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A PHONETIC ANALYSIS OF UVWIẸ VOWELS

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Abstract
This study presents a phonetic analysis of the vowels of Uvwiẹ drawing upon evidence from acoustic cues. The acoustic properties of the sounds were examined using Praat 6.0.16 software on a notebook running Windows 10. The aim was to identify the surface vowel qualities attested in the language and to examine the phonetic parameters within which the vowel system of Uvwiẹ could be described. Data for the study comprised lexical samples elicited from two adult L1 speakers of the language. The impetus for the study is the dearth of linguistic works on the Uvwiẹ language, an endangered language spoken by the Uvwiẹ people of southern Nigeria. So far, only Omamor (1973) has examined the phonetic vowels of Uvwiẹ. It was found that contrary to observation by Omamor, the formant frequency values suggest that there are seven surface vowels in the language. It was also found that the vowels vary in three phonetic lengths- short, normal and long, and in formant bandwidth which cues the distinction between oral and nasalized vowels. Thus given all phonetic parameters, the Uvwiẹ language may be understood as having a total of twenty-eight surface vowels.

Keywords: Phonetic analysis, surface vowels, Uvwiẹ

1. Introduction

This paper presents the report of a phonetic study on the vowels of Uvwiẹ, a south western Edoid language (Elugbe 1989) spoken in parts of Southern Nigeria. The paper is organized into two main sections. The first is a review of the previous study on the phonetics of Uvwiẹ, and the second focuses on the thrust of this study. The goal of the study was to identify and examine the surface vowel qualities which are attested in the language as well as the phonetic parameters for describing them. Data for the study comprised lexical samples elicited from two adult L1 speakers (one male and one female) using the Ibadan wordlist of basic items and a supplementary self-structured 300-wordlist. The male speaker is in his late forty's, while the female speaker is in her fifty's. Both speakers have lived in Effurun for more than 30 years. The speech of the informants was recorded under a controlled environment using Praat 6.0.16 on a notebook running windows 10, and encoded as 22 kHz 24 bit mono WAV files. The Praat software was also used for the acoustic measurements undertaken in this study.

2. Previous work

This section seeks to examine the extant literature on the phonetic vowels of Uvwiẹ. So far, only Omamor (1973) has examined the phonetic vowels of Uvwiẹ. The study was "…an attempt to see whether like Okpe, Uvwiẹ is at a transitional stage from a nine-vowel system to a seven vowel system" (Omamor 1973:113). Amongst other things, Omamor (1973) presented an acoustic phonetic analysis of the vowel system of Uvwiẹ. She demonstrated that on the basis of auditory perception, there are seven phonetic vowels in the language but that instrumental evidence suggests that there are nine phonetic vowels. These vowels are /i, e, ɛ, a, ɔ, o, u/ and /i, ɪ, e, ɛ, a, ɔ, o, ʊ, u/[1] respectively. Accordingly, although [ɪ, ʊ] are not perceived auditorily in the language, there is acoustic evidence that they are phonetically realised in the language. Omamor's acoustic evidence was drawn from the formant patterns of the spectrograms of two sets of vowels which she termed e_1 and o_1 and e_2 and o_2 occurring in prefix and in stem positions. According to her,

> *The results clearly show that in Uvwiẹ there is some acoustic difference between e_1 and e_2 on the one hand and o_1 and o_2 on the other. They demonstrate that in the stem*

[1]All non-IPA symbols in the works of authors cited in this study have been freely replaced with the corresponding IPA symbols. This is to allow for consistency and to eliminate confusion.

> *position, e_1 and e_2 and o_1 and o_2 have none overlapping patterns. In this position, both vowel pairs are separated by the first formant and the second formant does not seem to play any role in distinguishing these vowels. The same results, however, suggest that the distinction is not clear in prefix position; there is overlapping in formant patterns at this point although there is still a little differentiation that could be drawn from F_1.*
> (Omamor 1973:33)

Although she clearly notes that there is a discrepancy between the number of vowel qualities in her acoustic evidence and that of the auditory perception, no reason was offered for this. Furthermore, her instrumental analysis was limited to the formant frequencies of oral vowels. Other acoustic cues were not examined in the study. Also, since Omamor (1973), no further study has been conducted to further test the findings or to ascertain what the situation is years/decades after. Thus this study sought to bridge these gaps. It examines three acoustic properties of identified vowel categories. The examination and findings are discussed below.

3. Data and analysis

3.1 Acoustic analysis of Uvwiẹ vowels

Tokens of selected vowel categories in Uvwiẹ were extracted from the rest of the speech stream for acoustic measurements. The acoustic properties measured were formant frequencies, formant bandwidth and duration. In this section, the results of these measurements are discussed.

