RESEARCH ARTICLE

Indian Journal of
LANGUAGE AND LINGUISTICS

DOI: 10.54392/ijll2331

Analysis of Formant Frequencies and Vowel Articulation in the Spoken Standard Nigerian English of Undergraduate Students

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DOI: https://doi.org/10.54392/ijll2331
Received: 30-06-2023; Revised: 06-09-2023; Accepted: 10-09-2023; Published: 19-09-2023

Abstract: The study compares the first two formants' frequencies in the speech of male and female undergraduate speakers of Standard Nigerian English at the University of Lagos (UNILAG). The study examined eight monophthongs produced in the CVC context (hVd) by 40 males and 40 females, and analysed the vowel quality and phonetic vowel space used by the two gender groups using the Linear Predictive Coding and spectrogram techniques. The findings reveal that there are differences in vowel realisation and quality between male and female speakers, which affect their accents. Specifically, the male undergraduates exhibit compression in the phonetic vowel space while their female counterparts show expansion. This study contributes to the understanding of the vowel space in the speech of male and female speakers, and how these differences may influence speech accent.

Keywords: Formants, Pure Vowels, Gender, Vowel Space

1. Introduction

Languages are constantly evolving, with new words and expressions emerging, old words becoming obsolete, and changes in pronunciation becoming commonplace. Every speaker of English has their own unique system of pronunciation, known as their individual idiolect. Language change is often driven by the needs of speakers, with influences from immediate family members, peers at school, and national/international television broadcasters. Additionally, individuals in the entertainment industry may also serve as role models, leading to modifications in accents.

In other words, individuals tend to adjust their way of speaking based on who they are communicating with and the impression they want to convey. These decisions may not always be conscious, but they can influence language change. This is because every individual has their own unique way of using language, and no two individuals speak exactly the same way. Research has shown that sociolinguistic factors such as gender, age, speaking style, and education can result in various phonological and phonetic variations in accent, as highlighted by Cole *et al.* (2006). Different language communities may have distinct ways of speaking that set them apart from others. When a group is somewhat isolated regionally or socially, they may develop a particular style of language use, including differences in dialects, which encompass not only accents, but also grammar, vocabulary, syntax, and common expressions.

Different languages exhibit variability in the set of phonetic vowels used, as well as in the formants and acoustic properties of these vowels, as noted by Hunter & Kebede (2012). For example, Standard Southern British English has eleven phonetic vowels (iː/, /ɪ/,/ e/, /æ/, /ʌ/, aː/, / ɒ/, /ɔː/, / ʊ/, /uː/ and /ɜː/), while Castilian (European Spanish) has five (/a/,/e/, /i/, /o/, /u/), and they are distributed differently across formants 1 and 2 vowel space. Additionally, it has been established that the acoustic properties of vowels can vary based on factors such as the individual speaker, speech rate, and phonetic context of the vowel, as cited in Hillenbrand & Gayvert (1993), Gay (1978), Lindblom (1963), Peterson & Barney (1952), and Shankweller, Strange & Verbrugge (1977). In the context of undergraduate speakers, it has been observed that different pronunciations and accents are used among different gender groups, resulting in a variety of categorical accents. This further highlights the influence of sociolinguistic factors, such as gender, on language variation and accent differences.

Several studies have been conducted by phoneticians and phonologists on Nigerian English, focusing on segmentals and suprasegmental features. Awonusi (2004) investigated 'Some characteristics of Nigerian English Phonology', 'A phonological study of standard Nigerian English' was studied by Eka (1985), 'Problems of standardisation and Nigerian English Phonology' was examined by Adetugbo (2004), Akinjobi (2011) explored 'English intonation tune assignment', while Atoye (2005) investigated 'Non-native perception and interpretation of English intonation.' 'Patterns of Nigerian English intonation' was explored by Akinjobi and Oladipupo (2010) researched into 'Intonation and attitude in Nigerian English,' and, the 'Intonation of Nigerian English' was examined by Udofot (2002). These studies include investigations into Nigerian English phonology, intonation patterns, perception of intonation, and the relationship between intonation and attitude. However, none of these studies have examined the sociolinguistic variables of gender, age, and education as factors influencing vowel quality and the phonetic vowel space.

While there have been numerous studies on formant frequencies in English spoken in developed countries like the US, Britain, South Africa, and Australia, there is limited research on acoustic measurements of pure vowels in Nigerian English. To address this gap in the literature, this study aims to examine vowel quality and their impact on the phonetic vowel space, taking into account variations associated with gender, age, and education. The study investigates the formant frequencies of pure vowels in stressed monosyllabic words spoken by male and female undergraduate speakers of Standard Nigerian English at the University of Lagos (UNILAG) recorded between 2015 and 2017.

1.1 Literature Review

Several scholars have studied the Standard Nigerian English. The concept of Nigerian English is recognised as a variety of English with distinct features that differentiate it from other varieties of English, such as British English. Scholars such as Gut (2004) and Schneider (2007) have identified Nigerian English as one of the new Englishes that have emerged in different regions of the world, and Walsh (1967) suggests that there are common features in the spoken speech of Nigerian English that define it as a general type.

