Articulatory Coordination in Nama Click Consonants

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1. Introduction

Nama (a variety of Khoekhoegowab), is a Khoe (Khoisan) language of Namibia. Nama uses an extensive segmental inventory, including click consonants contrasting in four places and five manners of articulation [1]. Click production in Khoisan languages has been examined using palatography [2, 3, 4], X-ray [4], and ultrasound [5, 6]; however, the phonetic characterization of different clicks produced at the same place of articulation is still a matter of debate [1, 6]. A limitation of ultrasound and palatography – the main methods used to study clicks – is that they do not provide information beyond the tongue and palate. The goal of this study is to investigate the global behaviour of the vocal tract during click production in more detail, to better understand the nature of lingual consonant contrasts.

2. Method

The informant, a 32 year-old male speaker of Nama (born in Windhoek), Afrikaans and English, read out wordlists and prose eliciting Nama consonant contrasts, as he lay supine in an MRI scanner. The subject's upper airway was imaged using a real-time Magnetic Resonance Imaging (rtMRI) protocol developed specifically for speech research [7]. A 5 x 200 x 200 mm mid-sagittal acquisition slice was centred on the tongue, through the glottis so that the vocal folds could also be observed. Image data acquired in overlapping 54 msec windows were reconstructed into 33.18 f.p.s. video sequences. Audio was simultaneously recorded at 20 kHz inside the MRI scanner, noise-canceled, and reintegrated with the MRI video [8].

3. Results

Clear differences in the location and type of the anterior constriction, lingual posture, and articulatory kinematics, are observed across the four click series (e.g. Fig. 1). In particular, different articulatory actions were involved in generating rarefaction in the mid-oral cavity in different clicks. Dental clicks primarily involved dorsal lowering while maintaining a relatively stable laminal coronal constriction. Alveolar clicks were produced with a more apical, rapidly articulated coronal gesture, while maintaining a high dorsal posture at the posterior constriction. A deeper lingual cavity was released in the mid-palatal region in lateral clicks, and at a more posterior location in palatal clicks. The exact location and extent of the posterior linguo-velaric seal varied across click types and vowel contexts. Glottal abduction generally preceeded lingual release in voiceless [|] and voiceless aspirated [$|^{h}$] clicks, and the velum remained lowered into the initial part of the post-consonantal vocalic interval during nasal [$|^{n}$] click production.

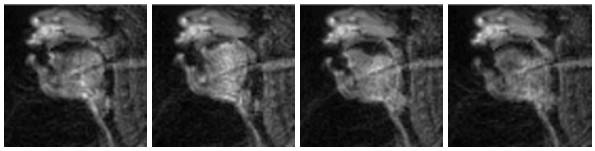

Figure 1: ***Midsagittal articulation at click release.*** *L-to-R: dental [$|^{h}$áà] 'sharply', alveolar [!àã] 'hang', lateral [$\|^{h}$ãá] 'wash', palatal [ǂãá] 'slaughter'.*

4. Discussion

These data provide further insights into the mechanisms of production of click consonants in Khoisan languages, and non-pulmonic consonant production in general. Further analysis is required, but initial observations of clicks produced by this speaker indicate that patterns of tongue, velum and glottal coordination do not differ fundamentally from those those observed in pulmonic nasals [9], lending support to previous analyses which characterize clicks as differentiated in manner, rather than by secondary 'accompaniments' [1, 6]. More data will be needed to determine which patterns observed in these data are speaker-specific, how they may be influenced by vocal tract morphology and prosodic factors. These data further illustrate the importance of real-time MRI as a method for studying inter-articulatory coordination – especially velic, pharyngeal and laryngeal articulation – during consonant production.[1]

5. References

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