

THE PERCEPTUAL RECOGNITION OF STOP CONSONANTS IN CV VS WORD CONTEXT IN ARABIC

Ziyad Rakan Kasim

Department of English, College of Education, University of Mosul, Iraq
ziyadrakan@yahoo.com

ABSTRACT

The context in which sounds occur exhibits some effect on the perception of these sounds. This study attempts to test the recognition of the Arabic stop consonants /p,b,t,d,k,g/ in two contexts, viz. CV and word. The purpose is to find out whether there is a recognition difference between these two contexts over a range of voice onset time (VOT). A test was conducted in which twenty-one native speakers of Arabic listened to the six stops in the two contexts. The result of the test showed that there was no statistically significant difference between the two contexts for all the stops except for /k/ which showed higher recognition in the word context.

Keywords: perception, stops, Arabic, VOT, context

1. INTRODUCTION

Many studies have dealt with the perception of the stop consonants using synthetic stimuli [1, 2, 3] or natural speech [6]. Most of these studies have utilized the syllable as a basic test unit, and some of them have used the word, or even the sentence for their tests [5]. The parameter of voice onset time (VOT) has been employed in most of these experiments and proved to be useful.

In a study on consonant identification in nonsense syllables and words [9] it has been found that "consonants were slightly more accurately identified in words than in nonsense syllables", p.252. It would be reasonable to predict that recognition of consonants in words will be higher than in syllables since the former context provides more information, like semantic clues for example, which could be utilized to assist recognition.

Few studies have investigated the subject in Arabic [4], and most of them have tackled the stop consonants from a production viewpoint [8]. This is a preliminary study to investigate the recognition of the Arabic stop consonants /p,b,t,d,k,g/ in two contexts, viz. CV and word over a range of VOT for each stop.

2. AIM OF THE STUDY

In a previous study [4] the perception of the Arabic stop consonants /p,b,t,d,k,g/ has been studied in the syllable context. The aim of the present study is to investigate whether the presence of meaning in context, at the word level, affects recognition. Thus, this study attempts to find out whether there is a statistically significant difference or not between the recognition of these stop consonants in a CV context compared to a word context.

3. HYPOTHESIS

The null hypothesis of this study states that there is no statistically significant recognition difference of the stop consonants between the CV context and the word context ($H_0: \mu_1 = \mu_2$). The alternative hypothesis states that there is a statistically significant recognition difference between the two contexts ($H_1: \mu_1 \neq \mu_2$). The level of significance used is (0.05).

4. PROCEDURE

4.1. Test material

In order to test the research hypothesis, a test has been conducted in which the six stops /p,b,t,d,k,g/ were imbedded in three minimal pairs: /pe:k,be:k/, /ti:n,di:n/, and /ki:l,gi:l/. These utterances are meaningful words. They were recorded by a native speaker of Arabic and a spectrogram was obtained for each word. It should be noted that the two stops /p/ and /g/ do not occur in Standard Arabic, but they do occur in many Arabic dialects. They have been included in this study for the sake of performance comparison with /b/ and /k/, respectively.

4.2. Recognition material

Each word was cut into two halves, thus, obtaining two types of tokens: a full word token (before the cut), and a CV token (after the cut) which consisted of the stop followed by approximately half of the following vowel. The reason why the

same words were used to slice the CV token from was to keep everything constant except for the variable under investigation, i.e. the presence, or absence, of meaning.

The VOT range for each pair of stops was measured; for /p,b/ it was 25 to -25 msec., for /t,d/ it was 55 to -55 msec., and for /k,g/ it was 88 to -88 msec.

The VOT range of the initial stop for each word was cut into 5 msec. steps and a set of three audio files was obtained. Each audio file contained the tokens of one of the voiceless stops with its voiced counterpart in random order. The interstimulus interval was 3 seconds. The same procedure was followed for the CV tokens and another set of three audio files was prepared. The number of tokens was as follows: 10x2 for /p,b/, 11x2 for /t,d/, and 16x2 for /k,g/.

4.3. Subjects

Twenty one subjects participated in the recognition test (12 males and 9 females). All of them were educated native speakers of Arabic. Their ages ranged between 25 and 40 years. None of them reported any hearing problems.

4.4. Test presentation

The test consisted of two sets of audio files: CV and word tokens. The CV tokens were presented before the word tokens for each subject. The arrangement of each pair of stops was randomized for the subjects.

Each subject listened to each audio file separately (/p,b/, /t,d/ or /k,g/) in a random order using a deadest. S/he was asked to identify the sound heard and write down the letter that corresponded to that sound (using Roman letters, either 'p' or 'b'; 't' or 'd'; 'k' or 'g'). If the sound heard was neither one of the pair, or not heard clearly, the subject was instructed to use a hyphen.

The subjects were tested separately in a sound treated lab. A brief preparation session preceded the test for each subject who listened to a sample of the test in order to be familiar with the procedure.