3.1.1 Formant Frequency

In this section, attempt is made to identify the vowel qualities which are attested in Uvwiẹ. To this end, vowel categories were identified for formant frequency measurement. The measurement, which was taken at a single time slice, namely mid-point, was done using Praat's broadband spectrogram default settings (0-5000Hz view range, 0.005 window length and 50dB dynamic range). A total of ten (oral) vowel categories were identified for formant frequency measurement. These are [i, e_1, e_2, ɛ, a_1, a_2, ɔ, o_1, o_2, u]. Seven of the vowel categories, namely [i, e_1, ɛ, a_1, ɔ, o_1, u], were identified from auditory perception, while the three others ([e_2, a_2, o_2]) were identified based on phonological prediction. Following from the auditory perception of the researchers (and informants), seven oral vowels were identified for measurement. These vowels are [i, e, ɛ, a, ɔ, o, u]. Although, seven nasalized vowels[2] ([ĩ, ẽ, ɛ̃, ã, ɔ̃, õ, ũ]) were also identified, these were not measured, given the overt effect of nasality on formant frequency. Below are some illustration of auditorily perceived oral vowels, nasalized vowels and the vowel categories estimated from phonological prediction.

1a) [i]— **[ìbí]** 'charcoal'
b) [e_1]— **[ɔ̀mɔ̃̀tʰétʰé]** 'child'
c) [ɛ]— **[kʰɛ́kʰɛ́tʰɛ́]** 'donkey'
d) [a_1]— **[làlàʒà̩]** 'pineapple'
e) [ɔ]— **[ɔ̀ɾàmã̀kʰó]** 'dog'
f) [o_1]— **[sònòbrùwé]** 'God'
g) [u]— **[ètʰú]** 'cap'

2a) [ĩ]— **[óg͡béĩ̀]** 'tortoise'
b) [ẽ]— **[ɔɟẽ̃da]** 'witch'

[2] 'nasalized vowel' refers to any vowel sound which is produced with the articulatory phenomenon of velic lowering, such that air passes through the oral and nasal cavities simultaneously.

c)	[ɛ̃]—	**[ɾ̥w̃ɛ̃̀k͡pòɾ̥ɔ̀]**	‘bend down’
d)	[ã]—	**[ɲã̀]**	‘cook’
e)	[ɔ̃]—	**[ìw̃ɔ̃̀]**	‘mosquito’
f)	[õ]—	**[ɔ̀m̩ṍfé]**	‘bird’
g)	[ũ]—	**[èṹ]**	‘up’

3a)	[e_2]—	**[ɛ̀rè]**	‘food’
b)	[a_2]—	[**íʃáβ̞ó̱**]	‘okra’
c)	[o_2]—	**[ɾ̥w̃ɛ̃̀k͡pòɾ̥ɔ̀]**	‘bend down’

In examples (1) and (2) respectively, both the oral and nasalized vowels are exemplified, while in example (3), vowel categories drawn from phonological prediction are shown. The above data indicate that two sets of [e, o, a] were measured, namely the set which co-occur with [+ATR] vowels, and the set which co-occur with [-ATR vowels]. This is because data from the language show a pattern tongue root harmony as illustrated in examples (4) and (5) below.

4a)	**ò gúnù**	‘3SG died’
b)	**ɔ̀ ɾ̥énì**	‘3SG came’
c)	**ɔ̀ ɾénì**	‘3SG ate’
d)	**ò k͡péɾénù**	‘3SG swept’

5a)	**ɔ̀ mɔ̂: dɛ́**	‘3SG will buy’
b)	**màmá mɔ̂: dɛ́**	‘2PL will buy’
c)	**ò mô: fé**	‘3SG will be rich’
d)	**ò mô: gú**	‘3SG will die’

In examples (4) and (5) respectively, it is shown that the phonetic shape of the third person singular {O} and that of the future tense marker {MOO} are determined by the vowel of the following lexical item. Implicitly, it seems to be the case that the language restricts the set of vowels that can co-occur. Accordingly, instances of auditorily perceived [e, o] vowels co-occurring with unadvanced vowels are assumed to be possible instances of [ɪ, ʊ] while instances of auditorily perceived [a] co-occurring with advanced vowels are assumed to be possible instances of [ɐ]. These instances are premised on Pulleyblank and Allen’s (2013:5) assertion that “even if a particular pattern is not readily perceptible, there may be a sense that some distinction exists in the language under study... In addition, phonological or syntactic analysis may predict that there should be a certain distinction.”

Ten tokens of each of the identified vowel categories evenly selected from the male and female speech were measured. The results of the formant frequency measures were subsequently normalized using the z-score algorithm. This is to reduce speaker-related variation in formant frequency values resulting from the size differences in the vocal tracts of the speakers. The result of the normalized formant values of the first two formants for the male and female speech is shown in the appendix. The z-score method was implemented using the equation in (6).

(6)[3]

$$Z = \frac{Fn\ - \mu\ (Fn)}{\sigma\ (Fn)}$$

[3] In the z-score equation used for this study, *Z* is the transformed normalized frequency value of F1 or F2 for a given vowel token, *Fn* is the raw frequency in Hz of that formant value, μ is the overall mean frequency of the relevant formant frequency (F1 or F2), and σ is the standard deviation of the overall mean of the same formant. The mean and standard deviations was calculated individually for each talker based on all of the tokens produced by that talker.

Z-score transform was proposed by Lobanov (1971). It is a vowel-extrinsic, talker-intrinsic normalization procedure that centres each talker's vowel space on the origin in an F1 × F2 plane (Clopper et al. 2005). This model was chosen because Adank et al.'s (2004) comparison of vowel normalization procedures showed that the z-score vowel normalization method is the best transformation method for preserving phonemic information and reducing anatomical variation in speech samples. The result of the average normalized formant values of the first two formants is plotted in an F_1-F_2 plane.

