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Acquisition of Articulatory Competence among the Nigerian Users of English: A Study of Praat Speech Analysis

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Abstract
Articulatory competence is one aspect of language learning that non-native learners grapple with. This paper suggests how articulatory competence can be enhanced using praat speech analysis tool. Nigerians usually experience difficulty in articulating some English speech sounds or pronounce words that contain them. In this study, praat was used to teach 12 to 15 years old female students of Girls High School, Gindiri how to produce vowels /i:/, /I/, /ɒ/, /ʌ/ and /ɜ:/. They were four each from northern, southern and western Nigeria. Formant frequencies of the sounds were retrieved from analysed utterances of native speakers extracted from Wells (2002) to serve as control. 20 participants produced 20 words containing the sounds, which were recorded and analysed using praat. The frequency values of formants one and two (F1, F2) of the participants' and native speakers'

utterances were compared to establish the student's articulatory competence. After learning the selected words using praat, the participants were able to pronounce them more appropriately. Although the pronunciations did not exactly match the control samples in all phonological aspects, they corresponded, to a large extent, in terms of F0 changes. The research is based on Laboratory phonology which is a phonological theory that ensures that empirical phonetic data are obtained and analysed through experimental methods. The research reveals the effectiveness of praat speech analysis tool in the acquisition of articulatory competence. It shows that Nigerians, as non-native learners of English, can develop the ability to pronounce English words that contain vowels not present in their native languages which will eventually improve communication among users of English in Nigeria.
Keywords: acquisition, praat, articulatory competence, formant, pronunciation, English

Introduction

Varieties of phonological realisations exist among Nigerian speakers of English such that it is difficult to establish the core common features that can be used to describe Nigerian English as a variety of English in terms of phonological competence. Evidences are observable when the Hausa, Igbo and Yoruba English varieties (being the major Nigerian languages) are compared. Other peculiarities could also be identified in the Englishes of "minority" tribe groups. Because these varieties exist, Nigerians experience intelligibility problems as interlocutors struggle to employ other tactics to solve any communication problems they experience. Nigerians have interacted linguistically by intermingling so that differences in the various English sub-varieties are almost unnoticeable by the speakers unless they are closely examined especially by language experts. However, it is possible to narrow the gap among these varieties for a more harmonized pronunciation and documentation of Nigerian English words considering its status in Nigeria as official language.

Nigerians have always learned English phonology based on assumption as they hardly can relate sound symbols with the actual pronunciations; words and their phonemic representations are usually memorised even when there is no proper understanding of the symbol-sound relationship. Some Nigerians may be gifted in sound perception that they could easily listen to the sounds and reproduce them after a short time of practice. But most learners find it difficult, some eventually become teachers of English and have to teach speech sound production without getting a good understanding of it as they find it complicated (Solomon, 1).

The problem gets even worse when the teachers have difficulty producing the speech sounds correctly themselves. Different teachers (affected by their level of phonological proficiency) tell their students different ways of pronouncing particular words; and in the end, the students get confused that they only learn to pass exams rather than to improve their communication. They may not be quite aware that poor English pronunciation can impede communication (Chitulu and Njemanze, 169; Keshavarz and Khamis, 61; Solomon, 1). Because they find teaching pronunciation difficult, most teachers in Nigerian schools avoid it.

Vowels are the most difficult to handle in terms of learning and teaching in Nigerian English; especially vowels /I/, /æ/, /ʌ/, /ɜ:/ and /ə/, and diphthongs like /ei/, /əʊ/ and /ʊə/. I/, /æ/ may not be considered as problematic as the others; however, they can constitute serious communication problem. For instance, *bit* (past tense of bite) and *beat* can constitute a problem in a statement like *Ada bit me on the back*. It becomes difficult to interpret the statement since *beat* and *bit* are basically differentiated based on duration among most speakers of Nigerian English, especially as the context of usage is the same. Generally, Nigerians do not differentiate between *bid* and *bead* as they pronounce both as *bead*; *hut* and *hurt* are usually pronounced as *hot*. *Cart* and *cat* are not pronounced differently in normal conversation. They are

differentiated only based on duration (that is usually in classroom discuss on the subject), and that usually happens only when the speaker pronounces the words carefully and in isolation. Articulatory properties such as openness/closeness and frontness/backness of vowels are not prioritized even though they constitute major differential properties of the vowels.