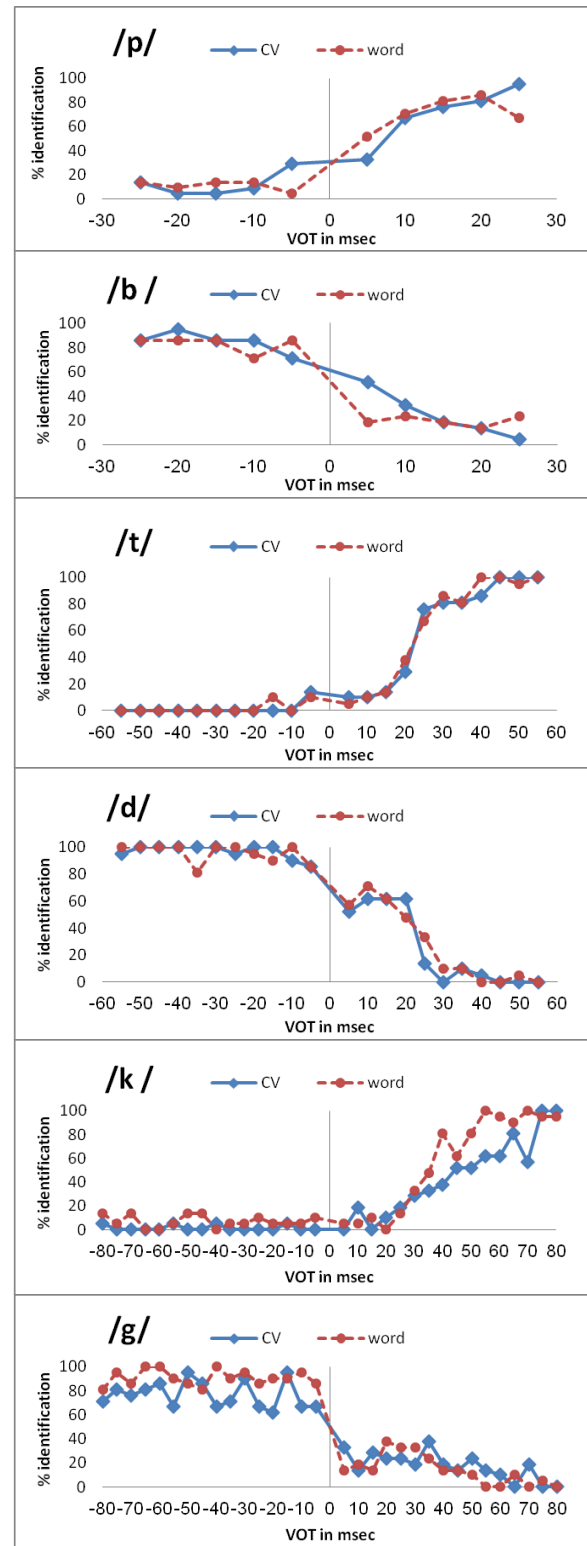
5. RESULTS

Fig. 1 shows the results of the test for each stop. A comparison has been made between the subjects' performance in the two contexts CV vs. word.

The comparison between the recognition of the stops in the CV context and the word context

demonstrated a similar pattern (there is almost a match with /t/ and /d/). However, the patterns of the two velar stops did not exhibit the same tendency.

Figure 1: A comparison between the recognition of the six Arabic stops in two contexts: CV and word.



In order to test whether a statistically significant difference existed between the two contexts, a T-test (two-tails, paired samples) has been used. A comparison was made between the percentages of identification of each stop in the two contexts. The results are summarized in Table 1. The percentages are given in Table 2.

Table 1: Summary of the T-test results.

stop	P value
/p/	1.000
/b/	0.510
/t/	0.535
/d/	0.703
/k/	0.001
/g/	0.052

It can be seen from Table 1 that the only statistically significant difference between the two contexts is with /k/ (p value < 0.05). The other stops did not illustrate any significant difference (p value > 0.05). Consequently, the null hypothesis was accepted for /p,b,t,d,g/ and rejected for /k/; i.e. there was no statistically significant context difference with /p,b,t,d,g/. The only statistically significant difference was related to /k/.

6. DISCUSSION

Two things need explanation in relation to the results obtained. The first thing is related to /p,b,t,d,g/ which showed no context difference effect. In the present study monosyllabic words were used and this might contribute to their being *similar* to the CV tokens. And this point is strongly related to the procedure followed in preparing the data. The CV tokens were sliced from the word tokens and this might contribute to the similarity, and hence lack of difference, between the two contexts. Thus, further investigation is needed where different types of tokens are taken from different sources to confirm the current result.

