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THE PRODUCTION OF ARABIC GEMINATE STOPS BY ENGLISH LEARNERS OF ARABIC

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AN ABSTRACT OF THE THESIS OF
AHMED SAAD ALMUTIRI, for the Master of Arts degree in Applied Linguistics, presented on 
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TITLE: THE PRODUCTION OF ARABIC GEMINATE STOPS BY ENGLISH LEARNERS 
OF ARABIC

MAJOR PROFESSOR: Dr. Karen Baertsch

This study aims to investigate the developmental ability of beginning and advance L1 
English learners of Arabic to pronounce standard Arabic geminate consonants when enrolled in a 
full time L2 program. The results showed that English learners produced shorter closure duration 
when pronouncing geminates. In particular, the beginners lengthened singletons more than the 
advanced learners did, while both groups of learners shortened geminates much more so than 
native speakers of Arabic. The advanced L1 English learners of Arabic produced longer 
geminate duration than beginners. The ultimate result was a smaller ratio between singleton and 
geminate consonants in comparison to native speakers of Arabic.

KeyWords: L1, L2, consonantal length contrasts, closure duration, geminate, singleton, ratio, 
aquisition, Arabic Learners, English, Markedness Differential Hypothesis, Speech Learning 
Model, Perceptual Assimilation Model, Ontogeny Phylogeny Model.
DEDICATION

To whom I promise to achieve their dreams, to whom I hear their prayers, to the great parents; my mother Habibah Almutiri and my father Saad Almutiri, to my lovely wife who is always my great assistant to be successful Aminah Almutairi, to my leader to the success Dr. Saleh Alshuwairekh I dedicate the first step in my life to serve the humanity in my field as you all wish and I love.
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*In the name of Allah, the most gracious, the most merciful*, I would like to give thanks for his blessings, for without him my work would not have been done.

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CHAPTER 1
INTRODUCTION

A contrast in segmental duration is a phonemic contrast found in many languages. Native speakers of such languages differentiate lexical items based on the phonetic length of pairs of segments. That is, the phonetic framework is the main cue to represent the phonemic contrasts. Thus, the absence of such phonetic length contrast can lead to misperception of speech. In the case of consonants, a geminate consonant is contrasted with a singleton consonant counterpart. Many studies have been done to describe the mechanism by which a consonant is considered geminate, its level of acoustical segmentation, the intensity at the point of articulation, and the closure duration period, as well as the shape of the syllable as a result of acoustic articulation (Homma 1980; Lahiri & Hankamer 1988; Esposito & Bendetto 1999; Ohala 2007; Kraehenmann & Lahiri 2008). The main focus in such studies has been the length of geminate consonants in contrast to their singleton counterparts.

With respect to the second language (L2) acquisition, L2 learners may have difficulty perceiving and producing such contrasts. Several studies have examined how the perception of geminate/singleton contrasts can be difficult for English learners (Hayes-Harb 2005; Hayes-Harb & Masuda 2008; Hardison & Motohashi-Saigo 2009). Kabak, Reckziegel, and Braun (2011) stated that studies on the production of geminates by L2 learners are limited to a small number of studies. They stated that even advanced learners of geminate contrasts have difficulty pronouncing geminates with accurate duration. It is commonly noticed that English speakers of Arabic pronounce geminates as singletons as they do not lengthen the target consonant (geminate) to represent the target word. In other words, native English speakers may produce /sakkara/ ‘he closed something’ as /sakara/ ‘he got drunk’. Also, they may produce /radda/ ‘he responds’ as /radaa/ ‘death’. Such mispronunciation leads to a misconception of the lexical
item. This misconception could lead to difficulties for the speaker or negatively affect the discourse. This study will shed light on such production difficulties with respect to singletons taking into account hypotheses and models associated with such acquisition, such as the Speech Learning Model (SLM) (Flege 1995), the Perceptual Assimilation Model (PAM) (Best 1994), the Markedness Differential Hypothesis (MDH) (Eckman 1977), and the Ontogeny Phylogeny Model (OPM) (Major 2001, 2008).

Chapter 2 will discuss the concept of geminate consonants. This will include the basic representation of geminates and their segmental phonetic framework, which is represented in production as the closure duration. The background will cover two studies on Arabic geminates, one of which is on geminated sonorants. In addition, it will focus on perception studies of geminates by non-native speakers, in particular native English speakers. Chapter 2 will also discuss three studies on geminate production by non-native speakers; two of them recruited adults and children. These studies will be supported by L2 acquisition theories. Chapter 3 will explain the methodology of the current study, chapter 4 will include the results and a discussion of the results, and chapter 5 will present the conclusion.
CHAPTER 2
BACKGROUND

2.1 GEMINATES.

A geminate consonant is a combination of two identical consonants occurring one after the other with no epenthetic interruption between them. Such a sequence is split between two syllables; the first portion is in the coda of the first syllable and the second half of the geminate is in the onset of the second syllable (See Figure 1a and 1b, taken from Catford 1977; Trubetskoy 1939).

![Figure 1. The segment /d/-/dd/ in shape of syllables with respect of both singleton (a) and geminate (b).](image)

With respect to acoustic representation, the main clue to the identification of geminates is a stronger release; intensity of articulation, length of sequence time, and heightened air pressure during articulation (Catford 1977; Trubetskoy 1969; Mitchell 1990). A geminate acoustically is also a combination of both consonant closure duration and articulatory pressure derived from pronouncing the same consonants at the same place and manner of articulation (Delattre 1971). That means a geminate has a longer duration since it is a sequence of two segments, and it has heavy weight caused by being produced with greater intensity.
To sum up, the phonetic representation of a geminate consonant is that it is longer than a singleton consonant and has extra intensity or pressure during articulation. The duration ratios are the fundamental difference between geminates and singletons.

In the study of geminate duration, many studies rely on the ratio of geminate vs. singleton segments. Mitchell (1990) stated that the duration of a geminate consonant is about one time longer than its singleton counterpart. Other researchers have stated that geminate duration is longer about twice as long as, or longer than, a singleton (Ladefoged & Maddieson 1996; Lahiri & Hankamer 1988).

Such consonantal duration ratios are limited to languages that have geminate consonants and are the most common way to measure geminates. Otherwise, it is difficult to differentiate singletons from their geminate counterparts. Lisker (1958) observed that one could discriminate geminates from singletons with a difference of at least 20 ms. If the duration difference is less than this measurement, a native speaker will not be able to discriminate geminate from singleton (Lahiri & Hankamer 1988). The absence of such ratios in languages such as English makes it difficult to learn geminates as will be explain later.

Languages such as Japanese, Swiss German, Turkish, Italian, and Hindi have consonantal length contrasts between singletons and geminates. More specifically, Japanese (Homma and colleagues 1980), Swiss German (Kraehenmann & Lahiri 2008), and Turkish (Lahiri & Hankamer 1988) have ratios where geminates are nearly three times longer than singleton stops, whereas Italian (Esposito & Bendetto 1999) and Hindi (Ohala 2007) have ratios where geminates are approximately twice as long as singleton stops. For example, Esposito and Bendetto (1999) investigated the duration of Italian geminate stops and their singleton counterparts, finding geminates to be twice as long as singletons. Ohala (2007) examined the closure duration of Hindi
geminates and found geminates to be about 76 ms longer than singletons with a ratio of 1:1.96. That means geminates were slightly less than twice as long as a singleton.