Praat is a speech analysis software developed by Paul Boersma and David Weenink (Boersma and Heuven, 341) for studies in phonetics. Unlike earlier methods of acoustic analysis, praat can analyse long utterances of more than two minutes. It is a computer program freely accessible online. It has been found effective for analysing pitch, intonation, intensity, etc. This study shows that articulatory competence can improve among learners of English language in non-native English speaking communities.

It is important to note that this research is not exclusively for error evaluation. This research recognises the impact of English variation in universal communication and the fact that some pronunciation patterns are accepted and recognised variants which should not be categorised as errors – a situation which can be controversial among language researchers based on certain factors. It however, admits that it is not out of place for Nigerian English speakers to thrive for near-native language competence as it enhances communication in general and that it can in the long run lead to harmonisation of the different regional English varieties in

Nigeria which will in turn improve English communication. Additionally, improved communication proficiency, at any linguistic level, is the goal of this research - whether to address error problems or to reduce inter-variety communication challenges. This research therefore intends to investigate how praat (a computational tool for utterance analysis) can be used to train students to improve their articulation of English vowel sounds.

Research questions

The research will answer the following questions:

i. Why do some Nigerians pronounce some English words as the same whereas native speakers pronounce them as different?
ii. How can Nigerian speakers of English learn to produce these English sounds and pronounce words that contain them – /i:/, /I/, /ɜ:/and /ʌ/ and /ɒ/?
iii. To what extent can praat help to improve students' articulation and differentiation of /i:/, /I/, /ɒ/, /ʌ/ and / ɜ:/ vowel sounds?

Aims and Objectives of the Research

The aim of this investigation is to establish whether or not non-native speakers of English can learn to produce English speech sounds by using praat.

The objectives of the study are to

i. review why most Nigerians experience difficulty in pronouncing some English words like the natives would;
ii. establish how Nigerians can improve on their articulation of English speech sounds and pronounce words that contain them; sounds like I/, /ʌ/ and /ɜ:/;
iii. establish the extent to which Nigerian speakers of English can attain better articulatory competence in the pronunciation of words that contain /i:/, /I/, /ɜ:/and /ʌ/ and /ɒ/ which are not present in the sound systems of their native or first languages.

Theoretical Framework

This researcher considers Laboratory Phonology ideal for this research. Laboratory phonology is a phonological theory that ensures that empirical phonetic data are obtained through experimental methods. This is opposed to traditional phonology investigation method which basically relies on impressionistic and abstract representations. In laboratory phonology speech is treated

as a measurable physical activity. It emerged in the 1980s and 1990s based on the works of Mary Beckam, Patricia Keating, and Janet Pierrehumbert as a response to the gap between phonological theory and phonetic reality. They argue that phonological categories and processes must be subjected to acoustic, articulatory, and perceptual evidence.

Laboratory phonology provides a practical approach to vowel articulation improvement. Vowels are defined acoustically by formant frequencies, duration, and intensity. These acoustic properties are treated as the phonetic correlates of phonological vowel categories. Improvement in articulation is attempted by modifying the articulatory gestures that produce target formant values.

In this research, the process of phonological investigation using this approach typically depends on data collection using tools like praat. A learner produces target vowels in controlled contexts, and their productions are recorded and analysed for fundamental frequency (F1 and F2) values, vowel duration, and spectral quality. These measurements are compared to reference values for native or target varieties. The difference between produced and target values reveals the specific articulatory adjustments needed. In applied settings, laboratory phonology can be used in second language pronunciation training, speech therapy, and voice coaching. It relies on corresponding abstract phonological predictions to concrete articulatory actions, using objective acoustic analysis to guide improvement.

This theoretical approach is considered apt for this study which is on vowel articulation. It allows the students under investigation to relate with their utterance on practical and physical bases. The students are trained to evaluate their utterances based on the physical phonological properties displayed on their computers and the numerical values extracted from the computational representation to show the actual fundamental frequency, rather

than relying on their perceptual abilities which, to a large extent, are unreliable assumptions.

