An Acoustic Analysis of the Short and Long Vowels in Ekegusii Language

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Abstract

This paper analyzes the vowel lengths of Ekegusii, a Bantu language spoken in South-Western Lake Region of Kenya. Orthographically, the Ekegusii language reveals only five vowels as a, e, i, o, and u. However, pioneering researchers like Guthrie (1948) and Whiteley (1965) have shown that the language has a seven vowel system /a, e, ɛ, i, o, ɔ, u/. These researches and many later researches such as Osinde (1988), Bosire (1993), Cammenga (2002), Nurse and Gerard (2003), and Mecha (2006) among others relied upon impression to identify and describe the vowels. Of recent, however, it has become necessary to use modern scientific acoustic methods of speech analysis to confirm earlier claims about the vowels in the language. In this research, we used Praat Software (Boersma & Weenink 2010) to identify and analyze the vowel system of Ekegusii. Results indicate that vowel length is distinctive in the language. Since vowel duration is phonemic in the language, then the vowels are fourteen as each short vowel has a corresponding long vowel as revealed in the data of this research.

Keywords: citation form, phonemic, running speech, vowel inventory, vowel length

1.0 Introduction

Ekegusii is a Bantu language spoken by the Abagusii who reside in Kisii and Nyamira counties (Omoke 2012; Basweti et. al. 2015). According to the 2009 National Census, EkeGusii has an estimated 2.2 million native speakers. The Abagusii are believed to have migrated from the Congo forest through Uganda entering Kenya through the Western part of the country. They are bordered to the East by the Kipsigis, to the West by the Luo, and to the South by the Maasai, all of whom are Nilotic speakers. They do not neighbour any Bantu speakers (Anyona 2017). In his zonal classification of languages, Guthrie (1948) classifies EkeGusii as a central Bantu language part of the sub-family of the Kuria language labeled E.42. He relates it to other languages including: Lulogooli, Ameru (Kenya) Kuria (Kenya and Tanzania) Ware, Ikizu, Ikoma, and Sanjo (Tanzania). Just like the majority of Bantu languages, Ekegusii is a tone language (Nash 2011).

According to Guthrie (1948) and Whiteley (1965), Ekegusii language has seven vowels as /i e ɛ a ɔ o u/.Whitely (1960) lists seven basic Gusii vowels as listed in figure 1.1 below.

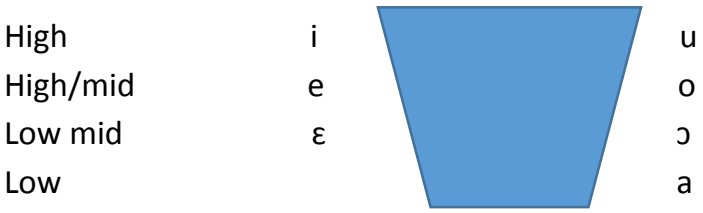

Figure 1: Whiteley (1960) annotation of Ekegusii vowel sounds

Cammenga (2002:36) points out that whitely (1960) did not define the phonetic or phonological significance of these symbols exactly. Cammenga goes ahead to give an Ekegusii vowel inventory where the vowel segments are differentiated in terms of minimally distinctive phonological features as in figure 2 below.

	i	e	ɛ	a	ɔ	o	u
High	+	+	-	-	-	+	+
Mid	-	+	+	-	+	+	-
Back	-	-	-	+	-	-	+
ATR	+	-	-	+	-	-	+

Figure 2: Cammenga (2002) Ekegusii vowel inventory

For Cammenga (2002), Advanced Tongue Root [ATR] feature is distinctive in EkeGusii. The vowels [i], [a] and [u] are specifically phonetically for [+ATR].

