

# Geminates in Libyan Arabic: investigating articulatory correlates

Amel Issa

University of Gharyan, Libya, University of Leeds, UK.

<https://doi.org/10.36505/TheLinguisticProceedings/2025/16/01/012/000672>

## Abstract

This EPG study examines articulatory correlates of singleton and geminate sonorants (/l, n, r/) in Tripolitanian Libyan Arabic (TLA). Alveolar contact (rows R1–R3) was quantified by Amount of Contact (AoC) and Centre of Gravity (CoG); mean palatograms were inspected visually. Despite prior acoustic evidence showing minimal strengthening for TLA sonorants (Issa 2017), geminates exhibit greater linguopalatal contact, more posterior contact and longer articulatory durations than singletons. Findings indicate that contrastive structure is preserved articulatorily even when acoustic strengthening is absent, supporting multimodal approaches to gemination.

Keywords: Libyan Arabic, gemination, sonorants, EPG, articulatory correlates

## Introduction and motivation

Duration is the most robust correlate of gemination cross-linguistically (Khattab, Al-Tamimi 2008, Arvaniti 1999), but non-durational articulatory indices — tongue shape, contact region and contact area — also differentiate singletons and geminates (Local, Simpson 1988, Payne 2006). EPG work reports laminal vs apical contact and increased contact area for geminates in several languages (Payne 2006; Kraehenmann, Lahiri 2007, 2008, Ridouane 2007). In TLA, gemination is pervasive and contrastive, yet articulatory evidence is lacking; acoustics show similar formant structure and intensity for singleton and geminate sonorants (Issa 2017). This study asks whether articulatory measures reveal systematic differences between singleton and geminate sonorants in TLA.

## Method

### Participant and design

One native male TLA speaker (34 y), born and raised in Tripoli, participated; he reported no speech or hearing deficits, acquired TLA as a first language and had L2 English. Resource and recruitment constraints limited the study to a single informant

### EPG data collection

EPG recordings used WinEPG with an Articulate-style custom palate (62 electrodes; eight rows). Audio was sampled at 22.05 kHz; EPG at 100 frames s<sup>-1</sup>. The participant read randomized trisyllabic minimal/near-minimal pairs containing medial intervocalic /l, n, r/ in singleton and geminate forms, elicited in the carrier ma tgu:lj \_\_\_\_\_ ta:ni. Fillers were interspersed.

### Data analysis

Data were annotated in Articulate Assistant v1.18 (waveform, spectrogram and palate contact displayed concurrently). Analyses targeted the anterior three electrode rows (R1–R3). Measures: Amount of Contact (AoC; proportion of electrodes active), Centre of Gravity (CoG; electrode-index weighted mean), and mean palatograms averaged over the constriction interval. Statistical tests were ANOVAs with factors phonological status (singleton/geminate) and sound category (/l, /n, /r/); post-hoc LSD tests applied where relevant.

## Results

### Amount of Contact (AoC)

AoC patterns differ reliably by sound and phonological status. Mid-frame ANOVA: sound category significant ( $F(2,5)=54.61$ ,  $p<0.001$ ); phonological status non-significant ( $F(3,5)=0.10$ ,  $p=0.955$ ); interaction significant ( $F(5,22)=3.72$ ,  $p<0.05$ ). Max-frame ANOVA: phonological status significant ( $F(3,5)=6.19$ ,  $p<0.05$ ); sound category significant ( $F(2,5)=80.83$ ,  $p<0.001$ ); interaction non-significant ( $F(5,22)=2.19$ ,  $p=0.092$ ). Interpretation: geminates show greater maximum AoC and longer articulatory durations than singletons (Fig. 1).

### Centre of gravity (CoG)

CoG is systematically lower (more posterior) for geminates than for singletons. Mid-frame ANOVA: sound category significant ( $F(2,5)=11.91$ ,  $p<0.05$ ); interaction significant ( $F(5,22)=30.12$ ,  $p<0.001$ ); phonological status non-significant ( $F(3,5)=1.61$ ,  $p=0.299$ ). Post-hoc tests show  $\text{CoG}(\text{singleton}) > \text{CoG}(\text{geminate})$ ,  $p<0.001$ . Max-frame CoG patterns mirror mid-frame results. These CoG shifts are consistent with more posterior/laminal contact in geminates and more anterior/apical contact in singletons (Fig. 2).

### Visual palatograms

Mean palatograms corroborate quantitative measures. For /l/ geminates show increased contact at R2–R3 and occasional posterior extension to R4; singletons concentrate at R1. For /n/ geminates occlude across R1–R3 (apico-laminal),

while singletons concentrate on R1. The rhotic /r/ likewise shows greater contact area in geminates (Fig. 3). Visual inspection therefore supports AoC and CoG findings.

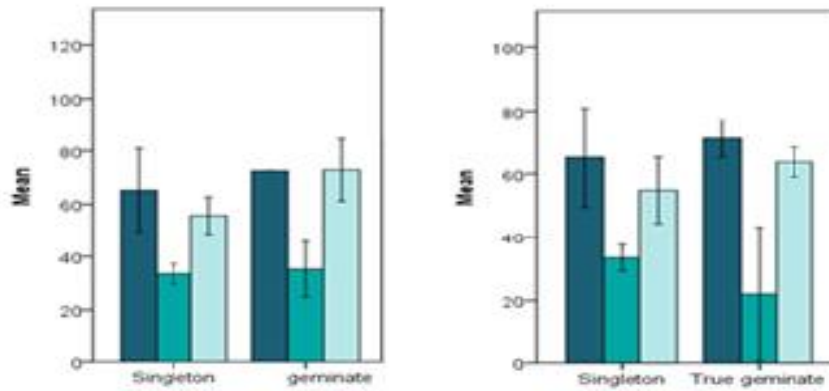


Figure 1. AoC Max-Frame (left) and Mid-frame (right).

