

On the EGG signature of clicks in South African languages

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Overview

- Standard descriptions of click articulation rarely discuss larynx movement
- X-ray and video show clear larynx movement
- We show a distinct click signature on EGG reflecting larynx movement

Click articulation: The standard story

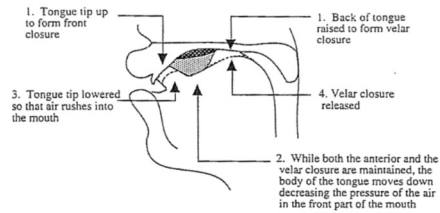


Figure 8.1 The articulatory sequence involved in production of an alveolar click in Xhosa. The dark shaded area shows the cavity enclosed when the closures are formed. The light shaded area shows the cavity just before the release of the anterior closure. The dashed lines show the lowered tongue positions corresponding to steps 3 and 4.

Ladefoged & Maddieson (1996:247)

Larynx activity in click articulation

- Click “accompaniments” include variations in phonation, nasality, and aspiration
- Xhosa’s click inventory:

	Dental		Alveolar		Lateral	
Plain	ǀ (c)	ǁ (nc)	ǃ (q)	ǂ (nq)	ǁǁ (x)	ǁǁ (nx)
Breathy-voiced	ǀ̤ (gc)	ǁ̤ (ngc)	ǃ̤ (gq)	ǂ̤ (ngq)	ǁǁ̤ (gx)	ǁǁ̤ (ngx)
Aspirated	ǀʰ (ch)		ǃʰ (qh)		ǁǁʰ (xh)	

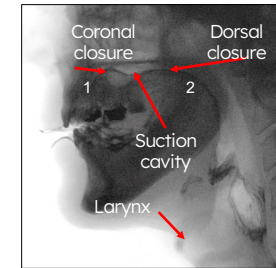
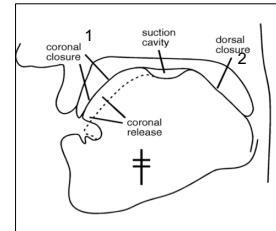
- Accompaniment names vary in the literature:
 - Plain - tenuis - ejective
 - Breathy-voiced - slack voice - voiced - murmured
 - (Sands 1990, Ladefoged and Trill 1994, Ladefoged and Maddieson 1996, Jessen and Roux 2002, Roux 2007)

Evidence for larynx movement



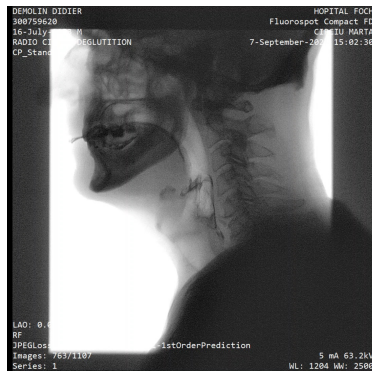
Southern Sotho

Evidence for larynx movement



Evidence for larynx movement

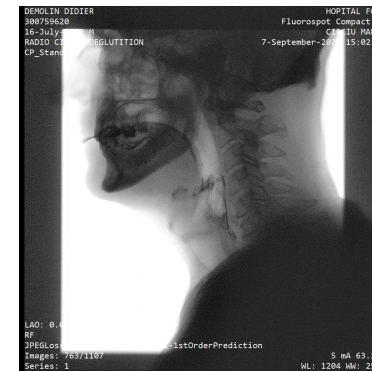
- Swallow
- Alveolar click [!]
 - Swallow
 - Palatal click [ʔ]



Demolin, Kingston & Cîrciu (2026)

Evidence for larynx movement

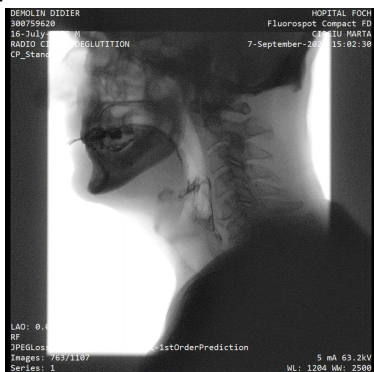
- Swallow
- Alveolar click [!]
 - Swallow
 - Palatal click [ʔ]



