

ON THE PHONETIC VARIATION OF INTERVOCALIC GEMINATES IN LIBYAN ARABIC

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ABSTRACT

This paper reports on the phonetic and phonological patterns of gemination in Libyan Arabic (LA). It also reports on the temporal relationship between geminate consonants and vowel length. While previous studies on Arabic gemination have either focused on True geminates or reported results on data that consists more than one type of geminates, without investigating its effect on the phonetic output, the present study investigates the effect of the phonological status of a geminate on the phonetic realization.

The results show that intervocalic geminates in LA are significantly longer than their singleton counterparts. The duration of the preceding vowels gives evidence in support of temporal compensation as one of the correlates of geminates. No significant durational differences could be found between three different intervocalic geminate types. However, the behavior of the preceding short and long vowels is suggestive and may contribute to the phonetic distinction between them.

Keywords: Gemination; Libyan Arabic; geminate types; duration; temporal compensation.

1. INTRODUCTION

Geminate and singleton consonants are contrastive in LA. All consonants in LA can be geminated. Vowel length is also phonemic, and both short and long vowels can occur before geminate consonants.

Durational and acoustic variations in geminates have been investigated for many languages (e.g. [11, 12] for Italy; [3] for Cypriot Greek; [13] for Berber), and generally the duration contrast between geminate and singleton consonants have been reported to be robust. The correlation between the duration of the word-medial single/geminate consonant and that of the preceding vowel have also served as the focus of a number of many cross-linguistic and cross-dialectal experimental investigation (e.g. [1, 2, 4, 6, 8, 10, 11]). Although the strategy of this “temporal compensation” is a dispute issue, it is thought that this acoustic cue contributes to the perceptual effect of gemination (see [1, 4]). The results of such studies are not

consistent across languages, however, which suggests that duration is the universal attribute of geminates, whereas the temporal compensation of the preceding vowel may be language specific.

Arabic geminates also reported to be significantly longer than their singleton counterparts (e.g. [1, 6]). The results of the effect of gemination on the duration of the previous vowel in Arabic are not consistent as well. For example, [1] have found evidence of temporal compensation in Jordanian Arabic that is not affected by the place or manner of articulation of the consonant. In contrast, [6] and [8] did not find any effect of gemination on the duration of the previous vowel in Lebanese Arabic

There are few phonetic studies of LA, and none on the acoustic patterns of geminates and/or the role played by the preceding vowel. In fact, as long as lexical contrastive geminates (‘true’), gemination in LA can also be the result of total assimilation in consonant clusters (‘assimilatory’). Additionally, it can be formed as a combination of two identical consonants at the juncture of a word or a morpheme (‘fake’) (see Table 1 for examples). Previous studies on Arabic have either focused on lexical contrastive geminates or reported results on data that consists more than one geminate type without making explicit the phonological status behind these different types or investigating its effect on the phonetic output. It is interesting to investigate whether this difference triggers any acoustic consequences.

In this study, the three intervocalic geminate types (true, fake and assimilatory) will be investigated acoustically in order to get a picture of what phonetic consequence the phonological status of a geminate might have. This study contributes to the literature on gemination (and the literature on Arabic language) by providing a detailed examination of both the durational correlates of the singleton-geminate contrast, the three geminate types, and the preceding vowels using approximant sounds in LA.

2. METHODOLOGY

2.1. Language Variety

The Arabic dialect used in this study is Tripolitanian Libyan Arabic (TLA), a dialect of Arabic spoken in the North West region of Libya (Tripolitania). In order to control any dialectal variation, this study focuses mainly on the dialect spoken in Gharian, a city in the region of Tripolitania, 80 km south west of the Capital Tripoli.

2. 2. Subjects

Four native speakers (3 males, 1 female) were recruited. They ranged in age, at the time of recording, from 30 to 38 years, and had no obvious speech or hearing defects.