However, the languages with geminate-singleton ratios longer than 1:2 are more important to the present study because they are closer to what is expected in the Arabic data. Lahiri and Hankamer (1988) examined geminated stop duration of native speakers of Turkish /t/, /tt/, /k/, /kk/. They concluded the average closure duration for a geminate in Turkish (176 ms) was nearly three times longer than the closure duration of the singleton counterpart (60 ms) with a ratio of 1:2.93. Similarly, Kraehenmann and Lahiri (2008) examined that Swiss German geminates were longer than singletons by a ratio of 1:3.

While variation in geminate-singleton ratios is apparent between languages, variation can also be seen in studies within the same language. In the case of Japanese, for instance, researchers have found ratios that are similar overall but that differ by a few milliseconds. Homma (1980) examined the ratio between Japanese geminate consonants and their singleton counterparts. She found that a geminate is longer than a singleton by a ratio of 1:3, or more than twice as long. In another study on Japanese, Han (1992) found that geminated voiceless stops were almost three times longer than their singleton counterparts, with a ratio of 1:2.88. Hayes-Harb and Masuda (2008) found Japanese geminate stops to be longer than singletons by a ratio of 1:2.9. However, Hardison and Motohashi Saigo (2009) found the Japanese geminate voiceless stop /t/ to be longer than the singleton by a ratio of 1:2.3. The results of these studies suggest that similar minor variations could be found in Arabic data.

To sum up, the duration of a geminate was found to be between two-to-three times longer than that of a singleton. Japanese, Turkish, and Swiss German have been shown to have ratios
with geminates being three times longer than singletons, while in Hindi and Italian, geminates were only about two times longer than singletons.

It should be mentioned that a vowel preceding a geminate is shorter than one preceding a singleton in all languages consulted with the exception of one. After listing many languages containing geminates, including Arabic, Amharic, Bengali, Hausa, and Sinhalese, Maddieson (1985) stated that the vowel before a geminate is generally shorter than normal but that such shortness is not necessarily related to a phonemic contrast between short and long vowels or other factors such as speech rate or stress. He confirmed that only Japanese showed no differences between vowels when preceding geminates and singletons. Nevertheless, the vowel preceding a geminate does not necessarily have a major effect on the geminate; for example, Lahiri and Hankamer (1988) found that the vowel preceding geminate voiceless stops in Turkish had no significant effect on geminates compared to their singleton counterparts, 112 ms vs. 116 ms, respectively, while they confirmed the effect of preceding vowels in Bengali (89.8 ms vs. 112.8 ms). In the case of Arabic, Al-Tamimi, Abu-Abbas, and Tarawnah (2010) investigated Jordanian Arabic word final geminates in comparison with singleton counterparts. They found the vowels preceding a geminate were shorter than those preceding singletons. Based on native listener judgments, they concluded that in order to perceive Arabic geminates, the compensation of total duration for both geminate with its co-articulated pressure and preceding vowel is required. The present study, however, will focus on the production of intervocalic Arabic geminates. Overall, closure duration is the main cue of all the languages containing gemination that were examined in these studies.

In Arabic, there are 28 singleton consonant phonemes, each of which contrasts phonemically with a geminate counterpart (Al-Ani 1970, Mitchell 1990). Arabic has a total of
six vowels, three short vowels and three long versions: /a/-/aa/, /i/-/ii/, and /u/-/uu/ (Mitleb 1984). Examples of singleton and geminate contrasts include /ʕadad/ ‘number’ vs. /ʕaddad/ ‘he calculated’, /ʃadəa/ ‘he sang’ vs. /ʃadda/ ‘he grasped’, and /qadima/ ‘he came’ vs. /qaddama/ ‘he gave’. Examples of vowel contrasts can be seen in /darasa/ ‘he studied’ vs. /daarasa/ ‘he joined someone for study’, /ʃamiʕa/ ‘he heard’ vs. /ʃamiiʕ/ ‘exaggeration of hearing’, and /jud/ ‘be generous’ vs. /juud/ ‘generosity’. It should be mentioned that a doubled symbol in a transcription, as in /a/-/aa/ and /d/-/dd/, represents both phonetic and phonemic contrasts (Mitleb 1984).

Al-Tamimi (2004) examined Jordanian Arabic intervocalic geminated sonorants and singleton counterparts regarding both closure duration and preceding vowels (long vs. short) as /a/-/aa/ preceding /m/-/mm/, /n/-/nn/, and /l/-/ll/ contrasts. Target words were embedded into one sentence. Examples of these words include /tana/ (nonsense word) /fatanna/ ‘he tempted us’, /ʃataana/ ‘our boy’, and /ʃataanna/ ‘he told us a logical opinion’. He found that closure duration of geminates was longer when preceded by a short vowel than by a long vowel. The mean ratio of geminate to singleton closure preceded by both long and short vowels was about 1:2.76.

Similarly, Ahmad (2012) investigated both closure duration and that vowels preceded and followed standard Arabic intervocalic geminated stops (/t/-/tt/, /d/-/dd/, /b/-/bb/, /k/-/kk/, /q/-/qq/, /ʕ/-/ʕʕ/). As Al-Tamimi (2004), the preceding vowel was phonemically contrasted as long and short. He selected 18 standard Arabic words, the first nine words categorized as mid singleton words, while the second nine words were categorized as mid geminate words. Each category was divided into two groups. The first group had short vowels, whereas the second group had long vowels. The set of words were shown as follows.
A. mid singleton words                                B. mid geminate words

Group 1: (CVCVCV)                                     Group 1: (CVCCVCV)
Group 2: (CVVCVCV)                                     Group 2: (CVVCCVCV)

Some examples for his data are /rakaba/ ‘he has ridden’, /rakkaba/ ‘he gave a ride’, /hadama/ ‘he destroyed’, /haddama/ ‘he has destroyed a lot’. He found that the mean ratio of singleton to geminate consonant contrasts when preceded by short vowels for the pairs /t/-/tt/-/d/-/dd/ /b/-/bb/-/k/-/kk/ was 1:2.58. The mean duration of all the singletons preceded by short vowels was 65.60 ms whereas the mean duration of all the geminates preceded by short vowels was 171.84 ms. That is similar to Turkish as mentioned above. He concluded that the only effect between a geminate and the following vowel was that the following vowel was shorter after a geminate than when coming after a singleton. This means the closure duration of a geminate shortened the following vowel as part of compensatory lengthening.

2.2 L2 ACQUISITION OF GEMINATES.

Several studies have found that L2 learners, and English learners in particular, of languages with gemination have difficulty in both categorizing phonemic geminate consonants and producing the accurate singleton-to-geminate closure duration ratio. Native English speakers in the beginning stages of learning tend to lengthen singletons and shorten geminates by producing a smaller singleton-to-geminate duration ratio. The advanced L1 English learners generally reduce the singleton duration and lengthen the geminate to approximate the pronunciation of native speakers, as will be explained below.