There are different definitions of Nigerian English by scholars. Adeniyi (2006) defines it as a variety of English used by Nigerians. Eka (2000) views it as a subset of English spoken and written by Nigerians, and Okoro (2004) refers to it as "the way Nigerians speak and write it." However, Akere and Pride (1982) refer to it as the "Standard Nigerian English." The Standard Nigerian English is believed to have evolved from the development of a local variety of English (Ekpe, 2010). Despite the phonetic and phonological differences from British English, Nigerian English remains mutually intelligible. It is known to exhibit systematic differences in areas such as stress, rhythm, and intonation when compared to British English, as noted by Bamgbose (1982), Jibril (1986), and Jowitt (2000).

The challenge of defining and characterising spoken English in Nigeria has led to different approaches by scholars. Some have proposed the use of educational attainment as a parameter, while others have considered ethnicity as a factor. Walsh (1967) specifically focuses on Nigerian English and distinguishes the non-standard form as the domain where "real mistakes" occur, including incorrect verb tenses and determiner usage. Banjo (1979) categorizes varieties of Nigerian English based on local acceptability in Nigeria and international intelligibility, identifying four varieties labeled as varieties I, II, III, and IV. Many scholars have used Banjo's (1971) 'points on a cline' categorisation as a benchmark for determining the standard form of Nigerian English (Eka, 1985; Udofot, 1997, 2000; Akinjobi, 2004, 2006). Wilmot (1979) also considers education as a yardstick for identifying the standard form of Nigerian English, although with a different perspective on the pattern of English used by educated Nigerians. Wilmot argues that the English spoken in Nigeria, even by the educated class, is not modeled after Standard British English. Wilmot suggests that much of the English heard in Nigeria could be considered as sub-standard, as speakers of Educated Nigerian English often lapse into Pidgin and Pseudo-pidgin several times within a sentence.

Jibril (1982) and Awonusi (1987) describe the Standard Nigerian English accent as a continuum that is pyramidal in shape. The basilect, located at the foot of the continuum, represents the non-standard or sub-standard Nigerian English. In the middle is the mesolect, which is described as "General Nigerian English," and at the top is the acrolect, which is viewed as the Standard Nigerian English. While Jibril and Awonusi share similarities in their description of the Nigerian English accent continuum, they have differences in their perspectives on the structural adjustment. Jibril suggests that Received Pronunciation (RP) is at the apex of the continuum, indicating that RP serves as the standard accent for Nigerian English. However, Awonusi does not share this view, as he believes that RP lies in phonetic space and that progress can be made from the basilect to the apex in the Nigerian English continuum. In other words, individuals can move up the continuum as they improve their level of competence in Nigerian English. Awonusi also suggests that stylistic down-shift is possible, which pushes the user to a level below the basilect, resulting in code-switching or code-mixing.

Udofot (2004:109) attempted to reclassify Banjo's (1971) varieties of Nigerian English based on the level of educational attainment, and identified three varieties: non-standard, standard, and sophisticated English. The standard variety users are considered to be undergraduates in their third to final year, university and college of education lecturers, high school teachers of English, and holders of Higher National Diploma (HND). Speakers of this variety are capable of making important phonetic distinctions, using impeccable speech, and identifying stressed syllables and unidirectional tones (the fall and the rise). For the purpose of the research, the standard variety was used as a basis for selecting respondents, not on the premise that they all speak the same accent, but rather as a control for participation in the study.

The research thus focuses on investigating vowel formants, which are known to reveal remarkable variations in the fundamental frequencies of human speech, in the speech of undergraduates at the University of Lagos (UNILAG). The purpose is to describe vowel quality, which may result in differences in phonetic space.

1.2 Formants

Formants, a fundamental concept in speech analysis, have been defined by scholars in various ways. Ladefoged (2002) defines formants as "the resonances of the vocal tract," while Patill *et al.* (2016) describe them as "the concentration of acoustic energy around a specific frequency in the speech wave." In speech, formants represent the resonating frequencies of the vocal tract and are visualised as dark bands in spectrograms. The intensity of a formant's darkness indicates the energy distributed around that frequency, with darker formant bands corresponding to stronger and more audible resonances. Formants can be easily observed and analysed in spectrograms, as well as in spectral slices, which provide a snapshot of the sound spectrum at a particular moment in time.

A spectrogram serves as a visual representation of the temporal, spectral, and intensity components of speech sounds. It displays time along the x-axis, frequency along the y-axis, and intensity through the varying darkness of the depicted frequencies. Within spectrograms, formants can be identified as peaks in the spectrum. These formants, characterised by specific frequencies, play a crucial role in determining the perceived vowels and contribute to the distinctive qualities of different periodic sounds. The number and frequencies of formants depend on factors such as gender and age, with an average of approximately one formant per 1000Hz band for men and one per 1100Hz band for women.

However, the true range of formants is influenced by the length of the vocal tract. Each formant corresponds to a particular resonance mode of the vocal tract, and the prominence of a formant is determined by the amount of energy concentrated around its frequency. The shape of the vocal tract directly influences the frequencies of the formants, with key formants such as F1 and F2 providing insights into the vocal tract's resonances. In speech analysis, the first four formants (F1, F2, F3, and F4) are of particular importance as they encapsulate crucial information related to vowel characteristics. Research by Hillenbrand and Gayvert (1993) has demonstrated the strong correlation between perceived vowel quality and the frequencies of the lowest formants. They assert that, "It has long been recognised that perceived vowel quality is strongly correlated with the frequencies of the two or three lowest formants."

