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Acoustic Study of Closing Diphthongs amongst Owerri (Igbo) Speakers of English

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Abstract
This work investigated the acoustic features of English closing diphthongs articulated by Owerri speakers, in order to show how these features are different from or similar to the Standard British English. Data for the study, which were elicited from ten bilingual Owerri speakers of English, comprise a wordlist that contained closing diphthongs read in isolation and within the context of connected speech and tape-recorded using a Sony Xperia Android phone recorder. The analysis, which was done acoustically using Praat, focused on lengths, formants and pitch. Formant measurement and the comparison of the glide from the first vowel to the second vowel within the diphthong showed that the respondents had almost the same values for F1 and F2 in /ɑɪ/, /ɑʊ/, and /ɔɪ/ sound, which were different from the values for the SBE, while the articulation of the /eɪ/ sound is varied among the respondents. Lower vowel heights were also observed for the L2 respondents than the SBE in addition to a more frontal F2 for the SBE than Owerri respondents.
Keywords: Acoustic phonetics, Articulation, Speech sounds, Closing diphthongs, Owerri speakers of English

1. Introduction

English as a second language (L2)refers to English spoken by people who are non-native speakers of English. Since the inception of English as a second language in Nigeria, many scholars have attempted to explain the varieties of English spoken by Nigerians. Widagsa(2017) believes that as a second language, learners of English - adult learners–are frequently unable to achieve a native-like pronunciation because their L1 highly influences their L2 production. This phenomenon has resulted in the production of various varieties of the spoken English in Nigeria. This variety has been considered by many scholars as Nigerian English as they believe that the variety of English spoken in Nigeria cannot be said to be British (Josiah &Babatunde, 2011).One of the major ethnic groups in Nigeria is the Igbo, who also speak their own variety of Nigerian English (Igboanusi, 2006; Melefa&Amoniyan, 2019).They have their L1 which is the Igbo language. It is a language spoken by those in the south eastern part of Nigeria namely, Abia, Imo, Ebonyi, Enugu, Anambra, parts of Rivers and Delta State. Generally, the standard Igbo language is made up of twenty-eight consonants and eight oral vowels; it is a tone language unlike the English language which is stressed timed. One feature of this language is its lack of consonant clusters, long vowels, diphthongs and sounds like /Θ/,/ʃ/,/ʌ/, and /ə/, although recently some scholars like Ugorji(2015)now counters this position.

Pronunciation has become a very important aspect in the learning of the English language, as it determines the effectiveness of the speaker's knowledge of the language (Fromkinet al., 2003).English vowels are pronounced with no obstruction of airflow. According to Lyons (1969), it is classified into three main articulatory dimensions: the degree to which the mouth is opened (close or open); the highest part of the tongue

(front or back), and the position of the lips (rounded or spread). We have the short vowels, the long vowels and the diphthongs, (the short vowel and the long vowels are called monophthongs, and when two vowels are combined together as one, they are called diphthongs). Diphthongs are vowels that glide from one particular vowel to another. Diphthongs in English are single vowel sounds that begin with one vowel position and glide into another vowel position. Roach (2009) defines diphthongs as sounds which consist of a movement or glide from one vowel to another. For him, the most important thing about diphthongs is that the first part is pronounced longer and stronger than the second. English diphthongs are eight in number and can be said to be closing or centring. The closing diphthongs start from open vowels and glide towards the close vowels, in the area of /i/ and /u/, and these include; /eɪ/ as in paid, /aɪ/ as lie, /əʊ/ as in go, /ɔɪ/ as in coil, /aʊ/ as in down. This means that three of the diphthongs glide towards /ɪ/, while two glide towards /ʊ/. Because the second part of the diphthong is weak, they often do not reach a position that could be called close (Roach, 2009).

Okoro (2017) believes that all languages show internal variation, the Igbo language inclusive. These internal varieties have their various multiplications and versions of consonants and vowels. Therefore, despite the claim that all is the Igbo language, we find local dialects whose degree of divergence arise in phonological and accentual variation (Okoro 2017). The focus of this research is the articulation of English closing diphthongs by speakers of Owerridialect of Igbo. This will help to shed light on how dialectal variations in Igbo shape the articulation of English diphthongs.

The analysis of the physical properties of speech sounds is called acoustic phonetics. This concerns topics in experimental phonetics that can be reasonably investigated by the analysis, manipulation and synthesis of speech sounds. Ladefoged&Maddieson (1996) notethat one of the main difficulties of studying speech is thatsounds are so fleeting and transient, for as each word is uttered, it ceases to exist and any attempt to reproduce this sound gives just a copy of the original sound because of certain contextual constraints. One important element in speech acoustics is the formants. It is the concentration of acoustic energy around a particular frequency in the speech wave (Ladefoged&Maddieson, 1996).Lyons (1969) notes that the frequency of the first three formats apply to the English vowels (which the diphthong is part of).

Many scholars have shown considerable interest in the segmental features of English spoken by Nigerians. Scholars like Awa&Ugwu (2018) have done a contrastive analysis of the phonological systems of the English language and the Izzi dialectof the Igbo language, concentrating on the similarities and the differencesat the segmental level.Widagsa (2017) has also examined the closing diphthongs of English and how they are pronounced by Javanese speakers of English. Fuchs &Dyrenko (2018) researched on the acoustic realization of English diphthongs in Nigerian English pronunciation. Their study discovered that the Nigerian English speaker produces more monophthongal realizations than the English native speakers as a result of mother tongue influence. Although manyhave worked on acoustic features of sounds, no specific insightis available on the acoustic features of closing diphthongs articulated by Owerri speakers of English. This is the gap that this study seeks to fill. It specifically seeks to use the physical properties of the diphthongs to ascertain how well Owerri speakers of English are able to pronounce them. It is hoped that the findings of this study will add to the insights on geo-tribal varieties Nigerian English.

