The Unnatural Tonology of Zina Kotoko
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Consonantal voicing affects tone in many languages, where voiced obstruents cause lowering of a following tone. This is documented for non-contrastive phonetic variation in phonemic tone, and for categorical tone-changing rules. Instrumental studies have shown that implosive consonants do not induce pitch lowering, and actually induce phonetic pitch raising on a following vowel. In addition, phonetic pitch effects are always manifested on the vowel which follows the consonant, and not on the preceding vowel.

This paper describes tone in Zina Kotoko, which contradicts these phonetically grounded generalizations. In this language, tone assignment in verbs is based on interaction between tense-aspectually determined underlying tones, and the consonants of the stem, so verbs are assigned H, M or L tones according to tense-aspect, and H and M tones are subject to tone lowering rules conditioned by neighboring consonants. For instance in the habitual, underlying H becomes M after “depressor” consonants which include voiced obstruents, so /bán/ → [bân] “bathes”, cf. /tám/ → [tâm] “touches” with no lowering after a voiceless consonant. In the remote past, depressor consonants cause M tone to become L, so /bán/ → [bân] “bathed”, cf. /tâm/ → [tâm] “ touched” with no lowering.

Some surprises emerge from the grammar of tone in Kotoko. First, contradicting the previous phonetic observation that only a preceding consonant conditions tone-lowering, a following voiced obstruents phonologically lowers M tone to L. Thus the initial M of /săbû/ becomes [săbû] “grow pl.” because it is followed by a voiced obstruent (cf. /sămû/ surfacing as [sămû] “hears” because the following consonant is not an obstruent). Second, quite surprisingly, implosive consonants (along with sonorants and voiced obstruents) fall into the class of phonological tone depressors for M tone. Hence the underlying M of the past tense becomes L after an implosive in /dâm/ → [dâm] “ate”, analogous to [bân] and differing from [tâm]: this rule contradicts phonetically grounded expectations. In a seemingly paradoxical manner, the separate rule which lowers H to M after voiced obstruents and sonorants does not lower H after an implosive, so H is not lowered in habitual [dâm] “eats”, analogous to [tâm] and different from /bán/ which becomes [bân] “bathes”.

The tone-depressing behavior of implosives is selective within the language: implosives behave in a fashion consistent with prior observation of implosives for one phonological rule which lowers H, but contradicts that pattern for another which lowers M. Compounding the paradox, phonetic perturbation of F0 induced by consonant type exhibits the expected correlations — F0 of all tones is highest after implosives. Thus the phonetically unnatural post-implosive lowering of M to L is restricted to a specific phonological rule.

This underscores a fundamental difference between phonetics and phonology, that phonology may tend to be phonetically natural, but is not inextricably bound to be. The formal theory of phonology gives no preference to “before” vs. “after”, so from a formal point of view, if there can be a rule lowering tone after certain consonants, there could equally exist a rule lowering tone before those consonants — as exists in Kotoko. The fact that implosives rarely pattern with other depressors is explained by the fact that it contradicts the phonetic motivation for tone lowering, so implosive-induced tone lowering is evolutionarily unlikely. The possibility of implosives patterning phonologically with other voiced consonants is explained by the fact that they are phonologically specified as [+voice]. Such data crucially support the existence of a system of phonological computations which may be historically influenced by phonetics, but which does not entirely reduce to phonetics.