Demolin, Kingston & Cîrciu (2026)

Evidence for larynx movement

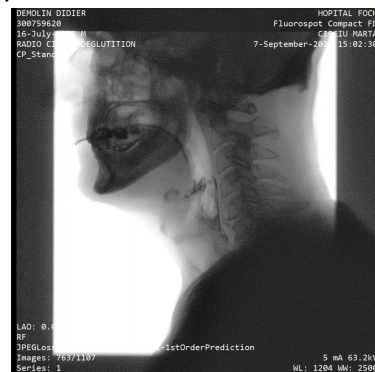
- Swallow
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 - Swallow
 - Palatal click [ʔ]



Demolin, Kingston & Circiu (2026)

Evidence for larynx movement

- Swallow
- Alveolar click [!]
 - Swallow
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Demolin, Kingston & Circiu (2026)

Larynx movement during click production

1. Creation of the air pocket involves tongue raising (velar closure)
2. Since the tongue root and larynx are both anchored to the hyoid bone, the larynx also raises
3. The larynx stays raised as the front closure is released
4. After the velar release, there is no longer upward tension on the larynx, so it rapidly lowers
5. Following the descent, the larynx rebounds up to its normal position



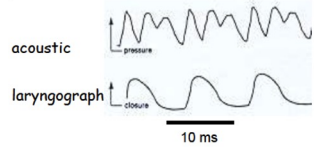
EGG

- Electroglottograph, AKA laryngograph
- Non-invasively measures *degree of contact* between vocal folds by measuring changes in conductivity between electrodes

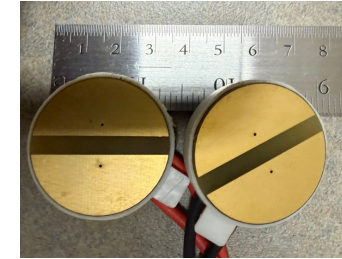


EGG

- Synchronized to audio signal



Glottal Enterprises® EGG

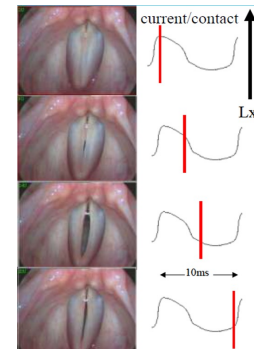
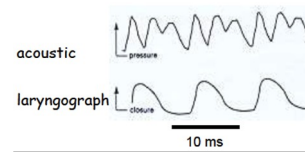


Laryngograph® laryngograph

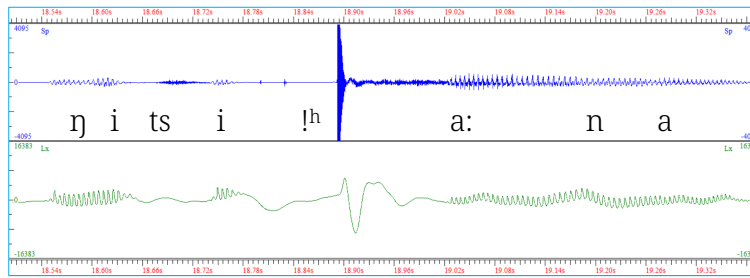


How to read EGG signals

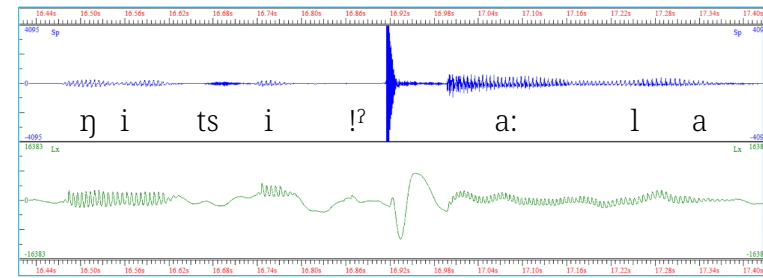
- More contact → more conductive
- Less contact → less conductive



