THE PHONETICS OF ANYUAK VOWELS

Noah Elkins[1], Christina M. Esposito[2], Edwin Reyes Herrera[2]
[1]Dept. Linguistics, UCLA, Los Angeles CA; [2]Dept. Linguistics, Macalester College, St Paul MN
noahelkins1@g.ucla.edu; esposito@macalester.edu; ereyeshe@macalester.edu

ABSTRACT

Little is known about the phonetics of Anyuak, a Western Nilotic language spoken in Ethiopia and South Sudan. The only descriptive grammar of the language focuses mainly on the syntax but does describe a number of vocalic features, such as length, contrastive tone (high, mid, low, low-high, high-low), and a ±ATR distinction [8] [9]. The current study provides the first description of the Anyuak vowel system based on phonetic measurements. Results show evidence for five vowel qualities, which differ based on ±ATR, with -ATR vowels having a lower F1 value. In addition, +ATR vowels are produced with a breathy voice quality. Finally, we propose a revision to the previous description of the tonal system; the two contour tones are better described as mid-high and mid-low. These findings demonstrate that the Anyuak vowel system is in keeping with what one would expect of a Western Nilotic language.

Keywords: Anyuak, Advanced Tongue Root, tone, phonation, vowel length, Western Nilotic

1. INTRODUCTION

Anyuak (commonly spelled Anywa) is a Western Nilotic language spoken by a minority group primarily on the border between Ethiopia and South Sudan, and by a large diaspora community outside of the African continent [11]. To the best of our knowledge, the only description of Anyuak comes from a grammar and a dictionary of the Sudanese variety (as spoken in the capital of Khartoum) completed in the 1990s by [8] [9]. Sudanese Anyuak is described as having a vowel inventory of 10 vowels, but only five qualities, [i, ɪ], [e, ɛ], [ʌ, a], [o, ɔ], [u, ʊ], where the first member of each pair is produced with an advanced tongue root (+ATR) [8] [9]. This inventory is similar to that of other Western Nilotic languages, which present either nine or ten vowels, divided into two groups of five qualities based on the feature ± ATR, such as Päri [2], Lango [7], Nuer [13] and Shilluk [10]. [8] [9]also mentions that +ATR vowels are produced with breathy voice. Cross-linguistically, +ATR vowels may be produced with breathy voice; breathy quality can arise via a lowering of the larynx involved in the articulation of ATR, though breathy quality can be achieved without such lowering [1] [4] [6].

Sudanese Anyuak also contrasts vowel length; according to [8] [9], vowels are distinguished by quality and not duration. Western Nilotic languages generally show contrastive vowel length, reflecting the commonly attested binary distinction between short and long vowels. However, at least one Western Nilotic language, Nuer [13], is claimed to have a three-way length distinction between short, long, and overlong vowels.

[8]'s account of Sudanese Anyuak also reports three level tones (high, mid, low), and two contour tones (low-high and high-low), though the high-low tone is reported to be quite rare. Tone is a common feature shared by Nilotic languages, and although other branches may have slightly different tonal inventories, in the Western branch, there is usually an inventory of three level tones (high, mid, low) and a small number of contour tones, such as low-high and high-low. We investigate tone in this study in order to construct as complete a picture as possible of all contrastive vocalic features of Anyuak vowels.

None of the impressionistic claims made in the literature have been studied using experimental methods. No laboratory phonetic examination of any dialect of Anyuak has been attempted before the present study. We aim, therefore, to examine Ethiopian Anyuak, a dialect without any prior linguistic documentation.

The following questions will be addressed:

1) What is the number of vowel qualities in Ethiopian Anyuak?
2) What are the durational differences between the vowels?
3) What is the basic tone inventory?
4) Does phonation vary as a function of ATR?

Using [8]'s work as a guide, one can expect Ethiopian Anyuak to have a similarly rich vocalic

inventory including at least ten vowel qualities, ±ATR, breathy phonation, and tone, though speakers do report pronunciation differences between the Sudanese and Ethiopian varieties.

2. PROCEDURE AND ANALYSIS

2.1 Speakers

10 speakers were recruited from the Ethiopian Anyuak diaspora community living in the USA. Speakers reported using Anyuak daily, and all speak English as a second language, with varying degrees of fluency. The results reported below are for a subset of speakers.

2.2 Speech Material

An initial wordlist was prepared using the Sudanese Anyuak dictionary compiled by [9] as a guide. The preliminary wordlist was verified and supplemented by an Ethiopian Anyuak primary consultant over the course of six months. Modifications were made to [9]'s transcription to reflect pronunciation differences between the two dialects. The majority of words were monosyllabic. To the best of our abilities, the onset and coda were controlled for such that both consonants were voiceless stops. Whenever possible, minimal sets were elicited.