Methodology

The researcher used the praat speech analyser to train ten non-native English-speaking girls from Girls High School, Gindiri how to produce vowels /I/ and /ʌ/ and /ɜ:/, which occur in *hit*, *hut*, and *hurt* respectively. The participants selected for this research were students of Girls High School, Gindiri; they were aged between 12 and 15 years. They first pronounced given words which were recorded using praat. The formants and fundamental frequencies (F0) were extracted and analysed to establish the speakers' current articulatory ability. They were trained on how to identify different vowels on praat by observing the first and second formants (F1 and F2) and the average frequency values of the formants which are automatically generated on the program. The words were played from an audio version of Oxford English Dictionary for the students to listen and imitate. The researcher explained the positioning of the articulatory organs for the vowel sounds in the five words to help them understand better how to produce them. F1 and F2 provided the frequency values used to determine the participants' change in pronunciation of the words given.

A second recording was done of their pronunciation of the words after they had been taught how to use praat in measuring their pronunciation accuracy. There was improvement in the latter pronunciations of the words. At the end of the exercise, the students could understand the sounds better and could differentiate between them and other similar sounds in Nigerian English realisation.

Formant frequency data was taken from the research done by Cartei et al. (2012). On formant variation in voice gender imitation against which the formant frequency values of the participants' utterances were measured. The participants produced each sound

in isolation before pronouncing the words in which they occur. The utterances were collected using a microphone connected to a computer. Recording was done in praat. F1 and F2 were computed and analysed to establish a range of differences for the words given. Praat object window is used to present the physical formants while the data is presented in excel chart.

Literature Review

English in Nigerian

Nigerian English has evolved from the contact of British English and native Nigerian languages since the 5th century with the coming of Europeans and the Portuguese to the coastal shores of West Africa for trade (Eka, 7; Taiwo, 1). Its acceptance was to a large extent with a mixed feeling especially with how its introduction has suppressed the local Nigerian languages (Ezeani and Nwobu, 78).

English was a child of necessity as it was needed to enable communication between the Europeans and Nigerians in especially trade relationship. Despite Ezeani & Nwobu's displeasure with the coming of English, English has continually remained the backbone of Nigerian existence on account of which increasing acceptance of the existence of Nigerian English is been recorded among Nigerians and globally.

It has become almost completely unarguable that different varieties of English exist. Nigerian English being one of the varieties now receives the scholarly recognition as a unique English rather than an error version of the native English; however, given that it is yet to be properly documented especially with respect to language-of-instruction status, the term, to some extent, remains deprecating. Oshodi and Owolewa (29) pointed out that there has been a contention on the existence of Nigerian English based on the believe that "Nigerian English is a product of inadequate knowledge of the Standard English". He added that it is difficult to

realise any particular form for Nigerian English as it is spoken differently by speakers of the different languages in Nigeria.

The description of Nigerian English by Uzor and Iguenyi (110) is based on the use of English in Nigeria in the media, official discusses, business etc. They argue that many years of coexistence of English and Nigerian languages has produced a different form that can be called Nigerian English. The claim is that this new form of English carries features of syntax, phonology, lexeme etc. to necessitate its separate identification. As believable as their presentation was going, it may not be reliable due to the addition that the diverse ethnic and cultural orientation of Nigeria has produced "too many varieties of English" in the country. If the varieties are too many, how then can Nigerian English be identified? Bamgbose made effort in describing three different realisations of English based on Hausa, Igbo and Yoruba native speakers:

> One example of such typical feature is that Igbo speakers of English, even well-educated ones, tend to transfer the vowel harmony system of their language into English. They say *folo* instead of *fɔlou* for the word "follow" because the sequence of /ɔ/ and /o/ in two successive syllables is not permissible in Igbo. Hausa speakers of English tend to insert a vowel between a syllable-final consonant and the initial consonant of an immediately following syllable: for instance, [rezigineiʃən] instead of [rezigneiʃən] for the word "resignation". Yoruba speakers of English generally nasalise English vowels which are preceded by nasals, for example, they say [mɔnin] for English "morning" [mɔniŋ]. (42)

Oko observes that varieties of English are a result of interference. They are from interference features from native languages noticeable in second or foreign language speech. He added that

language is rule governed; and native speakers of any language intuitively create their expressions in line with general appropriateness in the use of the language. On the other hand, an L2 speaker of the same may not be sensitive to grammatical appropriateness, 'and often ends up speaking a quaint, stiff variety that, in the case of Nigerian users, has been described as "bookish"' (7).

