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ACOUSTIC ANALYSIS OF THE LENGTH OF /ʃ/ AND /ʒ/ IN ENGLISH AFFRICATES

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Abstract
To participate in the ongoing debate of whether affricates are single phonemes or a combination of two distinct phonemes, this paper reports the results of an acoustic study of affricates. One of the arguments that supports one phoneme analysis is based on the assumption that the length of /ʃ/ and /ʒ/ as single phonemes tends to be shorter when they are involved within the affricates /ʧ/ and /ʤ/ respectively. However, this assumption has not been acoustically investigated. Thus, this paper measures the duration of /ʃ/ and /ʒ/: first when they are alone, and second when they are involved in affricates to identify any length variation between the two cases. The study is based on acoustic and statistical analyses of the recordings of Iraqi, British and American speakers of English, who were asked to pronounce words that have the two fricatives /ʃ/ and /ʒ/ alone and in affricates as well. The results of paired samples t-tests showed a significant difference in the length of /ʃ/ and /ʒ/ as single phonemes and their length when involved within affricates in the pronunciation of Iraqi, British and American speakers on both the group and the overall levels. These results support the one phoneme analysis of affricates. Moreover, the results indicated that Arab learners and Iraqis in particular count heavily on temporal cues rather than spectral cues in perceiving English sounds. This shows the need for more training on the part of learners and teachers, and more attention on the part of English textbook designers.

Keywords: acoustic analysis, affricates, one phoneme theory, two phoneme theory

Introduction

One of the problems of phonemic analysis referred to in Roach (2010) is whether to consider the affricates /ʧ/ and /ʤ/ as single phonemes, one-phoneme analysis, or as two phonemes, two-phoneme analysis. The latter analysis considers the phonemes /t/, /ʃ/, /d/ and /ʒ/, which make up the affricates /ʧ/ and /ʤ/ respectively, independent phonemes that are already included in the list of phonemes of the English language. This analysis is motivated by the idea of the economy i.e. the list of the language phonemes will be shorter. If the affricates /ʧ/ and /ʤ/ are treaded as being made up of the two phonemes each, there is no need to add two extra symbols to the list of phonemes. Hence, the list will not include

the symbols /ʧ/ and /ʤ/, because the symbols /t/, /ʃ/, /d/ and /ʒ/ are already included in the list. Based on the one-phoneme analysis, the word "church" for example is made up of five phonemes (/t/, /ʃ/, /e:/, /t/ and /ʃ/. The affricates here are seen to be composed of two phonemes.

The analysis that sees the affricates /ʧ/ and /ʤ/ as single phonemes consider these phonemes new distinct phonemes that should be added to the list of the English phonemes, even though they are phonetically composed of a stop sound followed by a fricative sound. Based on this analysis, the word "church" is composed of three phonemes only (/ʧ/, /e:/ and //ʧ/). This analysis assumes affricates to be distinct phonemes though they are phonetically made up of complete closure and a period of fricative release.

The affricate /ʧ/ is articulated in a similar position to that of /t/, but instead of a rapid release with plosion and aspiration as we would find in the word "tip" the tongue moves to the position for fricative /ʃ/ as we find at the beginning of the word "ship". Thus, in the affricate, the explosion is immediately followed by a fricative noise. Similarly, the word "judge" for example, begins and ends with the affricate /ʤ/. It is also articulated in a similar position to that of /d/; but, instead of a rapid release with plosion and aspiration as we would find in the word "dope", the tongue moves to the position for the fricative /ʒ/ as we find in the word "pleasure". Shariq (2015, p. 150) resembles the production of an affricate to that of a stop claiming that "there are three stages called; closing, compression, and release. However, the release is sudden in the case of plosives while it is gradual in the production of affricates. The closure part of the affricate is represented by a plosive, and the release part, fricative is produced at the same point". Accordingly, an affricate is often symbolized with two symbols in transcription and often in two letters in writing.

As it was mentioned above, the two-phoneme analysis is based on the desire to be as economic and brief as possible. Language users do not want to have a longer list of phonemes; hence, they consider affricates combinations of phonemes that are already listed as phonemes rather than two new phonemes to be added to the list. The one-phoneme analysis, on the other hand, is based on several assumptions related to the spectral properties of these phonemes as well as their distribution in the language. These assumptions are summarized in a later section of this work.