160 words were presented in the Anyuak practical orthography with English translations. Target words were placed within the same declarative carrier sentence, with care taken to ensure that target words were in the middle of the sentence. Speakers spoke the carrier sentences twice into a microphone, and their speech was recorded on Praat.

2.3 Measurements

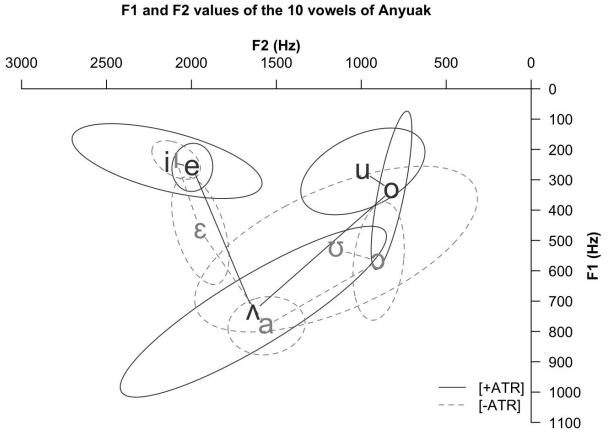
First and second formant frequency (F1 and F2), F0, and H1*-H2* were measured for all vowels automatically using VoiceSauce [12]. (Preliminary research showed that H1*-H2* was a good indicator of phonation differences in Anyuak.) Measurements were made at every millisecond and then averaged within nine parts of equal length. For the formant frequencies, we report on timepoint 5, which is approximately the middle of the vowel. For F0, all nine time points where examined. And, for H1*-H2*, we examined the middle of the vowel (time point 5) based on pilot research. Vowel length was measured by hand in Praat [3].

3. RESULTS

3.1 Vowel Quality

Formant analyses indeed revealed 10 disti The F1 and F2 value for the Anyuak vowels [i, ɪ], [e, ɛ], [a, ʌ], [o, ɔ], [u, ʊ], where the first member of each pair is produced with +ATR, are given in Figure 1 below.

Figure 1. F1 and F2 (Hz) values of 10 vowels of Anyuak.



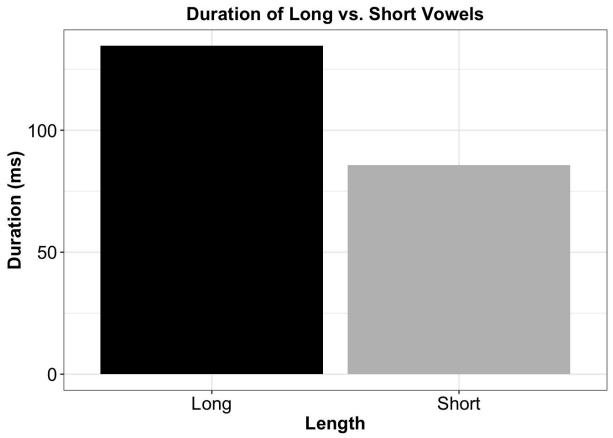
For vowels that are -ATR, F1 values tend to be higher and F2s values lower than their +ATR counterparts, with the exception of [o, ɔ]. A one-way ANOVA shows a significant main effect of Vowel ($p<2e\text{-}16$) with F1 as the dependent variable. Tukey comparisons show that there are significant differences between the +ATR and -ATR pairs for [u, ʊ], ($p<0.0002496$), [o, ɔ], ($p< 0.0021559$), and [e, ɛ], ($p<0.0096543$). However, there is no significant difference between the pairs [i, ɪ] ($p=1$) or [ʌ, a] ($p<-0.9961797$).

There is also a significant main effect of Vowel ($p<2e\text{-}16$) with F2 as a dependent variable, but there are no significant differences between +ATR and -ATR vowel pairs, suggesting they are produced with similar F2 values. This indicates that F1 is important in determining vowel category. It appears that the vowels [i, ɪ] and [ʌ, a] are not distinguished by F1 and F2 values; we will return to these vowels in our discussion.

3.2 Vowel Length

Figure 2 compares the short and long vowel contrast collapsed across vowel quality. Note that long vowels (shown in black) are longer than short vowels (shown in grey).

Figure 2. Duration (ms) of long and short vowels.

