VOICELESS SONORANTS AND LEXICAL TONE IN MOG

Shakuntala Mahanta[1], Amalesh Gope[2]

[1]Department of HSS, IIT Guwahati, [2]Department of EFL, Tezpur University
[1]smahanta@iitg.ernet.in, [2]amaleshgope5sept@gmail.com

ABSTRACT

This paper examines the phonetic and phonological properties of tone and explores the way voiceless sonorants interact with tone in a previously undocumented and lesser-known language, namely Mog (an Arakan tribe settled in Tripura in India).
In this study, a total of 62 words (62 words *4 repetitions *6 subjects = 1488 tokens) with two-way and three-way meaning contrasts were examined. A repeated measures ANOVA with a Greenhouse-Geisser correction confirm a significant effect of mean f0 on tone types ($F (1.87, 19.9) = .17$, $p < 0.05$) and confirms the presence of three contrastive tones in Mog, viz., high-falling, mid-rising, and low-rising. We would further argue that the voiceless sonorants significantly raise the f0 of the following vowel (18 Hz on average till the 60% of the total rhyme, when compared to the voiced counterparts, ($F [1.11, 17.) = .15$, $p < 0.00$).

Keywords: Mog, tone, voiceless sonorant.

1. INTRODUCTION

In this paper, we first explore the phonetic and phonological properties of tone in a previously undocumented language viz. Mog. Mog is an Arakan tribe who migrated to (southern) Tripura (a north-eastern state) in India. No previous studies have been conducted on Mog at any (linguistic) level in general and tone in particular. To the best of our knowledge, this is the first attempt that initiates an exploration of the acoustics and phonological properties of tone in this language.
The Mogs were a tribe from the Arakan Hills who eventually migrated to Chittagong Hills first, before settling down to Tripura in and around 1950. Considerable Mog pockets could be seen in the districts such as Subroom, Shantirbazar, Belonia in southern Tripura and Ambasa district in the Dhalai Tripura. According to the 2011 *Census Report* of India, the Mog people are estimated to be around 38,000 in Tripura. On paper, they are the sixth largest indigenous community of this state; though, the ground reality is that most of the younger generation speakers aren't too comfortable in using their mother tongue. Most of the native Mog speakers are bilingual and follow (either Noakhali or Sylheti) Bangla, the dominant language of the state. In 2013, Mog study materials were introduced in a few schools in this state to revitalize this highly threatened language. The Mogs initially used to write in Arakan script; however, most of younger and middle-aged generation speakers do not follow the original script. The native speakers informed us that they are trying to develop a new writing system keeping in mind the younger speakers. We speculate that Mog is a variety of Marma (one of the Lolo-Burmese language belonging to the Sine-Tibetan language family).
The primary goal of this paper is to explore the tonal properties of this language. We have developed a mini-corpus of around 1000+ lexical items over the years. We have also recorded around 500+ (various) sentences including a few folk stories. The analysis of the corpus gathered from a multiple number of native speakers confirm the presence of 25 consonants (viz., 9 plosives /p, p^{h}, b, t, t^{h}, d, k, k^{h}, g/, 6 nasals /m̥, m, n̥, n, ŋ̊, ŋ/, 2 tap/flap /ɾ̥, ɾ/, 4 fricatives /s, z, ʃ, h/, 2 approximants /w, j/, and 2 lateral approximants /l̥, l/) and 7 vowels (viz., / i, ɛ, ə, a, ɔ, o, and u/) in this language. Interestingly, nasals and sonorants maintain [±] voice contrasts in Mog ([m̥ia] 'fishing hook' [mia] 'wife', [l̥i] 'boat', [l̥i] 'bow', [li] 'air').
The following section describes the methodology adopted for exploring the tonal property of Mog.

2. ACOUSTIC ANALYSIS OF LEXICAL TONE IN MOG: METHODOLOGY

We conducted a controlled production experiment to examine the presence of possible tonal contrasts in Mog. During our pilot study, we noticed the presence of a few homophonous pairs with two-way and three-way meaning contrasts. The lists were further refined after consulting the primary subjects, and a total of 62 words were selected for the production experiment. The tones (if any) would be distinguished based on the phonetic pitch differences (realized as fundamental frequency or f0). Variations in the pitch of the vowels (the voiced portion of the vowel plus any sonorous coda) of the otherwise homophonous pairs will be considered to be an indicator of tonal contrasts in this language.