He corroborates several other researches who posit that harmonizing the phonology of Nigerian speakers in an attempt to achieve a standard, is largely an impossible task. Along with others, he is much comfortable with creating a standard Nigerian English based on grammar, semantics, and lexis.

The above researches recognise that second language learning of English can be a challenge and that there is always the evidence of mother-tongue to contend with. It is true that L2 and FL English has become inherent in English language discusses and that researchers in this regard is continuous. The present research is intended to improve phonological articulation whether at L1, L2 or FL levels.

Variation in Nigerian English

There are extreme cases of pronunciation variations like the replacement of voiceless labiodental fricative /f/ with the voiceless bilabial fricative /p/ by Hausa speakers of English in words like farm, father and fan (Keshavarz and Khamis, 64). Yoruba speakers also could omit the /h/ in *house*, *hole* and *heater*. Such extreme cases are more likely to cause communication problems than situations where the features of the sounds are not so obvious; like in replacing vowel /e/ with vowel /ɛ/ (/e/ and /ɛ/ are used here as in non-native *mate* and *met* respectively according the IPA representation). It has become difficult to differentiate between allophonic variation and incorrect pronunciation among Nigerian speakers of English.

Pronunciation Problems among Nigerian English Speakers

Pronunciation problems can be differentiated according to which part of Nigeria the speaker is exposed to. While /ʧ/ and /h/ may pose a problem to the Yoruba speaker, it may not be the same to the Hausa speaker whose challenge is usually the production of /p/ and /f/. The problematic variation has in fact become an object of humour such that comedians mimic some utterances to create humour and entertainment at comedy shows and other events.

Chitulu and Njemanze explain that speakers from Warri are likely to pronounce *change* and *church* as /ʃenʒ/ and /ʃɒʃ/ instead of /ʧeɪnʤ/ and /ʧɜ:ʧ/ respectively. They identify some reasons why these differences occur to include environmental influence. Nigerians do not attach importance to correctness of grammar let alone pronunciation. By implication, the pronunciation problems could be avoided if not for the lack of interest or willingness to endure the rigour of learning the correct language features (170).

Because the majority of the people use careless pronunciations, students easily learn them and find the correct pronunciation of words strange and difficult. Another problem they identify is absence of some English sounds in Nigerian languages. Sounds like /ʌ/, /æ/ and /ɵ/ are absent in Nigerian Languages therefore words that contain them are very likely to be pronounced different from the native pronunciations shown in dictionaries. Poor equipment of teachers is another problem they identify as affecting the learning of pronunciation among Nigerian students. Because the teachers themselves most times have difficulty producing some English sounds, they find teaching phonetics difficult and usually end up teaching the students different pronunciation of words.

Keshavarz and Khamis identify mother tongue influence as a major reason why Hausa speakers are not able to produce sounds like /ʌ/ and /ɜ:/ (61-62). This affects results in what Okoro refers to as substandard English forms of Nigerian English (26).

Lack of language laboratories and audio-visual materials such as the television and computer are identified by Egwogu to affect the learning of pronunciation in Nigerian schools (125). He added that handsets can be used to improve pronunciation if the facilities are installed in them but most teachers of English in Nigeria are not ICT compliant. The deficiency of ICT equipment in schools and the lack of consciousness to use the ones available are major problems that largely affect teaching and learning pronunciation among Nigerians.

Teaching Pronunciation in Nigeria

Solomon recommends that given the need for accuracy in pronunciation, strategies should be sought to teach it (7). Imitation is one strategy whereby learners should be made to listen and repeat what the teacher says (Egwogu, 216). Another strategy is the use of phonetic alphabet. He advises that learners should be able to identify symbols representing given sounds and learn how to manipulate the organs of speech to produce the sounds.

Chitulu and Njemanze recommend the use of the ICT in teaching pronunciation. He says that words could be played from electronic devices like the computer for learners to imitate (167). This suggestion is based on the assumption that most learners in Nigeria do not have regular contact with native speakers if they do at all. Therefore, they can use recorded utterances of native speakers during their learning. Other suggestions include debate and impromptu speeches, use of games, and panel discussions (Egwogu, 216). It is in line with this position that this research has chosen to investigate how efficiently, praat can be used to teach sound pronunciation for improved linguistic competence.