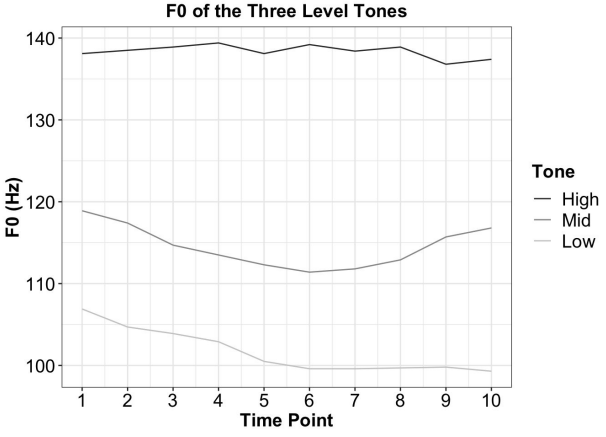


The distinction between short and long vowels is shown to be measurably contrastive. Across all vowels, the long vowels are, on average, 49 milliseconds longer than their short counterparts, or about 1.5x as long. A one-way ANOVA shows a significant main effect of Length ($p<0.0031765$), with long vowels being significantly longer than short vowels as seen in Tukey Comparisons ($p<0.0031765$).

3.3 Tone

The following graph shows the average f0 (Hz) values of the level tones of Anyuak. The high tone is shown in black, the mid-tone in dark grey, and the low tone in light grey. The numbers along the x-axis represent timepoints across the duration of the vowel.

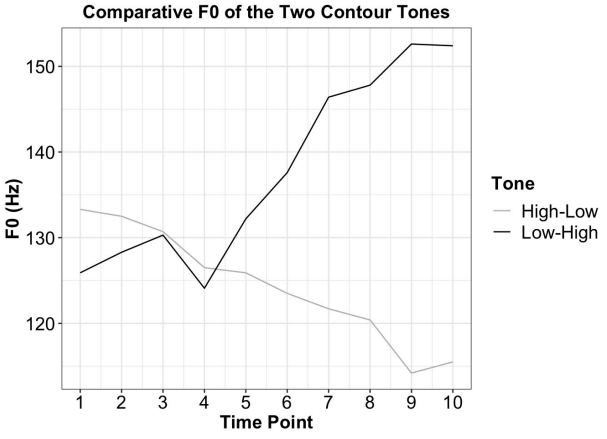
Figure 3. Anyuak's three level tones.



As can be seen from the graph above, all three level tones maintain a relatively constant pitch across the course of the duration of the vowel; the high tone maintains about 140 Hz, the mid tone about 115 Hz, and the low tone about 100 Hz. Interestingly, while there is only an approximately 15 Hz difference between the mid and low tones, there is a much larger, 25 Hz difference, between the mid tone and the high tone. As such, although there is phonetic evidence that the mid and low tones are measurably different, this is perhaps the reason why [8] and [9] were forced to conclude that the mid tone was hardly distinguishable from the low tone. [8] and [9] granted the mid tone phonemic status, however, particularly because it instigates a number of tone sandhi phenomena, which otherwise do not occur with low tones in similar positions.

Next, Figure 4 displays the pitch contours of Ethiopian Anyuak's two contour tones, the rising tone and the falling tone. The low-high tone is shown in black, and the high-low tone is shown in grey.

Figure 4. Anyuak's two contour tones.



While [8] and [9] described the contour tones as high-low and low-high, there is evidence from the current study that, for Ethiopian Anyuak, they are better described as mid-high and mid-low, as they begin with a pitch value that is closer to the mid-level tone. This study also confirms that there are no additional tones, be they level or contour, which are not accounted for in [8] and [9].

3.4 Breathy Phonation

The difference in breathiness (measured via H1*-H2* in dB) between the +ATR vowels versus their -ATR counterparts is averaged across vowel quality (Figure 5) and presented individually (Figure 6). . +ATR vowels have a significantly higher H1*-H2* value, meaning that they are much breathier on average than -ATR vowels ($p<9e-10$); in fact, the -ATR vowels have a slightly negative H1*-H2* value.

Figure 5. H1*-H2* values compared between +ATR and -ATR vowels.