To the best knowledge of the researchers, no previous test has acoustically measured the length of these consonants as they are pronounced by native or non-native speakers of English. Hence, this study is an attempt to test this assumption with regard to the native; American and British speakers, and non-native Iraqi EFL learners of English. The study aims to examine acoustically whether the length of single phonemes /ʃ/ and /ʒ/ is longer than /ʃ/ and /ʒ/ when they are within the affricate /ʧ/ and /ʤ/ respectively. The study also examines if there are any differences in these phonemes length among native and non-native speakers. The study is interested in the phonetic, length, assumption as one of the four assumptions that support the one phoneme theory. Other assumptions are beyond the scope of this study.

According to Philip (1999, P. 14), affricates are "sounds produced with a constriction of complete closure followed by a release phase in which friction occurs". Thus, affricates involve a complete closure like the one made in the

production of a stop and require friction as the one made in the production of a fricative. Mannell (2008) elaborates that affricates are frequently regarded as intermediate between stops and fricatives i.e. affricates share the features of stops (closure) and fricatives (friction). The complete closure and friction are two essential features in languages that distinguish between stops and fricatives, as it is the case in English. Figure 1 below illustrates the pronunciation of affricates.

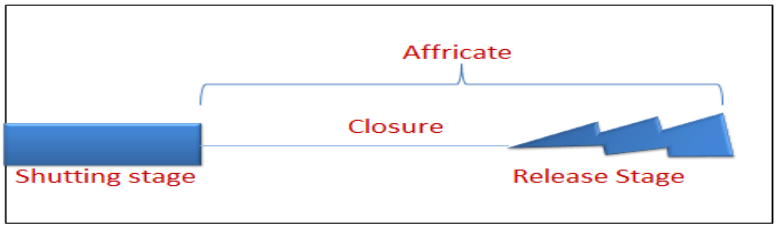

Figure 1 The Pronunciation of Affricates

O'Connor (2003, P. 47) gives a detailed account of the exact pronunciation of affricates stating that the tip of the tongue touches the back part of the alveolar ridge while the soft palate is raised. Consequently, the air stream is trapped for a short time behind the tongue-tip and the ridge as it is the case of an alveolar stop. The rest part of the tongue takes the position and shape of the fricatives /ʃ/ and /ʒ/. Then, the tip of the tongue moves away from the ridge, and the whole tongue takes the position for the /ʃ/ and /ʒ/. Hence, a short duration of friction becomes audible. Figure 2 shows the pronunciation of fricatives.

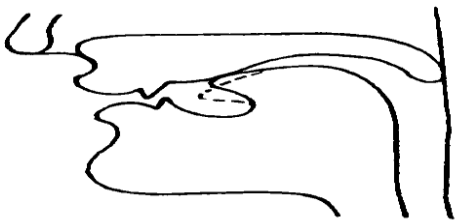

Figure 2 Speech Organs Shape in Producing Affricates (O'Connor, 2003, p. 47)

Roach (2010) assumes that the place of articulation of the stop and fricative that make up the affricate should be the same i.e. they should be homorganic. That is what justifies not transforming the stop /k/ and the fricative /f/ in the word (breakfast) into an affricate. They do not share the same place of articulation as /k/ is velar, while /f/ is labiodental. However, some scholars still believe that there is a place of articulation contrast between the stop and the fricative parts of the affricate. Mannell (2008) believes that the stops /t/ and /d/ are alveolar, while the /ʃ/ and /ʒ/ are postalveolar. The idea of homorganicity, for others, (e.g. Wee & Winnie, 2009) is to have the stop and the fricative at near (not necessarily identical) place of articulation. However, the debate is basically on whether affricates are to be considered as single segments or as two separate segments. This is discussed in the following sections.

A phoneme is a single "unit" of sound that has meaning in any language. According to Twaddell (1952), phonemes are rather abstract elements. The principles used to establish phonemes are largely distributional and articulatory. Phonemic analysis endeavors to find answers for questions about permissible and impermissible word structures in a certain language. Traditional analysis of phonemes must come up with a list of phonemes and allophonic rules. It should also state the constraints found in the language that decide permissible and impermissible combinations of phonemes.

These three steps provide an answer to the first question. A phonemic analysis will show if the studied phonemes/allophones of the particular language are in;

1. Complementary distribution: Phonemes are said to be in complementary distribution if they never occur in the same phonemic environment.
2. Contrastive distribution: Phonemes occur in the same phonemic environment where the distribution in meaning is due to the particular phoneme.
3. Free variation: Phonemes are said to be in free variation if they do not affect the meaning of the word. **Error! Reference source not found.** below shows a summary of the phonemic analysis process.