Rebold *et al.* (2010) conducted a study investigating how age affects fundamental frequency (f0) and formant frequencies in speech. The study involved five subjects who were measured at two different times, and the results revealed clear differences in f0 and F1 (the first formant), but no systematic differences in F2 and F3 (the second and third formants). The analysis, which spanned over 50 years, showed that age affected F1 by decreasing formants in females and increasing f0 and F1 in male speakers. This resulted in a 'V'-shaped pattern in the vowel quadrilateral, with a decrease followed by an increase in f0 in male speakers. The study also showed that changes in f0 were correlated with changes in F1 over time, indicating that F1 tracked F2. In other words, age-related changes in F1 affected f0, leading to a decline in f0 while maintaining a constant auditory distance between f0 and F1.

Gimson (1984) and Wells (1984) provided phonetic accounts of the changes taking place in Received Pronunciation (RP). They noted that younger, urban, or innovative speakers tended to lower front monophthongs, with /æ/ changing to [a]. Wells (1982) described /ɪ / and /ɛ / as more open and central, and Gimson (1984:49) predicted possible confusion between /æ/ and /ʌ/ due to the fronting of /ʌ/. Gimson (1984) also observed that /ʊ/ (back monophthong) was weakly rounded in many RP speakers, while Wells (1982) described it as centralised and unrounded. Furthermore, Wells noted that /u:/ was centralised in most urban speech and mainstream RP, and that /ɔ:/ had a more open quality in old-fashioned RP (1982:145).

Hawkins and Midgley (2005) conducted a study on the first two formants (F1 and F2) of monophthongs produced by five male speakers in four different age categories: 20-25, 35-40, 50-55, and 65-75. The study examined eleven monophthongs in a ‘hVd’ context. The results showed that F1 of the vowels /æ/ and /ɛ/ were higher in the younger generation compared to the older generations, while F1 was higher in /u:/ and /ʊ/. No other significant differences were in F1 and F2 among the different age groups for the remaining vowels. Hawkins and Midgley concluded that the differences between age groups illustrated intergenerational variation in speech communities, which could have implications for how linguistic innovations are adopted. This suggests that different age groups may exhibit distinct patterns of speech sounds, and changes in formant frequencies may reflect linguistic changes over time. This study highlights the importance of considering age-related variation in speech research and its potential impact on language change and variation in communities.

Wells (1982) observed that F1 and F2 of /ɔ:/ were expected to decrease with successive age groups, but did not show significant changes in Hawkins and Midgley's study (2005), indicating that the age group considered “old” in Wells' study may have been older than the one in Hawkins and Midgley's study. Furthermore, differences in F1 and F2 frequencies of /a:/ among age groups did not reveal age-related patterns, and vowels /ɪ:/ and /ɔ:/ showed little variation among age groups. In contrast, vowel /u:/ showed a progressive increase in F2, with the youngest age group (20-25) exhibiting a wide gap in mean frequency of F2, suggesting ongoing changes in the production of /u:/. This pattern was also observed in /ʊ/, but to a lesser extent in older age groups. On the other hand, vowel /æ/ showed age-related patterns in F1 frequency, with the youngest speakers exhibiting the highest F1 values. Similar trends were observed in F1 of vowel /ɛ/, where younger speakers also had higher values.

In order to accurately represent the vowels of a language, the average values of the formants must be shown, as demonstrated in Figure 1, which depicts the spectrogram of the word ‘heed’ with the first four formants represented by dark bands with dotted horizontal lines. Spectrograms are visual representations of speech sounds that show the distribution of energy across different frequencies over time, and can provide valuable insights into vowel production and variation in different age groups.