2. Aim and Objectives

This studyanalyses, acoustically, the articulation of closing diphthongs by Owerri speakers of English. The specific objectives of this study are:

(i) To identify the formant frequency and properties of closing diphthongs articulated by the Owerri speakers of English.

(ii) To discuss the similarities and differences in the acoustic features of closing diphthongs articulated by Owerri speakers of English and Standard British English (SBE).

3. Literature Review

A handful of studies have been conducted on the acoustic features of English sounds, especially within the context of second language situations. For example, Dyrenko and Fuchs (2018) analysedeight diphthongs of Nigerian English in the light of the argument on the extent of glide that Nigerian English speakers take in content and function words in comparison to that of the British speakers. They maintained that Nigerian English speakers produce more monophthongal realisations than speakers of British English. Using respondents who speak Yoruba as their L1, the study showed that diphthongs that involve a substantial glide in British English have shorter glide in Nigerian English, especially in the case of /əu/ and /eɪ/. It also revealed that the diphthong /əu/ is often monophthongized as [o] and /eɪ/ to [e] in content words. They concluded that since the Yoruba language has 4 diphthongs, historical influence of non-standard varieties of British English and L1 influence can be attributed to the cause of the results of this study.

Widagsa (2017) investigated Javanese L2 acquisition of English closing diphthong. The study focused on formant frequency and duration of their articulation. He believes that due to the articulatory difference in the vowel systems especially in the diphthongs (the Javanese diphthongs are 5 and that of English are 8), there is bound to be pronunciation difficulties. The analysis of data collected from five Javanese speakers of English was done acoustically. The result of the study showed that F1 starting point for most of the English closing diphthongs produced by the Javanese speakers are nearly identical to the native English in terms of vowel height. However, variations were observed in the articulations of the sounds by the L1 and L2 speakers for the F2 as well as durational differences. The study concluded that the absence of some diphthongs in the L2 speakers' phonological system was observed to be a barrier to a native-like pronunciation amongst Javanese speakers.

Also, Kitagawa (2015) attempted to characterize how the Japanese speakers of English realised the English closing diphthongs: /eɪ/, /aɪ/, /au/, /əu/, /ɔɪ/ in comparison to the native speakers of American English and British English. The study concentrated on acoustic characteristics of English diphthongs produced by Japanese learners such as duration, trajectory length and spectral rate of change. The resultsrevealed that Japanese learners' articulation of /əu/, /ɔɪ/, /aɪ/ and /au/ does not differ significantly from British and American native speakers of English in the three measures tested. However, the study noted that the /eɪ/ is problematic to the Japanese learners as the /eɪ/ trajectory length and rate of change were different from the British and American accents of English. The study concluded that the Japanese learner's problem in the pronunciation of the English diphthongs bordered on the rate of change of the /eɪ/ sound as the learner tends to speak in a fast manner in the articulation of this sound.

Kraus (2015), like Cubrovic (2014) who examined the acoustic characteristics of nine American English (AmE) vowels when pronounced by non-native speakers, used 15 speakers of Bahamian Creole to test four words (mouth, nurse, price and choice) which contain the closing diphthongs to investigate the extent of spectral change and relative position of the closing diphthong onset in Bahamian Creole. He also attempted to investigate how class can influence the articulation of speech production.The study established that the closing diphthong in **choice** is realised as a long back to front diphthong and monophthongal productions is seen in **nurse** in the articulation ofthe higher class. The working class speakers' production for **nurse**is reported to be more diphthongal and **choice** show shorter vector length for the higher class speakers.

From the studies reviewed above, it is evident that a number of studies have been conducted on the acoustic properties of English vowels within first language and second language situations. However, the acoustic properties of closing diphthongs articulated by the Owerri speakers of English have not been the subject of any specific scholarly engagement. Insights are lacking on the lengths, formants and pitch properties of the closing diphthongs articulated by these L2 speakers of English. This study, therefore, seeks to bridge this gap by examining the acoustic properties of English diphthongs articulated by Owerri speakers of English in Nigeria. This will extend the research on the internal varieties of Nigerian English.

4. Methodology

The data for this study comprised a specially prepared wordlist and sentences containing closing diphthongswhich were read into the recording feature of Sony Xperia Android phone by 10 Owerri speakers of English, who were undergraduate students of higher institutions in Owerri, Imo State, Nigeria. The study utilised 10 participants in order to make for a close analysis of acoustic features, which involved rigorous procedures of analysis.

Data collection and sampling were done randomly. Analysis of data was done acoustically using Praat and quantitatively using simple percentage. For the acoustic analysis, forced alignment was applied to the recordings and the boundaries were corrected manually in Praat. In order to measure vowel height and backness as well as the vowel trajectory, the first and second formants (F1, F2) were measured automatically at 20% and 80% of vowel duration, following the procedure by Dyrenko and Fuchs (2018). The features examined in the respondents' articulation of English closing diphthongs include formant, duration and pitch. John Lyons (1969; p.110) defined formant as the two frequency bands at which there is a concentration of energy. The frequency of the first three formant apply to the English vowels (which the diphthong is part of). These formants are often represented in the symbols: F1 (which deals with the vowel height; the higher the formant frequency, the lower the vowel height), F2 (deals with the degree of backness; the more frontal a vowel sound is, the higher the second formant, which is often affected by lip rounding), and F3 (the lower the formant frequency, the rounder the shape of the lips is). In this study, analysis is focused on the F1 and F2.Duration was only measured in the diphthongal words.Pitch is the fundamental frequency of speech signal, this signal is produced due to the vibration of the vocal folds, and it is represented with the Fo. These features were examined in the participants' articulations of the closing diphthongs as can be seen in sections hereafter.