2.1. Subjects, materials and recording procedure

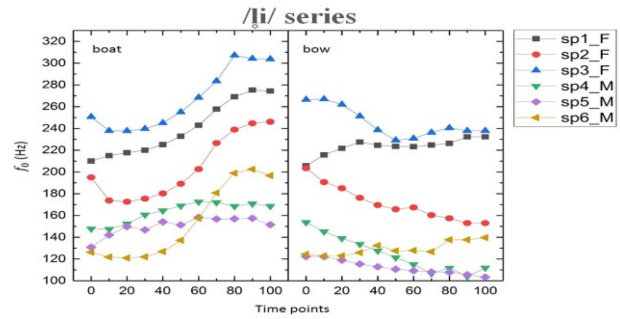
Six native speakers (3 males, 3 females), aged between 18 and 56 years from the Shantirbazar district of south Tripura participated in the production experiment. The dataset contained 62 lexical items (the dataset is not included due to space limitations). The target words were embedded in a fixed sentence frame of “I say **X**”, where **X** is the target word. A priming sentence was first used to elicit the target words, followed by the target word in the fixed carrier frame. All the words (along with their priming sentences) were manually randomized, and the Subjects were instructed to produce the scripted sentences naturally. A head-worn unidirectional microphone connected with a digital recorder was used for recording. All the sentences were digitized at a sampling frequency of 44.1 KHz and 32-bit resolution. Four repetitions of each of the target word (embedded in the carrier frame) were recorded. A total of 1488 tokens (62 words *4 repetitions *6 subjects) were examined.

All the f0 related measurements (f0 measured at various points such as mean f0, maximum f0, minimum f0, f0 at vowel mid-point), were made over the voiced part of the rhyme of the target word. However, duration and intensity were measured for the vowel only. A Praat script was written to measure the pitch contour at every 10% of the total duration of each pitch bearing rhyme (vowel + any sonorous coda [if any]). Pitch was thus calculated at 11 consecutive points- starting from the onset [0%]) till the offset [100%]), across the duration of each vowel (the rhyme); thus, each point represents 10% of the total length of the pitch track. Percentage-wise pitch values were averaged across all the four iterations of each word produced by each speaker separately, and was plotted as a line graph to observe the distinct pitch contours.

2.1.1. *Acoustic analysis of f0: Monosyllabic words*

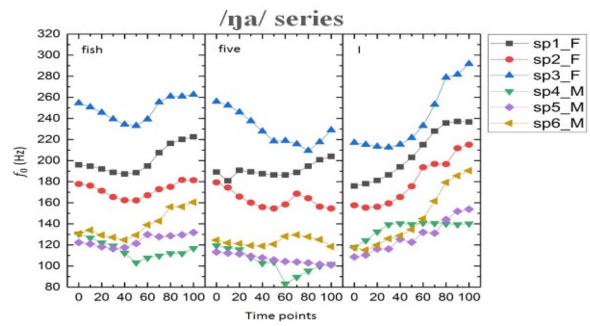
To understand the possible tonal contrasts in Mog, we first examined the minimal pairs with two-way meaning contrasts. The averaged percentage wise pitch values (averaged across all the iterations of each word) produced by each speaker were used to draw line charts for visual examination. Figure 1 displays the contrastive tonal pairs produced by each speaker.

Figure 1: Raw pitch tracks for [l̥i] series, averaged for each speaker separately, (n=4 for each word).



The [l̥i] series (Figure 1) displays contrastive tone (viz. a rising and a falling) tone in Mog- /l̥ĭ/ ‘boat’ and /l̥î/ ‘bow’. As mentioned above, we also gathered minimal sets with three-way and (a couple of) four-way minimal pairs. Therefore, to understand the nature of contrastive tones in Mog, we examined the words with three-way lexical contrasts (Figure 2).

Figure 2: Raw pitch tracks for [ŋa] series, averaged for each speaker separately, (n=4 for each word).



The raw f0 data (averaged across four repetitions) of the individual subject does not indicate the actual nature of contrastive tonal pairs, possibly due to the effect of gender and age. To counter this problem, we, therefore decided to use time-normalized f0 contours (averaged across all the speakers and iterations) to observe the visual differences (Figure 3 and Figure 4).