Speech is made of phonemes, and it is believed that each sound produced in an utterance is supposed to be identified as a definite phoneme. However, the task of identifying sounds as phonemes i.e. phonemic analysis is not straightforward as it seems. There are several cases where a one to one analysis of phonemes does not hold. One of these cases is the analysis of affricates. Roach (2010) states that there are two possible treatments of phonemic analysis concerning affricates:

1. One phoneme analysis: It is possible to treat each of the pairs as a single consonant phoneme. Such as / ʧ, ʤ/
2. Two phoneme analysis: It is also possible to say that they are composed of independent phonemes. For example /t+ ʃ/ and / d+ ʒ/.

The following discussion is a brief view of the assumptions that are often mentioned in support of the one-phoneme analysis of affricates. These assumptions are either phonetic or allophonic.

a. The first assumption in favor of the one-phoneme analysis is referred to in Roach (2010), which assumes that the phonemes /ʧ/ and /ʤ/ have a similar distribution to other English phonemes. These two phonemes can be found initially, medially, and finally as in (chin, gin), (riches, ridges), and (search, surge). However, there are English phonemes, which are established as distinct phonemes even though they are not freely distributed to all positions such as the phonemes /h/ and /ŋ/, which cannot occur finally and initially respectively.
b. The second assumption is also based on the distribution of the two affricates /ʧ/ and /ʤ/. Based on Roach (2010, P. 98), "If /ʧ/ and /ʤ/ were able to combine quite freely with other consonants to form consonant clusters, this would support the one-phoneme analysis". It is true that these affricates can be part of several clusters, however, there are several limitations. They cannot be, for example, part of initial clusters with other consonants. Moreover, they

are often followed by /t/ and /d/, and preceded by /l/ in final position. Furthermore, they cannot be part of different kinds of minimal pairs such as the (/lʃ/, /lʧ/) and (/nʒ/, /nʤ/) Roach (2010, PP. 98-99).

c. Native speakers intuitions are often used as a guide to resolve the ambiguity of such issues. Native speakers with no technical knowledge in phonetics have been asked to give their judgments on whether affricates are one phonemes or a combination of two distinct phonemes. They have expressed the feeling that affricates are two distinct phonemes; yet, this feeling could rather be tempted by spelling as these two consonants are represented in two consonant letters. Roach (2010), believes that using the untrained native speakers is not a good choice. Illiterate people might be a better choice in such tests; however, more problems an emerge and the test cannot be reliable enough.
d. The one-phoneme analysis assumes that the length of /ʃ/ as a separate phoneme as in "hush" /ɦʌʃ/ is longer than the /ʃ/ within the phoneme /ʧ/ as in "hutch" /ɦʌʧ/. The same is true for /ʒ/ and /ʤ/. It means that the length of /ʒ/ as a separate phoneme as in "measure" /ɱeʒə/ is longer than the /ʒ/ within the phoneme /ʤ/as in "jump" /ʤʌmp/. This phonetic argument has not been well tested in the literature (Roach, 2010).

The description of the sound system of Arabic does not always include affricates. Some Arab scholars believe that the affricate /ʤ/, which is the only affricate found in Arabic is a stop sound. Whereas, some others do mention the term **(احتكاكي انفجاري)** to refer to affricates. The pronunciation of /ʤ/ requires a complete closure between the tongue and the alveolar ridge. However, the tongue does not leave the ridge quickly. It rather moves away slowly leaving a chance to the sound to be released from a narrow opening causing a fricative release (Al-Hattami, 2010). Mostly, one affricate is reported to be found in Arabic. This occurs in "environments similar to those in which the different plosives occur, namely, word-initially followed by a vowel, word-medially and word-finally" (Ibid, P. 315). This makes it essential to establish a distinct phoneme to account for the sound.

Shariq (2015) states that in Arabic we have one affricate only, which is the voiced palatal-alveolar (ج) [dʒ]. The sound [dʒ] in Arabic is freely distributed to all positions such as "[جنوب] [dʒʊnu:b] 'south', at –medialposition [شجرة] [ʃədʒərah] 'tree' and at –final position [عالج] [ʕıla:dʒ] 'treatment'" (Ibid, P. 150). However, a voiceless palatal-alveolar affricate is not found in Standard Arabic, but may be found in accents of Arabic.