2. Methodology

2.1 Data

The source of words that provided data for this research was self-generated using native speaker intuition because the researcher is a native speaker of Ekegusii. The words containing the target sounds were listed in minimal pairs with duration/time as the variable. There were two contexts used: /tVt/ and /tVβ/. These contexts were chosen to control the phonetic environment just like Hillenbrand et al. (1995), Ladefoged (2003) and Jekale (2011) all chose phonetic environment (/hVd/) within which the vowels are elicited and analyzed. The words were also written in carrier sentences to analyze the same features in running speech. The list of words and sentences were presented to informants who read them aloud to a computer through a microphone. The speech was recorded and stored up in the computer for analysis using Praat software. The instrumental phonetic analysis was on the target vowel sounds as elicited by four adult men, four adult women and four (eight year olds) children. All the informants are native speakers of Ekegusii. This kind of classification was necessary because there is pitch, intensity and formant variation within the classes, as evidenced by the quality of the vowels produced, caused by differences of vocal fold thickness, with men having the thickest, followed by women and children in that order (Clark, Yallop and Fletcher 2007). All the informants were native speakers of Ekegusii. Table 1 (a) below provides the list of words in citation form while (b) is the list of carrier sentences used to get the vowels for analysis in the research.

Table 1(a) *List of minimal pairs (or near minimal pairs) used to provide data in the analysis of duration for Ekegusii vowels in the /tvt/ context alternating short and long vowels.*

Orthography	**Transcription**	**gloss**
titi	**ti**ti	very (black)
tiiti	**ti:**ti	calling a baby to carry him/her on the back
teta	**te**ta	name of a place
teeta	te:ta	let it not pass
teta	**tɛ**ta	have sex
t**ee**ta	t**ɛ:**ta	have sex for long/repeatedly

tata	**ta**ta	father
taata	**ta:**ta	(calling) father
toti	**tɔ**ti	make soft
tooti	**tɔ:**ti	let us warm/make one to bask
t**o**to	t**o**to	name of a person
t**oo**to	t**o:**to	calling 'Toto'
tuti	**tu**ti	name of a place/clan
tuutia	**tu:**tia	a variant of the place/clan name 'Tuti'

Table 1(b) *Carrier sentences used to provide data for the analysis of Ekegusii vowels.*

Sentence	Transcription	Gloss
Teba titi tari tiiti	teβa **titi** tari **tiiti**	Say titi and not tiiti
Teba otete tari oteete	tɛβa o**tete** tari **oteete**	say Otete not oteete
Tera buna matete tiga kobeeteeta	tɛra βuna ma**tɛtɛ** tiɣa kɔβɛɛtɛɛta	Sing like Matete don't go into a discord
rora tata taata esani	rɔra **tata taata** esani	See that dad does not break the plate
Ototi ake toototi pi	ɔ**tɔti** ake tɔɔtɔti	Make the ugali soft
Ototo neyotooto	**ototo** nejo**to:to**	Ototo is good for you
tututi ya sungutuuta	tututi ja suŋgutu:ta	Nonsensical tongue twister

2.2 Experimental study

The data recorded for analysis of vowels was downsampled to 11025 Hz with the CSL 4400 software and analyzed with Praat version 5.1.23 (Boersma & Weenink 2010). The duration of each vowel was extracted manually by investigating the spectrogram, waveform and formant traces. Each vowel was taken to be the beginning of a regular waveform where formants start stably. Once the boundaries were located, the duration was recorded in milliseconds by taking the first three decimal places on the Praat window used in the durational measurement. Each vowel was measured three times in each of the contexts for males, females and children.

3. Results and Discussion

Duration is an important element when analyzing the vowels of Ekegusii or of any language for that matter. Vowel duration may not be Phonemic in some languages but in Ekegusii it is phonemic. Apart from looking at spectrograms of any sound produced, the appropriate numbers of length are necessary for complete analysis. This is important when trying to create a computer speech synthesizer for a language

since this works by setting a number of parameters like formants and pitch. This is harder to get when dealing with running speech since it is hard to delineate all the rules that must be factored in so as to predict all the details of running speech. Duration which is basically the quantity of the vowel is got by the time taken to produce a vowel. Any recording in Praat has an automatic time tracking. These times can be manipulated to the users' needs. It has already been pointed out that no one utterance is exactly the same as the next one even when produced by the same person. While analyzing data in this paper, one could easily notice the variations in the duration of vowels. Since each informant had to produce three repetitions of any target vowel and then the average computed, it was noticed that the first word had a vowel that was longer than the second one which was equally slightly longer than the third one. Fig. 3 below is a Praat Object window displaying an informant produced the vowel sound /i/. The program allows for each of the segments to be separated and its times recorded.