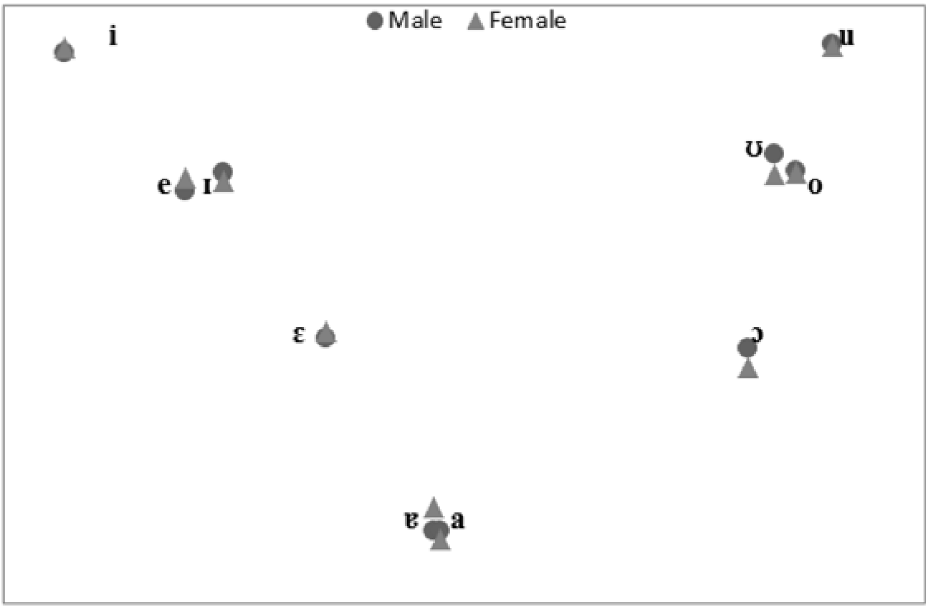

Figure 1: The average mean values of the normalized formant frequencies for the male and female speaker plotted against F_1F_2 plane

Given the pattern of distribution of the Uvwiẹ vowels in the F_1F_2 plane for the male and female speaker, it can be said that there are seven vowel qualities in Uvwiẹ as against the ten vowels tested for. This is because the relative distance between [e]/[ɪ], [o]/[ʊ] and [a]/[ɐ] is too minimal for them to be considered as different. Evidently, this runs counter to the claim by Omamor (1973). According to her, there is some acoustic difference between the spectrogram reading for [e, o] and [ɪ, ʊ] in the stem position especially in their first formant which occurs in none overlapping pattern. Although she also noted that despite the clear acoustic difference between [e]/[ɪ] and between [o]/[ʊ], [ɪ] and [ʊ] are perceived auditorily as [e] and [o] respectively (see Section 2). This implies that while there are nine vowel categories going by her acoustic evidence, there are seven going by auditory perception. No reason was however provided for this discrepancy between the number of surface vowels in the acoustic evidence and that of the auditory perception.

A logical explanation for this discrepancy would be that although the relative distance between these vowel categories within the acoustic vowel space was sufficient enough to see them as possessing distinct phonetic vowel qualities, it is insufficient to invoke perceptual distinction. A possible implication of this, therefore, is that it clues the direction of possible sound change in the language. Given this fact, the possibility is that the vowels [ɪ, ʊ] may merge with vowels [e, o] in the course of time. This possibility is supported by the present study following the result of the acoustic measurements of the formant frequency values of the vowels (see Table 2 and Figure 2 above). This possibility corroborates Casali's (1995:118) assertion that,

> *...in a number of CHVH [Cross-Height Vowel Harmony] languages the first and second formant values of [ɪ] and [ʊ] compare very closely with*

> *those of [e] and [o]… A natural outcome of this sort of acoustic overlap might be that at some point children learning such a language would fail to detect the contrast between the two pairs and consequently merge them in the grammar they construct.*

Thus, although Omamor (1973) argues that there is a clear distinction between the frequency values of the first formants of [e, o] and [ɪ, ʊ] respectively, that position is not currently supported by the finding in this study. This is because the relative distance between these vowels suggests a case of phonetic neutralisation between the vowels. The distribution of the selected tokens of vowels within the acoustic vowel space of Uvwiẹ shown in Figure 3 below further supports the claim that there is a case of absolute neutralisation rule which has conflated the phonetic vowels [ɪ, ʊ] identified in Omamor (1973) with [e, o] respectively. Thus as clearly shown in figure 2, while all other vowel categories examined are cleanly distributed within the acoustic vowel space, the vowel pairs: [e]/[ɪ], [o]/[ʊ] and [a]/[ɐ] are not, an evidence which clearly indicates that the phonetic contrasts between these vowels have been neutralized.