The affricate sound /ʧ/ is not found in Standard Arabic; yet, it is found in some Arabic accents such as Iraqi Arabic. The sound /ʧ/ is one of the frequent sounds in the "Geltu" dialect, which, according to Al Abdely (2016), is regarded the lingua franca of Iraq. This dialect is spoken by the majority of Iraqis living in Baghdad; hence, this dialect is alternatively called Baghdadi Iraqi Arabic. Moreover, this dialect is used in all southern provinces in Iraq as well as some parts of other provinces such as Anbar, Saladin, and Mosel. Al-Hattami (2010) states that "In the Iraqi dialect the voiceless velar plosive [k] as in the word [ʔıħkı] (talk) is replaced by the voiceless palato-alveolar affricate [ʧ]—[ʔıħʧı]". This justifies the high frequency of this sound in Iraqi Arabic.

Several studies have been conducted to investigate how learners of English as a second language acquire affricates. Some other studies were much concerned with the analysis and distribution of affricates. Some of these studies are reviewed below:

Thurgood (2003) conducted a study to investigate affricate germination produced in the English of polish speakers as a second language. She performed two tasks, in which Polish learners of English were divided into two groups; intermediate and advanced. She asked them to repeat twelve English sentences and responding orally to seventeen multiple choice questions. The findings revealed that the intermediate speakers had paid more attention to the phonetics of the English cues than producing more fully rearticulated affricates. This means that little attention was paid by the more advanced speakers to the phonetics of cues. This may be because of the influence of the polish norms or their pronunciation in English.

In the same vein, Maddieson (2005) conducted a study to investigate palato-alveolar affricates in several languages. The aim was to examine phonetic differences between affricates. Ten speakers of three languages; English, Italian and Spanish participated in this study. The most similar stops and fricatives have been recorded in closely matched medial positions from the participants at two different speech rates controlled by a metronome. The results revealed significant difference between the three languages in the phonetic of variability speakers and speech rates. This indicates that there are differences between the languages which can be related to the general hypothesis.

Van de Weijer (2014) conducted a study to investigate the rate of affricates in the phonotactics of English as a natural class. This is to prove that they behave differently from stops and fricatives. In addition, the study can provides evidence against the assumption that affricates cannot form a natural class by themselves which is one of the characteristics of "stop Approach" to the representation of affricates. He used data from Pengo (Davis, 1989) and from Cimbrian (Hall, 2012) which pointed to the same direction. The results revealed that affricates can act as a natural class not captured by [Strident] but can be made by reference to the classical feature [Continuant] as in the affricate approach or the complex segment approach.

Due to the fact that several phonetic and phonological procedures look like one another, researchers imply that phonetics and phonology are really very similar. Of them is Pycha (2009), who associated phonetic and phonological procedures of the case of consonants lengthening via examining length measurements obtained from 14 Hungarian speakers. Pycha (2009) investigated affricates as they are often described of bearing a two-part structure. The results obtained in this study revealed that affricates often experience phonetic lengthening at phrase margins. Pycha (2009, P. 1) elaborates that "the affected portion of the affricate is always that which lies closer to the boundary". Moreover, the study shows that affricates may frequently experience "phonological lengthening when next to a geminating suffix, but the affected portion of the affricate is always the stop closure". It is concluded that phonetic and phonological lengthening are fairly unlike each other.

Dorman and Raphael (1980, P. 397) conducted several experiments to determine some "acoustic cues of fricative-affricate contrast"in word final

position. Listening tests conducted automatically showed that both temporal and spectral variables may affect the informants' ability to identify fricatives and affricates. These variables include "vocalic interval; duration of silent arrival; presence or absence of a release burst; rise-time of the fricative noise and the duration of the fricative noise". The study concluded that neither one of acoustic property detector nor one natural category can by itself explain the perception of affricate and fricative sounds.