In a perception task, Hayes-Harb (2005) investigated the perception of singleton to geminate contrasts by groups of monolingual English speakers and native English speakers with one year of experience learning Japanese. Results indicated that monolingual English speakers
recorded 76.3% of discrimination the stimuli, in contrast to learners of Japanese recorded 83.9%. Monolingual English speakers were more likely to incorrectly contrast geminates and singletons even though they had the ability to discriminate 75% of the stimuli successfully, while learners of Japanese could discriminate such contrasts better than monolingual English speakers. In the categorization task, native speakers of Japanese judged singletons by consonant closure duration. On the other hand, monolingual English speakers did not show 100% judgment for singletons at any amount of duration. In contrast, learners of Japanese showed better judgment than monolingual English speakers. These tasks suggested that monolingual English speakers of languages with gemination had difficulty categorizing temporal consonant contrasts, likely due to English not having phonemic consonant length.

Hayes-Harb and Masuda (2008) conducted a study of native English speakers learning Japanese. The study investigated the ability of L2 learners to both perceive and produce L2 contrasts, and to create a new L2 category absent from their L1, in particular distinguishing the voiceless alveolar geminated stop from its singleton counterpart. The participants consisted of native English speakers who had never learned Japanese and native English speakers who had been studying Japanese for almost one year from first exposure. Both groups were able to discriminate the contrasts (out of 1.00 meaning perfect) 0.82 and 0.90 for both non-learners and learners of Japanese respectively, in contrast to native Japanese 0.95. However, only learners of Japanese were able to discriminate and categorize geminate-singleton contrasts. In the production task, learners of Japanese showed contrasts similar to native Japanese speakers but their contrasts were shorter. In contrast, non-learners of Japanese showed less ability to contrast geminates and singletons. Interestingly, participants in all groups were much more likely to make errors with singletons than geminates. Since the Japanese voiceless alveolar singleton is similar
to the one in English, both groups recorded highly accurate singleton performance with better accuracy for learners over non-learners, nevertheless their performance was not identical to native speakers. Such similarity among singletons makes it difficult for non-natives to contrast singletons from geminates. Therefore, they would regard a geminate as singleton, since they may tend to produce L2 sounds from the perspective of their L1 as will be explained with models later. Thus, since gemination (long consonant duration and re-syllabification) was absent from their L1 phonemic and phonetic categories they adjusted singletons to achieve a contrastive ratio instead of creating the L2 sound.

Jia, Mori, and Kasuya (2005) examined a contrastive production of Japanese geminates and singletons between native speakers of Japanese and native Chinese speakers in advanced levels of learning Japanese. The study aimed to observe the effect of speaking rate on pronouncing Japanese geminates and singletons based on the duration of the geminate/singleton, and on the length of the preceding long or short vowels. They conclude that the identical pronunciation between L2 learners of geminate and native speakers of geminate could not be predicted to occur at least for intermediate learners even though they could achieve apparently correct geminate length. Han (1992) supported this view when she found that even advanced English learners of geminate sounds either incorrectly perceived geminates and singletons as alike because they sometimes produced a geminate instead of a singleton and vice versa (no categorization) whereas in some tokens they successfully produced geminates with greater length than singletons but such length was not as long as that produced by native speakers. This depended on their experience with L2 speech. Regarding production, it could be important to measure the closure duration of target consonants to see the development trends of learners’ performance. Such specification is stated in the studies below.
Harada (2006) conducted an experimental study on the production of L1 English-speaking children who attended a Japanese immigrant program. The purpose of this study was to examine their ability to acquire Japanese geminate voiceless stops. Results of monolingual Japanese children indicated a singleton-to-geminate ratio of 1:2.20. The majority of the bilingual children pronounced both geminates and singletons with much longer duration than monolingual Japanese speakers (1:1.53). This small singleton-to-geminate ratio was due to lengthening the singleton beyond the target length with the geminates being shorter than the target length.

Han (1992) investigated the production stop closure duration of Japanese geminate and singleton by native speakers of Japanese and fluent American English speakers of Japanese. The study examined the duration of the contrast between minimal pairs among three voiceless segments in terms of the ratio of geminate to singleton. Findings of natives’ tokens confirmed that closure duration of geminates is more than twice as long as that of singletons. The overall ratio was 1:2.88. Results of American English showed that in many tokens, geminates were indistinguishable from singletons. Overall results showed that the ratio of singleton and geminate duration was shorter than that of natives (1:1.86). It should be mentioned that the mean duration of singletons pronounced by American English speakers was longer than native speakers of Japanese. For nonnative speakers, 30% of the tokens could not be identified between geminates and singletons, whereas 70% of the tokens did not show accurate contrasts. These results suggested that even fluent speakers of a language containing geminate-singleton phonemic contrasts could have difficulty producing geminates. The 30% of incorrectly contrasting geminate from singleton may indicate that L2 learners could have less difficulty in discriminating geminate from singleton than mastering the contrasts as phonemic categories.
Kabak, Reckziegel, and Braun (2011) investigated the capability of discriminating and producing geminate and singleton contrasts by L2 learners of Italian whose native language was German. L2 learners were divided into two groups; the first had no experience in Italian whereas the second group was composed of advanced learners. The results showed apparent variation of ratio in producing singleton to geminate closure duration based on native speakers of Italian, advanced learners of Italian, and native speakers of German, with ratios of 1:2.40, 1:2.0, and 1:1.80, respectively. Both learners and non-learners of Italian recorded longer durations for singletons, with an average of 96.1 ms and 106.8 ms respectively compared to native speakers of Italian (84.5 ms). Thus, advanced learners produced singletons 11.6 ms longer than native speakers, whereas non-learners produced durations of 22.3 ms. On the other hand, neither reached native geminate closure duration, which lasted only 185 ms compared to 196 ms among native speakers of Italian. That is, both learners and non-learners recorded 11 ms shorter geminate duration than native speakers. Production studies of geminate-singleton closure duration contrasts suggest nonnative speakers of languages with geminate sounds could be able to hold the proper consonant duration to produce singleton-geminate contrasts. However, the ratio of total differentiation between geminate and singleton is significantly shorter than native speakers’ contrasts. These shorter ratio contrasts are due to lengthening singleton duration and shortening geminate duration. Furthermore, the success of lengthening geminate more than singletons may indicate learners’ ability to acoustically discriminate geminates from singletons. However, such L2 novel phonemic contrasts prevent L2 learners from mastering the contrasts. With respect to development, the advanced group had more experience with the foreign language as they were more aware of the novel contrasts.
Han (1992) and Jia, Mori, and Kasuya (2005) confirmed that even advanced learners may show miscontrasting between singletons and target geminates. This is an implication that L2 learners would transfer the existing L1 category into the L2 novel category based on the similarity between singleton and geminate in their place and manner of articulation.

