

Reaffirming Catford: A Real-time MRI Investigation of Larynx Raising in Amharic Ejectives

Lavinia Price¹, Marianne Pouplier¹, Philip Hoole¹

¹*Institute for Phonetics and Speech Processing (IPS), LMU Munich*

Larynx raising is the defining characteristic of ejectives [2]. Several recent reports on ejectives across different languages, however, have cast doubt on the necessity for larynx raising [1, 3, 7], suggesting instead supra-laryngeal cavity reduction as the key factor, possibly achieved by various other articulatory strategies. This makes it currently unclear whether our traditional understanding of ejective production as glottalic initiation can be maintained. A complicating factor in this debate is the methodological difficulty of capturing larynx movement and pharyngeal volume. This study seeks to contribute to the debate surrounding ejectives on the basis of Amharic, a Semitic language of Ethiopia. We capitalize on the potential of real-time MRI to observe larynx raising in conjunction with supraglottal articulations. Gaining a better understanding of how laryngeal, supra-laryngeal, and aerodynamic factors coordinate in ejective production has important implications for the way in which we define control parameters in speech production and for our classification of non-pulmonic speech sounds.

Traditionally, ejectives are defined as products of larynx raising with simultaneous glottal and oral constrictions [2]. Larynx-raising reduces the supraglottal cavity, thereby elevating the intraoral air pressure (IOP). This results in the auditorily distinct quality of ejective release bursts. However, it has repeatedly been argued that larynx raising alone is insufficiently effective at increasing IOP to justify the intense bursts characterizing some ejectives [3]. It has even been conjectured that ejectives can be produced without any significant laryngeal involvement at all [1, 7] with other factors conditioning the build-up of IOP. The nature of these other factors remains unclear, though. Kingston, based on Tigrinya which is closely related to Amharic [5], proposed that supra-laryngeal articulations such as tongue root retraction may potentially be as important as larynx raising for volume reduction [3]. Larynx raising would then have a synergistic, rather than a defining role in ejective production and may or may not be present in any given token. This view is supported by the high intra- and inter-language variation found in studies on the acoustic properties of ejectives (e.g., [9, 10]). To gain new perspectives on the interplay of larynx raising and supraglottal articulations for ejective production, we recorded real-time MRI data of eleven native speakers of Amharic at 50 frames per second. Stimuli included all voiceless pulmonic and ejective plosives of Amharic across a total of 271 lexical items. From the MRI images the vertical position of the larynx's lower edge was extracted at the onset and offset of target consonant closure.

Results from the ten speakers analyzed so far reveal that Amharic ejectives agree with Catford's traditional account [2]: The larynx raises significantly during ejective closure (Fig. 1), while, acoustically, the ejectives are characterized by long, intense bursts followed by a gap of relatively more silence (Fig. 2). Importantly, this evidence supports the assumption that larynx raising is, at least for some languages, a defining characteristic of ejectives, contrary to recent claims [1, 7, 8].

Our laryngeal height analyses will be complemented by area function measures, allowing us to identify the possible role of supra-laryngeal articulators for cavity reduction. We will discuss whether the target of ejective articulation may be more accurately described as a global vocal tract configuration. This global-gestures-approach [6] would allow us to integrate the complexities of ejectives manifested cross-linguistically. This work has important implications for the way in which articulatory targets should be specified in speech production and is highly relevant for the discussion on the diachronic emergence of ejectives in otherwise purely pulmonic sound systems [4, 7].

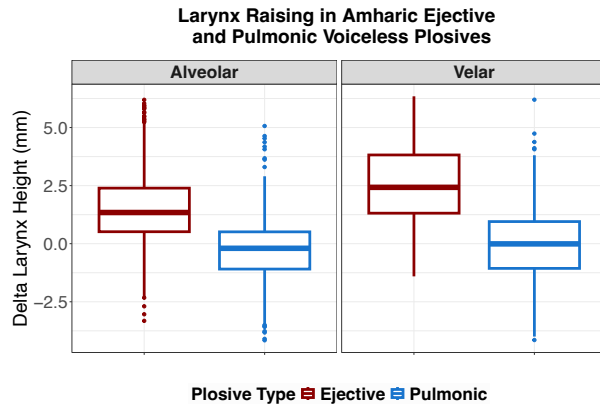


Fig. 1. Comparison of the amount of larynx movement during ejective and pulmonic voiceless plosives in Amharic by place of articulation. Larynx movement was calculated as the difference between vertical position of the larynx at onset (P1) and offset (P2) of the target consonant's acoustic closure, $\Delta \text{Larynx} = P2 - P1$.

