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thesis entitled

Vowel Systems of African Englishes: Acoustic and Perceptual Analysis

presented by

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has been accepted towards fulfillment of the requirements for

Ph.D. degree in Linguistics

Major professor

Date June 15, 2000

VOWEL SYSTEMS OF AFRICAN ENGLISHES: ACOUSTIC AND PERCEPTUAL ANALYSIS

By

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A DISSERTATION

Submitted to
Michigan State University
In partial fulfillment of the requirements
For the degree of

DOCTOR OF PHILOSOPHY

Department of Linguistics, Germanic, Slavic, Asian and African Languages

2000

ABSTRACT

VOWELS SYSTEMS OF AFRICAN ENGLISHES: ACOUSTIC AND PERCEPTUAL ANALYSIS

By
MUNGAI MUTONYA

This study analyzes production and perception of African English (AfrE) vowels by university students in Ghana, Kenya and Zimbabwe. Acoustic and perception tests are carried out and subsequently correlated in order to determine the characteristic of vowel systems in each sample. In order to determine the acoustic qualities of vowels, data was initially elicited from language groups with relatively homogeneous social and linguistic background. F1 and F2 scores of onset (steady state) vowels contained in eleven English monosyllabic were calculated and subsequently plotted using computer software; Signalyze (version 3.12) and Plotnik (version04) respectively. To account for vowel perception, data was elicited from AfrE listeners using the minimal pair and identification test methods.

Both acoustic and perception results challenge previously held assumptions regarding vowel variance in west, east and southern Africa. Ghanaian respondents in this study did not back RP central vowels [ɜ] and [ʌ] to [ɒ], a position so strongly held in earlier studies. Moreover, vowel system identity among 'Bantu English' speakers in

eastern and southern Africa is not corroborated by Kenyan and Zimbabwean respondents in this study. Gender distinction within and across varieties is also identified.

DEDICATION

I dedicate this work to my wife Laurah, my sons Mwariri and Mutonya, our parents, brothers and sisters.
Could not have made it without your love and support.

ACKNOWLEDGEMENTS

I am greatly indebted to many people who made substantive contributions, directly or indirectly, to this research project. Their inspiration, support and guidance has influenced the completion of this study. Needless to say, there have been numerous tough hurdles to clear, many sacrifices to make, short and long term goals to meet, numerous responsibilities to bear, and of course, a dissertation to write. Such challenges would have been insurmountable without the valuable insights, guidance, love and support from my professors, colleagues, friends and family members. To them all, I extend my grateful acknowledgements.

I have been lucky to work with a great teacher and sociolinguist, Dr. Dennis R. Preston, my mentor and advisor. From the formative stages of this study, through data collection, data analysis, to the completion of this research, Dennis has always been available to answer any questions, address any research concerns, and to read the drafts whenever I had one ready for him. I thanks him most sincerely.

Other members of my dissertation committee have equally informed the study in numerous ways: Dr. David Dwyer has enriched the study through his expertise on African linguistics and through his very constructive suggestions; Dr. Yen-Hwei Lin provided valuable insights on phonology and language variation; Dr. Denise Troutman painstakingly read my draft and gave very thoughtful and valuable insights. I am equally grateful to Dr. Geneva Smitherman, who agreed to participate in my dissertation defense as an outside reader. Her comments and suggestions helped ameliorate this final draft. I thank them all for their wise guidance.

Dr. Harry Akussa of University of Accra, Ghana; Dr. Patrick Kambewa of Malawi; Dr. Abraham Gitau Ndungu of Kenyatta University, Kenya; Maina Mutonya, currently a graduate student at the University of Witwatersrand, South Africa; and Mwangi Mutonya, assisted me with data collection. Without their assistance and the cooperation of all the respondents they interviewed, this research would not have taken its current form. I thank them most sincerely.

The vicissitudes and sacrifices encountered through Graduate school could not have been easily borne without the incredible support I received from my beloved family. My greatest appreciation and gratitude goes to my loving wife Laurah for the love, patience, support and friendship through the years; my precious boys, Mwariri and Mutonya for giving me a cherished learning, and the motivation to accomplish this task; my loving parents Jeremiah Mutonya and Rebecca Njoki for their inspiration and a firm educational foundation; the Mutonya family - Njuguna, Njoroge, Mari, Wangui, Wanjiru, Kamau, Muchiri, Maina, Mwangi, Mukami, Machira, and all the youngsters for their support, and for daring to dream. Thanks to my in-laws for the support, especially my late father-in-law, Jotham Mwariri Gichura, who supported and encouraged me. May his soul rest in peace. Thanks to Beatrice Wambui Cege for sharing her life with us.

I thank Michigan State University and in particular the chair of Department of Linguistics, Dr. George Peters, for the Teaching Assistant Fellowship that financed my graduate study. Laurie Koehler was more than a Graduate Secretary to us; she was a friend, a dear friend with a warm smile, an attentive ear, and a loving heart that radiated warmth and sunshine to our department. I am grateful to Saisunnee Visanyoongoon and Li Qing, for sharing the trials and rigors of comprehensive exams. I am thankful to fellow sociolinguists who shared in the joy of Preston's classes, the companionships in the language lab, and the inevitable sleepless nights during comps and dissertation writing. Thanks to Cege, Kuria, Smucker, Wangui, Walter, and Jamila for the solidarity, and to all my Kiswahili students for making it memorable.