Figure 3: Time-normalized averaged pitch tracks for [ŋa] series with three-way tonal contrasts (/ŋâ/ ‘five’, /ŋǎ/ ‘fish’ and / ŋa̋/ ‘I’); (n=24 [4 repetitions * 6 subjects] for each word).

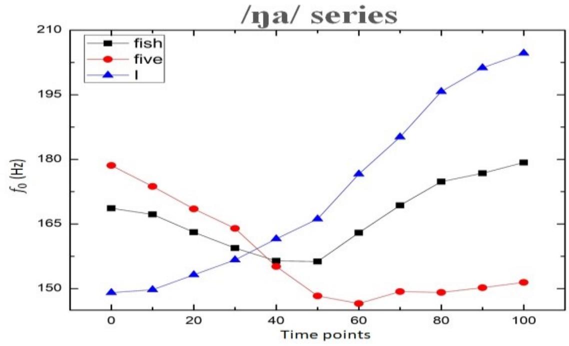
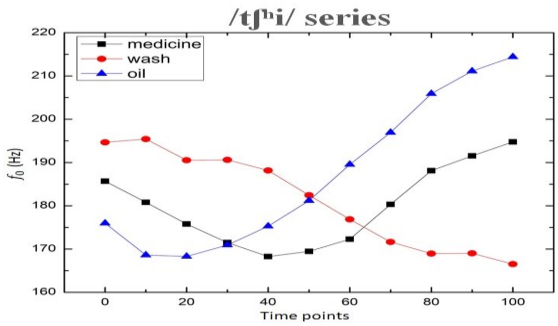


Figure 4: Time-normalized pitch tracks for [tʃʰi] series with three-way tonal contrasts (/tʃî/ ‘wash’, /tʃǐ/ ‘medicine’ and /tʃi̋/ 'bitter''); n=24 [4 repetitions * 6 subjects] for each word).



The time-normalized f0 contours (averaged across all the speakers and iterations) confirm three-way tonal contrasts in Mog namely high-falling, mid-rising, and low-rising. Similar f0 tracks were also observed for all the remaining pairs with three-way meaning contrasts (not reported in this paper).

2.1.2. *Acoustic analysis of f0: Disyllabic words*

Like the monosyllabic words, the averaged pitch contours of the disyllabic words also demonstrate two-way (Figure 5, /āsɔ̀/ (high-falling) 'nest' and /àsɔ́/ (low-rising) 'new') and three-way tonal contrasts (Figure 6, /ákʰà/ 'branch', /ākʰá/ 'season', /àkʰá/ 'bitter') in Mog. Further, it is also noticed that tonal contrasts are realized in both the syllables of the bi-syllabic words.

Figure 5: Time-normalized pitch tracks for [asɔ] series /āsɔ̀/ with two-way tonal contrasts (high-falling) 'nest' and /àsɔ́/ (low-rising) 'new'), n=24 [4 repetitions * 6 subjects] for each word.

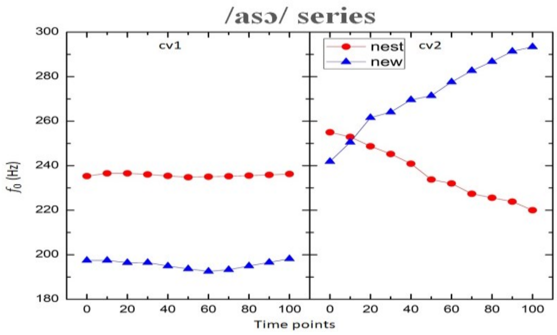
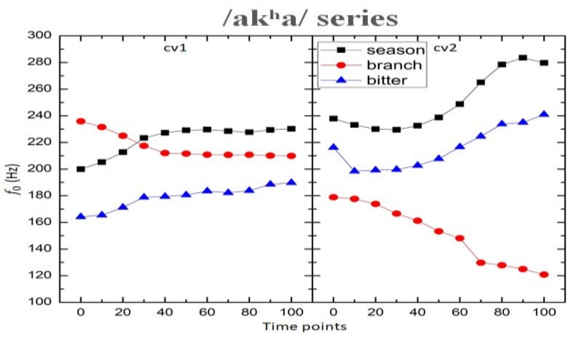


Figure 6: Time-normalized pitch tracks for [akʰa] series with three-way tonal contrasts (/ákʰà/ 'branch', /ākʰá/ 'season', /àkʰá/ 'bitter'); n=24 [4 repetitions * 6 subjects] for each word.