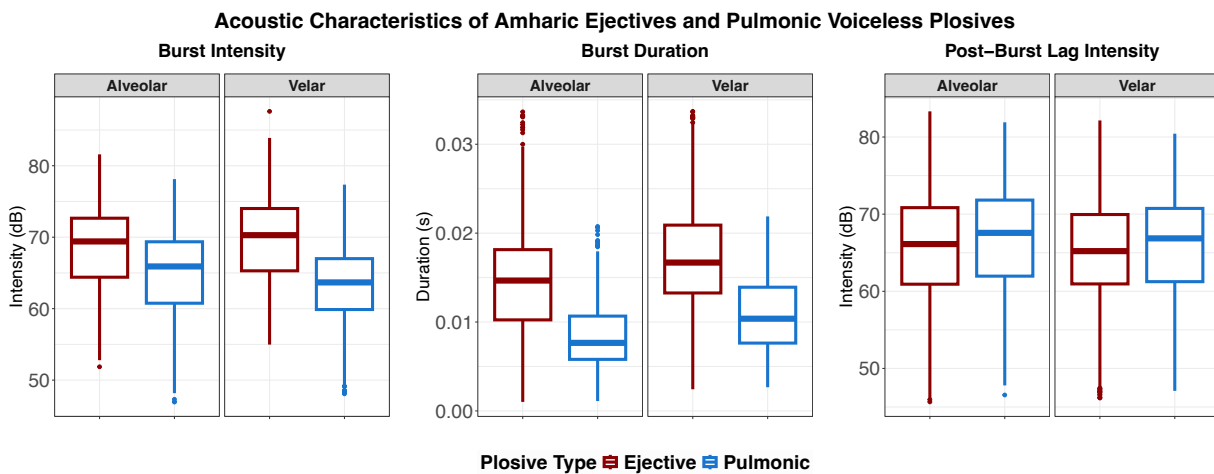


Fig. 2. Comparison of ejective and pulmonic voiceless plosives of Amharic in the three acoustic measures, Burst Intensity (dB), Burst Duration (ms) and Post-Burst Lag Intensity (dB), by place of articulation. Post-burst voicing lag is the interval following the burst release until onset of voicing which is typically characterized by glottal frication (VOT) in pulmonic consonants but glottal closure in ejectives.

References

- [1] Brandt, E., & Simpson, A. P. (2021). The production of ejectives in German and Georgian. *Journal of Phonetics*, 89, 101111.
- [2] Catford, J. C. (1977). *Fundamental problems in phonetics*. Edinburgh: Edinburgh University Press, 1977.
- [3] Kingston, J. C. (1985). *The phonetics and phonology of the timing of oral and glottal events*. Ph.D. thesis, University of California, Berkeley.
- [4] Kiparsky, P. (2003). The phonological basis of sound change. *The handbook of historical linguistics*, 311-342.
- [5] Leslau, W. (1997). Amharic phonology. *Phonologies of Asia and Africa (including the Caucasus)*, 1, 399-430.
- [6] Mattingly, I. G. (1990). The global character of phonetic gestures. *Journal of Phonetics*, 18(3), 445-452.
- [7] Simpson, A. (2014). Ejectives in English and German. *Advances in Sociophonetics, John Benjamins*, 189-204.
- [8] Sulaberidze, N., Brandt, E., Hoole, P., Krämer, M., Reichenbach, J. R., & Simpson, A. P. (2023). Ejectives in Georgian. A real-time MRI analysis of vertical larynx movement. In: Radek Skarnitzl & Jan Volin (Eds.), *Proceedings of the 20th International Congress of Phonetic Sciences* (pp. 952–956). Guarant International.
- [9] Warner, N. (1996). Acoustic characteristics of ejectives in Ingush. In *Proceeding of Fourth International Conference on Spoken Language Processing. ICSLP'96* (Vol. 3, pp. 1525-1528). IEEE.
- [10] Wright, R., Hargus, S., & Davis, K. (2002). On the categorization of ejectives: data from Witsuwit'en. *Journal of the International Phonetic Association*, 32(1), 43-77.