On the whole, despite much research has been done about affricates in English as a second or a foreign language in terms of different learners, little attention was paid to the production of affricates by Arab learners of English as a foreign language. However, few studies can be reviewed here. Alfehaid (2015) investigated problems Arab learners face while acquiring English as a foreign language. He refers to /tʃ/ and /dʒ/ as sources of difficulty for Arab learners. However, he claims that these sounds are not found in Arabic. This problem carries over into reading English. Alfehaid's statement is not accurate as Standard Arabic does have the sound /dʒ/, and some other accents of Arabic, including Iraqi Arabic, do have the sound /tʃ/. Arabic does not have affricate sound. He states that problems Arab learners encounter might be the result of spelling issues due to the fact that spelling and pronunciation are highly consistent in Arabic but highly inconsistent in English.

However, the current study was conducted to investigate the pronunciation of affricates by Iraqi undergraduate learners of English as compared to British and American native speakers of English.

Method

The study intends to measure the duration of /ʃ/ and /ʒ/ alone and when they are involved in affricates by using acoustic measures. The study uses scientific means to validate its findings and to process data quantitatively. This section explains in details the method adopted in collecting and analyzing data. It explains the samples of the study, the stimuli, the data collection and the analysis techniques used.

The aim of the study is to measure the duration of /ʃ/ and /ʒ/ alone and when they are involved in affricates; /ʧ ,ʤ/ to see if there are any variations in the length of these sounds that may support or weaken the one-phoneme analysis. For this purpose, a quantitative method is adopted. An ex post facto research design is used as the study measures the current performance of informants without any manipulation or training. Accordingly, the study collects and analyzes data as numerical indices that ultimately describe the data obtained and achieve the objectives set in this study (Ary, Jacobs, Sorensen & Walker, 2010).

The informants tested in this study belong to three groups; each one contains five participants. These informants were selected according to the information mentioned above, which were obtained through a demographic questionnaire. Informants were asked to give some personal information, some other information about the language(s) they and their parents speak. For more details about the questionnaire, see appendix (1). These groups are described below.

This group includes five undergraduate students majoring in English language. Their age is between 18-22 years old. All of them are females. They live in different parts of Anbar province. Their first language is Arabic, and they

study English as a foreign language at the University of Anbar, Education College for Women.

This group consists of five respondents; three males and two females. Their age is between 21-25 years old. They live in different parts of America. Their first language is English. Their parent's first language is also English.

The group consists of five respondents. All of them are females. Their age is between 21-48 years old. They originated from different parts of the UK Their first language is English and some of them speak Spanish or Arabic as a second language.

Twenty words have been selected for this study, five words for each of the sounds /ʃ/, /ʒ/, /ʧ/, and /ʤ/. These words are monosyllabic and show fricatives and affricates in initial position only except for the words (measure and treasure), which are two-syllable words that show the sound /ʒ/ in medial positions. The words selected for this study are frequent words often used in daily conversation. They were shown to many, namely 60, Iraqi foreign learners in the English Language Department, who claim that they are familiar with them. The words identified as totally new to them were eliminated from the test to avoid any incorrect pronunciation of these words due to lack of knowledge. The words were enlisted randomly in a sheet of paper to be pronounced by the participants. The full list of words is available in appendix (2).

Fifteen respondents, who volunteered to participate in this study and signed a consent letter, were asked to full in a questionnaire with information related to their social, locational and linguistic background. After that, respondents were asked to have a look at the list of words before they start the test and asked to state any issue they might have with the words. Later, the test started and the pronunciation of the participants was recorded directly through PRAAT 5.1.19 (Boersma & Weenink, 2009).

More specifically, the recordings of the American group were made in stocker center, Ohio university, Athens, Ohio 45701 U. S. A in the lab room which is very quiet in order to get clear recordings. The recordings of British participants were made in different places such as Leeds City College in the lab room, and Ireland Wood Primary School Leeds, English in the School Regimen. The recordings of Iraqi participants were made in the sound lab of the English Language Department, Education College for Women. Respondents were asked to pronounce the words as they are randomly listed with two second pauses between each word and another. The recordings of all participants of the three groups were made using lab tops in which PRAAT software program had been installed in order for the data to be processed acoustically later.

The data were transcribed and annotated using PRAAT version 5.1.19. In this study, PRAAT was used to measure the duration of fricatives /ʒ/ and /ʃ/ once as single phonemes and second as parts of the affricates /ʧ, ʤ/. Length measurements were stored in an Excel sheet to be sorted and filtered as necessary, and to be later used for statistical analysis using IBM SPSS. The study followed the mechanism adopted by Liu, Chen, Lin, Cheng, and Chang (2016, PP. 157-158). The beginning of a fricative/an affricate was identified via detecting "a boundary on the left side and the right side of an intensity envelope … The ending point of a fricative/an affricate was determined by the location where the F1 of the following vowel occurred".