Praat Speech Analysis Tool

Praat is a computer software used for speech analysis in phonetics developed by Paul Boersma and David Weenink (Boersma and Heuven, 341). Before the invention of computer programs for

speech analysis, utterances were analysed using sound spectrographic machines. The kay sonograph which only could record short utterances of about five seconds long at a time was used in the 1940s. Spectrographic representations were viewed only in black and white colours, and they could only provide the formants of a short utterance. Recently, speech analysers like praat could analyse longer utterances of more than two minutes.

Praat is a computer program freely accessible online. It is useful for analysing pitch, intonation, intensity, etc. It can also be used for spectrographic analysis, articulatory synthesis, and neural networks (Boersma and Weenink, 342). Computer-aided pronunciation instruction offers many advantages that are not usually available in conventional contexts (Le and Brook, 2). This study has found praat useful in this age of technology to enhance teaching of language and has applied it in this research endeavour.

Data Presentation and Analysis

The analysis focused on the first and second formants of the participant's utterances created displayed on the praat program. The visual display of the formants and their frequency values were examined and compared to native speakers' mainly in relation to ΔF (formant distance) of F1 and F2. 20 students were used for the investigation. Each of them was asked to pronounce *heat* and *hit* in one session, and *hot, hut, and hurt* in a different session.

Before using praat to examine the pronunciations, the participants pronounced *heat* and *hit* much alike with vowel /i:/ except that the vowel in *heat* was sustained to make it longer than *hit*. Therefore, the two words were basically differentiated only based on vowel length. One of the participants used /I/ in the two words and also differentiated them by sustaining *heat* more.

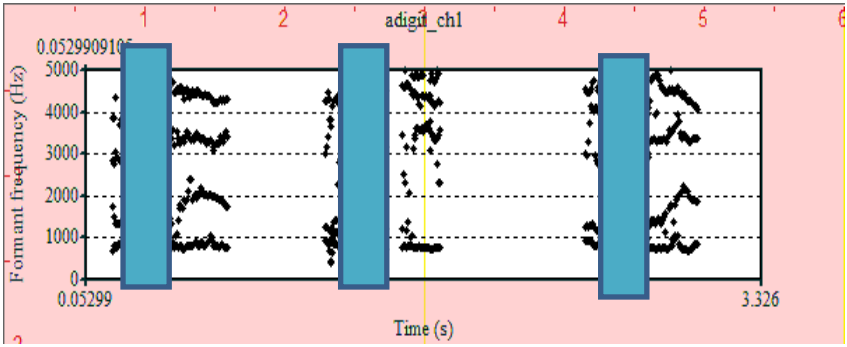

Figure 1: Participants' pronunciation of *hot*, *hut* and *hurt*

Figure 1 above shows formants of a participant's pronunciation of *hot*, *hut* and *hurt* captured in praat. The highlighted portions represent the vowels in the words. This participant's articulation of the vowels begins and ends differently to realise a diphthongal pattern, which is why the left end has a narrow spacing between F1 and F2, and which increases towards the right. However, the average value of the entire vowel portion is extracted to represent the participants' vowel realisation, and it is used for comparison with other realisations. The information is better presented in figure 2 below.

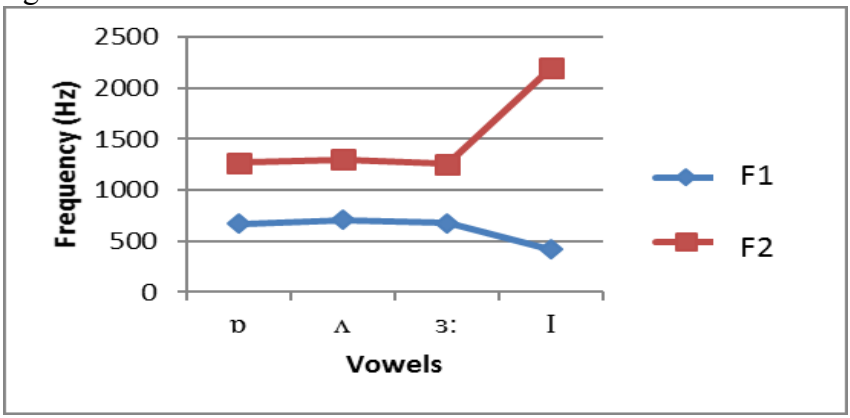

Figure 2: pronunciation of *hot*, *hut*, *hurt* and *hit* before the students training with praat

The above chart shows that the participant's F1 of /ɒ/, /ʌ/ and /ɜ:/are 666Hz, 709Hz and 675Hz respectively which are all within the range for the production of /ɒ/. F2 of the sounds are realised as 1270Hz, 1303Hz and 1255Hz in that order. The F2 values are also about the range for the production of /ɒ/. The average distance between F1 and F2 is about 600Hz for the three sounds. The pronunciation of *hot*, *hut* and *hurt* were therefore quite similar before the training exercise.