According to the Speech Learning Model (SLM), the difficulty of acquisition could be based on the similarity between L1 and L2 (Flege 1995). Flege (1987) investigated French /t/ by English learners, illustrating that the similarity between French /t/ and English /t/ in their respective phonemic inventories prevented inexperienced learners from noticing the differences in the level of phonetic variation to produce appropriate L2 phonemes. English learners of French succeeded in pronouncing the phonemic French /y/, whereas they failed to pronounce the similar phonemic vowel /u/. Thus, with the Arabic geminate-singleton contrast, it is expected that participants of the present study may fail to produce L2 singletons because of the influence of their L1 in the form of transferring L1 sounds into the L2. That is, L2 English learners of Arabic geminates may discriminate target contrasts as one category with some acoustical phonetic differences between them. They may lengthen the duration of both singletons and geminates, differentiating geminates by making them longer than singletons. Thus, the ratio between singletons and geminates would be shorter. To support this expectation, Best (1994), in postulating the Perceptual Assimilation Model (PAM), suggested that learners of L2 phonemic contrasts may categorize the novel phonemic contrasts as one phoneme similar to their L1 phonemic Single Category (SC). Such mis-categorization is difficult for L2 learners to contrast. In the inter-language stage the target contrasts may be assimilated into uncategorized phoneme or a native category between the L1 and L2 phoneme called Category Goodness of fit (CG) (Best, Mcroberts, Sithole 1988; Best 1994). Thus, it is possible that English learners of Arabic
geminate-singleton contrasts categorize geminates as singleton phonemes and then may assimilate geminate duration into singleton categorization with some adjustment of length to be similar to the novel category (geminate to singleton length ratio).

Bradlow (2008) found Japanese learners of the English /l/-/ɾ/ contrast assimilated them into one approximant category, since they did not have enough approximant categories in their native language inventory, even though they showed the ability to discriminate and produce the sounds. Thus, since English learners of Arabic geminates have only one consonant duration category (singleton) rather than a singleton-geminate contrast in their native language, they may be better able to discriminate the target contrasts than to categorize them into two separate phonemes. As a result, they may produce the contrast as phonetic variation (Han 1992; Kabak, Reckziegel, and Braun 2011).

This situation is an explanation for Eckman (1977) since he hypothesized that typologically marked sounds are more difficult to acquire than unmarked sounds (MDH), meaning unmarked sounds are acquired before marked ones. Eckman and Iverson (1994) examined coda clusters in inter-language stages of L2 learners of Korean, Japanese, and Cantonese in which clusters in coda position were prevented. Learners acquired the least marked sounds before mastering the more marked ones. English learners in the beginning stages of learning Arabic geminates are also expected to be affected by the process of transfer. In the inter-language stage, they may first fix the unmarked consonant duration (singleton) to be short enough to contrast with geminates, and then during a later stage they would lengthen the marked consonant duration (geminates) to approximate L2 utterances.

Major (2001, 2008) explained the OPM in which learners in the first stage of acquisition would be affected by their L1 categories due to the transfer patterns explained above. In the
inter-language stage, the effect of universal grammar (the markedness) is greater. For example, German learners of English devoice word-final voiced stops, so that /log/ would become /lok/ (Zampini 2008). English learners of the Arabic geminate contrast may not notice the difference at the suprasegmental level during the first stages of acquisition; they would thus likely have difficulty producing the target duration ratio. Such difficulty could be explained as being caused by transferring L1 singleton categories to L2 geminate categories by lengthening singletons much more than native speakers would. The result would be shorter geminate duration, leading to a smaller ratio between singletons and their geminate counterparts. In the inter-language stage they may first adjust the unmarked singleton closure duration to be as short as possible to extend the ratio between geminate and singleton counterparts then later lengthen the marked closure duration (geminate) to be as long as native speakers. Such an expectation is supported by several experimental studies (Han 1992; Kabak, Reckziegel, and Braun 2011).

Based on the previous studies and the theories, it could be possible that English learners of Arabic geminates would mispronounce singleton and geminates in the beginning stage, they may lengthen singletons much more than native speakers do. With geminates, they may shorten them much more than native speakers do. As a result, the ratio would be shorter than when produced by native speakers. Learners in advanced group may shorten singletons to approximate native Arabic speakers’ singletons. With geminate, they may lengthen their utterances of geminate duration to be closer to Arabic native speakers. The ratio between singletons and geminates would be longer than the ratio produced by the beginners. The target ratio of native Arabic singleton to geminate could be higher than 1:2.60 (Ahmad 2012) since the tokens in this study were pronounced in isolated words rather than in carrier sentences.
CHAPTER 3
METODOLOGY

This study investigated developmental trends related to the acquisition of Arabic geminate stops by learners of Arabic whose L1 is English. L2 learners of a language have difficulties in pronouncing the consonant length contrast, as explained from several studies stated above. In particular, such difficulties can lead them to change whole meaning of a word when mispronouncing a singleton as a geminate or vice versa. This study will shed light on the nature of these difficulties.

3.1 Research questions.

1. Do learners of Arabic whose L1 is English have difficulties in pronouncing Arabic geminate stops as they do in other languages that have phonemic gemination in consonants?

2. Is the ratio of geminate: singleton stops produced by L1 English speakers the same as the ratio of L1 Arabic speakers?

3. Is there a difference in the ratio of geminate: singleton stops in advanced L2 Arabic learners vs. beginning L2 Arabic learners?

3.2 Participants.

The participants consisted of 22 students. The target groups have been enrolled in the intensive Arabic program at Indiana University in Bloomington, Indiana. The researcher asked for permission to have access to the learners. After being granted permission by the NELC department, the researcher asked for the participants’ e-mails to introduce himself to each participant, explain to him/her the nature of the research, what the data is being collected for, and ask for his/her participation. After receiving their agreement to participate, the researcher asked
to set up an appointment for each participant. During the appointment, the researcher distributed the consent form and the word list.

The first group consisted of 8 native English speakers in the first semester of their Arabic program (three months from when they began learning the language). This group was asked to affirm that they had not had the previous opportunity to study a language that has geminate consonants, such as Japanese or Italian. The second group consisted of 8 native English speakers in the seventh semester (the fourth year) of their Arabic program. The first group consisted of five females and three males, their ages ranging from 18 to 23 years old, whereas the second group consisted of seven males and one female, their ages ranging from 21 to 47 years old. Every group had been attending reading and speaking courses regularly, so they could produce the data. The third group consisted of 6 native speakers of Arabic who were studying at SIU; three females and three males, distributed based on their Arabic dialects (Kuwaiti, Hejazi-West Saudi Arabia, qatifi-East Saudi Arabia, Jordanian, Yemani and Sudanese). Their ages ranged from 21 to 32 years old.

3.3 Instruments.

The data consisted of 16 words in randomized order containing geminate and singleton stops /b/,/bb/-/t/,/tt/-/d/,/dd/-/k/,/kk/ preceded by only short vowels rather than long vowels to prevent overwhelming learners and allowing them to focus on the target of the study (the geminate-singleton contrast). Also, these words are divided equally between bisyllables and trisyllables to represent a common environment in which geminates occur in Arabic. The bisyllables are represented as CV.CV (singleton) and CVC.CV (geminate), while the trisyllables are represented as CV.CV.CV (singleton) and CVC.CV.CV (geminate) as shown below in the appendices. All of the trisyllables are minimal pairs differing only by the geminate and singleton
contrasts, such as /sakana/ ‘he lived in home’ and /sakkana/ ‘he let someone to live in home’. The bisyllables, on the other hand, are different only in the final syllable in which the singleton is followed by a long vowel while the geminate is followed by a short vowel due to the difficulty of finding short vowels in the second part of a bisyllable such as /ʃakka/ ‘he doubted’ and /ʃakaa/ ‘he complained’. It should be mentioned that all of the segments share similar place and manner of articulation to English except the target geminate and long vowels mentioned above to prevent drawing attention away from the target sounds. None of the students were aware of the purpose of this study.