The following (**Error! Reference source not found.**) is a PRAAT window for the word (jeans) as pronounced by an American speaker, a British speaker, and an Iraqi speaker. The speaker is annotated within the window together with the word and its transcription.

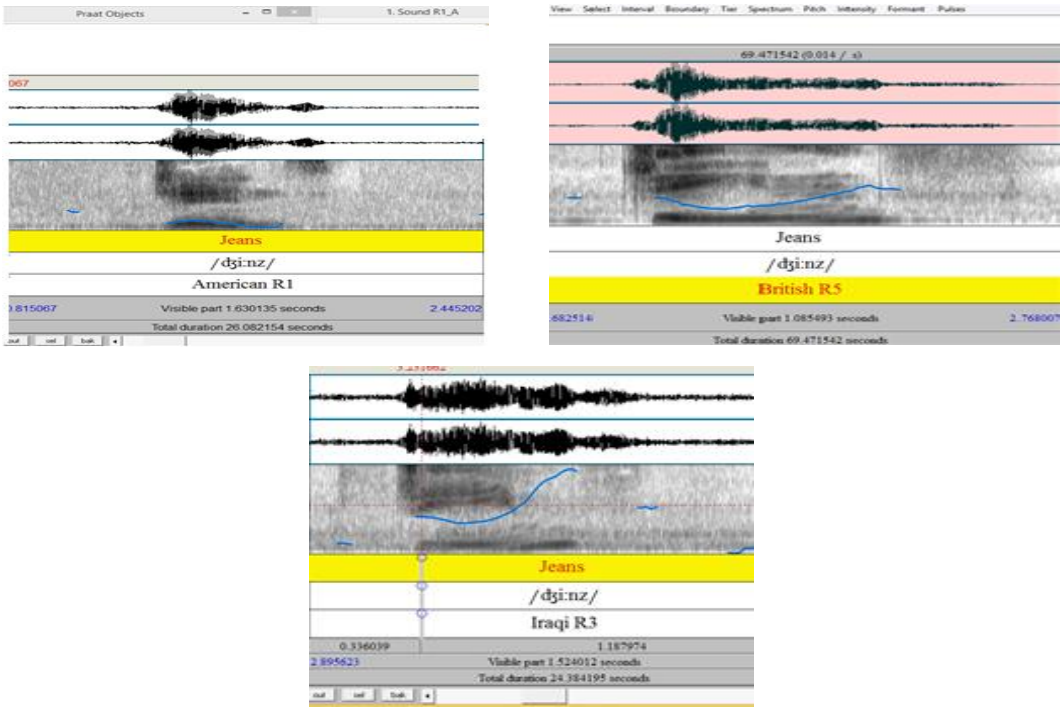

Figure 3 A PRAAT window for the word (jeans)

A series of eight paired samples t-tests were conducted length significant differences between the pronunciation of /ʒ/, /ʃ/, /ʧ/, and /ʤ/ for each group individually. Later, another paired samples t-test was conducted to identify length differences for all participants of three groups. Furthermore, a series of four independent samples t-tests were also conducted to identify any significant difference in the pronunciation native (American & British) speakers and non-native (Iraqi) speakers. The results were tabulated providing descriptive and inferential statistical results.

Findings and Discussion

To identify whether the length of the sounds /ʒ/ and /ʃ/ is statistically different from their length when involved in the /ʤ/ and /ʧ/, length means obtained from the analysis of the pronunciation of the three groups of participants were compared using paired samples *t*-tests. Paired samples t-test were first conducted to identify statistical differences within each group i.e. length measurments of the sounds concerned in this study were compared as they were produced by each group individually.

The tests revealed significant differences between the overall means of length measurments with > 0.05 ***P*** value for the three groups. This means that length means for fricatives /ʒ/ and /ʃ/ alone were significantly diffeerent from length

means of these fricatives when they are parts of the affricates /ʤ/ and /ʧ/ respectively. The follwing tables (

and Table 2) dispaly the results of paired samples t-tests.