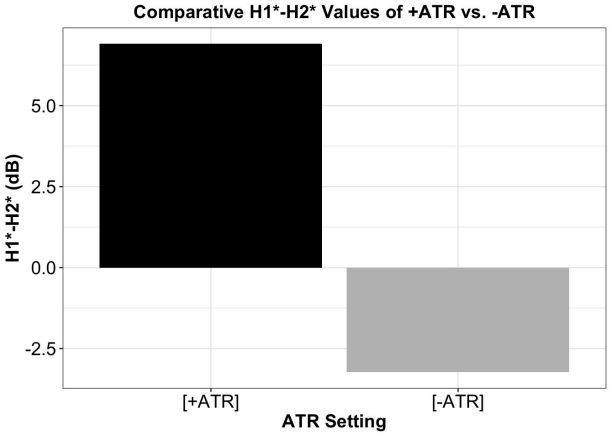
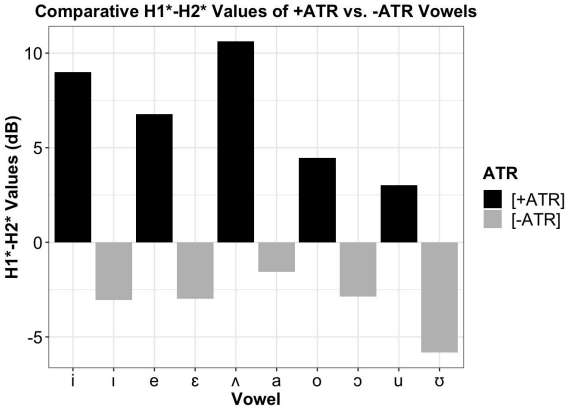


Figure 6. Individual vowel H1*-H2* values for +ATR and -ATR vowels.



A one-way ANOVA with H1*-H2* as the dependent variable shows a significant main effect of Vowel ($p<1.02e-06$), in which Tukey comparisons show a significant difference in H1*-H2* values between +ATR and -ATR pairs of [i, ɪ] ($p<0.0075083873$) and [ʌ, a] ($p<0.0098828402$). This is very interesting considering that the formant values of these two vowel pairs were not significantly different. As such, these results suggest that phonation is the most important contrastive feature between these vowels.

4. DISCUSSION AND CONCLUSION

This study reports phonetic data on the vowels of Ethiopian Anyuak. Results show that length is a contrastive feature and that the tonal inventory is: high, mid, low, mid-high and mid-low. The tonal inventory of Ethiopian Anyuak is different from that of the Sudanese variety, in that the two contour tones begin with a mid, rather than low tone. Results of F1 and F2 measurements suggest a vowel inventory of [e, ɛ], [o, ɔ], [u, ʊ], and a close vowel [i] or [ɪ] and an open one [ʌ] or [a]. While previous accounts of Anyuak found [ʌ, a] and [i, ɪ] to be distinct vowel qualities, our findings suggest that the difference between these vowels is due to phonation, rather than formant frequency. At this time, we are unable to conclude which of the vowels ([i] or [ɪ]; [ʌ] or [a]) is the underlying one.

The fact that the close vowels contrast modal/breathy phonation is particularly interesting when we consider the cross-linguistic distribution of breathy vowels; there is a tendency for open vowels, not closed ones, to be produced with breathy voice [5].

5. REFERENCES

[1] Anderson, C. 2003. In search of an acoustic correlate to [ATR] in ɪkpɔsɔ. Mugane, J. (ed.). In *The Linguistic Typology and Representation of African Languages*, 5, 83-92.

[2] Andersen, T. 1989. The Päri Vowel System with an Internal Reconstruction of Its Historical Development. *Journal of African Languages and Linguistics*, 11(1), 1-20.

[3] Boersma, P., Weenink, D. 2018. Praat: doing phonetics by computer. Computer Program. http://www.praat.org/.

[4] Casali, R. 2008. ATR Harmony in African Languages. *Language and Linguistics Compass*, 2, 496-549.

[5] Esposito, C., Sleeper M., Shafer, K.. (to appear) Examining the relationship between Vowel Quality and Voice Quality. *Journal of the International Phonetic Association.*

[6] Guion, S., Post, M., Payne, D. 2004. Phonetic correlates of tongue root contrasts in Maa. *Journal of Phonetics*, 32, 517-542.

[7] Nooman, M. 1992. *A Grammar of Lango*. Berlin: de Gruyter.

[8] Reh, M. 1996. Anywa Language: Description and Internal Reconstruction. Köln: Rüdiger Köppe Verlag.

[9] Reh, M. 1999. Anywa-English and English-Anywa Dictionary. Köln: Rüdiger Köppe Verlag.

[10] Remijsen, B., Ayoker, O., Mills, T. 2011. Shilluk. *Journal of the International Phonetic Association*, 41(1), 111-125.

[11] Simons, G., Fennig, C. (eds.) 2018. Anuak. Ethnologue: Languages of the World, Twenty-first edition. Dallas, Texas: SIL International.

[12] Shue, Y.-L., Keating, P., Vicenik, C. 2009. VoiceSauce: A program for voice analysis. *J. Acoust. Soc. Am.* 124(4), 2221.

[13] Yigezu, M. 2009. The Nuer vowel system. *Journal of African Languages and Linguistics*, 16(2), 157-170.