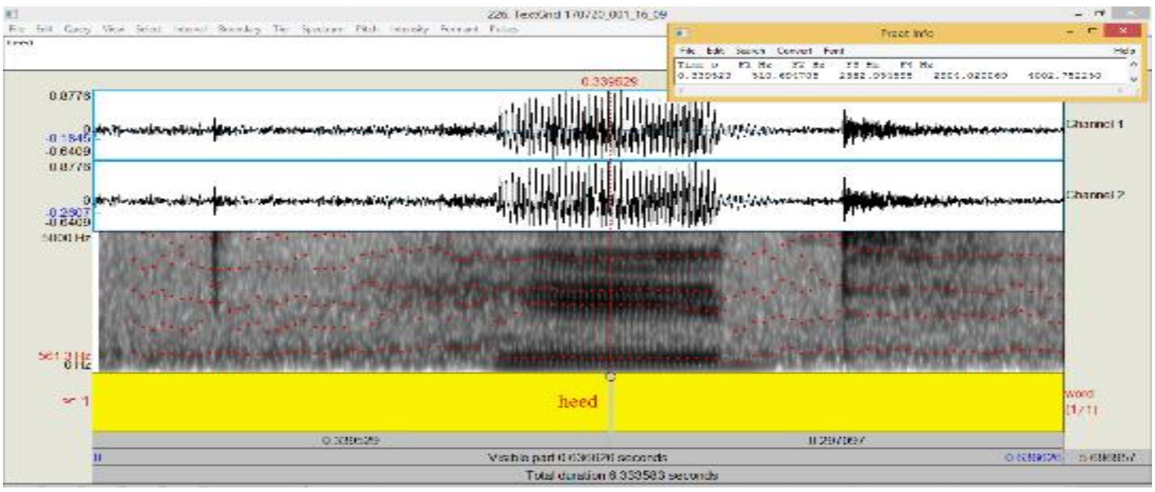

Figure 1. Spectrogram showing formant

The conceptual framework of this study involves the use of the Source Filter model and Linear Predictive Coding concepts. The Source Filter model describes speech sounds as the response of a vocal tract system, where a sound source (the glottis) is filtered by the resonance characteristics of the vocal tract (Mannell, 2008). The vocal tract acts as a resonator that modifies the sound source produced by the vocal folds in the laryngeal source.

The Source Filter model explains that the vocal tract configurations or articulations alone do not produce any sound, but rather modify the sound source. The vocal folds vibrate, producing sound, and the vocal tract acts as a filter that suppresses or strengthens certain frequencies depending on its shape at a given moment. The strengthened frequencies are known as formants, which are seen on a spectrogram and represent the sounds that resonate the loudest in the particular filter formed by the vocal tract. Formants are usually numbered successively from the lowest frequency upward.

In the field of speech analysis, accurately measuring formant frequencies is crucial for understanding the characteristics and nuances of spoken language. To achieve this, the concept of Linear Predictive Coding (LPC) combined with spectrograms has emerged as a reliable method. Researchers such as Right and Nicholas (2009) emphasise the effectiveness of spectrograms in conjunction with LPC for obtaining highly precise measurements of vowel formants with minimal error. This approach enables researchers to identify errors in the LPC estimation by visually examining the spectrogram, while the LPC itself provides an accurate estimation of the central value of the formant. Deng (2003) and Homayoon (2011) highlight that LPC is widely recognised as one of the most powerful techniques for speech analysis. Its ability to encode speech at a low bit rate while maintaining good quality makes it a valuable tool.

Additionally, LPC offers exceptional precision in approximating speech parameters. By utilising LPC, researchers are able to display spectra and broad band spectrograms, which serve as important references for determining the measurement points of formant frequencies. Specifically, formants are measured at the center of the targeted vowel, providing valuable insights into the acoustic correlates of speech. In the context of formant analysis, the key acoustic correlates measured in Hertz are F1, F2, and the duration of the entire vowel. Wright and Nicholas (2009) suggest that Praat's default settings, which employ a maximum frequency of 5500Hz, are suitable for analysing formants in adult males and females. Therefore, this setting was adopted for both genders in the study, ensuring consistency and comparability across the data.

1.3 Articulatory Vowel Space

Phonetic vowel space is defined in terms of the restrictions to the extremes of tongue location that continue to give rise to non-nasal resonating sounds. The notion is that if the position of the tongue becomes farther than these restrictions, then turbulence would occur. In other words, the phonetic vowel space reveals where different vowels are produced in the oral cavity with respect to the position of the tongue and the maximal values. The three tongue positions can be used to illustrate these sounds: [i] high/close unrounded front vowel and [æ] open/low unrounded front vowel.

2. Methods

Participants: The participants in this study were undergraduate students at the University of Lagos (UNILAG) from the 300 level and above. A total of eighty (80) participants were included, evenly divided between male and female subjects. The participants were selected randomly (though not on an equal probability basis) from various disciplines, including Arts/Humanities, Social Sciences, and Sciences. The age range of the participants was 18-29 years, based on the sociolinguistic age classification by Roach, P. (2004) and Holmes (2013), with minor modifications to include undergraduates from the 300 level.

Measures: The study employed a combination of qualitative and quantitative methods for data collection. A questionnaire was designed to gather demographic and linguistic information from the participants. The questionnaire covered aspects such as gender, age, level of schooling, state of origin, state of residence, educational background, mother tongue (L1), and target language (L2). Additionally, acoustic measurements and visual inspection of F0 traces were conducted using the Praat acoustic software, version 6.1.52. The acoustic measurements focused on parameters such as formant frequencies (F1, F2), durations of the entire vowel, and other relevant acoustic correlates.

Procedures: Data collection was carried out using a SONY IC digital recorder, model ICD-UX543F/B, with a built-in flash memory of 4GB. The recordings took place in quiet rooms at different times within the UNILAG campus. The recorded data were later transferred to a laptop computer for transcription and analysis. The files were converted to wave format and analyzed using the Praat software. The Praat software provided features such as spectrogram and waveform displays, as well as playback options for easy identification of individual words and phonemes in the recordings.

Analysis: The primary analytical tool used in this research was descriptive statistics. The analysis focused on examining vowel formants in the speech of male and female undergraduates at UNILAG. The main objective was to describe the vowel space and vowel quality, which contribute to pitch differences observed in the data. The analysis involved acoustic measurements of formant frequencies and visual inspection of F0 traces using the Praat software.