The students were required to answer the demographic questionnaire and then practice the word list before they individually read them aloud. The words were written in Arabic orthography in mixed order. That list of words had three copies, the whole words were randomized throughout the copies, so that the learners would read the three copies at a normal speech rate in a quiet room to record the data. Ten out of the 16 words did not contain the target contrast. They were inserted into the data to prevent participants from potentially finding a strategy or pattern for pronouncing the data. The 10 unrelated words are /masaajid/ ‘mosques’, /ʔqlaam/ ‘pens’, /Jabal/ ‘mountain’, /baab/ ‘door’ /dafana/ ‘he buried’ /ramaa/ ‘he threw’ /sanaam/ ‘hump’ /rasama/ ‘he drew’ /salaam/ ‘peace’ /nawa/ ‘he planned’. All participants had been coded beforehand as ALA1 (Advanced), BLA1 (Beginner), NAR1 (Native Arabic), etc. to keep track of their data. The total tokens are 26 words x 3 repetitions = 78 x 22 participants = 1716 tokens. The data was analyzed through Speech Analyzer as shown below. Arabic native speakers’ data were used as the standard of accurate singleton to geminate production ratios.
3.4 Variables.

The independent variable, as stated in the research questions, is the proficiency level of the students. The dependent variable, on the other hand, is the ratio of the Arabic singleton-geminated stops.

3.5 Data Analysis.

Every participant’s target word was analyzed through Speech Analyzer. The participants’ pronunciations have been measured with respect to the closure duration of geminates and singletons starting from the end of the preceding vowel until the offset at the burst before the release. The three target words’ repetition (singleton and geminate) for each participant is the mean. The ratio of the mean between geminate and singleton was calculated to compare it to the native Arabic group. Bisyllabic and trisyllabic ratios were taken into account. Measurements were reviewed by an assistant to ensure accuracy. Descriptive analysis was used on the data; the ratio between singletons and geminates was analyzed between and within target groups on the one hand and between/within the ratios of each group with respect to the native Arabic speakers on the other.
CHAPTER 4
RESULTS AND DISCUSSION

The results were divided into three sections based on the participants’ groups. The ratios between singletons and geminates were calculated based on each group’s mean. The ratios of bisyllabic and trisyllabic words were also calculated.

First, the Native Arabic group (NAR) showed an apparent ratio of 1:3.52 between the means of singletons and geminates in all tokens, with a singleton mean of 71.4 ms and a geminate mean of 251.5 ms. Table 1 below represents the results of the NAR for each participant based on the mean of their tokens in singletons, geminates, and the ratio.

TABLE 1. The mean of the singleton/geminate closure duration and the ratio of the NAR.

<table>
<thead>
<tr>
<th>The Participants</th>
<th>The Mean of Singletons’ Closure Duration</th>
<th>Ratio</th>
<th>The Mean of Geminates’ Closure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAR 1</td>
<td>69.6 ms</td>
<td>1:3.71</td>
<td>258.7 ms</td>
</tr>
<tr>
<td>NAR 2</td>
<td>75.1 ms</td>
<td>1:3.40</td>
<td>256.0 ms</td>
</tr>
<tr>
<td>NAR 3</td>
<td>68.9 ms</td>
<td>1:3.01</td>
<td>207.4 ms</td>
</tr>
<tr>
<td>NAR 4</td>
<td>80.7 ms</td>
<td>1:3.58</td>
<td>289.6 ms</td>
</tr>
<tr>
<td>NAR 5</td>
<td>64.3 ms</td>
<td>1:3.87</td>
<td>249.3 ms</td>
</tr>
<tr>
<td>NAR 6</td>
<td>69.9 ms</td>
<td>1:3.55</td>
<td>248.4 ms</td>
</tr>
<tr>
<td>Mean</td>
<td>71.4 ms</td>
<td>1.3.52</td>
<td>251.5 ms</td>
</tr>
</tbody>
</table>
The geminate closure durations were clearly longer than their singleton counterparts. However, the ratio was much longer than previous studies due to the fact that the singletons/geminates in previous studies were inserted in carrier sentences, which led the air stream of speech to be distributed among more segments. Then the time for each segment would be smaller than the time of an isolated word because the airstream has more power to allow for much more time for each segment. Indeed, the bisyllables were much longer than trisyllables. The results for NAR showed the ratio of the bisyllabic tokens to be 1:3.67, with singletons of 75.4 ms and geminates of 276.8 ms, whereas the ratio of the trisyllables was 1:3.36, with singletons of 67.4 ms and geminates of 227 ms. Table 2 shows the mean of the closure durations of singletons/geminates and the ratios for each participant based on the syllables.
Based on these results it was found that the segments’ closure stops lengthen as long as syllables shorten. Also, it could be possible that the singleton stops, on the one hand, have limited variation in contrast with geminates. In particular, this limitation was not affected by the situation of the target words, whether they were in a carrier sentence or isolated, since the current study showed the trisyllabic singleton stops were 67.4 ms long, which is close to Ahmad’s (2012) study, which found them to be 65.6 ms.
On the other hand, geminates could be the main factor of constructing the ratio between singletons and geminates, because singletons have limited variations in contrast with singletons in both bisyllables and trisyllables with a difference of 8 ms. In Ahmad’s (2012) study, the same limitation occurred frequently with the singleton stops in both the isolated trisyllabic words and carrier sentences with a difference of only 1.8 ms. This was not the case with geminate stops, since they apparently varied from the bisyllables to the trisyllables with a difference of 49.8 ms and from the isolated trisyllabic words from carrier sentences with a difference of 55.2 ms.

These findings propose that the time of the closures is the main trigger of geminates as stated in previous studies, whereas this is not the case for singletons. Therefore, since time is affected by the number of syllables and the number of words produced in a given context, the variation is clearly presented in geminates rather than singletons.

The Beginners of Learning Arabic (BLA) group showed a smaller ratio (1:1.45) between geminates and singletons with a singleton mean of 109.2 ms and geminate mean of 159.3 ms. The bisyllabic tokens had a longer closure duration in terms of singleton and geminate stops than trisyllabic tokens. The BLA recorded bisyllabic singleton tokens of 117.9 ms and geminates of 171.9 ms, whereas they recorded singletons of 100.4 ms and geminates of 146.5 ms in trisyllabic tokens. However, the ratios for both bisyllables and trisyllables between singleton stops and geminate stops were alike, with ratio of 1:1.45. Table 3 below shows the results of the BLA for each participant based on the mean of their tokens in singletons, geminates, and the ratio.
TABLE 3. The mean of the singleton/geminate closure durations and the ratio of the BLA.