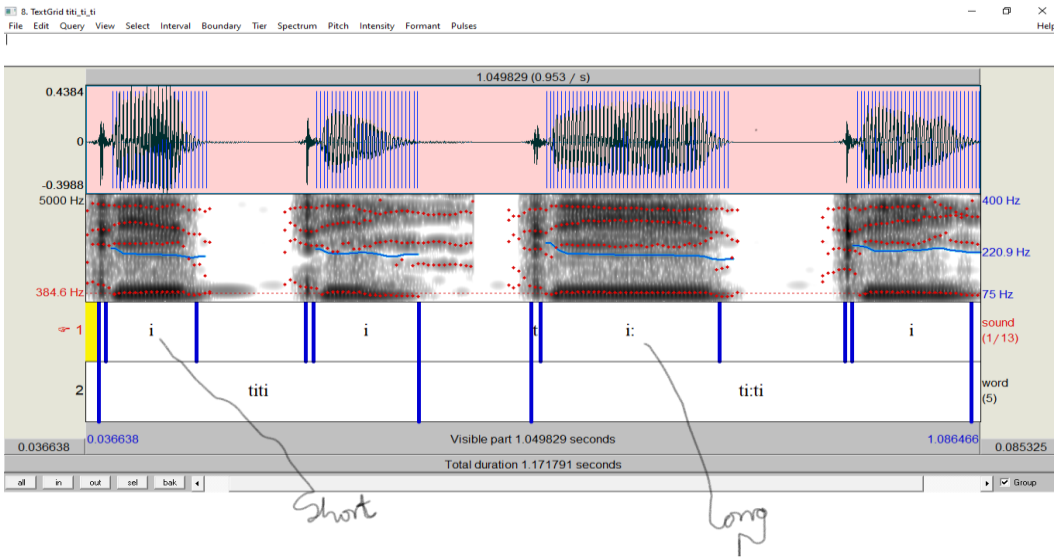

Figure 3 *waveform and spectrogram for the Ekegusii short vowel /I and long vowel /i:/ as produced by an adult female informant.*

In each of the words, the first vowel sound in the initial syllable was the one under focus and it is the one whose times were extracted and analyzed. Two words are contrasted above with /t**i**ti/ compared to /t**i:**ti/. Vowel length for highlighted sounds being the contrast. This object window shows that the target vowel sound /i:/ is longer just by the space it occupies on the window. The same procedure can be repeated for each of the words recorded with similar or near similar results. In This paper, the duration of each Ekegusii vowel was tracked using data from words that were minimal pairs differing only in the perceived duration/length differences. Where a minimal pair was not available in the required phonetic environment, a

nonsense word was coined to fit the context. Data were also elicited from carrier sentences. It is commonplace to see formants of resonance normally attached at the end of vowel formants. This makes the vowel look longer than it actually is. This is usually the case with the final vowel, a distinctive feature in Ekegusii syllabification. To avoid this, the research sought to analyze the lengths of inter-consonantal vowels, those in the first syllable mainly. These resonance formants come up since the vocal tract is not closed immediately after the vocal fold vibration has ceased. This can be exemplified in the following figure of a waveform for the second male informant M2.

