An ultrasound study of the implosive in Eastern Oromo

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This study uses ultrasound imaging to examine the tongue shape during the production of the implosive and other coronal stops in Eastern Oromo, a Cushitic language of Ethiopia with a four-way contrast in the coronal region between voiced, aspirated, ejective, and implosive stops.

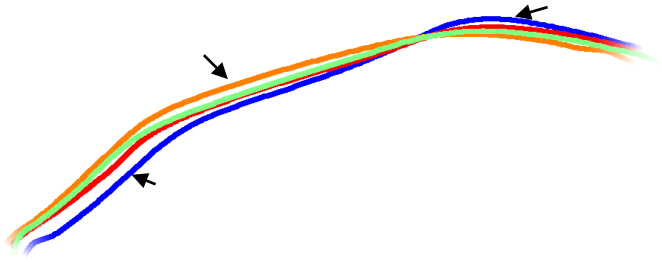
Implosive stops have been the subject of articulatory studies exploring the relationship between implosives' ingressive airflow and the downward movement of the larynx that occurs in the production of implosives and other voiced sounds (Nihalani 1986). Other studies have considered voicing properties, since the sounds have been found to have phonological characteristics of voiceless stops (Lloret 1994, Wright & Shryock 1993). But studies of place of articulation and tongue shape in implosives are rare, perhaps non-existent. In Eastern Oromo, such a study is of relevance because unlike the other coronal stops in the language, which have been described as dental, the implosive is reported as "alveolar, may be slightly retroflexed" (Owens 1985: 10) and "more or less retroflex in most dialects [including Eastern Oromo]" (Lloret 1997: 500). It is unclear what is meant by "slightly" or "more or less" retroflex in these statements–i.e. whether there is subapical articulation or not. Retroflex can vary between apical (less curling) and sub-apical (more curling), with the latter having a more vertical tongue blade (Kochetov et al. 2014). The goal of the study is therefore to determine the tongue shape during the production of implosives and how this compares to the other coronal stops in the language.

To investigate, ultrasound data from 5 native speakers of Eastern Oromo (2 male, 3 female) were collected. Articulate Assistant Advanced (AAA) software was used to record the data with an Echo B Portable Ultrasound, sync it to audio, and create tongue tracings. 12 repetitions of intervocalic [t^h, t', d, ɗ, g, b] were recorded at a frame rate of ~35f/sec. The stops were embedded in two-syllable words of the form Ca_aa (where C was a labial consonant), and read in carrier phrases. Tongue images were chosen at the point of maximum constriction and traced by hand to create 42° fan splines with X,Y coordinates for statistical analysis.

Preliminary results, based on t-tests, indicate that most implosive tokens do not appear to have sub-apical articulation. However, one notable feature of the implosive is that it seems to be produced with a more fronted tongue root than other stop types for all speakers, and that for some speakers its constriction appears to be farther back, alveolar rather than dental. These can be seen in the averaged data for Speaker 5 in Figure 1. Another notable pattern in Figure 1 is that ejectives seem to have higher tongue bodies. Statistics to confirm the significance of these patterns is underway in the form of a linear mixed effect regression analysis.

The ejectives and implosives taken together suggest that tongue shapes are influenced by the differing larynx height gestures of the two sounds: lowered larynx in implosives leads to a retracted tongue tip and fronted/lower tongue root while raised larynx in the ejectives leads to a higher tongue body. This may provide evidence for Ladefoged's (1964 et seq.) that ingressive airflow forms a continuum with voiced stops in terms of degree of larynx lowering.

Figure 1. Averaged tongue splines for O5



tongue root to the left
tongue tip to the right
blue = implosive
orange = ejective
red = aspirated
green = voiced
arrows indicate

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