5. Data Analysis and Discussion

The analysis considered the articulations of the closing diphthongs in two contexts. The articulations done by the respondents were analysed within the context of words in isolation, represented by the wordlist and in connected speech situation. The results of the articulations in the two contexts are presented and discussed in the sections that follow.

5.1 Articulation of Closing Diphthongs in the Wordlist

The results for the participants' articulations of the diphthongs within the context of words in isolation are presented in the subsections that follow.

5.1.1 The Articulation of diphthong /eɪ/ by the Respondents

In the respondents' articulation, the position of the tongue is from the vowel /e/, a front vowel which is a little lower than the half position, to the direction of the vowel position /ɪ/. It is a little above the half close position and the lips are spread as they gradually close. The word sampled for this sound is *maid.* The acoustic features of the articulations are represented in Figure 1 and Table1.

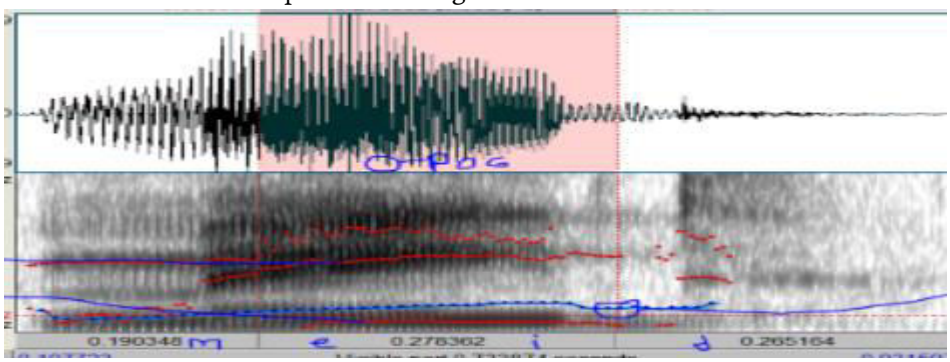

Fig 1: Spectrogram showing actual articulation of /eɪ/by a respondent in the wordlist

Table 1: Duration, Fo, F1 and F2 of the SBE and L2 Speakers for /eɪ/

Respondents	Duration	Fo	F1	F2	
SBE	**0.278362**	**142.3**	**508.4-208.8**	**2363.6**	
Respondent 1	0.391101	191.9	413.5	2582.5	
Respondent 2	0.281134	148.4	387.3	2179.9	
Respondent 3	0.247957	110	631.5	2196.9	
Respondent 4	0.157394	244.6	554.1	2729	
Respondent 5	0.246541	220.6	537.9	2481.1	
Respondent 6	0.300127	160.6	559.9	1530.4	
Respondent 7	0.161107	130.7	381.8	2062.6	
Respondent 8	0.269054	174.4	484.0	2153.0	
Respondent 9	0.111807	100.7	404.1	1189.9	
Respondent 10	0.218988	122.2	516.7	1921.2	

In vowel height, it is evident that the F1 start of the SBE control is higher than those of the respondents by a slightly wide margin. This also applies to the F2 where there is evidence the SBE control'spronunciation is more frontal than that of L2 respondents. This generally shows that although the L2 speakers are able to articulate the diphthong /eɪ/, their articulation is clearly different from the L1 speaker of English. The Fo quality of the L1 is also significantly lower than those of the L2 speakers.

Again, in articulating this diphthong, it was noted that out of seven correct articulations of the respondents, only two speakers (Participant 2) and Participant 8) were able to articulate almost to the duration range of the native speaker (0.278362). Generally, the respondents' duration is noticeably shorter than that of the L1 speaker. Three speakers articulated the diphthong sound differently; they replaced the /eɪ/ sound with the /e/ sound. This could be as a result of similarity in pronunciation which makes the /eɪ/ sound to be easily taken for granted, resulting in the articulation of the /e/ instead of the /eɪ/.

5.1.2 The Realisation of the diphthong /ɑɪ/ by the Respondents

In the articulation of the /aɪ/ sound, the tongue starts in a position between /əe/ and /ɑ: /, and then moves to a closer position as if to produce the /ɪ/ sound,while the lips are apart and gradually closing (Roach, 2009). Here, we see the vowel /a/ dominating as the /ɪ/comes in at the last quarter of the diphthong (Roach, 2009). The articulation of this diphthong by the respondents is similar to the pattern that is obtainable in the SBE. However, differences in acoustic features were observed. These are presented in Figure 2 and Table 2.

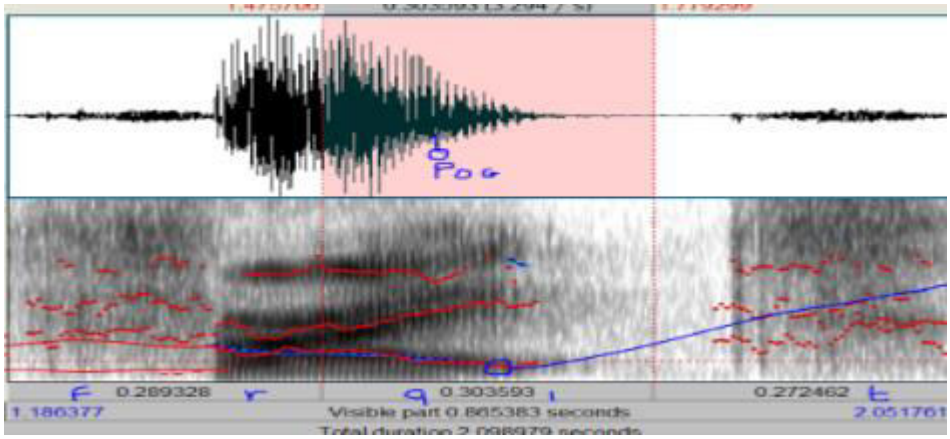

Fig 2: Spectrogram showing actual articulation of /ɑi/ in the word *fright*in the wordlist