Table 1 Paired samples t-test for /ʒ/ and /ʃ/

Group	No	/ʒ/		/ʤ/		
		Mean	Std. D	Mean	Std. D	*P*
American	**5**	.13712	.036044	.03992	.005951	**0.00**
British	**5**	.13740	.029992	.03700	.006857	**0.00**
Iraqi	**5**	.19360	.031829	.03936	.005392	**0.00**

It can be snoticed in

above that length means of /ʒ/ and /ʃ/ are higher than length means of /ʤ/ and /ʧ/ i.e. /ʒ/ and /ʃ/ were were pronounced longer thn the fricative parts of the /ʤ/ and /ʧ/.

Table 2 Paired samples t-test for /ʤ/ and /ʧ/

Group	No	/ʃ/		/ʧ/		
		Mean	Std. D	Mean	Std. D	*P*
American	**25**	.15456	.026442	.04716	.007273	**0.00**
British	**25**	.15600	.020376	.04084	.007215	**0.00**
Iraqi	**25**	.15640	.031829	.04948	.009562	**0.00**

Another independent samples t-test was conducted to identify significant differences between length means of /ʒ/ and /ʃ/ when they occur alone and their length means when thay are parts of affricates /ʤ/ and /ʧ/ as they were uttered by all (American, British, Iraqi) speakers of English. The results of the test show that there is a statistical significant difference in the length means for /ʒ/ and /ʃ/ and /ʤ/ and /ʧ/ with (p=) as show in table (Table 3) below.

Table 3 Overall paired samples t-test

Group	No	/ʒ/		/ʤ/		
		Mean	Std. D	Mean	Std. D	*P*

	.14440	.036203	.03876	.006147	0.00
All Groups 75	**/ʃ/**		**/ʧ/**		
	Mean	**Std. D**	**Mean**	**Std. D**	
	.15661	.022222	.04583	.008786	0/00

To identify any statistical differences in the duration of the sounds /ʒ/, /ʤ/, /ʃ/, and /ʧ/ between native, American and British speakers of English in one hand, and non-native, Iraqi, speakers of English on the other hand. To verify the null hypotheses raised above, four independent samples *t*-tests were performed. These four null hypotheses are provided below:

1. The length of the sound /ʒ/ pronounced by American and British native speakers of English is not significantly different from that sound's length as pronounced by Iraqi non-native speakers of English.
2. The length of the sound /ʤ/ pronounced by American and British native speakers of English is not significantly different from that sound's length as pronounced by Iraqi non-native speakers of English.
3. The length of the sound /ʃ/ pronounced by American and British native speakers of English is not significantly different from that sound's length as pronounced by Iraqi non-native speakers of English.
4. The length of the sound /ʧ/ pronounced by American and British native speakers of English is not significantly different from that sound's length as pronounced by Iraqi non-native speakers of English.

Before, conducting the independent samples *t*-tests, the normal distribution of the data was checked for suitability. The native and non-native distribution was sufficiently normal for the purpose of conducting *t*-tests (i.e. skew< 2.0 and Kurtosis < 9.0; Scmider, Ziegler, Danay, Beyer, & Buhner, 2010). Levene's Test for Equality of Variances was also conducted to make sure that equal variances are assumed. The ***P*** values for this test were all >0.05; hence, data are suitable to be processed via independent samples t-tests. The results of the four independent samples t-tests for the four sounds /ʒ/, /ʤ/, /ʃ/, and /ʧ/ respectively are summarized in the following table (Table 4).

Table 4. Descriptivestatistics, Levene's test, and Independent Samples t-test

Sound	**Levene's Test of Eq. & Var.**		**Native N.50**			**Non-native N. 25**			
	F	**Sig.**	**T**	**df**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviatio**	**Sig. (2-tailed)**

								n	
ʒ	2.969	.089	-2.500-	73	.13726	.032817	.19360	.165897	.015
ʤ	2.493	.119	-.596-	73	.05626	.071488	.03936	.005392	.553
ʃ	.837	.363	-.733-	73	.15528	.023374	.15640	.031829	.466
ʧ	.283	.596	-2.648-	73	.04400	.007848	.04948	.009562	.010

The results show significant differences based on group factor in the length of /ʒ/ and /ʧ/ [p = 0.015], and [p = 0.010] respectively. However, statistically significant differences were not found between the two groups, native and non-native speakers, in the mean length of /ʤ/ and /ʃ/ with [p =0.553], and [p =0.466] respectively.