2. 3. Stimuli

A list of 22 real minimal or near-minimal utterances divided into six sets was compiled. Each two sets contain one of the approximant sounds /l, m, n/ both as singletons and three geminate types, with the exception of the alveolar nasal /n/, which have only two geminate types due to the lack of the assimilatory geminate. Table 1 shows an example of one of the sets compiled for the bilabial nasal /m/.

Table 1: An example from the stimuli: one of the two sets compiled for the bilabial nasal /m/.

/m/		
	miʃma:ʃa	singleton
	kamma:ʃa	True geminate
kam#ma:ʃi →	kamma:ʃi	Fake geminate
ka:n#maʃi→	ka:mma:ʃi	Assimilatory G. [n→m]

2. 4. Recording

Each subject was asked to read a list composed of 84 utterances (22 randomized utterances x 3 repetitions + 6 filler words x 3 repetitions). Each target utterance was produced in the carrier sentence [gæ:l aħmid _____ tæ:ni] “Ahmed said _____ again”.

2. 5. Data analysis and measurements

A total corpus of 264 utterances (22 utterances x 3 repetitions x 4 speakers) were extracted from the list each into a separate wavfile for auditory and acoustic analysis. Durational measurements (in millisecond) of the singleton consonants, the different geminate types and the preceding vowels

were made using PRAAT [5]. The durational measurements were obtained using a script and checked by hand.

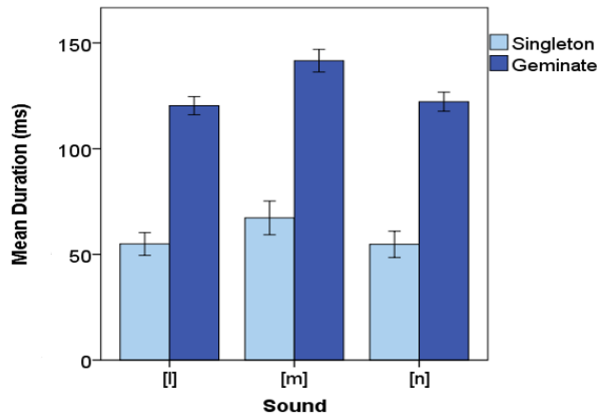
3. RESULTS

The results are based on a serious of independent analysis of variance (ANOVAs) and independent T-tests.

3.1. Singleton-geminate contrast

ANOVA shows that the durational differences between all geminate-singleton contrasts are significant ($F(3,26)=203.686, p<0.001$). The durational differences between singleton consonants and each geminate type separately also achieves significance at ($p<0.001$) level.

Figure 1: Mean duration (in ms) and standard deviation of each of the consonant categories in singleton and geminate targets.



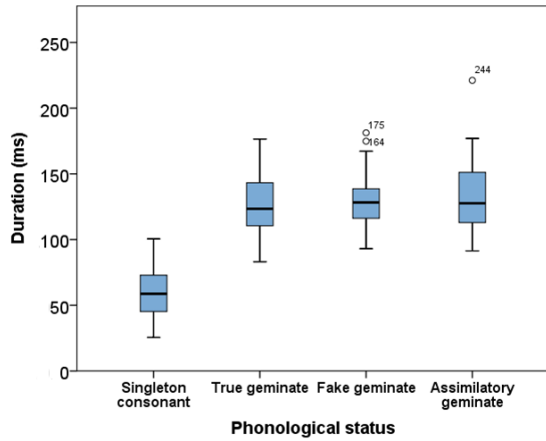
As Figure 1 shows, the durational results for each of the three sounds in the context of singleton and geminate consonants (C and CC contexts) is also significant ($F(1,2)=629.390, p<0.001$). It is clear that there is a consistency in the durational behaviour of these sounds in the context of C and CC, where the alveolar nasals and the laterals (which show similar durational patterns), are shorter than the bilabial nasal ($p<0.001$).

3. 2. Geminate type

The durational differences between the three geminate types (Figure 2) did not achieve significance ($F(2,18)=0.822, p=.441$). Post-hoc LSD tests failed to show any significant differences between the three levels as well. No interaction between speaker and the geminate type could be found ($F(6,18)=1.013, p=.418$), which suggests that

the speakers' durational patterns of the three geminate types are similar.