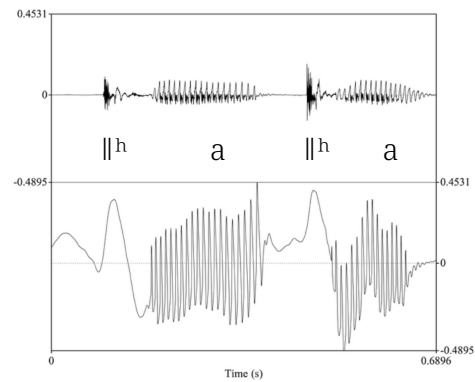
Zulu voiceless (aspirated) click



Zulu voiceless (glottalized) click

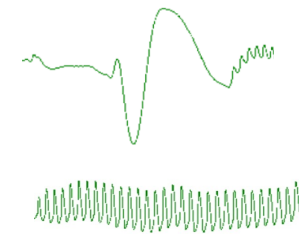


Glottal Enterprises EGG (Xhosa)

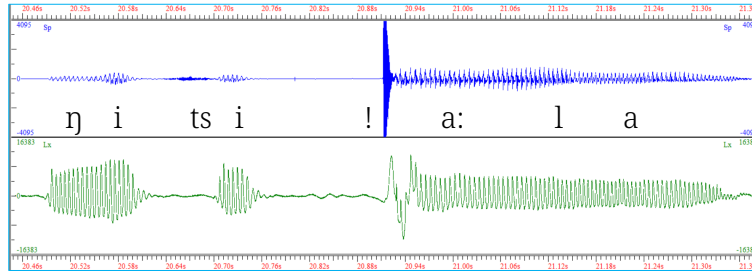


The 'swoop'

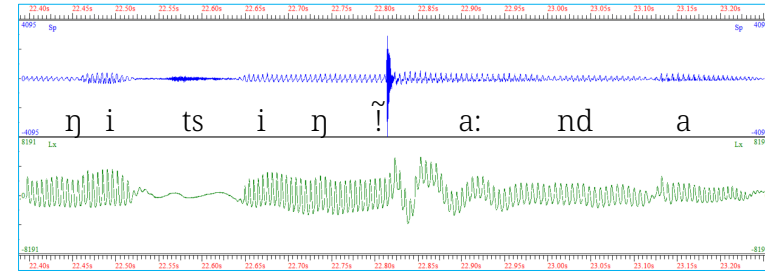
- Vertical movement of the larynx registers as *large, slow fluctuations* in the EGG signal—often labeled *Gx*
- Vocal fold contact/separation registers as *smaller, more rapid fluctuations* in the signal, often labeled *Lx*



Zulu voiceless (plain) click



Zulu nasal click



Closed quotient (CQ; Qx)

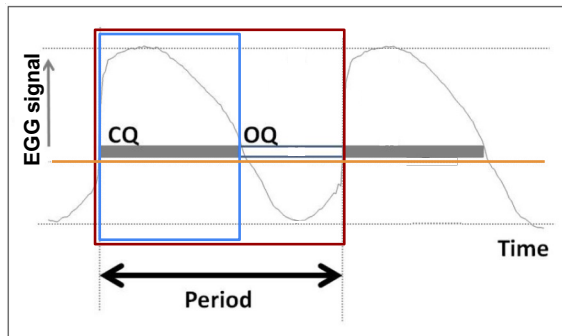
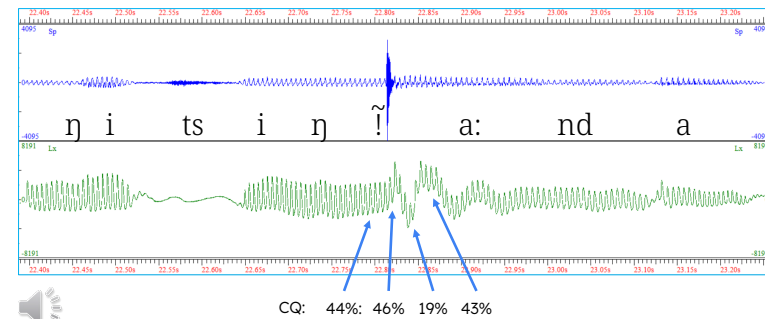


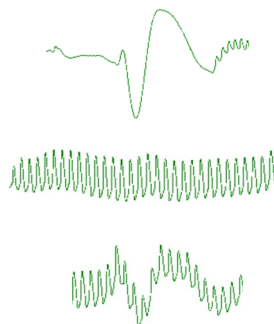
Figure adapted from Lã (2012)