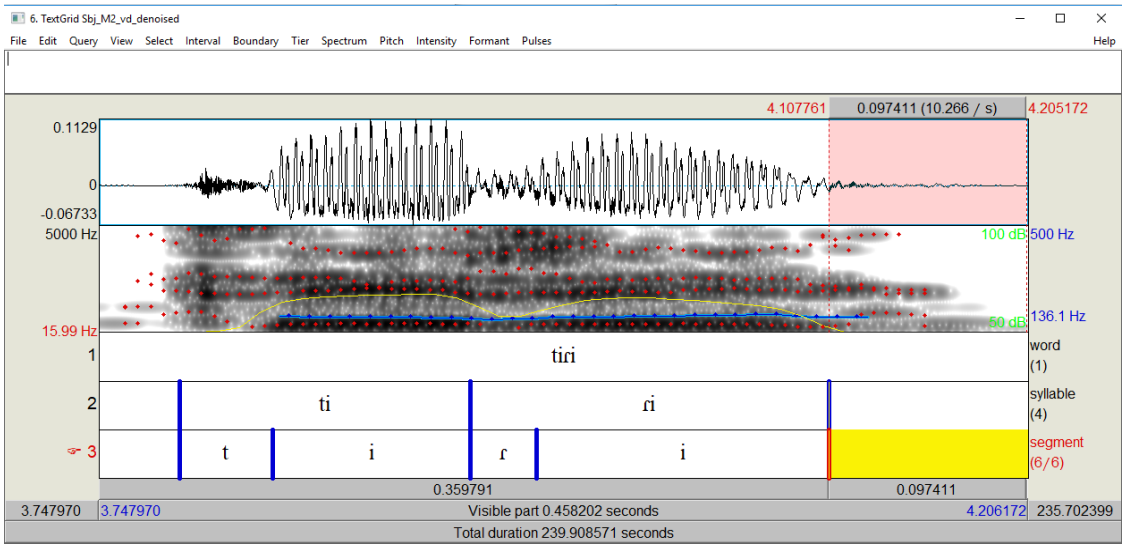

Figure 4 *wave form for second male informant*

The part that is highlighted in the wave form in the Fig. 4 is the resonance tail for the final vowel /i/ of the final syllable. Essentially, the vowel ended at the point where the red dot lines delineating the first and second formant change their steady trajectory and start to fall or disappear. One can always confirm it by listening in to that part by clicking on the rectangle below it that has the measurement of 97 milliseconds.

3.1 Results for males

The following are the results for each vowel from the informants whose voices were recorded for this research. The duration of the vowels was measured in milliseconds for uniformity. The data for males was summarized as in table 5.1 for purposes of drawing a graph

Table 2 *Summary of average duration for men as group for Ekegusii pure short and long vowels*

Vowels For Men	Short vowel Duration	Long vowel duration
i	75	243
e	86	241
ɛ	75	258
a	74	272
ɔ	95	283
o	79	248
u	75	213

The table above can be presented better in a visually appealing graph as follows.