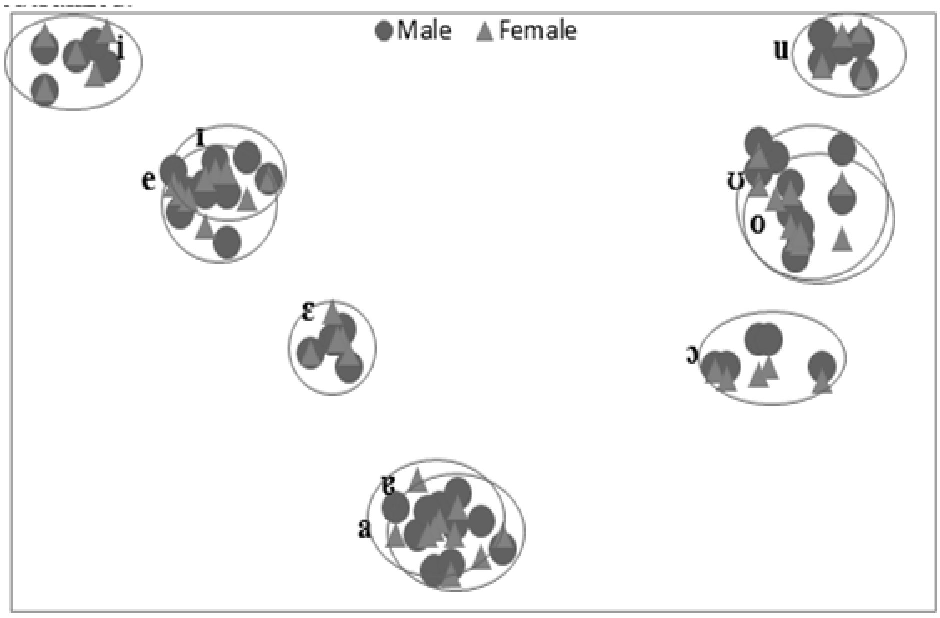

Figure 2: Vowel plot with ellipsis showing the distribution of the normalized formant values for the male and female speaker

An examination of the data and of the formant patterns of some of the lexical formatives of Uvwiẹ indicates that surface vowel sequences are attested in the language. This is at variance with what is reported by Aziza (2002) for Urhobo, an immediate sister/neighbouring language. According to Aziza, sequences of vowels do not occur in Urhobo at the phonetic level. She further stated that "…underlying CVV… obligatorily undergo either glide formation if V_1 is [+High} or vowel elision if V_1 is [-High]." In Emai however, it is reported that vowel sequences are well attested (see Rolle 2013:287), although the pattern attested in Emai differs. This is because there seems to be some restrictions on surface vowel sequence in Uvwiẹ. For instance, with the exception of the [iV][4] sequence, the differences of sonority values

[4] Phonetic [iV] is well attested in Uvwie. This runs counter to the claim by Elugbe (1989) that an underlying /iV/ is realized as [jV] and not as [iV] in Ẹdoid languages. Its occurrence has earlier been noted in Ẹdo (Amayo 1976) and recently in Urhobo (Rolle 2013). This apparent behaviour of /i/ to evade glide formation process suggests that vowel strength hierarchy plays a role in vowel processes such as vowel elision and glide formation.

between the attested sequences of vowels in Uvwiẹ is less than three.[5] Data and graphic displays of spectrogram illustrating the occurrence of surface vowel sequences are shown in example (7) and Figures 3 and 4 respectively.

7a) **[óg͡béȉ]** ‘tortoise’
  b) **[èṹ]** ‘up’
  c) **[kàé]** ‘lock’
  d) **[ɔ̀mɔ̀óxwá]** ‘boy’
  e) **[ɔ̀βìɔ̏]** ‘eat’

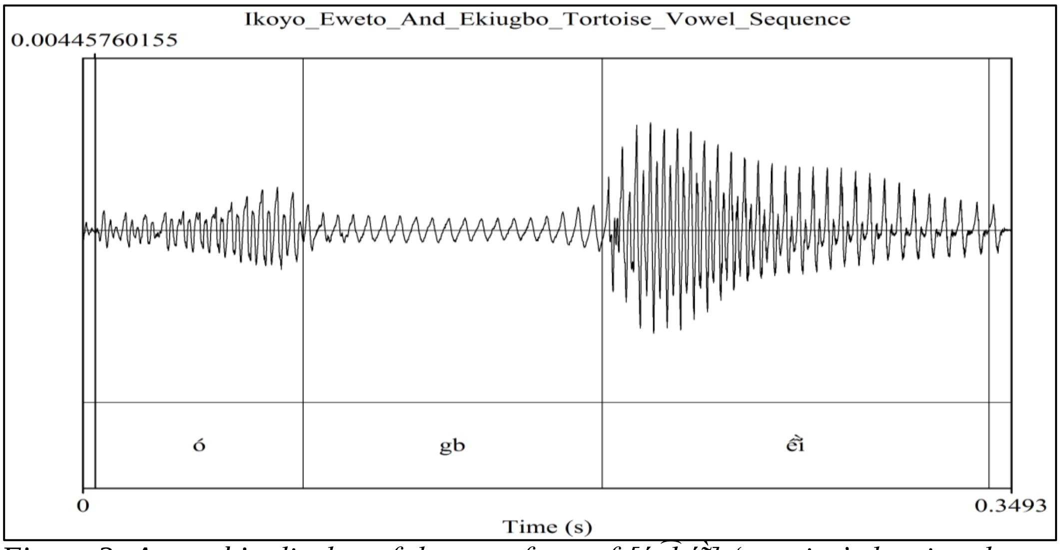

Figure 3: A graphic display of the waveform of [óg͡béȉ] ‘tortoise’ showing the sequence [ei] in Uvwiẹ