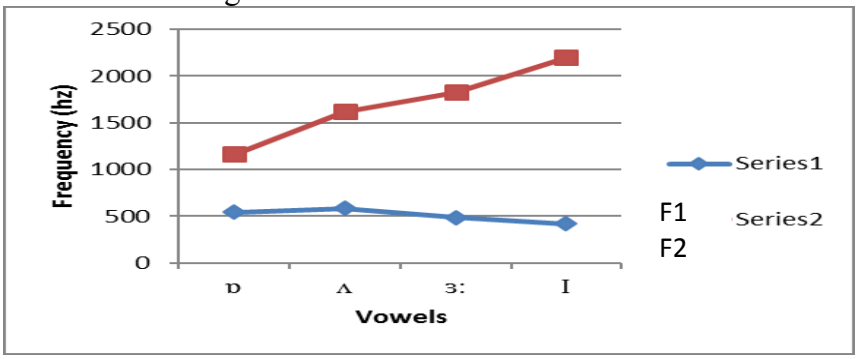

Figure 3: Pronunciation of *hot*, *hut*, *hurt* and *hit* after students' training with praat.

The chart represents the result of the participant's pronunciation of the given words after using praat to learn the vowels. The data shows that the average ΔF (F0 distance) between the sets of formants increases in the order of *hot*, *hut*, *hurt*, and *hit*. The F1 frequency value for /ɒ/shows 545Hzwhile F2 shows 1146Hz.That of /ʌ/ changed so that F1 and F2 became 583Hz and 1620Hz respectively with average distance of 1130Hz. The production of /ɜ:/ also changed to read F1 and F2 as 485Hz and 1825Hz respectively with average ΔF of 1340Hz.The first three sounds whose earlier pronunciations were about the same now show obvious differences of Fi (formant frequency) and average ΔF of F1 and F2. The difference between the ΔF of the *hot* vowel and the ΔF of the *hurt* vowel rises to about 739Hz which makes the two vowels very different from each other.

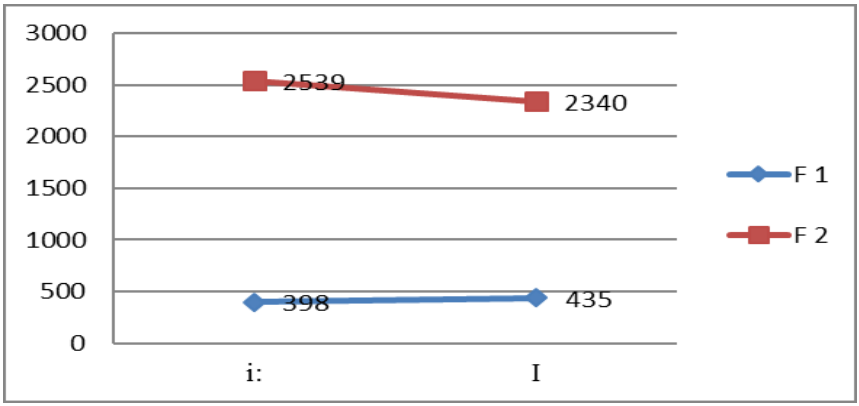

Figure 4: F0 of /i:/ and /I/ in the pronunciation of *heat* and *hit* after participants' training with praat.

On this chart, it is displayed that /i:/ and /I/ are articulated differently based on their different Fi values. /i:/ has 398 Hz for the F1 and 2539 Hz for the F2. In the articulation of /I/, the values realised for F1 and F2 are 435Hz and 2340 Hz respectively. The values show a reduction in the ΔF of /I/ compared to that of /i:/. The difference in the average Fi and ΔF values of the two sounds shows that they are identifiable as different sounds not only based on duration. It is therefore important that learners should be able to realise these different features when pronouncing words that contain the sounds.