2.2. Statistical Analysis

To confirm the differences between the tonal categories, we conducted a statistical test. Since all the tokens were repeated four times by all the subjects, we preferred RM ANOVA. In the ANOVA test, tone types (three tones) were kept as a fixed factor, speakers (6 subjects) as a random factor and the mean f0, duration, and intensity of all the words (62 words *4 repetitions *6 subjects = 1488 tokens) were kept as the dependent variable. The RM ANOVA with a Greenhouse-Geisser correction confirm a significant effect of mean f0 on tone types $F(1.87, 19.9) = .17$, $p = 0.00$. A subsequent post hoc tests using the Bonferroni correction revealed a significant difference (mean f0) between Tone 1 and Tone 2 ($p < 0.05$), Tone 2 and Tone 3 ($p < 0.05$), and Tone 3 and Tone 1 ($p < 0.05$). The test also confirms that f0 is the only significant acoustic correlate of tone in Mog.

3. INTERACTION BETWEEN (CONTRASTIVE) TONE(S) AND [±] VOICE SONORANTS

Much has been explored the way (stop) consonants modify the pitch of the following vowel (voiced consonants reduce the f0 of the following vowel, whereas voiceless consonants may even raise the f0), however, very little is known whether [±voice] sonorous consonants maintain consistent pattern of such raising and lowering (this may be due to the fact that sonorous consonants are universally [+voice]). Since Mog allows voicing contrasts among the nasals and laterals ([m̥ia] 'fishing hook' [mia] 'wife', [l̥i] 'boat', [l̥i] 'bow', [li] 'air'), we examined the way pitch is realized in contexts where there are following [±] voice contrasts among sonorous consonants. Figure 7 ([±] voice nasal, m̥iá/ 'fishing hook' and /mià/ 'wife') and Figure 8 ([±] liquid; /l̥ǐ/ 'boat', /l̥î/ 'bow', and /lì/ 'air') show the effects of [±voice] sonorants on tone types in Mog.

Figure 7: Time-normalized pitch tracks for /m̥iá/ 'fishing hook' and /mià/ 'wife', (averaged across all the speakers and all the repetitions, (n=24 [4 repetitions * 6 subjects] for each word).

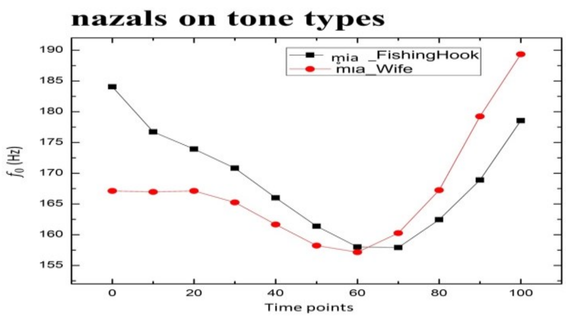
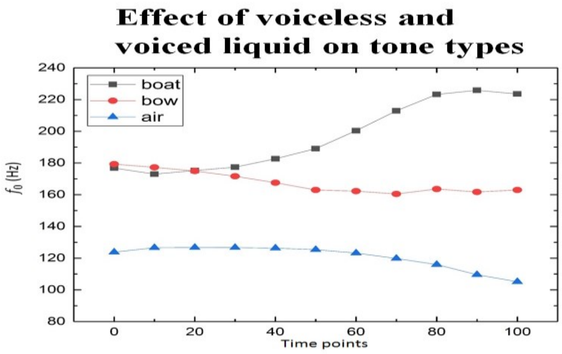


Figure 8: Time-normalized averaged pitch tracks for /l̥ĭ/ 'boat', /l̥î/ 'bow', and /lì/ 'air' (averaged across all the speakers and all the repetitions, (n=24 [4 repetitions * 6 subjects] for each word).