Instruments and Software: The data collection involved the use of a SONY IC digital recorder, model ICD-UX543F/B, with a built-in flash memory of 4GB. The recordings were later analyzed using the Praat acoustic software, version 6.1.52. The Praat software provided the necessary tools for spectrogram and waveform visualization, acoustic measurements, and analysis of the recorded data.

Table 1. Demographic and Linguistic Distribution of Subjects

Variable		**No of Subjects**	**Percentage (%)**
Gender	Male	40	50.0
	Female	40	50.0
Total		80	100
Age Brackets	18-29		
Level of Education			
Undergraduates		80	
States Of Origin			
(Southerners)			
Ekiti		07	
Abia		03	
Lagos		11	
Imo		02	
Ogun		10	
Delta		06	
Oyo		09	
Cross River		04	
Osun		09	
Akwa Ibom		03	
Enugu		04	
Ondo		06	
Anambra		03	
Bayelsa		01	
Benue		02	
Total		80	**100.0**

Table 1 presents the frequency distribution of various variables concerning the background and demographic information of the respondents. Through the application of stratified sampling, the subjects of the study were selected to represent sixteen states across Nigeria, encompassing diverse linguistic backgrounds. This approach was employed to ensure that the data collected encompassed a wide range of Southern speakers of Standard Nigerian

English. The selection of participants from the southern region was specifically intended to provide a sample that reflects the population of undergraduate students at UNILAG, considering the observed variance in accent among them. It is important to note that UNILAG is a cosmopolitan institution, contributing to the diversity of speakers of Standard Nigerian English in the sample.

3. Results and Discussion

The data analysis involved the examination of vowel quality and vowel space in the speech of UNILAG undergraduates. To achieve this, a total of eight sentences containing 'hVd' words, along with filler words, were administered to each respondent. The 'hVd' words consisted of combinations of 'h + vowel + d', such as 'hid' and 'hood.' Each respondent read the sentences three times, resulting in a total of 1920 recorded items (80 respondents x 24 + 1920 items).

Table 2 Mean Formant Values of UNILAG Subjects

No.	Vowels	Male UGS F1	Male UGS F2	Female UGS F1	Female UGS F2
1.	<heed> /iː/	420	2159	505	2370
2.	< hid> /ɪ/	396	2111	494	2275
3.	<head>/e/	565	1910	694	2097
4.	<had> /æ/	769	1368	887	1635
5.	<hod> /ɒ/	594	1016	630	1080
6.	<hawed>/ɔː/	658	1232	635	1030
7.	<hood> /ʊ/	503	1507	547	1325
8.	<Who'd> /uː/	547	1533	593	1376

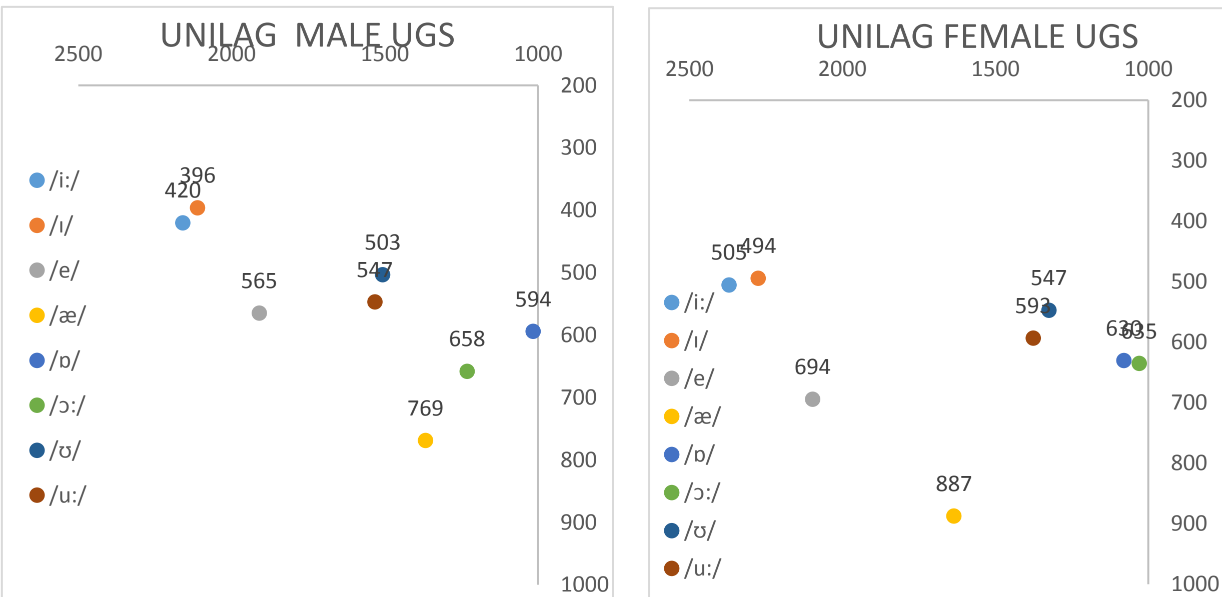

Figure 2, 3 Phonetic Vowel Spaces for Male and Female Undergraduates

This study replicated an experiment conducted at Bell Telephone Laboratories by Peterson and Barney (1952), which analysed the sounds of General American English (GAE) in the /hvd/ context. The experiment by Peterson and Barney is widely recognised and used in vowel formant research (Giacomino, 2012), and it has been referenced by other researchers such as Giacomino (2012). In Peterson and Barney's experiment, speakers were given a list of twelve monosyllabic words with a CVC phoneme structure. Each word began with [h] and ended with [d], with the only variation being the vowel sound, creating the /hvd/ context. The words produced by the participants in the present study were: "heed," "hid," "head," "hayed," "had," "hawed," "hood," and "who'd." It was decided to use only these eight words from the original twelve investigated by Peterson and Barney, following Roach's (2004) representation of English vowels for transcription.