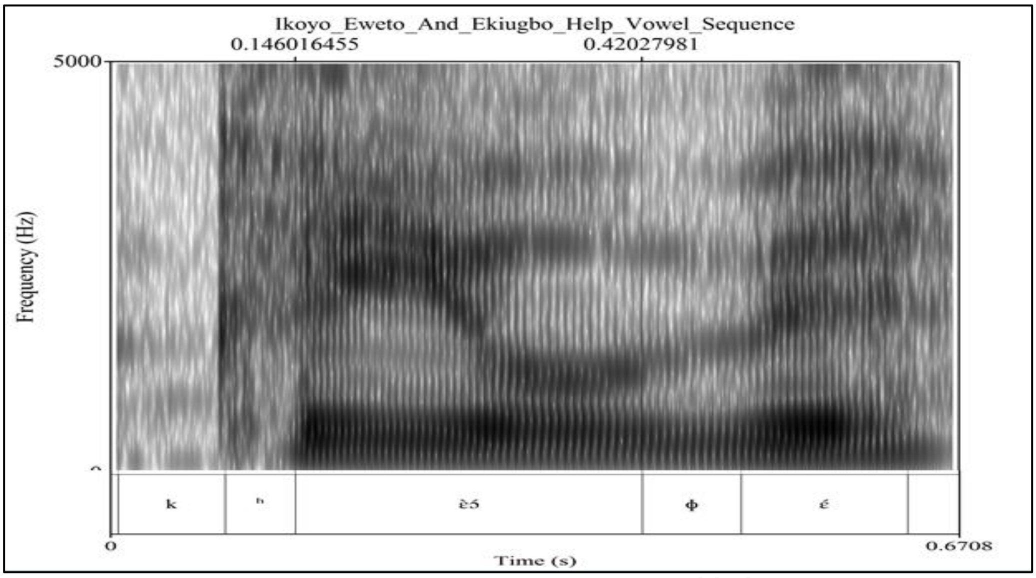

Figure 4: A graphic display of the spectrogram of [kʰɛ̀ɔ́ɸɛ́] ‘help’ showing the sequence [ɛɔ] in Uvwiẹ

3.1.2 Result of Formant Bandwidth Measurement

[5]Surface vowel sequences in Edoid languages result from the deletion of an underlying intervocalic consonant in rapid speech or from the loss of intervening consonants. This has been reported for Edo (Wescott 1962), Isoko (Donwa-Ifode 1990), Esan (Ejele 1994) and Uvwie (Ekiugbo 2016).

The first formants bandwidths of vowels were also examined in this study. The aim was to confirm whether the bandwidth of the first formant is affected by the nasality feature of vowels. To this end, words containing the vowel [i] in oral and nasal contexts were measured from the speech of the male and female speakers. Five tokens of oral and nasalized [i] were measured.

	Bw1
Oral [i]	152
Nasal [i]	333

Table 1: Average formant bandwidth of oral and nasal [i] in Uvwiẹ as produced by a male and a female speaker

Evident from the table above, the result shows a broader bandwidth for nasal vowels, than for oral vowels. Implicitly, variations in formants bandwidths are reliable acoustic cues in oral-nasal distinction in Uvwiẹ vowels. This is similar to findings in acoustic studies of nasal vowels (Harrington 2010; Styler 2015, etc). According to Harrington (2010), one of the main acoustic consequences that result from coupling of the oral and nasal tubes in the production of nasalized vowels is changes in the oral formants. In particular, F1 moves up in frequency, is lowered in intensity, and has a broader bandwidth. Implicitly, the acoustic effect of nasal coupling on formant bandwidth is only on the bandwidth of the first formant.

3.1.3 Vowel Duration

A survey of the speech data of Uvwiẹ shows that there are variations in the length of vowels. Although this variation in vowel length has no semantic significance in Uvwiẹ, it seems to play a phonetic role in the language. Accordingly, the lengths of the seven vowel qualities in Uvwiẹ were examined. It was observed that:

i) there is no significant length variation existing between the different vowel qualities,
ii) there is some evidence to argue for length variation within the tokens of a given vowel quality,
iii) prosodic context is the primary factor that triggers vowel duration in Uvwiẹ.

Subsequently, the overall length of vowels in different prosodic and phonetic contexts were examined for each informant. The goal was to verify the observations above, and if necessary, set up the duration ranges for each length level. The vowel qualities were measured by locating vowel onset and offset. Following Clopper et al. (2005), the onset of the vowels was identified by locating the onset of voicing for those vowels which are preceded by voiceless consonants and by sudden changes in the intensity or formant frequency for those vowels preceded by a voiced consonant. The offset of the vowel was marked by the offset of voicing or a sudden drop in intensity, indicating closure. Vowel duration was calculated as the difference between offset and onset of the vowel in milliseconds for eight prosodic/phonetic contexts. Twenty tokens of oral vowels evenly selected from male and female speech were measured in each context. The average values are shown in Table 2 below.