Based on the results of the four *t*-tests, null hypotheses 2 and 3 are accepted as the p-values obtained were (P= 0.243 and 0.863) for the sounds /ʤ/ and /ʃ/ respectively. Whereas, null hypotheses 1 and 4 are rejected with (P= 0.023 and 0.10) values for the sounds /ʒ/ and /ʧ/ respectively. Statistical differences were recorded in terms of the length of the fricative /ʃ/ and the affricate /ʤ/, however, significant statistical differences were not identified with regard to the fricative /ʒ/ and the affricate /ʧ/.

Discussion

The results obtained in this study generally support the one-phoneme analysis of affricates. More specifically, the results support the assumption that fricatives /ʒ/ and /ʃ/ in isolation have spectral features that are different from the ones they have when they are included in the affricates /ʤ/ and /ʧ/. This has been evident from the the results of the statistical tests conducted, which show significant differences in the length of the sounds /ʒ/ and /ʃ/ and the fricative part of the affricates /ʤ/ and /ʧ/. This significant differences was shown by the three groups of American, British, and Iraqi speakers.

This shows that Iraqi learners of English are aware of length variation between /ʒ/ and /ʃ/ in one hand, and /ʤ/ and /ʧ/ in the other hand. This might have resulted from the fact that Iraqi learners do have the sounds /ʤ/ and /ʧ/ in their Iraqi accent of Arabic, which might have facilitated the task for them. L1 influence is thought to be positive as it aids Iraqi learners to produce these sounds as accuarte as their native counterparts in this study. L1 positive tarnsfere has been reported with regard to different types of learners including Arabic learners (Al Abdely, 2016; Nikolova, 2012; Odlin, 2003).

It is worth noeting here that the sound /ʒ/ is not found neither in Standerd Arabic nor in Iraqi Arabic. This may explain the difference found in the pronunciation of this sound between native and Iraqi speakers as it was shown through the independent *t*-test. Moreover, Iraqi speakers of English were also different from native speakers with regard to the pronunciation of /ʧ/ sound as

they pronounce the friciative part of the sound with more length. The same was reported in the pronunciation of /ʒ/, which was also pronounced longer than usual. This refers to the fact that Arab, more specifically Iraqi, learners of English rely heavily on sound length or what is so called durational cues in their perception and production of the sounds of the foreign language (Al Abdely & Yap, 2016; Alzahrani, 2014; Munro, 1993).

Conclusions

Based on the results of the study, it can be concluded that the actual characteristics of /ʒ/ as a single phoneme were different from that of /dʒ/ In addition, the characteristics of /ʃ/ as a separate phoneme was also different from that of /ʧ/. The arguments raised by Roach (2010) is well supported in this study. In other words, the results of the current study support the idea that affricates represent a natural class. This means that these results are in favor of the complex segment approach, which assumes affricates to share features with stops ([–cont]) and with fricatives [+cont]) (van de Weijer, 2014). The results of this study are also in good agreement with Clements (1999, P. 2), who stated that "though affricates superficially resemble plosive + fricative sequences, they are counted as single segments in the phonology". Hence, affricates are be treated as single distinct phonemes and not as a combination of a stop+ fricative.

The results are against the other two approaches of affricates, which are the stop approach and the fricative approach. The stop approach assume that affricates are mostly stops with the feature [strident stop] (Kehrein, 2002). However, more studies are still needed to further validate Roach's assumption and the results obtained in this study. Besides, this study's sample is limited to 5 participants from each group; hence, researchers are invited to conduct more studies that include greater number of respondents. Arab researchers are also invited to validate the results of the current study with samples from other Arab speaking communities.

Despite the fact that Iraqi learners examined in this study succeeded in realizing the variation in length between fricatives and affricates, they still need more practice in the pronunciation of these sounds, as they tend to produce these sounds longer than required. Iraqi learners heavy reliance on temporal cues is motivated by their lack of spectral knowledge that is supposed to enable them to identify and produce foreign language sounds more accurately. On the contrary, Flege et al. (1997) states, native speakers frequently depend on spectral rather than durational cues in their perception of sounds.

Listening and speaking skills are what Iraqi learners badly need to focus on and improve in order to be good speakers of the English language. This is what is clearly lacked at Iraqi schools and even universities, and this could be a major reason of why Iraqi speakers of English show accented pronunciation of English even at high levels of education. Syllabus and text books designers are recommended to allocate more attention to listening and speaking skills. Teachers of English are also invited to show their students more details of the spectral, in addition to temporal features of the foreign language sounds.

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