**Introduction**

Existing studies on gemination in Arabic show that durational cues play a major role in the contrast, with little or no overlap in the duration ranges for singleton and geminate consonants (e.g., Ghalib 1984; Hann 2001; Hassan 2003; Khattab, 2007; Khattab and Al-Tamimi, 2008; 2014).

There have been hardly any investigations of non-durational cues in the implementation of the singleton-geminate contrast in Arabic. Yet the Arabic word for gemination is /tald/ī/, which means strengthening or intensification.

Our recent work on Fricatives in Lebanese Arabic (Al-Tamimi and Khattab, 2015) showed systematic non-durational manifestations in the realisation of geminate fricatives and their surrounding vowels. These included intensity, F0, spectral peak and shape, dynamic amplitude and voicing patterns of medial fricative; vowel quality and voice quality correlates of surrounding vowels. Their collective patterns suggested tenseness as a secondary feature.

Singleton fricatives are generally long, leading to small g-s ratios (1:1.85).

Hypothesis: non-temporal cues in fricatives support a durational contrast that is less salient/perceptible than for other manners.

CC to C duration ratios vary widely according to manner → is there a trade-off between quality and duration in the realisation of the Arabic geminates?

To test this hypothesis, we looked at sonorants (lateralis and nasals) which have much higher g-s ratios (1 : 2.64 and 1 : 2.60 respectively).

**Methods**

- 20 Lebanese adults from Beirut (10 males, 10 females).
- Read randomised word lists with the following structures:

<table>
<thead>
<tr>
<th>CVICV2</th>
<th>CVICV</th>
<th>CVICCV2</th>
<th>CVICCVV</th>
</tr>
</thead>
<tbody>
<tr>
<td>malak</td>
<td>malak</td>
<td>malak</td>
<td>malak</td>
</tr>
</tbody>
</table>

(he) owned | your money | (he) made | someone own |

- **Medial C:** /m/, /n/ and /l/ (~ 480 tokens)
- **Measurements:**
  - Duration of V(V1), C(C), V2
  - F1; F2-F1: F3-F2 at V(V1) offset and V2 onset
  - F0 + intensity of V(V1) offset, C(C) midpoint, V2 onset
- **Statistical design:**
  - Three-way Linear Mixed effect Models (LMMs) for consonant (/V(V)1, /C(C), /V2/) for nasals (Consonant Length*/Vowel length*/Sex)
  - Four-way for nasals (Consonant Length*/Vowel length*/Sex*/Place of Articulation)
  - Dependent variables: acoustic measures
  - Random slopes: Consonant Length*/Vowel Length
  - Crossed random intercepts: speaker and item

**Results**

High level interactions for sex, place and manner of articulation were not significant, so the remaining comparisons explore consonant and vowel length. While durational differences between singleton and geminate consonants are stark and non-overlapping, the non-temporal manifestations in the consonants and surrounding vowels are largely insignificant, showing that the contrast for s-g sonorants is firmly rooted in durational differences in the consonant.

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**Results (cont.)**

Duration

- Lower F1 in medial G vs CV in nasals
- Lower F1 in medial G vs CC in medial C.
- Higher F2-F1 in medial CC vs C in nasals.
- Higher F2-F1 in medial CC vs C in nasals.
- No other effects of gemination on CV or VCC.

Intensity

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**Discussion**

- **Duration** was a robust cue for the singleton-geminate contrast in sonorants in Lebanese Arabic.
- **No V(V1) shortening was found in CC contexts** → similar results to Engström and Krull, 1994 for Estonian.
- **Non-temporal cues appear to be minimal in the realisation of sonorant geminates and their surrounding vowels in Lebanese Arabic.**
- Very little evidence of strengthening or fortition in nasal and lateral geminates, and the implementation of gemination is very local rather than long domain (cf. Arnbar and Tsafrir, 2000; Levelt and Simpson, 1999; Payne 2006) → fortion is not an automatic consequence of duration in LA.
- Spectral effects are noted in the consonant, mainly showing lower F1 and higher F2, suggesting closing and fronting effects of gemination.
- Hypothesis confirmed: despite geminate sonorants being dispreferred due to their vowel-like patterns which blur their boundaries with those of surrounding vowels, their high g-s ratio plays a role in their salience and robustness of the contrast without recourse to secondary cues.

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**References**


