieb, J. (1980). Production Deficits in Aphasia: A Voice-Onset Time Analysis. *Brain and Language, 9,* 153-170. http://dx.doi.org/10.1016/0093-934X(80)90137-6

Blumstein, S., Cooper, W., Zurif, E., & Caramazza, A. (1977). The Perception and Production of Voice-Onset Time in Aphasia. *Neurophysiologia, 15,* 371-383. http://dx.doi.org/10.1016/0028- 3932(77)90089-6

Catherine T. Best, Pierre A., & Hall é M. (2010). Perception of initial obstruent voicing is influenced by gestural organization. *Journal of Phonetics, 38,* 109-126.

Cho, T., & Ladefoged, P. (1999). Variation and universal in VOT: evidence from 18 languages. *Journal of Phonetics, 27,* 207-227.

Daprati, E., Nico, D., Duval, S., Lacquaniti, F. (2010). Different motor imagery modes following brain damage. *Cortex, 46,* 1016-1030. http://dx.doi.org/10.1016/j.cortex.2009.08.002

Frank, B., & Alfredo, A. (1996). *Aphasia: A Clinical Perspective*. New York: Oxford University Press.

Gandour, J., & Dardarananda, R. (1984a). "Voice Onset Time in Aphasia: Thai II. Production. *Brain and Language* 23, pp. 177-205. http://dx.doi.org/10.1016/0093-934X(84)90063-4

Goodglass, H. (1993). *Understanding aphasia*. San Diego, CA: Academic Press.

Itoh, M., Sasanuma, S., Tatsumi, I., Murakami, S., Fukusako, Y., & Suzuki, T. (1982). Voice Onset Time Characteristics in Apraxia of Speech. *Brain and Language, 17,* 193-210. http://dx.doi.org/10.1016/0093-934X(82)90016-5

John, H., Sharmistha, S., Wooil, K. (2010). Automatic voice onset time detection for unvoiced stops (/p/,/t/,/k/) with application to accent classification. *Speech Communication,* 109-126.

Keating, P. (1984). Phonetic and Phonological Representation of Stop Consonant Voicing. *Language, 60,* 286-319.

Keating, P., Linker, W., & Huffman, M. (1983). Closure duration of stop consonants. *Journal of Phonetics, 11,* 277-290.

Kent, R., & Read, C. (2002). *The acoustic analysis of speech*. 2nd ed. Albany: Delmar. http://dx.doi.org/10.1002/9781444301007.ch22

Khattab, G. (2002). VOT in English and Arabic bilingual and monolingual children. In: D. Parkinson & E. Benmamoun (eds.), ed. *Perspectives on Arabic Linguistics XIII-XIV*. Papers from the Thirteenth and Fourteenth Annual Symposia on Arabic Linguistics. Amsterdam/ Philadelphia: John Benjamins Publishing Co.

Klatt, D. (1975). Voice onset time, frication, and aspiration in word-initial consonant clusters. *Journal of Speech and Hearing Research, 17,* 51-63.

Kyriakos, S., Hermann A., Michael, W., & Ingo H. (2010). Temporal processing capabilities in repetition conduction aphasia. *Brain and Cognition,* 73, 194-202.

Lisker, L., & Abramson, A. (1964). A cross-language study of voicing in initial stops: Acoustical measurements. *Words, 20,* 384-422.

Morten, H., Louise, M., Richard, C., & Shillcock, K. (2010). Impaired artificial grammar learning in agrammatism. *Cognition, 116,* 382-393

Pazzaglia, M., Smania, N., Corato, E., & Aglioti, S. (2008). Neural underpinnings of gesture discrimination in patients with limb apraxia. *Journal of Neuroscince, 28,* 3030–3041. http://dx.doi.org/10.1523/JNEUROSCI.5748-07.2008.

Robb, M., Gilbert, H., & Lerman, J. (2005). Influence of Gender and Environmental Setting on Voice Onset Time. *Folia Phoniatrica*, *57*, 125-133. http://dx.doi.org/10.1159/000084133

Shewan, C., Leeper, H., & Booth, J. (1984). An Analysis of Voice Onset Time (VOT) in Aphasic and Normal Subjects. In J. Rosenbek, M. McNeill, & A. Aronson (Eds.), *Apraxia of Speech.* San Diego, California: College-Hill Press, 197-220.

Weismer, G. (1979). Sensitivity of Voice-Onset-Time (VOT) Measures to Certain Segmental Features in Speech Production. *Journal of Phonetics*, *7*, 197-204.