Table 2: Formant frequencies, Fo and duration of the SBE and L2 Speakers for /ɑɪ/

Respondents	Duration	Fo	F1 start-end	F2
SBE	**0.303593**	**153.8**	**626.7 - 392.5**	**1876.9**
Respondent 1	0.194669	122.3	1069.0	2130.8
Respondent 2	0.249500	118.5	1057.8	2097.2
Respondent3	0.201275	87.26	688.9	1992.8
Respondent4	0.218032	114.1	757.7	1703.4
Respondent5	0.1418856	100.9	664.1	2195.2
Respondent6	0.209466	176.3	605.6	1650.7
Respondent7	0.205692	97.8	612.8	1841.0
Respondent8	0.232861	163	575.4	1779.9
Respondent9	0.191660	198.3	688.7	2045.9
Respondent10	0.240794	184.2	690.1	2152.5

Based on the F1 start points, the /ɑɪ/of the English closing diphthongs produced by Owerri speakers of English is considerably higher than that of the native speaker (626.7). Regarding vowel height, the F2 of the respondents is more frontal than that of the SBE. This shows a glide towards the long /i:/ sound by the Owerri speaker instead of the /ɪ/ sound. In pitch, there is a significant difference between the L1 (153.8) and the respondents. The duration of the /ɑɪ/ sound for the Owerri speakers varies when compared to that of the SBE. The L1's duration is significantly longer than that of the Owerri speakers. This could be as a result of the influence of first language on the L2 speakers' articulation (Melefa&Okemuo, 2023).

5.1.3 The Articulation of the Diphthong /ɔɪ/ by the respondents

In the SBE articulation, it is expected that /ɔ/ should be more open than the /ɔ:/, then a glide to /ɪ/. This was attested in the articulations of most respondents. Only two respondents realised what is close to the SBE. The acoustic features of the articulations by Owerri respondents are largely different from the SBE. The results of the acoustic analysis are presented in Figure 3 and Table 3.

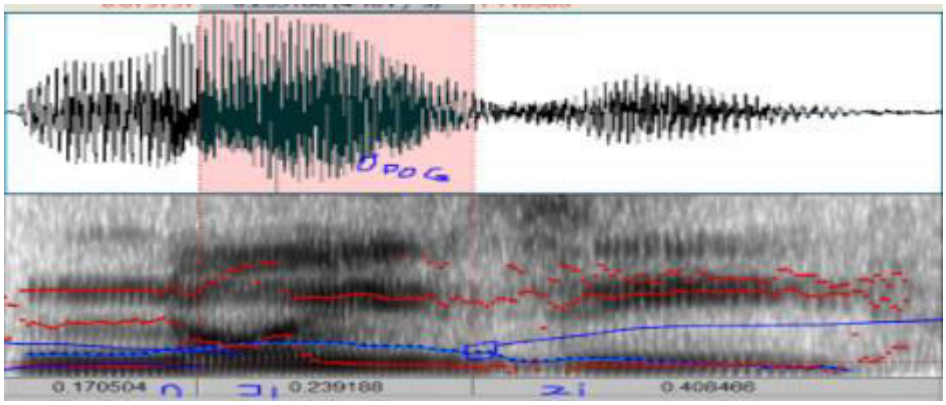

Fig 3: Spectrogram showing the actual articulation of the /ɔɪ/ sound in the word *noisy*

Table 3: Formant Frequencies, Fo and Duration of the SBE and L2 Speakers for /ɔɪ/

Respondent	Duration	Fo	F1	F2
SBE	**0.239188**	**146.3**	**547.2 – 361**	**2337.7**
Respondent 1	0.417311	121.9	695.7	2289
Respondent2	0.389194	122.5	735.1	2325.3
Respondent3	0.216530	98.24	477.0	1378.2
Respondent4	0.215484	158.9	665.9	1591.0
Respondent5	0.258540	208.7	530.6	1224.0
Respondent6	0.271762	107.4	585.6	2551.3
Respondent7	0.194858	193.2	452.4	1654.3
Respondent7	0.321530	192	566.6	1424.1
Respondent8	0.222960	174.8	431.4	2223.9
Respondent9	0.231544	109.9	467.2	1608.4
Respondent10	0.180887	114.1	757.7	1703.4

The vowel height for Owerri respondents varies as only two respondents are able to articulate the /ɔɪ/ sound almost to the point of the L1 speaker (547.2). Generally, the L2 speakers' tongue heights are lower than that of the L1 speaker. Their duration is noticeably longer than that of the L1 speaker. Both the L1 (146.3) and L2 speakershave almost the same resonance.

5.1.4 The Realisation of Diphthong /əʊ/ by the Respondents

The pronunciation of the /əʊ/ sound is expected to begin as the schwa /ə/ sound which will lead the lips to a slightly rounded position as it glides towards /u/toproduce a noticeable lips rounding. The articulation of the sound by all the respondents except one differs significantly from the SBE. The acoustic features of the realisations are presented in Figure 4 and Table 4.

