

# Differences in the Timing of Front and Back Releases among Coronal Click Consonants

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Clicks are multiply articulated consonants that have one constriction at the front of the mouth and another constriction at the back of the mouth. In coronal clicks, the front constrictions are produced by the tongue tip or blade contacting the hard palate, and the back constrictions are formed by the back of the tongue dorsum or uvula contacting the soft palate. Air is trapped in a lingual cavity between the two constrictions, and is rarefied by tongue body lowering and tongue dorsum retraction gestures, which differ among click types (Thomas-Vilakati 2010; Miller 2015a).

Differences in the timing of the coronal and dorsal releases in clicks have been deduced from acoustic properties of the bursts (Sands 1991; Johnson 1993). However, direct investigation of the timing of the two releases has not been previously undertaken. Ladefoged and Traill (1994) and Ladefoged and Maddieson (1996) note that it is necessary for the front release of a click to occur prior to the back release in order to rarefy the air and produce the “popping” sound that is characteristic of clicks. However, Stevens (1998) notes that while the front release in clicks generally occurs prior to the back release, some clicks have a more gradual front release with a distributed source. The current study investigates differences in the timing and the degree of opening of the coronal and dorsal releases in the four contrastive coronal clicks in the /i/ context in the Kx'a language Mangetti Dune !Xung using 114 fps ultrasound data collected using the CHAUSA method (Miller and Finch 2011). Results have implications for our understanding of two sound patterns in the Kx'a languages. The first is a C-V co-occurrence restriction, which is the basis for the complimentary distribution of [əi], which follows the alveolar and lateral clicks, and [i], which follows the dental and palatal clicks (Miller-Ockhuizen 2003). The second pattern is an innovative diachronic sound change from a palatal click in the proto language to a laminal alveolar click that occurs in the Northern branch of the Kx'a language family (Sands 2010; Miller and Holliday 2014).

The experiment presented here tests two hypotheses:

**H1:** Alveolar and lateral click types that retract and lower [i] to [əi] involve abrupt coronal releases with a large degree of opening; while the dental click type that co-occurs freely with [i] involves a more gradual front release that overlaps temporally with the back release.

**H2:** The palatal click type that occurs in [i] contexts has an abrupt release with a narrow opening resulting in secondary frication, which differs from the abrupt unfricated variant of the palatal click type with a wide opening that occurs preceding [ɑ].

The height of the tongue front and back at three time points, measured at 8.77 ms intervals over a 27 ms release phase that covers both the coronal and dorsal releases was measured from ultrasound tongue traces. The duration of different temporal phases of the click releases were also analyzed from acoustic data. Ultrasound and acoustic results support H1 by showing that the alveolar and lateral clicks, which co-occur with [əi], have more abrupt coronal releases that quickly change from a complete constriction to a wide aperture. The dental click, which occurs with [i], displays frication of the dental release that occurs due to a gradual front release with a very narrow aperture.

In keeping with H2, the results show that in the palatal click that co-occurs with [i], the front release barely opens to allow rarefaction, and then quickly returns to a more closed constriction resulting in secondary palatal frication. Thus, both clicks that co-occur with [i]

have more narrow front openings that overlap with the dorsal release. Conversely, the alveolar and lateral clicks that co-occur with [əi], have abrupt releases, leaving only the back constriction to overlap temporally with the following vowel.

The existence of the fricated palatal click variant is of great interest, as it provides evidence that there are two allophones of the palatal click type. The allophone of the palatal click with secondary palatal frication occurs in front vowel contexts (similar to other types of palatalization), while the abrupt variant of the palatal click occurs in back vowel contexts. Conversely, the dental click type is fricated in all contexts.

Differences in the timing of the front and back releases in clicks have implications for our understanding of how the lingual airstream mechanism works. The results also suggest a path for the development of the synchronic C-V co-occurrence restriction involving clicks and the high front vowel [i], as well as a possible path for sound change from a palatal click type to a fricated alveolar click type in the Kx'a language Ekoka !Xung (Miller 2015b) that is described by Miller and Holliday (2014).

## References

- Johnson, K. (1993). Acoustic and auditory analyses of Xhosa clicks and pulmonics. *UCLA working papers in phonetics* 83, 33-45.
- Ladefoged, P. & Maddieson, I. (1996). *Sounds of the world's languages*. Cambridge, MA: Blackwell.
- Ladefoged, P. & Traill, A. (1994). Clicks and their accompaniments. *Journal of Phonetics*, 22, 33-64.
- Miller, A. (2015a). Posterior Lingual Gestures and Tongue Shape in Mangetti Dune !Xung Clicks. MS. The Ohio State University.
- Miller, A. (2015b). Timing of the Two Release Gestures in Coronal Click Consonants. MS. The Ohio State University.
- Miller, A. and Holliday, J. J. (2014). Contrastive apical post-alveolar and laminal alveolar click types in Ekoka !Xung. *Journal of the Acoustical Society of America* 135, 4, pp. 2351-2352.
- Miller-Ockhuizen, A. (2003). *The Phonetics and phonology of gutturals: A case study from Ju|'hoansi*, In Horn, L. (Ed.), *Outstanding Dissertations in Linguistics Series*, New York: Routledge.
- Sands, B. (2010). Juu subgroups based on phonological patterns. In Brenzinger, M. & König, C. (Eds.), *Khoisan Languages and Linguistics. Proceedings of the 1<sup>st</sup> International Symposium January 4-8, 2003. Riezlern / Kleinwalsertal*. Köln: Rüdiger Köppe Verlag.
- Sands, B. (1991). *Evidence for click features: acoustic characteristics of Xhosa clicks*. *UCLA working papers in linguistics*, 80, pp 6-37.
- Stevens, K. N. (1998). *Acoustic Phonetics*. Cambridge, MA.: MIT Press.
- Thomas-Vilakati, K. (2010). *Coproduction and coarticulation in IsiZulu clicks*. University of California Publications in Linguistics. Volume 144. Berkeley and Los Angeles, CA. University of California Press.