Figure 2: Durational results of the singletons, true, fake and assimilatory geminates.



3. 3. Preceding vowel

As Figure 3 shows, there is a significant difference between the absolute durational results of the preceding short vowel (V) in the C and CC contexts. That is, gemination significantly shortens preceding short vowels ($t(120) = 6.403, p < 0.001$). On the contrary, the durational values for the preceding long vowels (VV) in the two contexts are not significant ($t(103) = -.404, p = .687$). However, by examining the proportional durations (Figure 4) as a function of the VC sequence, it is clear that the long vowel in the VVCC sequence contributes a smaller proportion of the overall duration compared with the long vowel in the VVC sequence. This suggests an overall proportional rather than absolute temporal compensation between preceding long vowels and geminate consonants.

Figure 3: Absolute mean duration (in ms) of the preceding short and long vowels in the context of singular and geminate consonants.

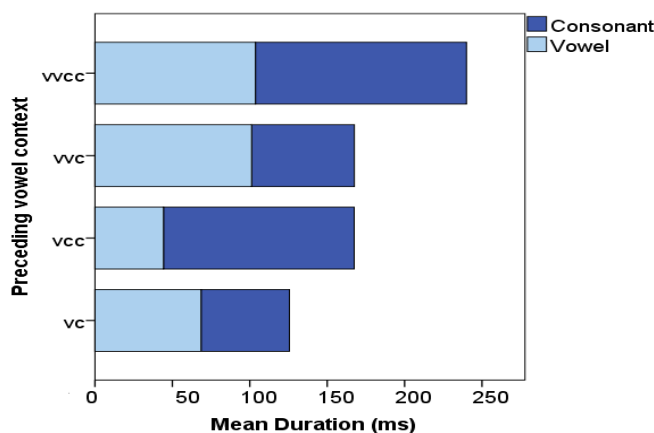
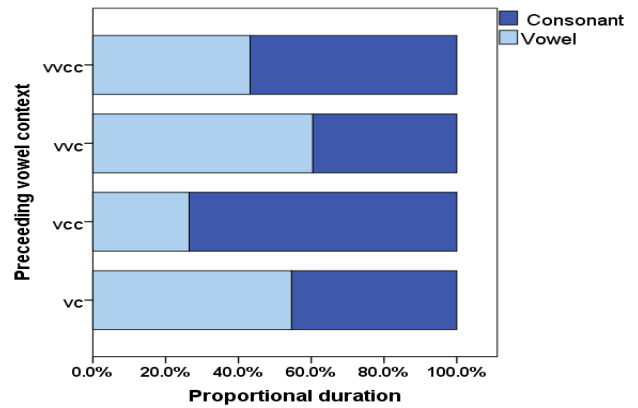
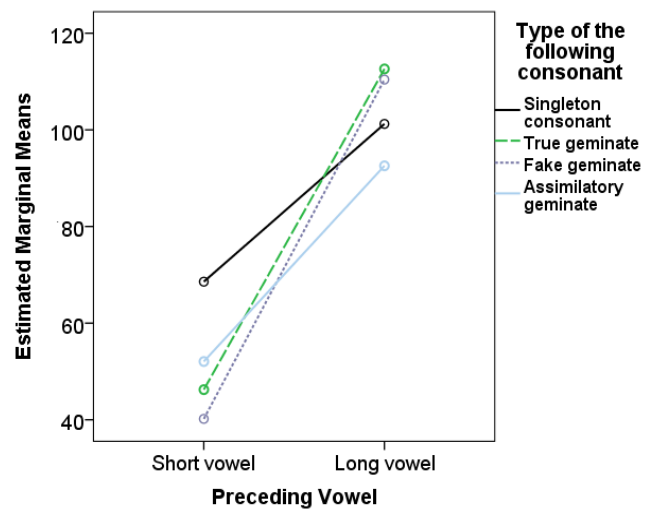