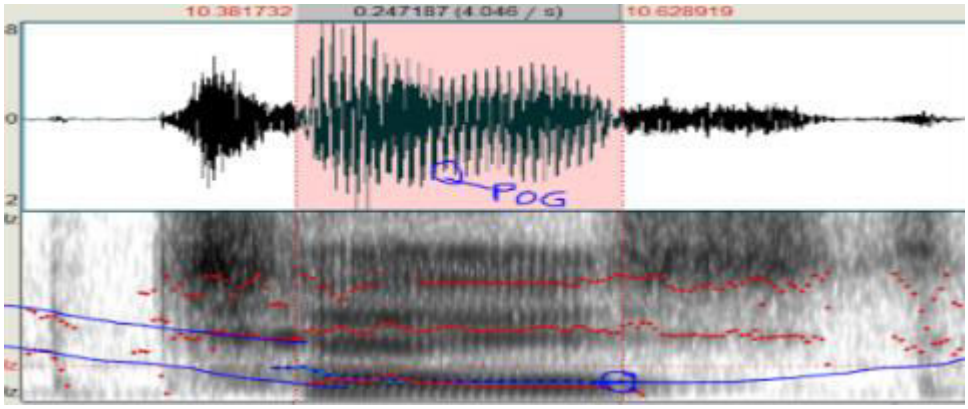

Fig 4: Segmentation Window showing the diphthong /əʊ/ in the word *toast*

Table 4: Duration, Fo, F1 and F2 of the SBE and the L2 speakers for /əʊ/

Respondent	Duration	Fo	F1	F2
SBE	**0.247187**	**120.7**	**448.7 -315.1**	**1889.0**
Respondent 1	0.145298	97.3	427.2	1405.6
Respondent2	0.139406	194.1	611.0	2187.9
Respondent3	0.174237	138.8	588.8	2778.0
Respondent4	0.137038	234.6	441.1	982.9
Respondent5	0.195127	121.6	492.4	1565.1
Respondent6	0.288536	210.5	410	1156.8
Respondent7	0.136598	175.9	474.5	1651.0
Respondent8	0158506	133.1	435.2	1621.4
Respondent9	0.171451	186.3	517.2	2328.7
Respondent10	0.163414	192	462.1	1460.2

The F1 start of the L1 respondent (448.7) is slightly differentfrom the L2 speakers' F1. From Table 4, only Respondent 4 was able to slightly get close to the F1 of the L1 speaker. Generally, the vowel height of the L2 speakers is lower than that of the L1. Also, the F2 of the L1 respondent (1889.0) is more frontal than those of the L2 and the pitch of the L1 (120.7) is noticeably lower than those of the L2 respondents. In terms of duration, the L1 (0.247187) is significantly longer than the L2 speakers.Noneof the Owerri respondents is able to articulate this sound like the L1 speaker, as nine of the L2 speakers pronounced /o/, while only Respondent 6 articulated the /ou/ sound which is the American English version of the sound. The cause of variation here can be attributedto the difficulty in pronouncing the schwa/ə/ sound which the speakers are unfamiliar with, and is often represented by them as /o/.

5.1.5 The Realisation of the Diphthong /ɑu/ by the Respondents

`This diphthong begins with a vowel similar to /aɪ/. Since it is an open vowel, a glide to /ʊ/ would necessitate a larger movement and the tongue does not reach the /ʊ/ position. There is only a slight lip rounding (Roach, 2009). The acoustic features of the articulations by Owerri participants are largely different from those realised by SBE. These are presented in Figure 5 and Table 5.

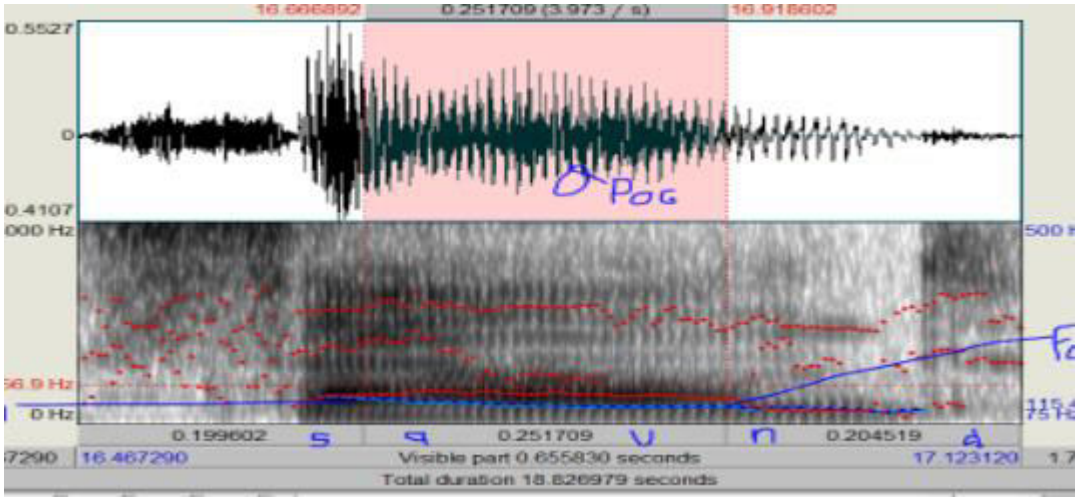

Fig 5: Spectrogram showing the articulation of the diphthong /ɑu/ by the L1 speaker

Table 5: Duration, Pitch, F1 and F2 of the SBE and L2 Speakers for /ɑʊ/

Respondent	Duration	Fo	F1	F2
SBE	**0.251709**	**115.4**	**717.0 - 411.8**	**1904.0**
Respondent1	0.187808	203.1	849.0	1488.7
Respondent2	0.216562	152.5	1051.2	2241.2
Respondent3	0.135297	230.2	592.5	1134.3
Respondent4	0.244481	117.6	713.0	1363.7
Respondent5	0.222838	191.1	984.8	1471.9
Respondent6	0.222925	171.8	886.5	1730.2
Respondent7	0.223811	131.4	660.8	1457.4
Respondent8	0.207483	177.8	566	1187.3
Respondent9	0.251709	97.99	648.6	1174.5
Respondent10	0.248029	191.3	698.8	1446.9

In the articulation of the /ɑʊ/ sound, only Respondent 4, with 713.0, is able to attain almost the same height with the L1 in vowel height. The F1 of other Owerri speakers varies, especially with Respondent 2 whose height is significantly low (1051.2).The F2 of the L1 (1904.0) is noticeably frontal than those of the L2 speakers. This shows that there are differences in the articulations of the L2 speakers and the control L1 speaker. In terms of pitch, the resonance of the L1 (115.4) is lower than those of the L2speakers. This means that in the articulation of the /ɑʊ/ sound, the vocal cords of the L1 control is more open than those of the L2 speakers. There are equally durational differences in the articulations.