Initial position + low tone	42 ms
Initial position + high tone	89 ms
Medial position + low tone	79 ms
Medial position + high tone	84 ms
Final position + low tone	85 ms
Final position + high tone	94 ms
Contour tone context	153 ms

Table 2: Average values of the duration (in miliseconds (ms)) of the vowels of Uvwiẹ as produced by a male and a female speaker.

Given the pattern of relative distance shown in Table 2 above, it is argued that vowel length varies, and that the variation is determined by the tone borne by a vowel sound vis-à-vis its phonetic environment of the vowel[6]. It is further argued that the vowel qualities vary in three phonetic lengths, which, for the purpose of this study are short, medium and long. The short vowels occur in initial position or after relatively short consonants, and bear low tones, with a mean of 42ms. The approximate maximum duration for extra-short vowels is 50ms. Medium length vowels occur in any position, and can bear any level tone but do not bear low tone in initial position. The mean value of the duration is 86 ms, while the approximate minimum is 90 ms. The long vowels are contour tone bearing vowels, having a mean value of 153 and an approximate minimum duration of 20 ms.

Thus for instance, vowels bearing low tones and occurring at word initial position tend to be relatively shorter than other vowels (see for example Figure 5 in which the initial vowel [u] bearing a low tone is shorter than the medial and final vowels), while vowels are longer where they bore contour tones (see Figures 6 and 7). Thus, although vowel length is not phonemic in Uvwiẹ, it plays a phonetic role in the language.

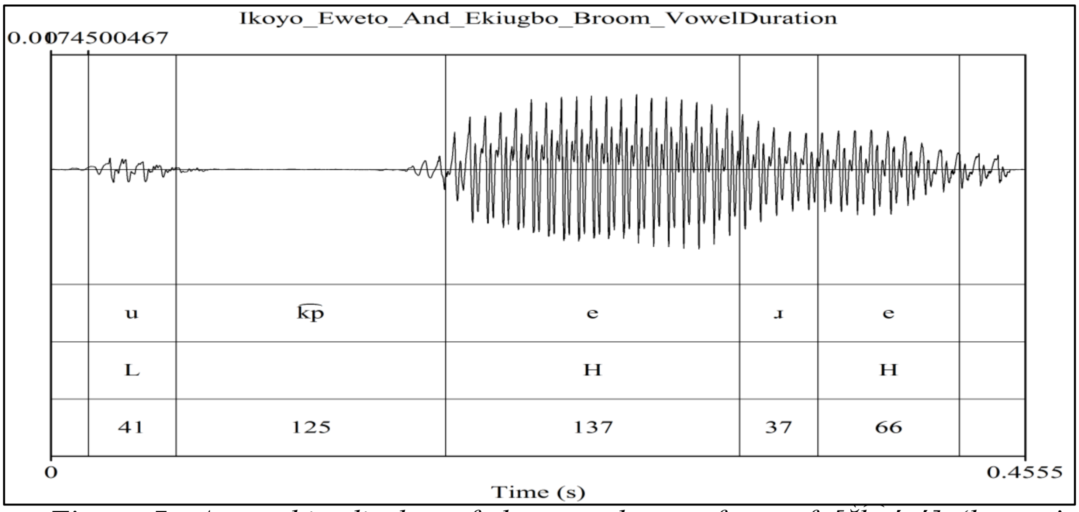

Figure 5: A graphic display of the speech waveform of [ŭk͡péɹé] 'broom' showing the duration of the vowels vis-à-vis their position of occurrence and the tone borne

[6] Vowels which are preceded by voiceless obstruents tend to be relatively longer, but this is not a major factor in the systematic variation in vowel length observed.

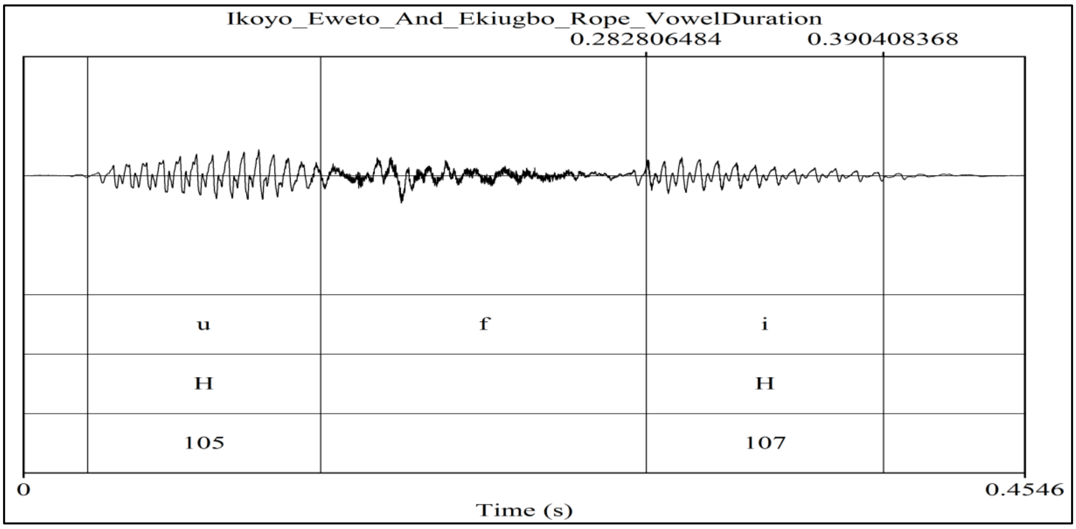

Figure 6: Graphic display of the speech waveform of [úfí] 'rope' showing the duration of the vowels vis-à-vis their position of occurrence and the tone borne