<table>
<thead>
<tr>
<th>The Participants</th>
<th>The Mean of Singletons’ Closure Duration</th>
<th>The Ratio</th>
<th>The Mean of Geminates’ Closure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLA 1</td>
<td>159.5 ms</td>
<td>1:0.76</td>
<td>122.5 ms</td>
</tr>
<tr>
<td>BLA 2</td>
<td>107.0 ms</td>
<td>1:1.94</td>
<td>208.5 ms</td>
</tr>
<tr>
<td>BLA 3</td>
<td>121.0 ms</td>
<td>1:1.80</td>
<td>219.0 ms</td>
</tr>
<tr>
<td>BLA 4</td>
<td>104.3 ms</td>
<td>1:1.76</td>
<td>184.6 ms</td>
</tr>
<tr>
<td>BLA 5</td>
<td>81.3 ms</td>
<td>1:1.34</td>
<td>109.7 ms</td>
</tr>
<tr>
<td>BLA 6</td>
<td>96.5 ms</td>
<td>1:1.06</td>
<td>102.9 ms</td>
</tr>
<tr>
<td>BLA 7</td>
<td>107.0 ms</td>
<td>1:1.54</td>
<td>165.1 ms</td>
</tr>
<tr>
<td>BLA 8</td>
<td>97.0 ms</td>
<td>1:1.81</td>
<td>162.1 ms</td>
</tr>
<tr>
<td>Mean</td>
<td>109.2 ms</td>
<td>1:1.45</td>
<td>159.3 ms</td>
</tr>
</tbody>
</table>

Table 4 shows the mean of the closure durations of singletons and geminates and the ratios for each participant based on the syllables.
TABLE 4: The mean of singletons/geminates and the ratios for each participant in both bisyllabic and trisyllabic tokens.

<table>
<thead>
<tr>
<th>The Participants</th>
<th>The Mean of Bisyllabic Tokens</th>
<th>The Mean of Trisyllabic Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Singletons</td>
<td>Ratio</td>
</tr>
<tr>
<td>BLA 1</td>
<td>196.4 ms</td>
<td>1:0.72</td>
</tr>
<tr>
<td>BLA 2</td>
<td>128.9 ms</td>
<td>1:1.95</td>
</tr>
<tr>
<td>BLA 3</td>
<td>116.0 ms</td>
<td>1:1.99</td>
</tr>
<tr>
<td>BLA 4</td>
<td>110.3 ms</td>
<td>1:1.97</td>
</tr>
<tr>
<td>BLA 5</td>
<td>81.5 ms</td>
<td>1:1.30</td>
</tr>
<tr>
<td>BLA 6</td>
<td>99.7 ms</td>
<td>1:1.11</td>
</tr>
<tr>
<td>BLA 7</td>
<td>115.4 ms</td>
<td>1:1.19</td>
</tr>
<tr>
<td>BLA 8</td>
<td>95.2 ms</td>
<td>1:1.84</td>
</tr>
<tr>
<td>Mean</td>
<td>117.9 ms</td>
<td>1:1.45</td>
</tr>
</tbody>
</table>
These findings suggest that the BLA are capable of producing some ratio between singletons and geminates. However, such ratio is too small in comparison with the NAR. The singletons were longer than that recorded with the NAR by about 37.8 ms, and the geminates were shorter by about 92.2 ms. The trisyllabic singletons and geminates were slightly closer to the NAR trisyllabic singletons and geminates than the bisyllabic singletons and geminates. The difference between BLA and NAR in the trisyllabic singletons is that BLA recorded singletons 33 ms longer than NAR, and the difference between BLA and NAR in the trisyllabic geminates is that BLA recorded geminates 80.5 ms shorter than NAR. In contrast, the difference between the bisyllabic singletons is that BLA recorded singletons 42.5 ms longer than NAR, while the bisyllabic geminates were 104.9 shorter. However, such differences did not affect the ratio from the bisyllables to the trisyllables since they recorded one identical ratio of 1:1.45. In other words, the bisyllabic and trisyllabic singletons have almost the same variation as their geminates since the difference between the bisyllabic and trisyllabic singletons was 17.5 ms and the difference in their geminates was 25.4 ms. That was different from the NAR, which displayed a small variation between bisyllabic/trisyllabic singletons and high variation between the geminates.

Based on these results, it could be that the difficulty of producing geminates comes from the failure of producing small closure duration in the singletons as well as the failure of producing high closure duration in the geminates, even though the geminates are longer than the singletons, since the ratio is short between them.

The Advanced Learning Arabic group (ALA) also showed a ratio of 1:1.71 between singletons and geminates, with a singleton mean of 100.7 ms and a geminate mean of 172.9 ms. This is larger than the BLA group, but is smaller than the Native speakers. The bisyllabic tokens had longer duration between singletons and geminates than the trisyllabic tokens. The bisyllabic
singletons were recorded as 117.6 ms and the geminates as 200.5 ms, whereas the trisyllabic
singletons were recorded as 85.5 ms and 145.4 ms for the geminates. However, such differences
between the bisyllabic results and those of the trisyllables were limited in terms of the ratio,
since both the bisyllabic and trisyllabic ratios were the same (1:1.70). Table 5 below shows the
results of the ALA for each participant based on the mean of their tokens in singletons/geminates
and the ratio.

**TABLE 5.** The mean of the singleton/geminate closure durations and the ratio of the ALA.

<table>
<thead>
<tr>
<th>The Participants</th>
<th>The Mean of Singleton Closure Duration</th>
<th>The Ratio</th>
<th>The Mean of Geminate Closure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALA 1</td>
<td>121.8 ms</td>
<td>1:1.35</td>
<td>164.8 ms</td>
</tr>
<tr>
<td>ALA 2</td>
<td>126.8 ms</td>
<td>1:2.40</td>
<td>305.5 ms</td>
</tr>
<tr>
<td>ALA 3</td>
<td>111.3 ms</td>
<td>1:1.72</td>
<td>192.2 ms</td>
</tr>
<tr>
<td>ALA 4</td>
<td>69.7 ms</td>
<td>1:3.10</td>
<td>216.1 ms</td>
</tr>
<tr>
<td>ALA 5</td>
<td>135.9 ms</td>
<td>1:1.43</td>
<td>195.4 ms</td>
</tr>
<tr>
<td>ALA 6</td>
<td>90.4 ms</td>
<td>1:1.17</td>
<td>106.6 ms</td>
</tr>
<tr>
<td>ALA 7</td>
<td>99.6 ms</td>
<td>1:1.27</td>
<td>127.2 ms</td>
</tr>
<tr>
<td>ALA 8</td>
<td>50.2 ms</td>
<td>1:1.51</td>
<td>75.9 ms</td>
</tr>
<tr>
<td>Mean</td>
<td>100.7 ms</td>
<td>1:1.71</td>
<td>172.9 ms</td>
</tr>
</tbody>
</table>

Table 6 shows the mean of the closure durations of singletons/geminates and the ratios for each
participant based on the syllables.
Table 6. The mean of singletons/geminates and the ratios for each participant in both bisyllabic and trisyllabic tokens.