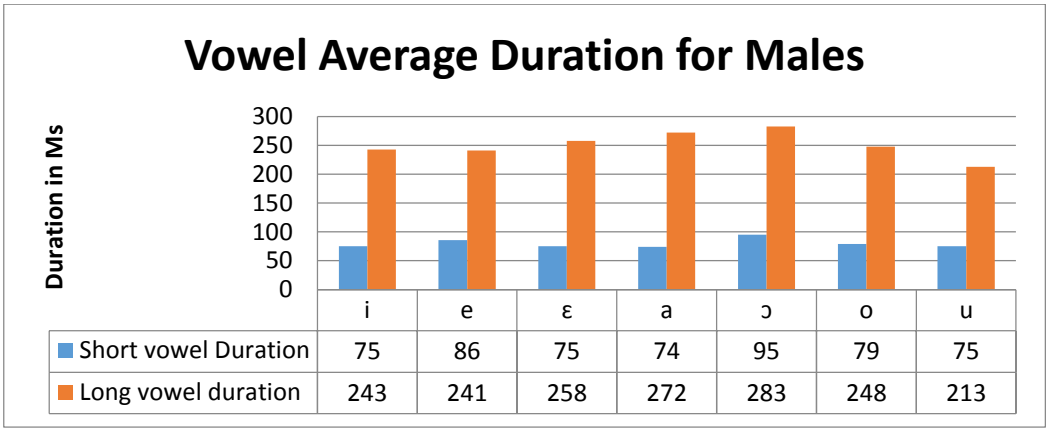

Figure 5 *Mean vowel duration for adult males*

The group scores like the ones presented above can now be compared with those of other groups for This paper. The average scores for men showed that the short vowel /i/ was 75 milliseconds while the long form /i:/ was 243 milliseconds in length. The short /e/ was 86 milliseconds and its longer counterpart /e:/ was 241 milliseconds long. /ɛ/ was 75 milliseconds and /ɛ:/ 258 milliseconds; /a/ was 74 milliseconds while /a:/ was 272 milliseconds long; /ɔ/ was 95 milliseconds long as /ɔ:/ had a mean of 283 milliseconds. /o/ settled at a mean of 79 milliseconds for the short vowel and the long one /o:/ was 248 milliseconds long. Lastly, /u/ was 75 milliseconds long and /u:/ was 213 milliseconds long. The data indicates a clear distinction between the short and long vowels of Ekegusii. This proves the point that vowel length in the language is phonemic. The group scores for males presented above can be compared with those of the other groups in this paper as follows in section 3.2 and 3.3.

3.2 Results for females

The combined average length of vowels extracted from women's sound files are presented in the table that follows.

Table 3: *Summary of average duration for women as a group for Ekegusii pure short and long vowels*

Women's Mean	short vowel duration	long vowel duration
I	76	229
E	91	241
ɛ	95	265
A	96	246
ɔ	116	351
O	105	265
U	79	225

The bar graph out of the above values is as follows.

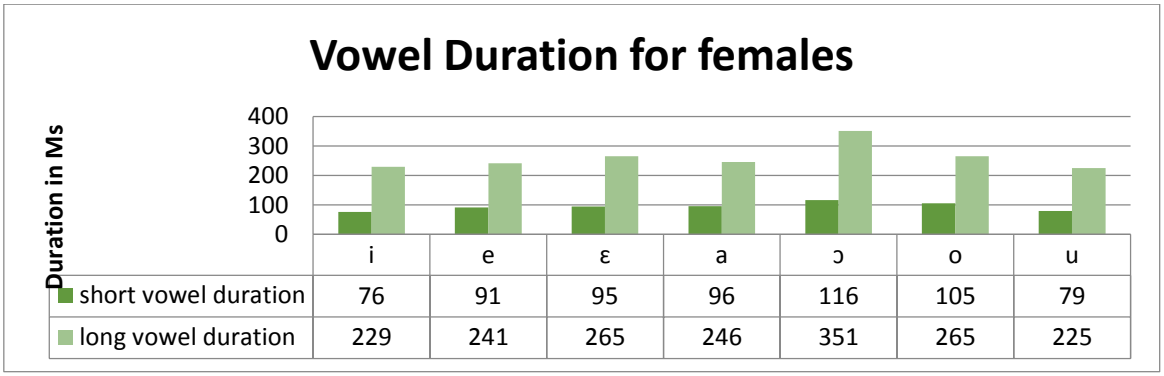

Figure 6*: Mean vowel duration for adult females*

The women had a mean of 76 milliseconds for /i/ and 229 milliseconds for /i:/. The vowel sound /e/ had a mean of 91 milliseconds for the short version and 241milliseconds for the longer version. /ɛ/ had 95 milliseconds for the short form and 265 milliseconds for the long form. /a/ was 96 milliseconds for the long form and 246 milliseconds for the long. /ɔ/ was 116 milliseconds for the short vowel and 351 milliseconds for the long vowel. /o/ was 105 milliseconds for the short form and 265 milliseconds for the longer version. Lastly, /u/ had a short form of 79 milliseconds for the short form and 225 milliseconds for the longer version.