Presentation of Finding

The reason for this investigation has been to find a means by which Nigerians, especially at the secondary school level, can be helped to pronounce words that contain English vowels they find difficult to articulate. The problem necessitated the need to find any other possible cause of pronunciation difficulty among non-native learners of English other than mother tongue interference, absence of some speech sounds in the learners' mother tongue, poor learning facilities etc.

It is eventually revealed in this research that non-native learners find certain English speech sounds difficult because they are not made to realise that slight differences in sounds matter in communication; they therefore do not take time to study those slightly different sounds which would vary the different words in a situation of similarly structured grammatical constructions. Words are differently pronounced only to show where a speaker is from; for instance, the pronunciation of *hit* has to be different if it is said by a Briton.

In differentiating between the vowels in *hit* and *heat*, the participants relied mainly on duration – that /i:/ in *heat* is a long vowel while /I/ in *hit* is a short vowel. However, this contrastive feature of length has not adequately represented the sounds in actual communication. One problem with depending only on the duration is how long should /i:/ be sustained in other to differentiate it from /I/? One common instance of the problem can be noticed in the expressions *He bit me* and *He beat me* which could easily co-occur in contexts, especially as used by children in Nigeria. Using the correct tense makes the meaning unclear to them, perhaps that is why children and parents would rather use the present tense *He bite me* even though it is meant to express a past event, so that it would not sound like *He beat me*.

This exercise helped the participants to understand that the more important differential features of the vowels are based on openness and frontness which is noticeable in the different values of the formant frequencies rather than vowel length. Vowel length does very little in differentiating words, but they are important in determining stress.

Nigerians pronounce words like *hit* and *heat* the same because of the notion that /i:/ and /I/ are different only based on length. The difference in their placement on the vowel chart is ignored. It is however significant to note that /i:/ is situated a little above /I/ and

moved a little to the left. That makes it a little closer and a little more front than /I/. The symbols are also physically differentiated in the sense that the *heat* vowel is shaped like the lower case *i* while the *hit* vowel is like the upper-case *I*. While the length differences may be indicated with the colon, the articulatory reality is differentiated in the purposive physical representations of the symbols.

The exercise with praat reveals that Nigerians do not have difficulty in pronouncing *hot.* This is basically because this vowel sound is quite similar to the variant present in most Nigerian languages. However, they use it as the allophone for *hut* and *hurt* since the vowels are not present in most Nigerian languages.

Therefore, the three words are given generally the same pronunciation and not much is said about length difference in this case. At the end of the training exercise, the participants were able to pronounce the three words differently and similar to the native variations regardless of the native constraints generally blamed for pronunciation differences and difficulties. With this result, it is deduced that non-native learners of English can overcome mother-tongue limitation in pronunciation if they use praat in their learning. At the end of the research, the participants were satisfied with the discovery and wished to apply the same strategy in learning other problematic sounds. Although several other strategies have been suggested and employed to teach pronunciation in Nigeria, not much has been achieved as the conflict in pronunciation of words still exists. Praat is an option that should be considered to address the issue.

Conclusion

This research reviews why most Nigerians experience difficulty in pronouncing some English words; establishes how Nigerians can improve their articulation of English speech sounds and pronounce words that contain them; and establishes the extent to which Nigerian speakers of English can attain better articulatory

competence in the pronunciation of words that contain /I/, /ʌ/ and /ɜ:/ which are sounds absent in the sound systems of native Nigerian languages.

Praat is used to prove that second language learners are capable of learning and producing English speech sounds they find difficult to produce due to the absence of those sounds in the sound systems of their mother-tongues. The participants in the research were able to produce the difficult sounds after they were trained on how to use praat to improve their pronunciation. This helped them to pronounce *hot*, *hut* and *hurt* more accurately. Also, *hit* and *heat* were no longer differentiated only based on vowel length. This research verifies that by using praat to learn pronunciation, a second language learner can overcome mother-tongue interference in their speech. Therefore, praat speech analysis program should be used in schools especially at the secondary and tertiary levels to teach sound production and word pronunciation to learners of English in Nigeria. This will go a long way in unifying word pronunciation in Nigerian English.

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