<table>
<thead>
<tr>
<th>The Participants</th>
<th>The Mean of Bisyllabic Tokens</th>
<th>The Mean of Trisyllabic Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Singletons</td>
<td>Ratio</td>
</tr>
<tr>
<td>ALA 1</td>
<td>162.5 ms</td>
<td>1:1.44</td>
</tr>
<tr>
<td>ALA 2</td>
<td>163.6 ms</td>
<td>1:2.18</td>
</tr>
<tr>
<td>ALA 3</td>
<td>126.2 ms</td>
<td>1:1.68</td>
</tr>
<tr>
<td>ALA 4</td>
<td>75.5 ms</td>
<td>1:3.16</td>
</tr>
<tr>
<td>ALA 5</td>
<td>138.7 ms</td>
<td>1:1.51</td>
</tr>
<tr>
<td>ALA 6</td>
<td>109.5 ms</td>
<td>1:0.92</td>
</tr>
<tr>
<td>ALA 7</td>
<td>101.5 ms</td>
<td>1:1.53</td>
</tr>
<tr>
<td>ALA 8</td>
<td>49.4 ms</td>
<td>1:1.89</td>
</tr>
</tbody>
</table>
| Mean             | 117.6 ms   | 1:1.70 | 200.5 ms  | 85.5 ms    | 1:1.70 | 145.4 ms  

The ALA group showed potential development toward the NAR results since they scored larger ratios than the BLA. However, the ALA ratio was smaller than that of the NAR since the singletons were longer by 29.7 ms and the geminates shorter by 78.6 ms. The trisyllabic singletons were closer to the trisyllabic singletons of the NAR than the bisyllabic singletons,
whereas the bisyllabic geminates were closer than the trisyllabic geminates to NAR geminates. That is, the ALA recorded trisyllabic singletons only 18 ms longer than the NAR trisyllabic singletons, whereas they recorded bisyllabic singletons that were 42.2 ms longer. Such differences with geminates in terms of trisyllables and bisyllables were not alike since the difference in ALA results was 81.6 ms shorter with the trisyllabic geminates and 76.3 shorter with the bisyllables than NAR results. Despite the varied results, in a way the ratios of the trisyllable were similar to those of the bisyllable since the ratio in the two types of syllables was identical, 1:1.70 for each; both trisyllabic singletons and geminates were shorter than their results in bisyllabic singletons and geminates, in which they recorded longer closure durations than in the trisyllabic singletons and geminates. This is in contrast with NAR results in which both trisyllabic and bisyllabic singletons were short and the bisyllabic geminates were longer than trisyllabic geminates. The difference between the singleton bisyllable/trisyllable was 32.1 ms and 55.1 ms with the geminates. That is, the variation of the geminates from the trisyllables to the bisyllables was similar to that in the NAR group when they recorded bisyllabic geminates longer than trisyllabic geminates with a difference of 49.8 ms. However, in terms of singletons, the ALA failed to record a small variation since they recorded 85.5 ms for the trisyllabic singletons and 117.6 for the bisyllabic singletons.

These results indicate that the ALA showed a higher ratio than the BLA since they succeeded in shortening the singletons closure duration of the trisyllable and lengthening the bisyllabic geminates. However, they did not show any improvement with the trisyllabic geminates or the bisyllabic singletons.

As previous studies indicated, this study confirmed that L2 learners of Arabic have difficulty in achieving the singleton-to-geminate contrasts of native speakers. The BLA group
showed smaller ratios between singletons and geminates even though they could lengthen the geminates more than the singletons. The ALA group also showed small ratios but their ratios showed an improvement in both the singletons and the geminates even though such development was far from the NAR ratio. This is similar to the findings of Hayes-Harb and Masuda (2008) when they showed that learners of Japanese showed an improvement much more than non-learners of Japanese. Also, the improvement of ALA over the BLA comes from shortening the trisyllabic singletons and lengthening the bisyllabic geminates. In other words, the trisyllabic geminates of the ALA did not show an improvement nor did they do so with the bisyllabic singletons. The trisyllabic singletons and geminates were closer to the results found in Kabak, Reckziegel, and Braun (2011) since the advanced learners of Italian recorded geminate durations similar to that recorded by the non-learners, whereas the advanced learners recorded shorter singleton duration than non-learners. The difference in this study is that the trisyllabic singletons and geminates were limited to stops and in isolated words whereas the study of Kabak, Reckziegel, and Braun (2011) included bisyllabic singletons/geminates, obstruent and sonorant, which were embedded in sentences.

The findings of the present study are in agreement with current L2 theories since both BLA and ALA failed to categorize a novel category for the geminates and failed to adjust the singletons to have shorter duration. This process is clearly under the effect of SLM and PAM since the similarity of the L2 sounds is in the place and the manner of articulation of L1 sounds. The BLA did not show any trends in categorizing the geminates, unlike the ALA, which adjusted the trisyllabic singletons to be shorter in order to approximate the novel category (the geminates), and they adjusted the bisyllabic geminates to be longer. This strategy enabled their production to achieve longer ratios than the BLA.
The trisyllabic singletons and geminates indicated that the ALA was under the effect of the MDH since they did not show the improvement in the marked phoneme (the geminate), unlike the singletons where they showed apparent improvement, since the singleton is unmarked and similar to their L1 categories. However, in the bisyllabic singletons and geminates, they showed an improvement in the geminates, not in the singletons.

With respect to the ALA group, improvement was apparent in two participants: ALA2 and ALA4, since the rest of the participants scored ratios smaller than 1:1.80, while they scored a total ratio of 1:2.40 and 1:3.10 respectively. The mean of their results altogether indicated that, on the one hand, they scored longer singleton durations in both trisyllables (76.9 ms) and in bisyllables (119.5 ms), and on the other hand they showed improvement in the trisyllabic geminates (223.6 ms almost acquired, close to the 227 ms recorded by the NAR) and overcorrection for the bisyllabic geminates (298 ms). These results suggest that the singletons are the most difficult part of making the ratio between singleton and geminate since the singletons are always longer than the NAR group and the variation between the bisyllabic/trisyllabic singletons is longer than that in the NAR group, whereas the variation between the bisyllabic/trisyllabic geminates is almost the same as to the NAR. To support this view, based on the results of the two participants in comparison to the NAR, the mean of the trisyllabic/bisyllabic singletons are too long (98.2 ms), that is, 26.8 ms longer, whereas the geminates are longer (260.8 ms) for only 9.3 ms. This may indicate that the singletons are the last stage toward acquisition of the contrast. However, this possibility cannot be confirmed based on only two participants even though the two participants took the lead for the developmental trend of the ALA to be better than the BLA.
Overall, the results showed that the learners in the first stage of the acquisition process have difficulty in making native-level ratios between singletons and geminates, since they failed to adjust the singletons to be shorter to achieve the native speakers’ singleton length, and failed to lengthen geminates as native speakers did. This trend was similar to the results for bisyllables and trisyllables. For the advanced learners, the difficulty was also noticeable based on the ratio. However, they showed improvement in the trisyllabic singletons since they produced shorter singletons than the beginners. In addition, improvement was found in the bisyllabic geminates since the advanced learners lengthened the geminates much more than the beginners.
CHAPTER 5
CONCLUSION

This study investigated the difficulty and the developmental trends of pronouncing the Arabic singleton/geminate contrasts in isolated words among English learners of Arabic. It also discussed the ratio between singleton and geminate in both bisyllabic and trisyllabic tokens, where the singleton/geminate contrast is commonly produced in Arabic.

The results indicated that both the beginners and the advanced learners of Arabic have difficulty in producing singleton/geminate contrasts, whether in bisyllabic or trisyllabic tokens. Their ratios were less than those of the native speaker group. In contrast to the beginners, the advanced group showed an improvement in the total results of the bisyllabic/trisyllabic tokens as they shortened the singletons and lengthened the geminates much more than the beginners. They improved the ratio by only shortening the singletons in the trisyllabic tokens, whereas they improved it in the bisyllabic tokens by lengthening the geminates. Based on the results for advanced learners, two of the participants displayed more native-like ratios than the other participants in the same group. Their total results showed improvement by lengthening the geminates over the native speakers’ tokens by only 9.3 ms, whereas they failed to shorten the singletons since they scored 26.8 ms over that of the native speakers.