5.2 Articulation of Closing Diphthongs in Connected Speech

There is acoustic evidence that the respondents' articulations of closing diphthongs in the wordlist is markedly different from the articulation in connected speech situation. This raises the issue of the influence of phonological context on sound articulation (Dosia&Rido, 2017; Ladefoged&Maddieson, 1996). The acoustic features of the respondents' realisations of the diphthongs in this context is different from the realisations in the wordlist. The acoustic features of the realisations of the diphthongs within the context of connected speech are presented in the subsections that follow.

5.2.1 Articulation of closing diphthong /əʊ/

The participants' articulations of **/əʊ/** in this context shared differences with the SBE as well as their realisations in the wordlist. The acoustic features are presented in Figure 6 and Table 6.

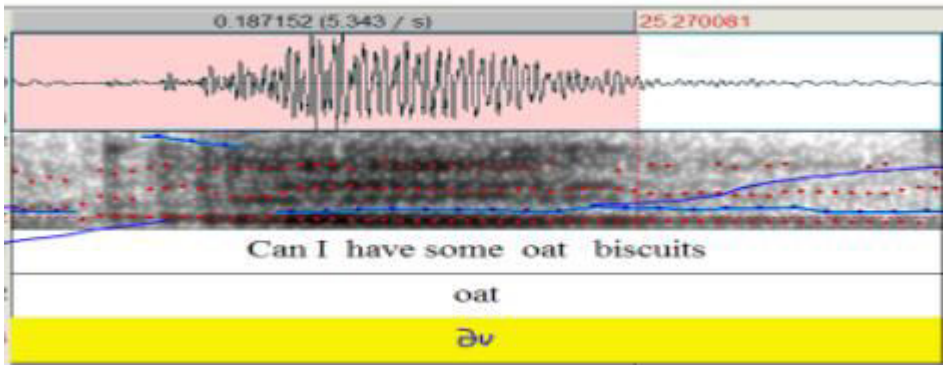

Fig 6: Segmentation window showing the articulation of the word /əʊ/ in a sentence

Table6: Duration, Fo, F1 and F2 of the SBE and L2 speakersfor /əʊ/ in connected speech

Respondent	Fo	Duration	F1	F2
SBE	**211.9**	**0.187152**	**491.0– 211.8**	**1946.3**
Respondent 1	215.5	0.145588	453.7	1890.9
Respondent2	152.2	0.175884	756.6	2634.4
Respondent3	114.1	0.210208	473.7	1119.8
Respondent4	152	0.175884	564.0	1612.2
Respondent5	213.6	0.196917	464.5	1842.1
Respondent6	114.5	0.162637	553.9	1610.2
Respondent7	175.7	0.129268	507.7	1577.9
Respondent8	244.4	0.203522	465.8	1172.3
Respondent9	104.1	0.092469	417.8	1751.5
Respondent10	107.7	0.142617	337.3	1499.4

From the analysis, the duration for the L2 speakers is shorter than that of the L1 speaker (0.187152). The articulations by the L2 speakers are different from the SBE. The Fo of the L2 speakersis low when compared to that of the L1 speaker. Expectedly, the F1 of the L2 speakers is higher than that of the SBE (491.0), while the F2 is more frontal for the SBE than the L2 speakers.

5.2.2 Articulation of the closing diphthong /ɑʊ/

The participants' articulations of **/ɑʊ/** in this context is different from the SBE as well as their realisations in the wordlist. The acoustic features are presented in Figure 7 and Table 7.

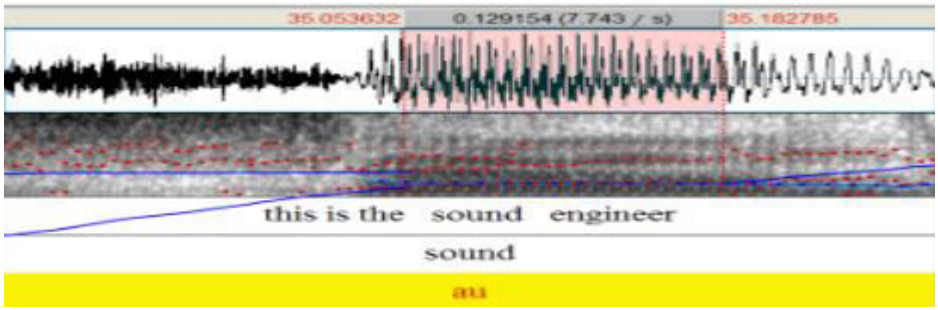

Fig 7: Segmentation window showing the articulation of /ɑu/ in connected speech

Table 7: Duration, Fo, F1 and F2 of the SBE and L2 speakers for/au/

Respondent	Fo	Duration	F1	F2
SBE	**140.8**	**0.129154**	**712.7- 445.4**	**1918.7**
Respondent 1	209.6	0.168153	745.4	1329.1
Respondent2	167.5	0.151870	1079.3	2529.6
Respondent3	128.1	0.125443	761.0	1346.2
Respondent4	227	0.170074	552.0	1050.1
Respondent5	186.2	0.100558	658.5	1346.3
Respondent6	118.1	0.106323	718.6	1151.4
Respondent7	161.2	0.152472	616.8	1245.2
Respondent8	169.2	0.380655	546.8	1703.9
Respondent9	107.2	0.128047	595.6	1159.1
Respondent10	118	0.100541	741.6	1234.6

The L2 respondents' duration for the realisation of the diphthong in this sentence is considerably longer than that of L1 respondent. The L2 respondents' F1 is also higher than that of the L1 speaker (701.5). Generally, the pitch is more prominent for the L2 respondents (159.2). Although their articulations of the diphthong are generally similar to the SBE, five of the L2 speakers replaced it with the /o/, /ou/, or /ɔ:/ sound.