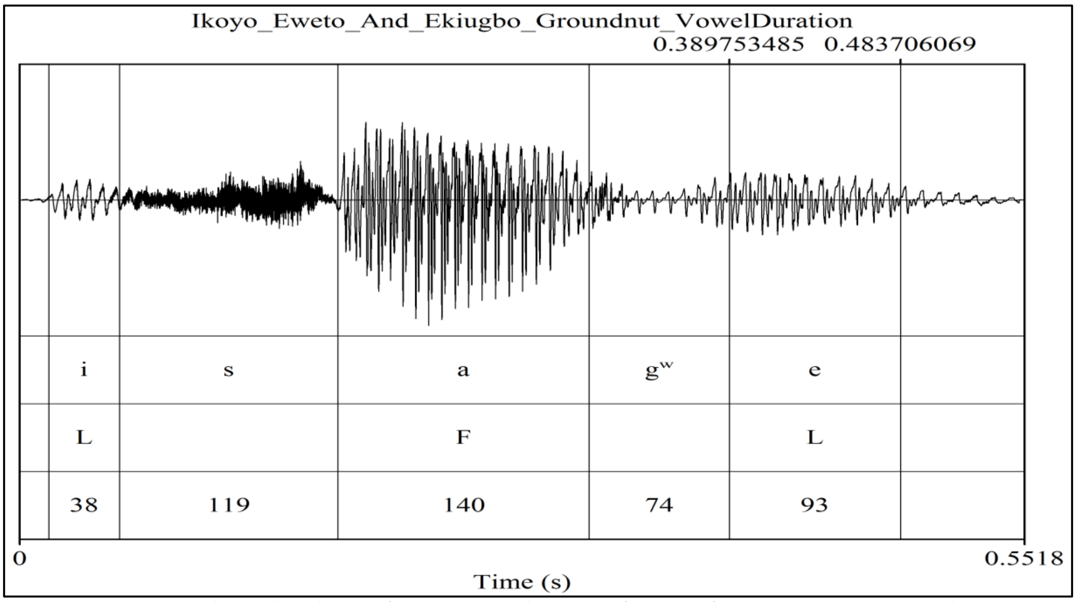

Figure 7: Graphic display of the speech waveform of [ìŝaɣwè] 'ground-nut' showing the duration of the vowels vis-à-vis their position of occurrence and the tone borne

3.2 The surface vowels of Uvwiẹ

Most acoustic phonetic studies of the vowel systems of most African languages are often restricted to formant frequency measurement of the vowels. This, perhaps, is because experiments drawn from vowel synthesis show that listeners require only the two lowest formants in order to identify a vowel. Evidence from instrumental studies indicates that vowels can be distinguished by the differences in the location of the frequencies of their first two or three formants (Johnson 1997; Reetz and Jongman 2010). However, it is observed that other acoustics properties of vowels are often employed by native speakers both in the identification of a given vowel and other linguistic information. Hence this study examined other acoustic cues besides the formant frequency.

It is shown, based on the analysis of the formant frequency of the vowels of Uvwiẹ that the language has transited from nine vowel qualities to seven vowel qualities. It is also shown that the vowels vary in nasality and length. Thus, given the three acoustic cues examined, a total of twenty-eight surface vowels were identified. The vowels are shown and exemplified respectively in Table 3 and example (8).

	Front	Central	Back
Close	[I, ĩ, iː, ĭ]		[u, ũ, uː, ŭ]
Half-Closed	[e, ẽ, eː, ĕ]		[o, õ, oː, ŏ]
Half-Open	[ɛ, ɛ̃, ɛː, ɛ̆]		[ɔ, ɔ̃, ɔː, ɔ̆]
Open		[a, ã, aː, ă]	

Table 3: The surface vowels of Uvwiẹ

8a) [i]— **[ìvũ̀]** ‘intestine’
b) [ĩ]— **[òmĩ̀ȷ̃ɛ̃́mɛ̃́]** ‘brother’
c) [iː]— **[fj̩îːdɔ̀nɔ̀]** ‘spray money’
d) [ĭ]— **[ĭ̀sâːɣwɛ̀]** ‘groundnut’
e) [e]— **[ẹ̀tʰẹ̀]** ‘snake’
f) [ẽ]— **[ẽ̆̀ɲẽ́]** ‘breast’
g) [eː]— **[ụ̀kwĕːg͡bé]** ‘story’
h) [ĕ]— **[ĕ̀vũ̀]** ‘stomach’
i) [ɛ]— **[kʰɛ́kʰɛ́tʰɛ́]** ‘donkey’
j) [ɛ̃]— **[ɛ̀mɛ̃́]** ‘word’
k) [ɛː]— **[k͡pɛ̃̆ː]** ‘peel’
l) [ɛ̆]— **[ɛ̆̀dɛ́]** ‘day’
m) [a]— **[dạ̀]** ‘drink(v)’
n) [ã]— **[ɲ̩ã̀]** ‘cook’
o) [aː]— **[ĭ̀sâːɣwɛ̀]** ‘groundnut’
p) [ă]— **[ằvé]** ‘and’
q) [ɔ]— **[ɔ̣̀kʰẹ́]** ‘time’
r) [ɔ̃]— **[ɔ̆̀mɔ̃̀tʰétʰé]** ‘child’
s) [ɔː]— **[ɛ̣̀twɔ̂ːxɔ́]** ‘feather’
t) [ɔ̆]— **[ɔ̆̀ɾàmã̀kʰó]** ‘dog’
u) [o]— **[ɛ̆̀tʰọ́]** ‘hair’
v) [õ]— **[ọ̀dõ̀]** ‘noise’
w) [oː]— **[ĭ̀ɾwộːmɛ́]** ‘nose’
x) [ŏ]— **[ŏ̊lòg͡bò]** ‘cat’
y) [u]— **[ètú]** ‘cap’
z) [ũ]— **[èw̃ṹ]** ‘cloth’
aa) [uː]— **[ụ̀ḍûːmɛ́]** ‘my chest’
bb) [ŭ]— **[ŭ̀k͡pèɹé]** ‘broom’