The data for this study were collected over a span of two years, specifically from 2015 to 2017, and analysed to examine the speech of undergraduate students at UNILAG. The inclusion criteria for the subjects ensured that only individuals who grew up solely in Nigeria were included in the study. This was done to focus on speech that was not influenced by foreign accents or linguistic backgrounds. The primary focus of the study was on investigating the first two formant frequencies of monophthongs produced by the subjects. It is widely accepted that the first two formants are the most important for vowel classification (Hunter & Kebede, 2012; Ladefoged, 2002). Therefore, the analysis specifically looked at the first two formants of the vowels produced by the participants. To visualize the formant frequencies, they were plotted on an Excel scale, with F1 (the first formant frequency) represented on the vertical axis and F2 (the second formant frequency) represented on the horizontal axis. This allowed for a graphical representation of the vowel spaces and facilitated the examination of vowel quality based on the formant frequencies.

3.1 Analysis of Male Undergraduates' Formants

The analysis of the formants of male undergraduates' vowel production is depicted in Figures 2 and 3. Figure 2 displays F1 on the vertical axis, representing the degree of tongue openness or raising during vowel production. F2 is represented on the horizontal axis, indicating the location of the vowel and the specific part of the tongue involved in its production (front, central, or back).

Figure 3 illustrates that there is not a significant observable difference between the F1 values of the high close vowel /iː/ and the mid high vowel /ɪ/. This violates the general rule that states higher vowels should have lower F1 values. In this case, the vowel /iː/, which should have a lower F1, actually exhibits higher values compared to the mid high vowel /ɪ/. The positions of the two vowels are reversed, with the mid high vowel assuming the position of the high close vowel. This reversal of vowel positions aligns with the findings of Labov (1998) and Labov *et al.* (2006) regarding these two vowel sounds. Interestingly, this reversal does not apply to F2, as there is overlapping and minimal distinction between the F2 values of the two vowels.

The analysis also reveals that the high back vowel /uː/ is raised beyond its counterpart, the high front vowel /iː/, in the phonetic space. Although these vowels typically occupy parallel high positions on the vowel chart, the analysis shows that /uː/ is fronted and produced with less rounding, while the mid-high back vowel /ʊ/ is also fronted and realised with less rounded lips. This fronting of back vowels is reminiscent of the Southern Vowel Shift observed in the southern regions of the United States of America. The phonetic height of the high back vowel and the high back mid vowel is reversed, similar to the reversal between the high front close vowel and the mid front close vowel. The mid-high back vowel /ʊ/ is lowered compared to the raised /uː/, and their F2 values overlap, indicating minimal distinction between the two sounds.

In terms of the front half open vowel /e/, it is realised at its appropriate position in the phonetic vowel space. However, its counterpart, the back mid low vowel /ɔː/, undergoes a shift in position. While /e/ maintains its position as a half-open vowel, /ɔː/ is raised in F1 while /e/ is lowered. This deviates from the expected parallel positions of the two vowels in the vowel chart.

Furthermore, the low back vowel /ɒ/ is lowered and occupies the position of /ɔː/, resulting in a mid-low back vowel realisation. However, the F2 values for these vowels do not reverse to align with their F1 shifts. Consequently, the two sounds are not distinctly differentiated and can be used interchangeably. Additionally, the open vowel /æ/ undergoes a raising effect and is produced more as a back vowel rather than its original front position.

Generally, the analysis highlights the fronting and shifting of certain vowels in the phonetic vowel space, as well as the lack of clear distinction between some vowel sounds. These findings shed light on the specific vowel patterns observed in the speech of male undergraduates at UNILAG.

3.2 Analysis of Female Undergraduates' Formants

From the entry in figure 3, the analysis of formants in the speech of female undergraduates reveals several notable findings. Firstly, the high close front vowel (/iː/) and half close vowel (/ɪ/) occupy a more frontal phonetic space compared to males. In females, these vowels are raised in F1 and shifted to the left, whereas in males, they are lowered and shifted to the right. The auditory distance between /i:/ and /ɪ/ in females is larger than in males. Additionally, the F2 values for these vowels are raised in females, in contrast to males. Interestingly, the positions of /i:/ and /ɪ/ in the female vowel chart are reversed compared to the male vowel chart. /ɪ/ occurs before /i:/, but their vowel space allocation differs.

The half open front vowel /e/ is realised with more frontal openness in females compared to males. It is raised and positioned further to the left, while in males it is lowered and moves to the right. The F2 value for /e/ is decreased in males compared to females. Similarly, the open front vowel (/æ/) is produced as a central sound and is raised in females compared to males.