5.2.3 Articulation of the closing diphthong /eɪ/ in connected speech

The respondents' realisations of **/eɪ/** in this context is different from the SBE as well as their realisations in the wordlist. The acoustic features are presented in Figure 8 and Table 8.

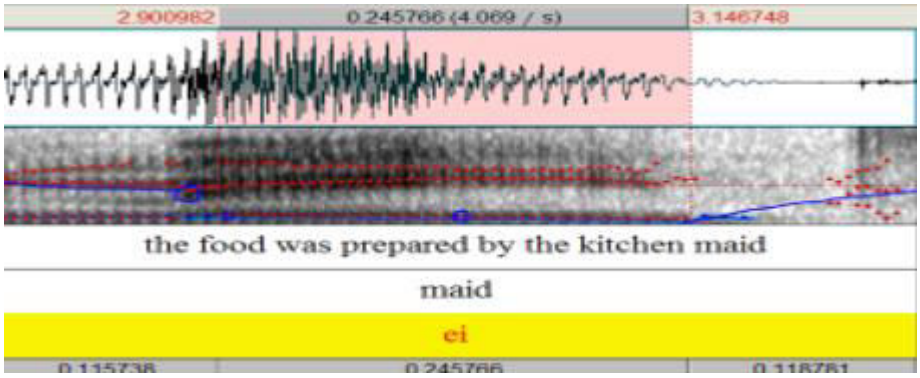

Fig 8: Segmentation window showing the articulation of /eɪ/ in connected speech

Table 8: Duration, Fo, F1 and F2 in /eɪ/ sound articulated by the SBE and L2 speakers

Respondent	Fo	Duration	F1	F2
SBE	**99.41**	**0.245766**	**345.0– 202.7**	**2185.7**
Respondent 1	182.1	0.188006	355.5	2680.7
Respondent 2	120.1	0.202699	813.2	2394.9
Respondent3	88.8	0.209508	360.8	2123.3
Respondent4	190.2	0.150965	391.7	2711.3
Respondent5	142.7	0.244449	396.5	2551.9
Respondent6	96.3	0.177665	555.9	1902.5
Respondent7	122.6	0.197139	383.6	1775.2
Respondent8	139.2	0.146246	444.2	2167.5
Respondent9	94	0.126181	460.2	2304.1
Respondent10	96.8	0.171597	537.4	1869.4

The L2 respondents have a shorter duration than the L1 speaker. This could be as a result of the continuous use of /e/ in place of /eɪ/ by most respondents as only Respondent 1, 2, 3 and 5 are able to articulate the sound similar to the SBE. The low tongue height of the L2 speakers is also testimony to this fact. For the F2, the L2 speakers' articulations of /eɪ/ is more frontal than that of L1, while the pitch is also higher. In the pronunciation of the diphthong /eɪ/ in words like face, we see a deletion of /ɪ/ in the articulation of the L2 speakers. Lack of mastery of the glide can be seen as acause of the variation in the articulation of this sound.

5.2.4 Articulation of the closing diphthong /aɪ/ in connected speech

The participants' articulations of **/aɪ/** in this context is different from the SBE as well as their realisations in the wordlist. The acoustic features are presented in Figure 9 and Table 9.

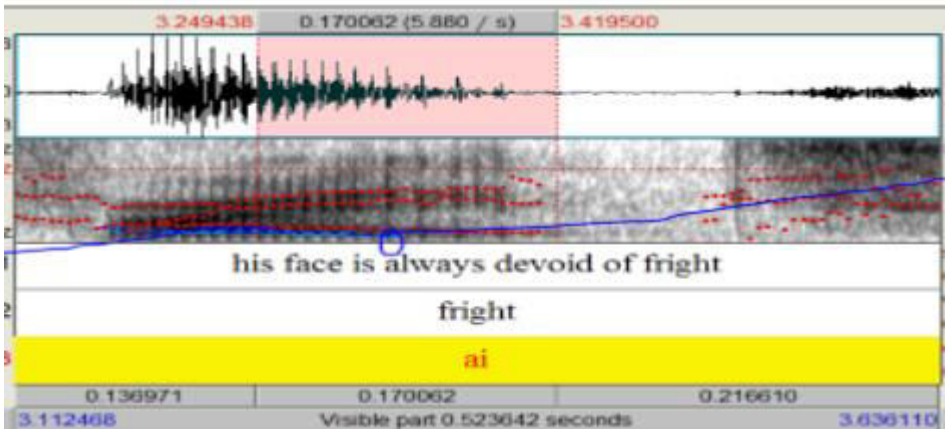

Fig 9: Segmentation window showing the articulation of the /ai/ sound in connected speech

Table 9: Duration, Fo, F1 and F2 of the SBE and L2 Speakers for /aɪ/ in connected speech

Respondents	Fo	Duration	F1	F2
SBE	**108.7**	**0.170062**	**527.8 - 318.0**	**1872.9**
Respondent 1	159.3	0.2158	594.0	1907.9
Respondent2	100.8	0.231972	667.6	1899.1
Respondent3	109.1	0.24261	615.2	1854.1
Respondent4	158.8	0.272253	591.3	2155.4
Respondent5	205.4	0.31500	794.4	1438.6
Respondent6	84.5	0.144638	677.211	1902.6
Respondent7	118.1	0.238532	641.1	1854.2
Respondent8	144.7	0.182785	576.2	1887.5
Respondent9	85.8	0.147612	676.1	2028.5
Respondent10	107	O.171111	765.6	1757.3

In the articulation of the /aɪ/ sound, the duration of the L2 respondents is considerably longer than the L1 speaker (0.170062). Although the pitch and F1 is also higher, the L2 speakers are unable to get as frontal as the L1 speaker (1872.9).

