

## Acoustic characteristics of oral clicks in Zimbabwean Ndebele: A preliminary case study

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Zimbabwean Ndebele ('Ndebele') is a Bantu language with click contrasts at three places of articulation: dental, palatal and lateral (Bowerman & Lottridge, 2002), combining with five possible accompaniments: voiceless, voiceless aspirated ('aspirated'), voiced depressed ('voiced'), voiced nasalised and voiced nasalised depressed (Sibanda, 2004). These clicks impressionistically resemble their counterparts in Zulu (Doke, 1926) and Xhosa (Sands, 1991), both closely related to Ndebele, however it is not clear whether they share the same phonetic properties, as the acoustic and articulatory characteristics of Ndebele clicks have not previously been investigated. To begin to address this issue, this study provides a preliminary acoustic analysis of the oral (i.e. non-nasalised) clicks of a single speaker of Ndebele, with the aim of determining the acoustic correlates that characterise (a) the three places of articulation and (b) the three oral accompaniments.

The subject of this case study is a 37-year-old female native speaker of Ndebele residing in Sydney, Australia. Polysyllabic target words in a carrier phrase were used to elicit clicks word-initially and word-medially in a controlled phonetic environment (Table 1). Six acoustic characteristics were investigated: total click duration, closure duration, burst duration, post-burst noise duration, voice onset time (VOT) and burst amplitude (cf. Jessen, 2002; Sands, 1991). 266 tokens were analysed as follows: the onset and offset of the closure, burst and post-burst noise portions were identified on the waveform as shown in Figure 1; total click duration was considered the sum of these three components; VOT was defined as the time from the onset of the burst to the offset of post-burst noise, except where pre-voicing was present, where it was considered as the time from closure onset to burst onset; and burst amplitude was measured as the average intensity in decibels across the burst portion. A factorial analysis of variance was performed for each acoustic measure (Bonferroni correction was applied) with place of articulation (dental, palatal or lateral), accompaniment (voiceless, voiced or aspirated) and segment position (initial or medial) as the independent variables in each case.

The results showed that place of articulation was characterised by closure duration and burst amplitude. Palatal clicks had longer closures and greater burst amplitudes than either dental or lateral clicks, but the latter two did not differ from each other on any measure. Accompaniments were characterised by differences in total duration, burst duration, post-burst noise duration, VOT and burst amplitude. Of these, the most consistent acoustic correlate of accompaniment type was the combined values of burst and post-burst noise durations (Figure 2), which existed in different ratios between the different accompaniments. Additionally, VOT revealed that pre-voicing was less likely to occur in aspirated clicks than voiced or voiceless. Finally, word-initial clicks were found to have a longer total duration than word-medial and were less likely to be pre-voiced. These results corresponded to findings for Xhosa (Sands, 1991) with regard to some factors but differed on others.

These preliminary results suggest that all six of the included measures are relevant in acoustically characterising Ndebele oral clicks and that Ndebele clicks display at least some unique acoustic features, even when compared to a closely related language.

References

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Table 1 – Sample target words in the carrier phrase

	<i>Dental</i>	<i>Palatal</i>	<i>Lateral</i>
<i>Voiceless</i>	Uthi cabanga. Uthi bacabanga.	Uthi qabuka. Uthi baqabuka.	Uthi xabana. Uthi baxabana.
<i>Aspirated</i>	Uthi chasisa. Uthi bachasisa.	Uthi qhamuka. Uthi baqhamuka.	Uthi xhawula. Uthi baxhawula.
<i>Voiced</i>	Uthi *gcabala. Uthi *bagcabala.	Uthi gqagqela. Uthi bagqagqela.	Uthi gxamuza. Uthi bagxamuza.

Figure 1 – Sample waveform and spectrogram showing closure, burst and post-burst noise durations

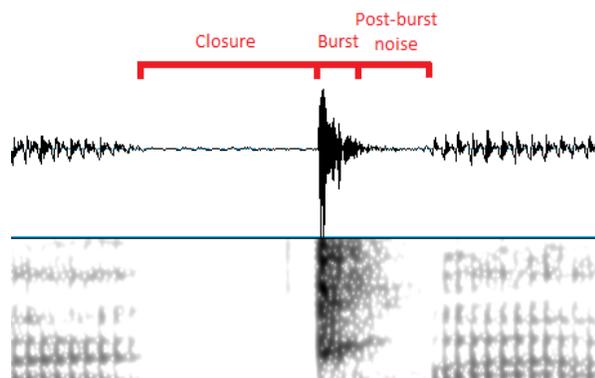


Figure 2 – Component durations by accompaniment showing burst/post-burst noise ratio