Regarding the vowels /ɔ:/ and /ɒ/, they overlap in their realisation. /ɔ:/ is raised in comparison to /ɔ/, and both vowels are articulated using reversed positions. They are both realised as mid-low back vowels with minimal phonetic space. Consequently, the two vowels are not adequately distinguished by females and are used interchangeably.

Furthermore, the vowels /u:/ and /ʊ/ also overlap in their realisation. Their original positions have been swapped, with /u:/ being raised and /ʊ/ being lowered. /ʊ/ is realised as /u:/ and vice versa. Both vowels tend towards the front and appear to be mid-high vowels.

Generally, the analysis reveals specific patterns in the realisation of vowels by female undergraduates at UNILAG, including frontal raising and shifting, as well as the lack of clear distinction between certain vowel sounds.

4. Discussion of Findings

The findings of the study suggest that there are both similarities and differences between male and female undergraduate students at UNILAG in terms of their vowel realisation. One notable difference is the compression observed in the phonetic vowel space of male undergraduates, while female undergraduates show expansion. This variation in vowel space may contribute to the distinct accents observed among female undergraduates at UNILAG.

Furthermore, the study highlights that there is not a clear distinction between the vowels /i:/ and /ɪ/ in both male and female undergraduates. Surprisingly, the two vowels are realised in reverse positions, with /ɪ/ being lowered and /i:/ being raised. While male undergraduates realize these vowels as close front vowels, their female counterparts realize them as half close vowels.

Similarly, the study reveals that the vowels /ɒ/ and /ɔ:/ are also swapped in positions by both male and female undergraduates. As a result, /ɒ/ is lowered, and /ɔ:/ is raised. In both gender groups, there is minimal phonetic space between these vowels, which leads to a lack of clear distinction. Female undergraduates, in particular, tend to overlap these vowels.

The study also reveals an interesting characteristic regarding the roundedness of the vowel /u:/ among both male and female undergraduates at UNILAG. Both groups realize this vowel with less roundedness, with a tendency to raise /u:/ and lower /ʊ/. However, there is no clear distinction between these two sounds. Additionally, both male and female undergraduates exhibit similarities in their realisation of /ʊ/ and /u:/ as mid high back vowels. There is also evidence of fronting in the pronunciation of /u:/ among both gender groups.

The phonetic vowel spaces observed in the study highlight the unique features of each gender group's pronunciation, which in turn affect their accents, particularly among the female undergraduates. This observation was a primary motivation for conducting the research.

Although the study focused on eight specific monophthongs to identify the phonetic vowel space, it is important to note that there are other monophthongs and diphthongs that were not included in this research. These unexplored vowel sounds could be an area of interest for future studies, providing opportunities for further discoveries in the realm of gender formant frequencies.

Overall, this study has provided a description of the phonetic vowel space utilised by UNILAG undergraduates. It serves as a foundation for future researchers to delve into a broader range of vowel sounds, including diphthongs, and to explore the nuances of gender-related formant frequencies.

5. Conclusion

In summary, the formant analysis of vowel articulation in male and female undergraduate speech at UNILAG has revealed distinct characteristics and noteworthy patterns. Female students exhibit a broader vowel space compared to males, indicating a wider range of vowel articulation and potential influence on their accents. An unexpected inversion of vowel positions between /iː/ and /ɪ/ was observed in both groups, challenging conventional notions of vowel height. Additionally, the overlapping of certain vowels such as /ɒ/ and /ɔː/ suggests a lack of distinction in their usage among students of both genders. Furthermore, the reduced differentiation between /uː/ and /ʊ/ may impact their speech patterns and accents. This study underscores the importance of considering gender-specific phonetic patterns in understanding language variation and serves as a basis for future research. However, it's essential to acknowledge that this study focused solely on specific monophthongs, leaving room for further exploration of a wider range of vowel sounds and their implications on gender-related formant frequencies and speech patterns.

References

Adeniyi, H.O. (2006). Attitudes to Nigerian English among Lagos State Teachers: A Sociolingusitics survey. *University of Ilorin*, Illorin.

Adetugbo, A. (2004). Problems of standardization and Nigerian English phonology. *Nigerian English: influences and characteristics*, 179-199.

Akere, F., & Pride, J.B. (1982). Sociolinguistic constraints and the emergence of a Standard Nigerian English. *New Englishes*. 85-99.

Akinjobi, A. (2004). A phonological investigation of vowel weakening and unstressed syllable obscuration in Education Yoruba English. *University of Ibadan,* Ibadan.

Akinjobi, A. (2011). Academic competence and linguistic performance: A study of English intonation tune assignment by some Nigerian English language post-graduate students. *In African Nebula,* 66-76.

Akinjobi, A. & Oladipupo, R. (2010). Intonation and attitude in Nigerian English. In *LWATI a Journal of Contemporary Research,* 7(1), 159-167. https://doi.org/10.4314/lwati.v7i1.57478

Akinjobi, A. (2006). Vowel reduction and suffixation in Nigeria. *English Today*, *22*(1), 10-17. https://doi.org/10.1017/S0266078406001039

Atoye, R. (2005). Non–native perception and interpretation of English intonation. *Nordic Journal of African Studies,* 14(1), 26-42.