Generally, we concur with Blevins (2018) that there are recurrent phonetic properties in voiceless sonorants, that is, longer duration in the voiceless than their voiced counterparts. Voiceless sonorant consonants arise from RH or HR clusters (or HM HN as in Mog) as pointed out by Blevins, and therefore the markedness of such clusters should be prioritized. We propose here, that notwithstanding the markedness of such clusters, it is the phonetic attributes of voiceless sonorants such as longer duration (on average 20ms more than the voiced counterparts) (Figure 9) and raised f0 (Figure 10), etc. which make the contrast between voiceless and voiced sonorant consonants possible. Additionally, we have shown here that such distinctions are more pronounced when there is a contrastive tone as well.

Figure 9: Duration of voiceless and voiced onset consonants /l̥/ and /l/ with standard deviation as error bar (averaged across all the speakers and all the repetitions, n=24 [4 repetitions * 6 subjects] for each word).

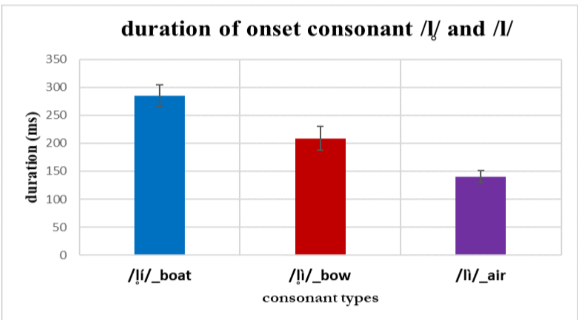
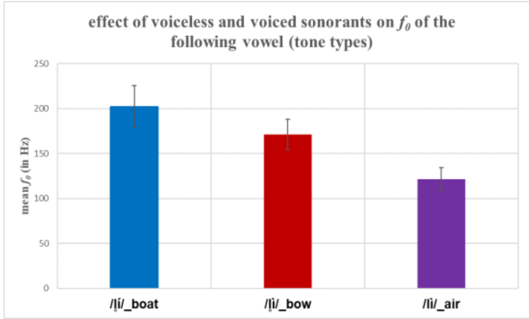


Figure 10: Mean f0 of the vowel when preceded by voiceless (also specified for distinct tone) and voiced lateral with standard deviation as error bar (averaged across all the speakers and all the repetitions, n=24 [4 repetitions * 6 subjects] for each word).



A successive statistical test confirms that the rise in f0 following the voiceless sonorants is statically significant (18 Hz on average till 60% of the total rhyme, when compared to the voiced counterparts, (F [1.11, 17.) = .15, p = 0.00) (Figure 10). It has also been observed that even though the voiced sonorants lower the pitch of the following vowel (till 50% to 60% of the total rhyme) (please see Figure 7 and Figure 8), the pitch gradually increases towards the final portions of the rhyme (60% to 100%), indicating that the presence of voicing contrasts among the sonorous consonants may modify the voice quality (we did not report that in this paper) of the following vowel.

4. CONCLUSION

This paper examines the status of lexical tone in Mog and establishes with acoustic and statistical evidence that Mog preserves a three-way tonal contrast- high-falling, mid-rising, and low-rising. Further, we have also explored the way voiceless sonorants modify tonal properties in Mog. We also noticed the absence of a glottal pulse (voicing) (at least till 20%-30%) in the vowel spectrogram following the voiceless sonorant. We speculate that the voicing properties of the sonorous consonants may even modify the phonation qualities of the vowels carrying contrastive tones (not reported in this paper). Nonetheless, this study attempts to explore the tonal properties of this lesser known endangered language at length, which is first of its kind. We believe that the findings and analysis carried out in this paper will contribute to a better understanding of the typologically rare phenomenon of contrastive voiceless and voiced sonorants and their interaction with contrastive tones.

7. REFERENCES

[1]Abramson, A. S., “The vowels and tones of Standard Thai: Acoustical measurements and experiments”, International Journal of American Linguistics, 28; 2, part II, 1962.

[2] Abramson, A. S., “The Plausibility of Phonetic Explanations of Tonogenesis”, in Gunnar Fant et al. (eds), From Traditional Phonology to Modern Speech Processing: Festschrift for Professor Wu Zongji’s 95th Birthday. 17-29, Beijing: Foreign Language Teaching and Research Press, 2004.