3.3 Results for children

The duration results for the four children informants indicated higher duration than the values recorded for the adults. This is seen in table 4. The first child informant, RCF1 had the overall high scores for nearly all the vowels both short and long. The

means for the children as in the following table were used to create the graph for easier comparison of the durations. The following are the vowel average durations for the children.

Table 4: *Summary of average duration for children as a group for Ekegusii pure short and long vowels*

Children vowels	Short vowel	Long Vowel
i	91	276
e	98	263
ɛ	97	265
a	85	228
ɔ	92	272
o	91	239
u	85	231

This table can be translated into the following bar graph.

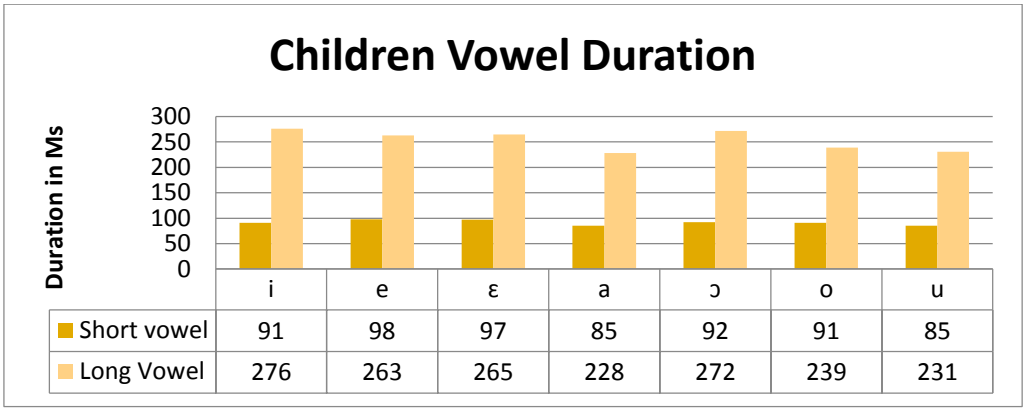

Figure 7*: Mean vowel duration for children*

The children had a mean of 91 milliseconds for the short vowel /i/ and 276 milliseconds for the long counterpart. /e/ had a mean of 98 milliseconds for the short form and 263 milliseconds for the long form. /ɛ/ had a mean of 97 milliseconds for the short form and 265 milliseconds for the long form. The central vowel /a/ was 85 milliseconds for the short form and 228 milliseconds for the longer counterpart. For the back vowels, /ɔ/ had a short form of 92 milliseconds and the long form was 272 milliseconds. /o/ was 91 milliseconds for the short form and 239 milliseconds for the long form. Lastly, /u/ had a short form of 85 milliseconds and the long form was 231 milliseconds. The vowels of Ekegusii are best presented as in the following chart.

Table 5*: Hypothetical Ekegusii vowel chart*

Front		**Central**		**Back**					
	Short	**Long**		**short long**		**short long**			
High		i	i:					u	u:
Upper mid	e	e:					o	o:	
Lower mid	ɛ	ɛ:					ɔ	ɔ:	
Low					a	a:			

On average, adult males had the longer short vowels than the other two groups as attested above. They were followed by adult females and then the children who had the shortest short vowels. The mean at the end is what we can take as the average length of Ekegusii short vowels for each group separately. For all the vowels, the range was within 100 milliseconds indicating that the spread and dispersion from the normal was very significant. On average, the women had longer vowel sounds followed by the children then the men.

4. Conclusion

This research used experimental phonetics to compliment the data got from impression. Instrumental analysis is far better since instruments are modelled in a way to visualize a particular aspect of speech and then provide a basis of measurement (Hayward 2014:32). This is so since so many aspects of speech are completely inaccessible for analysis by use of senses except through machines. The results from the data confirm that the seven vowel identified by earlier researchers exist in Ekegusii. Further, each of those vowels can either be long or short as confirmed by the data in this research. The data for this paper demonstrate that duration is distinctive in the language, then this research can suggest that there are fourteen vowel phonemes in Ekegusii with seven short and seven long vowels.

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