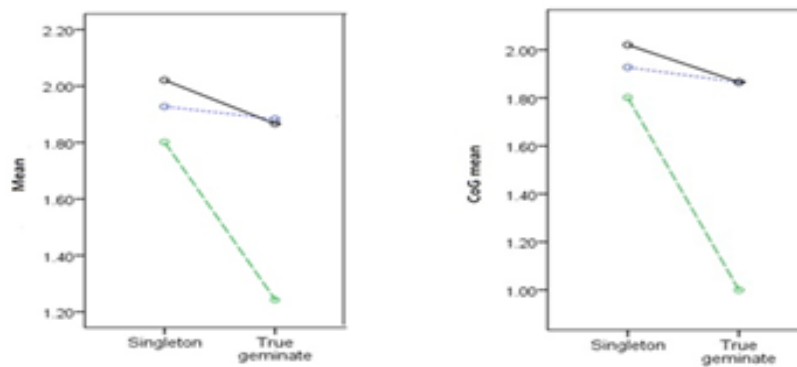


Figure 2. CoG Max-Frame (left) and Mid-frame (right).

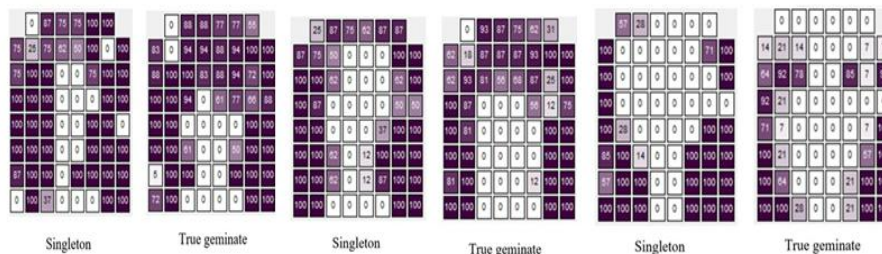


Figure 3. Palatograms of the singleton and geminates /l/ (left), /n/ (middle), and /r/ (right).

## Discussion and conclusion

The AoC, CoG and palatographic inspection consistently distinguish singleton and geminate sonorants in TLA: geminates involve greater and more posterior linguopalatal contact and longer articulatory durations. These spatial and temporal enhancements parallel reports for Italian and other languages (Payne 2006, Kraehenmann, Lahiri 2008, Ridouane 2007) and suggest articulatory fortition. However, Issa (2017) found no acoustic strengthening for TLA sonorants (similar formant structure and intensity for singletons and geminates), therefore, the present articulatory strengthening may be primarily an articulatory phenomenon not reflected in the acoustic signal. This dissociation has implications for phonological representation and articulatory planning of geminates and supports the use of multimodal (acoustic + articulatory) evidence in gemination research. This study provides the first EPG documentation of gemination in a Libyan Arabic dialect and contributes new data to the typology of geminate consonants.

## References

- Arvaniti, A. 1999. Effects of speaking rate on the timing of single and geminate sonorants. *Proceedings of the XIVth International Congress of Phonetic Sciences* 599-602. San Francisco, CA.
- Issa, A. 2015. On the phonetic variation of intervocalic geminates in Libyan Arabic. *Proceedings of the 18th International Congress of Phonetic Sciences, Glasgow, UK.*
- Issa, A. 2017. Acoustic cues to the singleton-geminate contrast: the case of Libyan Arabic sonorants. *Proceedings of the 18th conference of the international speech communication* 2988-2992. *Interspeech 2017, Stockholm.*
- Kraehenmann, A., Lahiri, A. 2007. Non-neutralizing quantity in word-initial consonants: articulatory evidence. In J. Trouvain and W. Barry (eds.), *Proceedings of the 16th International Congress of Phonetic Sciences* 465–468, Saarbrücken.
- Kraehenmann, A., Lahiri, A. 2008. Duration differences in the articulation and acoustics of Swiss German word-initial geminate and singleton stops. *Journal of the Acoustical Society of America* 123(6), 4446–4455.
- Khatab, G., Al-Tamimi, J. 2008. Durational cues for gemination in Lebanese Arabic. *Language and Linguistics* 22, 39-55.
- Lavoie, L. 2001. *Consonant strength: phonological patterns and phonetic manifestations.* Garland Publishing, Inc.
- Local, J., Simpson, A. 1988. The domain of gemination in Malayalam. In D. Bradley., E. J. A. Henderson., M. Mazaudon, (Eds). *Prosodic Analysis and Asian Linguistics: To Honour R. k. Sprigg.* *Pacific Linguistics, C-104*, 33-42.
- Payne, E.M. 2006. Non-durational indices in Italian geminate consonants. *Journal of the International Phonetic Association*, 36(1), 83-95.
- Ridouane, R. 2007. Gemination in Tashlhiyt Berber: an acoustic and articulatory study. *Journal of the International Phonetic Association*, 37(2), 119-142.