Zulu nasal click

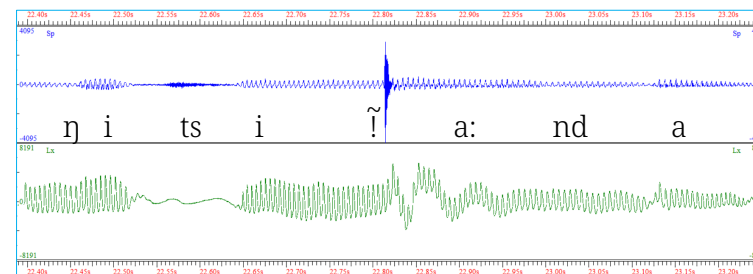


Interaction of vocal fold vibration and larynx movement

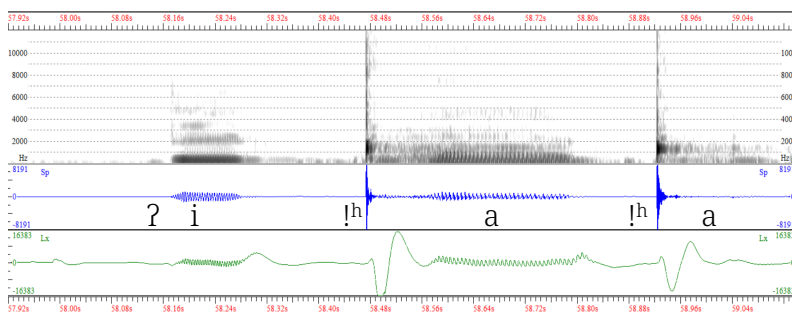
- In voiced/nasal tokens, we can see the effect of voicing (small/rapid fluctuations) imposed upon the effect of larynx movement (large/slow fluctuations)
- That the voicing registers when expected, even during the "swoop", suggests that the EGG recordings are accurate, and that the swoop isn't likely an artifact of e.g. signal filtration



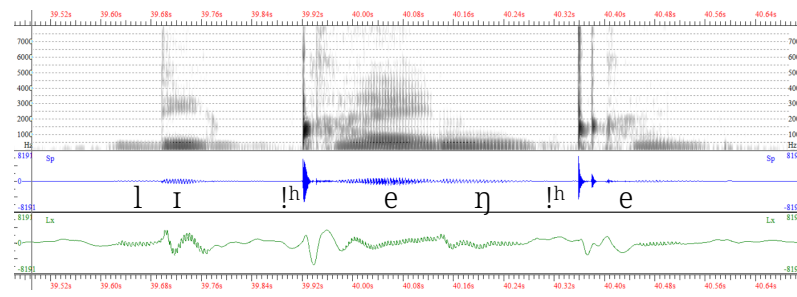
Zulu nasal click



Xhosa



Southern Sotho

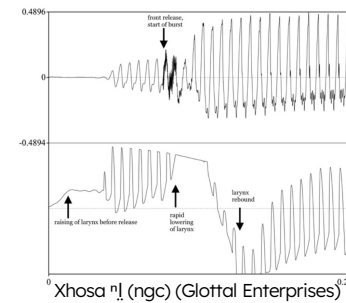


A tangent on reliability of EGG devices

- Some have raised concerns about anomalous signals from interference and normal signal filtering
- Lee (p.c.) reports that Glottal Enterprises systems may show low-frequency oscillations when set on top of certain materials
- We do not see this effect; the “swoop” effect is robust across machine type and recording venue, and voicing oscillations show up where expected

A tangent on reliability of EGG devices

- Differences between Glottal Enterprises and Laryngograph devices may be due to electrode size and shape



Conclusion

- Clicks demonstrate a “swoop” pattern on EGG, robust across multiple languages, speakers, machines, and venues
- Larynx movement seen in video and x-ray video correlates to this pattern
- Larynx movement in click articulation deserves further study, especially with respect to possible depressor effects (as speculated by Jessen and Roux 2002)

Thanks!

Download slides:
aaronbraver.com/acal57-egg



References

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