5.2.5 Articulation of the /ɔɪ /sound in connected speech

The participants' productions of **/ɔɪ /**in this context is different from the SBE as well as their realisations in the wordlist. The acoustic features are presented in Figure 10 and Table 10.

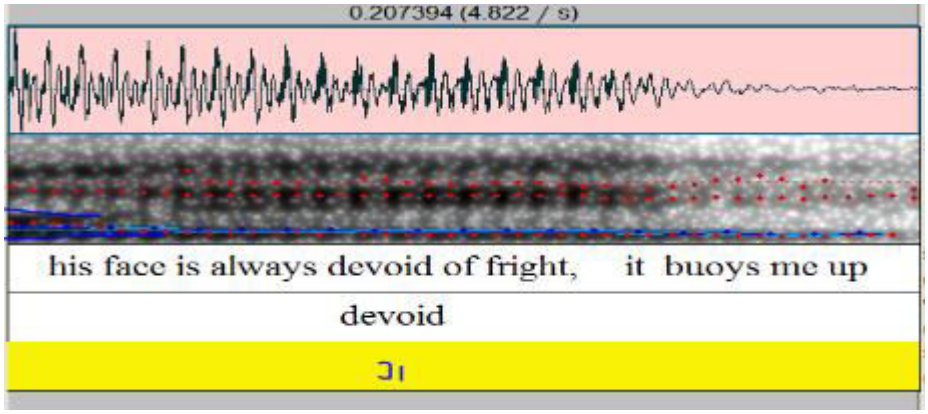

Fig 10: Segmentation window showing the articulation of the /ɔɪ/ sound by the L1 speaker

Table 10: Duration, Fo, F1 and F2 of the SBE and L2 Speakers for /ɔɪ/

Respondent	Duration	Fo	F1	F2
SBE	**0.213215**	**126.6**	**533.0 – 287.2**	**2394.0**
Respondent 1	0.12404	182.9	424.1	2616.9
Respondent2	0.144532	122	1055.8	2727.2
Respondent3	0.18201	102	546.0	2162.8
Respondent4	0.240471	183.4	439,7	1166.7
Respondent5	0.351	153.9	572.1	1166.9
Respondent6	0.121320	90.77	568.2	1414.8
Respondent7	0.228845	148.2	532.0	2227.2
Respondent8	0.100826	169.3	517.8	1276.7
Respondent9	0.162310	98.6	544.2	1406.1
Respondent10	0.202401	105.9	477.7	1466.0

The duration of the L1 speaker (0.213153) is considerably longer than that of the L2 respondents (0.185775) by a wide margin. The L2 respondents' articulation of the sound is lower in vowel height (581.9) than the L1 respondent, and so the articulation isnot as frontal as the L1 speaker (2394.0). Pitch for L2 respondents is considerably higher than L1 (126.6).

6. Discussion/Conclusion

This study discussed the acoustic features of closing diphthongs articulated by Owerri(Igbo) speakers of English. Generally, there are marked differences in the acoustic features of the articulations of closing diphthongs by Owerri speakers of English and the SBE. Some of these differences have been pointed in the literature, particularly for the diphthongs of formal Nigerian English (Dyrenko& Fuchs, 2018). Although there are certain articulatory similarities in the articulations, the acoustic features revealed variation in the articulations. There were differences in the values for F1, F2 and durations. The vowel height of the articulations was different.

Variationsin acoustic features which may arise due to inadequate learning and L1 interference (Milinar, 2011; Widagsa, 2017) were noticeably evident in the articulations of the diphthongs by the respondents. For example, clear evidence of L1 influence is seen in the articulation of /əʊ/ among others by the L2 respondents. The /əʊ/ sound is not in the Igbo phonetic system, and so the L2 respondents are not unfamiliar with the sound. This had impact on their articulation of the diphthong. Theyseem to have simply articulated the sound with the next available alternative of the sound. This was found in /o/ and /ou/ sounds.

The articulations of /au/, /ɔɪ/ and /ai/ sounds had relatively similar acoustic featuresin the respondents' realisation with the SBE. This observation is contrary to submissions (e.g. Eka, 1985;Jowitt, 1991) that diphthongs are non-existent in Nigerian English accent. In the articulation of /au/, the L2 speakers retained their tongue height and frontness of the F2 start in both wordlist and connected speech situations. Although the duration in connected speech is lower, this could be seen as a consequence of the assimilation of sounds associated with connected speech.In the articulation of /ɔɪ/, the L1 speaker was able to retain same duration in wordlist with just a slight difference in the connected speech situation. But for the L2 speakers, there was a wide margin between the values for the wordlist and the context of connected speech.

Another important observation is the point of glide, which is often seen as the F1 end. Here, the L2 speakers' glide was as long as the native speaker's duration and vowel height in all the sounds. The acoustic distance shown through the F1 end of the L2 speakers shows that their vowel height is higher than that of the SBE. This study concludes that the acoustic features of the articulations of closing diphthongs by the respondents, though share certain similarities, are significantly different from the SBE. The differences are considered to have resulted from the influence of the speakers' L1.

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