Awonusi, V.O. (1987). The identification of standards within institutionalized non-native Englishes: The Nigerian experience. *Lagos Review of English Studies: A Journal of Language and Literary Studies*, 47-63.

Awonusi, V.O. (2004). The English language in a global context. *Nigerian English, influences and characteristics*, 33-45.

Banjo, A. (1971). Towards a definition of standard Nigerian spoken English. In *Actes du 8th Congress de la Societe Linguiste de l'Afrique Occidentale*, 165-175.

Banjo, A. (1979). Beyond intelligibility in Nigerian English. Varieties and Functions of English in Nigeria, *African University Press*, Ibadan.

Cole, J., Thomas, E.R., Britt, E., & Coggshall, E. (2008). Gender and ethnicity in intonation: A case study of North Carolina English.

Deng, L., & O'Shaughnessy, D. (2003). Speech processing: a dynamic and optimization-oriented approach. CRC Press.

Eka, D. (1985). A Phonological study of Standard Nigerian English. *ABU,* Zaria.

Eka, D. (2000). Issues in Nigerian English usage. *Scholars Press.Ltd*, Uyo.

Gay, T. (1978). Effect of speaking rate on vowel formant movements. *The journal of the Acoustical society of America*, 63(1), 223-230. https://doi.org/10.1121/1.381717

Gimson, A.C. (1984). The RP accent. In P. Trudgill (ed), Language in the British Isles. *Cambridge University Press*, Cambridge

Gut, U. (2004). Nigerian English: phonology. A handbook of varieties of English. *Mouton de Gruyter*, Amsterdam.

Hawkins, S., & Midgley, J. (2005). Formant frequencies of RP Monophthongs in Four Age Groups of Speakers. *In Journal of International Phonetic Association Cambridge University Press,* 35(2) 183 - 199. https://doi.org/10.1017/S0025100305002124

Hillenbrand, J. & Gayvert R. (1993). Vowel classification based on fundamental frequency and formant Frequencies. *In Journal of Speech and Hearing Research,* 36(4)*,* 694-700.

Homayoon, B. (2011). Fundamentals of speaker recognition. *Springer-Verlag*, Berlin.

Holmes, J. (2013). An Introduction to the Sociolinguistics. 4th edition, Routledge, London and New York.

Hunter, G., & Kebede, H. (2012). Formant frequencies of British English vowels produced by native speakers of Farsi. *In Acoustics 2012*.

Jibril, M. (1982). Phonological variation in Nigerian spoken English. *University of Lancaster.* England.

Jibril, M.A. (1986). Sociolinguistic variation in Nigerian English. English World-Wide, 7(1), 47-74. https://doi.org/10.1075/eww.7.1.04jib

Ladefoged, P. (2002). Vowels and consonants. An introduction to the sounds of languages. Blackwell Publishers, United Kingdom.

Lindblom B. (1963). Spectrographic Study of vowel reduction. *In Journal of the Acoustical Society of America* 35, 1773-1781. https://doi.org/10.1121/1.1918816

Mannell, R. (2008). Source-Filter Theory of Speech Production, 278.

Patill, V.H., Kaushal, A., Gupta, T. & Lalotra, V. (2016). Comparative analysis of pitch and formant frequency. *International Journal of Innovative Research in Computer and Communication Engineering*, *4.*

Peterson, G. & Barney, H.L. (1952). Control methods used in a study of the vowels. *In Journal of Acoustical Society of America.* 24, 175–184. https://doi.org/10.1121/1.1906875

Rebold, U., Harrington, J. & Kleber, F. (2010). Vocal ageing effects on F0 and the first formant: A longitudinal analysis in adult speakers.

Roach, P. (2004). British English: Received Pronunciation. In Journal of the International Phonetic Association. pp. 239-245.

Schneider, E.W. (2007). Postcolonial English: varieties around the world. Cambridge University Press. https://doi.org/10.1017/CBO9780511618901

Shankweiler, D., Strange, W., & Verbrugge, R. R. (1977). Speech and the problem of perceptual constancy. *Perceiving, acting, and knowing: Toward an ecological psychology*, 315-345.

Udofot, I.M. (2002). The Intonation of Nigerian English. *Journal of Nigerian English and Literature*, 3, 13-38.

Udofot, I.M. (2004). Varieties of spoken Nigerian English. *The Domestication of English in Nigeria*. *University of Lagos Press*. 93-113.

Udofot, I. (2007). A tonal analysis of standard Nigerian English. *Journal of the Nigerian English Studies Association*, 3(1), 58-68.

Walsh, N. (1967). Distinguishing types and varieties of English in Nigeria. *Journal of the Nigerian English studies association*, 2(2), 47-55.

Wells, J. C. (1984). English accents in England. *Language in the British Isles*, 55-69.

Wilmot, M. B. (1979). Variety signifiers in Nigerian English. *ELT Journal,* 33 (3) 222-233. https://doi.org/10.1093/elt/XXXIII.3.227

Wright, R., & Nichols, D. (2009). How to measure vowel formants using praat. *Available from https://depts.washington.edu/phonlab/resources/measuring-formants.pdf*

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Conflict of interest

The Author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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