4. Conclusion

This study sought to present a phonetic analysis of the vowels of Uvwiẹ. Specifically, the surface vowel qualities in Uvwiẹ, their phonetic behaviour and the articulatory parameters for describing them were investigated in the study. The outcome of the investigation was based on the results of three acoustic properties of the vowels of Uvwiẹ which were examined by the researchers. The acoustic properties examined/measured are formant frequencies (F_1 and F_2), formant bandwidth, and duration.

The measurements were done using Praat’s broadband spectrogram default settings (0-5000Hz view range, 0.005 window length and 50dB dynamic range). The study demonstrated that the frequency values of the formants suggest that there are seven vowels, and not nine as identified by Omamor (1973), and that this difference in findings result from the merger of [ɪ, ʊ] with [e, o] respectively. Furthermore, it was demonstrated that the vowels vary in formant bandwidth, cuing oral-nasal distinction and that the vowels can be sustained for relatively short, shorter or longer time intervals during their production.

Thus given all phonetic parameters for identifying sounds (See Ball and Rahilly 2013) and the acoustic evidence provided in this study,

1) Uvwiẹ may be understood as having a total of twenty-eight surface vowel qualities,
2) in all contexts, all the vowels are voiced in Uvwiẹ,
3) surface vowel sequences are attested in the language,
4) there are five main articulatory features which can be used to describe the surface vowels in Uvwiẹ. These defining attributes are (i) height (ii) backness (iii) tongue root position (iv) state of velum, and (v) prolongability.

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Appendix: Result of normalized formant frequencies

	F2 (Male)	F1 (Male)	F2 (Female)	F1female
[i]	1.95	-1.58	1.97	-1.98
	1.66	-1.75	1.97	-2
	1.72	-1.9	1.7	-1.7
	1.8	-1.82	1.62	-1.85
	1.95	-1.88	1.5	-1.6
[e_2]	1.2	-0.9	1.08	-0.6
	1.1	-0.5	1.2	-1
	0.9	-0.95	1.19	-0.95
	1	-1.1	1.15	-0.8
	1.15	-1.07	1.2	-1
[e_1]	1.35	-1	1.4	-0.9
	1.32	-0.7	1.25	-0.85
	1.1	-0.85	1.25	-1
	1.28	-0.85	1.15	-0.8
	1.2	-0.85	1.22	-0.95
[ɛ]	0.6	0.2	0.58	0
	0.55	0.13	0.7	0.2
	0.58	0.2	0.6	0.2
	0.52	0.4	0.7	0.3
	0.7	0.3	0.52	0.3
[a_2]	-0.2	1.7	-0.3	1.6
	0.1	1.4	0	1.5
	0.2	1.6	-0.1	1.2
	0.01	1.3	0.25	1.4
	0.3	1.4	-0.3	1.6
[a_1]	-0.1	1.5	0.05	1.75
	0.12	1.85	0.14	1.55
	0.03	1.52	0.05	1.6
	0.15	1.42	-0.1	1.6
	0.04	1.8	-0.3	1.88
[ɔ]	-1.4	0.2	-1.45	0.45
	-1.2	0.4	-1.6	0.43
	-1.25	0.4	-1.5	0.48
	-1.7	0.4	-1.8	0.5
	-1.45	0.2	-1.5	0.4
[o_1]	-1.6	-0.5	-1.58	-0.5
	-1.8	-0.8	-1.75	-0.52
	-1.55	-0.7	-1.6	-0.6
	-1.58	-0.4	-1.9	-0.52
	-1.6	-0.6	-1.66	-0.55

[o_2]	-1.4	-1	-1.5	-0.9
	-1.48	-1.1	-1.52	-0.8
	-1.4	-1.2	-1.9	-1.12
	-1.8	-1.15	-1.55	-0.92
	-1.55	-0.9	-1.55	-0.85
[u]	-1.9	-1.7	-1.85	-1.7
	-1.8	-1.87	-2	-1.98
	-1.7	-1.78	-1.95	-1.75
	-1.88	-1.92	-2	-2
	-1.7	-1.98	-1.6	-1.75