The second important result is the statistically significant difference with /k/. Although the explanation offered above might hold for /p,b,t,d,g/, /k/ seems to resist this explanation. If we look at Fig.1, we notice that the recognition of /k/ started to score higher than 50% when the VOT value was above 40 msec. This might indicate that the listeners had the opportunity to distinguish /k/ in the word context from the CV context since another acoustic clue was present and that was aspiration. This explanation might hold when /k/ is compared to /p/ because /k/ was followed by a close vowel /i:/ and /p/ was followed by a nonclose

Table 2: Identification percentages of the six Arabic stops in two contexts: CV and word.

VOT range in msec.	CV		Word	
	% /b/	% /p/	% /b/	% /p/
-25	86	14	86	14
-20	95	5	86	10
-15	86	5	86	14
-10	86	9	71	14
-5	71	29	86	5
5	52	33	19	52
10	33	67	24	71
15	19	76	19	81
20	14	81	14	86
25	5	95	24	67
	% /d/	% /t/	% /d/	% /t/
-55	95	0	100	0
-50	100	0	100	0
-45	100	0	100	0
-40	100	0	100	0
-35	100	0	81	0
-30	100	0	100	0
-25	95	0	100	0
-20	100	0	95	0
-15	100	0	90	10
-10	90	0	100	0
-5	86	14	86	10
5	52	10	57	5
10	62	10	71	10
15	62	14	62	14
20	62	29	48	38
25	14	76	33	67
30	0	81	10	86
35	10	81	10	81
40	5	86	0	100
45	0	100	0	100
50	0	100	5	95
55	0	100	0	100
	% /g/	% /k/	% /g/	% /k/
-80	71	5	81	14
-75	81	0	95	5
-70	76	0	86	14
-65	81	0	100	0
-60	86	0	100	0
-55	67	5	90	5
-50	95	0	86	14
-45	86	0	81	14
-40	67	5	100	0
-35	71	0	90	5
-30	90	0	95	5
-25	67	0	86	10
-20	62	0	90	5
-15	95	5	90	5
-10	67	0	95	5
-5	67	0	86	10
5	33	0	14	5
10	14	19	19	5
15	29	0	14	10
20	24	10	38	0
25	24	19	33	14
30	19	29	33	33
35	38	33	24	48
40	19	38	14	81
45	14	52	14	62
50	24	52	10	81
55	14	62	0	100
60	10	62	0	95
65	0	81	10	90
70	19	57	0	100
75	0	100	5	95
80	0	100	0	95

vowel /e:/. It has been shown that aspiration before a close vowel was greater than before a nonclose vowel [7, 8]. The same explanation could be offered to /t/ since a velar stop is expected to have greater aspiration than an alveolar stop due to the oral configuration difference between the two articulations.

7. CONCLUSION

This study has investigated the effect of context on the recognition of the Arabic stops /p,b,t,d,k,g/. The stops have been used in CV and word contexts. The result of the study has shown that there was no statistically significant difference between the two contexts in relation to /p,b,t,d,g/. The only statistically significant difference found was with /k/ which has shown higher recognition in the word context.

8. REFERENCES

- [1] Abramson, A.S., Lisker, L. 1965. Voice onset time in stop consonants: Acoustic analysis and synthesis. In Commins, D.E. (ed.), *Proc. 5th Int. Congr. on Acoustics* Liege, Vol. Ia, Paper A51.
- [2] Abramson, A.S., Lisker, L. 1970. Discriminability along the voicing continuum: Cross-language tests. *Proc. 6th ICPhS Prague*, 569-573.
- [3] Cooper, F.S., Delattre, P.C., Liberman, A.M., Borst, J.M., Gerstman, L.J. 1952. Some experiments on the perception of synthetic speech sounds. *J. Acoust. Soc. Am.* 24, 597-606.
- [4] Kasim, Z.R. 2011. The perceptual voiceless-voiced distinction of Arabic stop consonants. *Journal of Education and Science* 18, 186-195.
- [5] Lisker, L., Abramson, A.S. 1965. Voice onset time in the production and perception of English stops. *Status Report on Speech Research*, Haskins Lab, 1.3.1.
- [6] Lotz, J., Abramson, A.S., Gerstman, L.J., Ingemann, F., Nemser, W.J. 1960. The perception of English stops by speakers of English, Spanish, Hungarian and Thai: A tape-cutting experiment. *Language and Speech* 3, 71-77.
- [7] Ohala, J.J. 1983. The origin of sound patterns in vocal tract constrains. In MacNeilage, P.F. (ed.), *The Production of Speech* New York: Spring-Verlag, 189-216.
- [8] Rahim, A.J., Kasim, Z.R. 2009. A spectrographic study of voice onset time in Arabic. *Journal of Education and Science* 16, 28-41.
- [9] Woods, D.L., Yund, E.W., Herron, T.J. 2010. Measuring consonant identification in nonsense syllables, words, and sentences. *Journal of Rehabilitation Research & Development* 47(3), 243-260.