[3] Alves, Mark., “Tonal Features and the Development of Vietnamese Tones”, Working Papers in Linguisticsi, Vol. 27: 1-13. Department of University of Hawaii. Manon, 1995.

[4] Blevins, J. “Evolutionary Phonology and the life cycle of voiceless consonants”. In Typological Hierarchies in Synchrony and Diachrony, Eds Sonia Cristofaro and Fernando Zúñiga[Typological Studies in Language 121] 201829–60, 2018.

[5] Boersma, Paul & Weenink, David., Praat: doing phonetics by computer (Version 5.3.04_win32) [Computer program], 2008., Online: http://www.praat.org/Bradley 1982.html, Retrieved on December 22, 2011.

[6] Bradley, David. “East and Southeast Asia”. Encyclopedia of the World’s Endangered Languages, ed. by Christopher Moseley. 349-422. London and New York: Routledge, 2007.

[7] Bradley, David. “Changes in Burmese Phonology and Orthography”. Keynote Presentation at SEALS 21 Conference, Kasetsart University, Thailand, 2011.

[8] Bradley, David. The Characteristics of the Burmic Family of Tibeto-Burman”. *Language and Linguistics* 13:171-192, 2012.

[9] Burling, Robbins. *Proto Lolo-Burmese*. Indiana University Research Center in Anthropology. Folklore and Linguistics. Publication 43, 1967.

[10] DeLancey, Scott. “Sino-Tibetan Languages”. *International Encyclopedia of Linguistics* 4:445-449. New York: Oxford University Press, 1992.

[11] Gope, Amalesh, and Shakuntala Mahanta. "Lexical Tones in Sylheti" in *Fourth International Symposium on Tonal Aspects of Languages*. 2014. (pp 10-14). 2014.

[12] Hombert, Jean-Marie., “Consonant types, vowel height and tone in Yoruba”, in Victoria A. Fromkin (ed.) *Tone: A linguistic survey*. 77-111, New York: Academic Press, 1978.

[13] Hombert, Jean-Marie. Marie., John. J. Ohala. and William G. Ewan., “Phonetic Explanations for the Development of Tones”. *Language* Vol. 55 (1), 37-58, 1979.

[14] Kingston, John., “Tonogenesis”, in Oostendorp, Marc van et.al (Eds) *The Blackwell Companion to Phonology* (Vol. IV). Blackwell, 2011.

[15] Ladefoged, Peter and Ian Maddieson. “The sounds of the world’s languages”. Malden, MA: Blackwell. 1996.

[16] Ladefoged, Peter., *Elements of Acoustic Phonetics* (2nd Edition). The University of Chicago Press, Chicago & London, 1996.

[17] Ladefoged, Peter., *Preliminaries to linguistic phonetics*. Chicago, IL: University of Chicago Press, 1971.

[18] Lewis, M. Paul, Gary F. Simons, and Charles D. Fennig. (eds.) *Ethnologue: Languages of the World*, Seventeenth edition. Dallas, Texas: SIL International, 2014. Online version: http://www.ethnologue.com.

[19] Maggard, Loren, Sayed Ahmad, and Mridul Sangma. “The Marma and Rakhine communities of Bangladesh: a sociolinguistic survey”. Dhaka: SIL Internationa, 2007.

[20] Marma. *Encyclopædia Britannica*, 2014. http://www.britannica.com/EBchecked/topic/365911/ Marma [accessed 06/20/2014].

[21] Matisoff, James A. “Lahu and Proto-Lolo-Burmese”. *Occasional Papers of the Wolfenden Society on Tibeto-Burman Linguistics* 1:117-221. Ann Arbor: Department of Linguistics, University of Michigan, 1969. [22] Okell, John. “Three Burmese Dialects”. *Papers in Southeast Asian Linguistics*, No. 13, Studies in Burmese languages, ed. by David Bradley. 1-138. Canberra: Pacific Linguistics, 1995.

[22] Svantesson, J. –O., and House, D. “Tone production, tone perception, and Kammu tonogenesis”. Phonology vol. 23, 309-333, 2006.

[23] Thurgood, Graham., “Vietnamese and Tonogenesis: revising the model and the analysis”, Diachronica, 19, 333-363, 2002.

[24] Yip, M., Tone. Cambridge: Cambridge University Press, 2004.