In addition, both groups of learners failed to make the bisyllabic ratios longer than the trisyllables as the native speaker group did, since the learners lengthened one ratio for each syllable. The beginners failed to make bisyllabic geminates longer than the trisyllables since they made geminates only 25.4 ms longer than their trisyllabic counterparts, whereas the advanced learners succeeded in doing so because they lengthened the bisyllabic geminates to be 55.1 ms
longer than the trisyllabic counterparts. These results were close to the native speaker group as they lengthened the bisyllabic geminates to be 49.8 ms longer than their trisyllabic counterparts.

These results supported the SLM, PAM, and OPM since the beginners did not display large differences in the ratios between singletons and geminates. These results could be explained by the similarity between the L1 and L2 categories on the segmental level. Thus, the beginners failed to categorize the geminates as a novel L2 category, leading them to transfer the L1 singleton segments to approximate geminates by lengthening the singletons much more. As a result, the geminates were shorter than those of native Arabic speakers, and the singletons were longer. In terms of the MDH and OPM, the advanced group did not correctly categorize the marked phoneme (geminates) since they did not reach the native geminate duration, although they adjusted the singletons to be shorter than in the results for the beginners.

Producing singleton-to-geminate ratios that contrast one consonant (singleton) with two identical consonants with different kinds of syllabification (geminates) is suggested to be a marked phenomenon. The beginners in the first stage of acquisition failed to create long ratio since they were transferring L1 categories to L2 categories. The advanced group, on the other hand, showed a trend in creating a ratio similar to the native speakers; nevertheless, the improvement was found in the singletons in the trisyllables, where the marked categories (geminates) did not differ from those of the beginners, and the improvement in the bisyllables was in the geminates, where the singletons did not differ from the beginners. In addition, the advanced group showed significant difficulties in even producing ratios that were half as long as the native speaker ratios, since they did not reach the ratio of 1:1.76. This suggested that further studies need to be conducted on Arabic geminates with more participants, based on both bisyllables and trisyllables.
REFERENCES


KABAK, BARIŞ; TANJA RECKZIEGEL; and BETTINA BRAUN. 2011. Timing of second language singletons and geminates. *Hong Kong* 17.994–997.


LISKER, LEIGH. 1958. The tamil occlusives: short vs. long or voiced vs, voiceless?. *Indian Linguistics* 1. 294–301.


APPENDICES
APPENDIX A

Demographic survey:

Dear participant,

I would like to thank you for agreeing to contribute to this study. This work is NOT a test or evaluation of your study. It is only a study for academic purposes. So, I would like to have your precision in providing this information. Do not hesitate to take your time to read.

Best wishes, Ahmed Almutiri.

Please check the appropriate answer and fill in the blank if necessary:

1. What is your student status?  2. What is your age and gender?
   a) Undergraduate.  a) Age:
   b) Graduate, seeking MA.  b) Gender:
   c) Graduate, seeking PhD.
   C) Other:

3. Do you speak language(s) other than English and Arabic? If you do, please list them.

4. How long have you studied Arabic? Where has this study taken place?

5. Have you been in an Arabic-speaking country? If you have, where? For how long?
### APPENDIX B

#### Word List:

<table>
<thead>
<tr>
<th>Type of syllable</th>
<th>No.</th>
<th>A. mid singleton words</th>
<th>B. mid geminate words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bisyllable</strong></td>
<td>1.</td>
<td>&quot;كبا&quot; /kabaa/ 'he stumbled’</td>
<td>&quot;كب&quot; /kabba/ ‘he scattered something’</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>&quot;فتي&quot; /fataa/ ‘guy’</td>
<td>&quot;فث&quot; /fatta/ ‘he grinded something’</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>&quot;مدى&quot; /madaa/ ‘extent’</td>
<td>&quot;مذ&quot; /madda/ ‘he lengthened something’</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>&quot;شكا&quot; /ʃakaa/ ‘he complained’</td>
<td>&quot;شك&quot; /ʃakka/ ‘he doubted’</td>
</tr>
<tr>
<td><strong>Trisyllable</strong></td>
<td>5.</td>
<td>&quot;كبت&quot; /kabata/ ‘he suppressed’</td>
<td>&quot;كبت&quot; /kabbata/ ‘he suppressed with much power’</td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td>&quot;كتم&quot; /katama/ ‘he kept the secret’</td>
<td>&quot;كتم&quot; /kattama/ ‘prevent the air from getting inside something’</td>
</tr>
<tr>
<td></td>
<td>7.</td>
<td>&quot;مدى&quot; /madaa/ ‘he extended something’</td>
<td>&quot;مذ&quot; /madda/ ‘he extended something’</td>
</tr>
<tr>
<td></td>
<td>8.</td>
<td>&quot;سكن&quot; /sakana/ ‘he lived in’</td>
<td>&quot;سكن&quot; /sakkana/ ‘he let someone to live in.’</td>
</tr>
</tbody>
</table>
Dear participant,

My name is Ahmed S. Almutiri. I am a graduate student in the Department of Linguistics at Southern Illinois University at Carbondale (SIUC). I am currently developing a study as part of my Master’s Degree in Applied Linguistics. In this study, I will investigate issues related to the production of certain Arabic sounds by Arabic native speakers and English learners of Arabic. If you agree to participate in my study, you will be asked first to fill out demographic information (gender, nationality, academic status, age, length of exposure, etc.) about yourself. In order to record the data for the second part, you will sit in a quiet room and be asked to put on a headset connected to a laptop. Then you will be asked to pronounce 78 words by reading them from a separate sheet of paper. The entire session will take about 20 minutes to complete. All your responses would be CONFIDENTIAL, and your participation in the test is VOLUNTARY. Each participant will be identified in the study using only a numerical code. Your name will not be connected to that numerical code. If you agree to take part in the investigation, you need to sign this form. However, if you change your mind, you may withdraw at any time without hesitation. The people who will have access to the data will be myself and my thesis advisor, Dr. Karen Baertsch. After the study is completed, the raw data sheets will be destroyed.

For additional information, you can contact me, Ahmed S. Almutiri, Project Researcher, at:

62901 W. Sunset Dr. Apt. B
Carbondale, IL 62901
Tel: (812) 606-0654
Email: aalmutir@siu.edu

Or you may also contact Dr. Karen Baertsch, Research Advisor, at:

Department of Linguistics, Faner Hall 3234, MC 4517
1000 Faner Drive. SIU, Carbondale, IL 62901
Email: kbaertsch@siu.edu

Please, read the statement below and check if you agree or do not agree with it. Then, sign and date this form.

“I agree _____ I do not agree _____ to participate in the study and I know that my responses will be recorded on audio/video tape.”

Signature ________________________ Date ________________
This project has been reviewed and approved by the SIUC Human Subjects Committee. Questions concerning your rights as a participant in this research may be addressed to the Committee Chairperson, Office of Sponsored Projects Administration, Southern Illinois University, Carbondale, IL 62901-4709. Phone: (618) 453-4533. Email: siuhsc@siu.edu.
VITA

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Thesis Title:
The Production of Arabic Geminate Stops by English Learners of Arabic

Major Professor: Dr. Karen Baertsch