Figure 4: Mean proportional duration of the preceding short and long vowels in the context of singular and geminate consonants



In as far as the geminate type in Arabic is concerned, ANOVA shows that the preceding vowel length is significant ($F(1,3) = 34.289, p < 0.05$), the phonological status is not significant ($F(3,3) = 0.289, p = .832$), and the interaction between them is significant ($F(3,21) = 11.030, p < 0.001$). This relates to the fact that short vowels preceding singleton consonants and assimilatory geminates are longer than those preceding both true and fake geminates (see Figure 5) and that long vowels preceding singleton consonants and assimilatory geminates are shorter than those preceding both true and fake geminates.

Figure 5: Significant interaction between the quantity of the preceding vowel and the phonological status of the following consonant.



ANOVA shows that the durational differences of VV in the context of the three geminate types are significant ($F(3,10) = 4.113, p = 0.008$). Post hoc LSD tests show that long vowels preceding assimilatory

geminate are significantly shorter than those preceding both true geminates ($p=0.003$) and fake geminates ($p=0.007$). Although the long vowels preceding assimilatory geminates are shorter than those preceding singletons, the durational difference did not achieve significance by t-test ($t(55)=1.265$, $p=.211$). Long vowels preceding true and fake geminates did not achieve significant differences from those preceding singletons as well, ($t(45)=-1.790$, $p=0.08$) and ($t(45)=-1.344$, $p=0.186$) respectively). This result suggests that the three geminate types do not have temporal correlations with the preceding VV on the absolute level.

As regarding the behavior of short vowels, ANOVA shows that the durational differences of short vowels in the four contexts are significant ($F(3,11)=19.211$, $p<0.001$). Post hoc LSD tests show that short vowels preceding singletons are significantly longer than those preceding each geminate type ($p<0.001$), which give evidence that all geminate types show temporal compensation effects with the preceding short vowels. Post hoc tests show that short vowels preceding fake geminates are significantly shorter than those preceding both true geminates ($p<0.05$) and assimilatory geminates ($p<0.001$). However, the durational difference between short vowels preceding true and assimilatory geminates is not significant ($t(60)=-1.616$, $p=0.111$).

4. DISCUSSION AND CONCLUSION

Duration is found to be a robust cue for the singleton-geminate distinction in LA. This result supports previous findings from other studies (e.g. [6, 7]). The duration of geminates in this study is generally comparable to what has been found for Jordanian Arabic [1], and Lebanese Arabic [9, 10], with the duration of a geminate consonant being around twice as long as its singleton counterpart.

This study presents evidence that the duration of the preceding vowels is another cue to the distinction between singleton and geminate consonants in LA. However, only short vowels show absolute temporal compensation, which agree with the findings for Jordanian Arabic [1] but contrasts with the findings for Iraqi Arabic [6, 8]. This suggests that the correlation between the preceding vowels and the intervocalic singletons/geminates can be a dialect-specific. In the case of long vowels, the temporal compensation is found to be proportional rather than absolute. This agrees with the findings from [9].

The results show that the phonological status of a geminate seem to have a phonetic output. This phonetic correlation could not be found in the durational parameters of the geminates themselves, but rather it is represented in the durational properties of the preceding short and long vowels showing salient temporal alternation that may contribute to their perceptual effect. The present study show evidence that the three geminate types shorten the preceding V, however the behaviour of the preceding VV does not show temporal compensation and is not consistent among the three geminate types. Assimilatory geminates seem to be phonetically distinctive in that the behaviour of both V and VV before assimilatory geminates is significantly different from the other geminate types. Obviously, the behavior of the VC sequence with the C element being an assimilatory geminate is different from its behavior with a true or fake geminate. The same can be said for fake geminates, where the preceding V is significantly shorter than before true and assimilatory geminates. This seems to be the phonetic correlate associated with this geminate type. More investigation is required on this domain, however.

It is fair to say that the results are based only on approximant sounds and further research involving other segment types and other acoustic parameters will be necessary.

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