# Understanding Patterns of Voicing and Prenasalization in Medʉmba: Evidence from Speech Timing

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**Introduction** Medʉmba (Grassfields Bantu) is one of only 3% of the world's languages which feature voiceless prenasalized (NC) onset sequences [1]. In contrast with their voiced counterparts, voiceless NC sequences are argued to be phonologically marked in syllable onsets due to the articulatory difficulty of raising the velum in time to produce a subsequent voiceless consonant [2]. In some languages, onset 'clusters' have been shown to have temporal properties which are actually more consistent with heterosyllabic consonant sequences [3]—this has been termed a *simplex* timing relation, and contrasts with the more common *complex* relation, where onset consonants are coordinated together. We tested the hypothesis that voiceless NC sequences occur with simplex timing in Medʉmba using a metronome alignment task. In previous work, the point in the word which speakers align to the metronome beat (the word's *perceptual center*, or *p-center*) has been shown to shift as a function of onset complexity [4,5]. Results show, contrary to predictions, that timing relations are similar for voiced and voiceless NC sequences. Unexpected effects of morpheme category on timing suggest that postnasal voicing, where present, does not happen due to articulatory conflicts between voicing and nasalization, but rather due to overlap in consonantal and tonal timing which encourages vocal fold vibration during the consonant closure.

**Background** Medʉmba contrasts simplex stops /b/, /t/, & /k/ with prenasalized stops /mb/, /nt/, & /ŋk/; all can occur in root-initial position (NONDERIVED context). Homorganic NC sequences can also be formed through concatenation of a nasal prefix with a C-initial root (DERIVED context) in 2 morphological environments: pluralized nouns and tensed verbs. While voiceless consonants regularly voice post-nasally in verbs, they remain voiceless in nouns. In previous work, it was found that p-centers for CV syllables in Medʉmba occurred right after the consonant release. While derived NCV syllables showed a similar pattern, nonderived NCV syllables showed a shift in p-center to a position earlier than the consonant release; this was taken as evidence that nonderived NC sequences are timed as a unit (complex timing), and derived NC sequences as separate units (simplex timing) [6]. Voicing was not considered in that study, however. We predict that, if voiceless NC sequences are overall simplex-timed, differences shouldn't emerge among plain CV, derived, and nonderived sequences for voiceless stops; they should only emerge for voiced stops.

**Method** 10 Medʉmba speakers repeated 36 (N)CV high toned words comprising all 3 onset types and both voiced and voiceless stops 8 times each to a metronome set to a period of 770 ms. Timing of stop consonant release and vowel onset were measured relative to the metronome beat. Timing across conditions was compared with linear mixed effects models including fixed effects of ONSET TYPE, ONSET DURATION and VOICING, and a random intercept for SUBJECT.

**Results** Contrary to predictions, nonderived NC onsets showed distinct patterning from CV and derived NC onsets for both voiced and voiceless conditions (Fig. 2). Unexpectedly, there was a timing difference between voiced and voiceless derived onsets: p-centers occurred significantly later relative to consonant release in the voiced condition (Fig. 3). We hypothesize this is due to an additional high tone (apart from the root high tone) that is present on the verbs which comprise the voiced derived NC condition which acts similarly to an additional consonant in conditioning a complex timing pattern [6]. The tone's presence is most clear with low tone verb roots, where a HL falling tone results on the vowel (Fig. 4). For high tone roots, it is standardly assumed that the 2 tones are 'absorbed' to a single tone [7], though our results seem to demonstrate otherwise. Previous work on tone and consonant timing has shown that syllables bearing multiple tones show

a competitive timing pattern with one another, such that tones are overall timed earlier when more than one is present [6]. This could explain why stops in Medʉmba derived NC onsets always voice in verbs, but not in nouns (where no competing tone is present). Our results suggest 1) that voiceless prenasalized stops are quite run-of-the-mill in terms of their timing properties; and 2) that postnasal voicing does not serve as a repair for marked voiceless NC sequences in Medʉmba, but is rather conditioned by factors independent of NCV articulatory coordination.

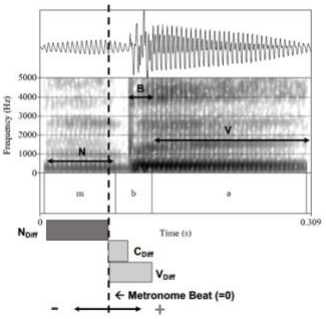


**Figure 1**: Example of method for measuring p-centers. Dotted line represents metronome beat. Difference between beat and consonant release (beginning of burst *B*) and between beat and vowel onset (*V*) were measured for this study.

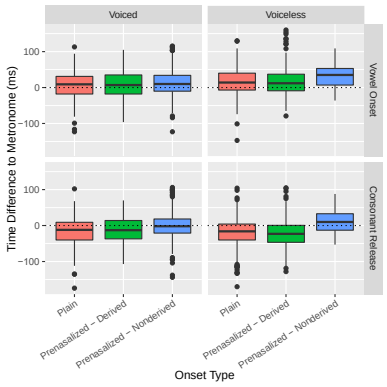


**Figure 2:** Timing of consonant release and vowel onset across onset type and voicing conditions. Overall, consonant release was realized later w.r.t. the beat for nonderived NC words (blue) compared with plain CV (red) and derived NC (green) words for both voiced and voiceless stops.

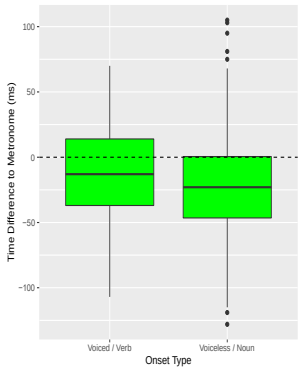


**Figure 3:** Consonant release for voiced derived NC sequences in verbs was found to occur later with respect to the beat than for voiceless derived NC sequences in nouns

a. tà ‘be difficult’ b. /n̋-/ + /tà/ → ndâ ‘be difficult (past tense)’

**Figure 4:** Voicing and tone change in the past tense as occurs on a low tone verb root concatenated with a nasal tense prefix. The verb root is low underlyingly (a) but is realized with a HL falling contour when tensed (b)


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