The faculty and staff of the African and Afro-American Studies program at Washington University in Saint Louis provided me with the necessary support and conducive environment that expedited the completion of my dissertation work. I am especially grateful to Professors Gerald Early, Rafia Zafar, Priscilla Stone, Tim Parsons and Richard Kisiara for their continued support. Adele Tuchler and Raye Riggins have made my life at Wash U and AFAS in particular more exciting. Thank you all.

I am very grateful to the University of Nairobi, Kenya and the Department of Linguistics and African Languages for granting me study leave to pursue my doctoral studies at Michigan State University.

I am grateful to Mzalendo Kibunja and Carolyn Harford for facilitating the opportunity.

To all my teachers, classmates, friends and relatives who have positively impacted my educational pursuits, I say, ASANTE SANA. THAAAAIIII.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One: Introduction

Introduction

In an earlier study, Mutonya (1997) observed that university students in three African countries positively identified regional varieties of African Engish (AfrE), and they assigned contrasting attitudinal values towards local and non-local varieties based on degree of accentedness. The scope of the study, however, did not allow for the measurement of physical and nonphysical qualities of the sounds that respondents reacted to in their judgments. Consequently, the current study focuses on the measurement of acoustic and perceptual characteristics of AfrE vowel systems.

In general, the current study further investigates the nature of documented varieties of AfrE; West African English (WAfrE), East African English (EAfrE), and Southern African English (SAfrE). Specifically, the study seeks to determine what the vowel system of each regional variety looks like based on acoustic and perceptual analysis of data elicited from university students from Ghana, Kenya and Zimbabwe.

However, unlike previous research in this field, the current study has paid considerable attention to empirical methods of sampling, data collection, acoustic and perceptual analysis, in an effort to tease out the most probable vowel systems in each region.

1. 0 An Overview of the Study

The present study investigates the production and perception of English (L2) vowels by university students in three African countries. While holding L1 dialectal factors as homogeneous as possible, F1 and F2 scores of African English (AfrE) vowels produced by multilingual speakers from Ghana, Zimbabwe and Kenya were measured and analyzed. Furthermore, AfrE listeners' perception of Received Pronunciation (RP) vowels were analyzed and subsequently correlated with acoustic results. The probable vowel system for each group was determined by correlating the more physical attributes of the vowels (production) with the more abstract ones (perception). Consequently, conclusions drawn in this study challenges some widely held assumptions about AfrE, particularly, in regard to the nature of AfrE vowel systems.

Although the primary objective of this study is to define and interpret the phonetic and phonemic identities of AfrE vowel systems, defining a methodological framework for future studies is an equally significant goal. This study accentuates the need for more empirical investigation in the study of English (as well as other languages) in the densely multilingual sub-Saharan Africa. The lack of information about the techniques and instruments used in the study of AfrE vowels has been a major shortcoming of previous studies. The lack of empirical evidence pertaining to L1s and L2s in this region, has, needless to say, created impediments and challenges to this study.

In order to provide an empirical investigation of AfrE vowel systems, this study has adapted tools of investigation and analysis applied in fields of sociolinguistics, acoustic phonetics, and the social psychology of language.

Towards this end, sociolinguistic methods of sampling and data collection have been applied in identifying a relatively homogeneous sample. Moreover, the physical characteristics of vowels realized by AfrE speakers of each regional variety have been quantified using tools adapted from acoustic phonetics. Likewise, vowel perception methods, primarily used in field of the social psychology of language, have been utilized in quantifying vowel perception. Collectively, the theories and methods derived from these fields of study have informed this study immensely.

Chapter one defines the parameters of this study. Chapter two provides a background to the study while chapter three delineates the guiding theoretical framework. Chapter four is a discussion on methodology while in chapter five, an analysis of acoustic and perception data is discussed. Conclusions are drawn thereafter in chapter six.

1. 1 Statement of the Problem

The existing literature characterizes AfrE vowel systems as homogeneous varieties with regionally distinct qualities. The widely documented comparison of RP and AfrE vowel systems (see Figure 1) suggests a seven-vowel system for West African English (WAfrE), and a five-vowel system for East African English (EAfrE). Hardly any empirical evidence is provided to account for the vowel system variation.

Research in AfrE vowel systems is not only limited in scope and methodology but also replete with conflicting generalizations and conclusions. The literature exhibits significant flaws in methodology such that reported findings and conclusions require verification. Taking advantage of available tools of investigation and analysis, this study seeks to accomplish that goal.

Adegbija (1994: 53) outlines existing shortcomings in current research:

> Deficiency in methodology appears to be the principal weakness of most language ...[variation] studies hitherto carried out in sub-Saharan Africa. Some of such studies... appear to be largely impressionistic in approach and sampling techniques and instruments, when indicated are often weak.

Adegbija's observation echoes Schmied's (1989) earlier challenge to African English researchers to employ new approaches in data collection and analysis, in order to ensure that studies of English in Africa provide a systematic empirical account.

In the study of variant vowel systems of African English, many researchers have failed to acknowledge the dense multilingual complexities of sub-Saharan Africa. The assumed homogeneity of speech communities has led to overgeneralizations that seem to outlook the linguistic complexities prevailing in many sub-Saharan countries where tens or hundreds of diverse indigenous languages are spoken, and English is acquired as a second or third language by a great majority of its speakers. Moreover, the use and function of English in these countries, is limited to official settings.

In such dynamic language contact situations, complex patterns of influences and transfer of features from one language to another may be easy to find. However, although the exposition of such patterns and transfers are not within the purview of the current study, we should note that the realization of English vowels in such dense multilingual setting may depend on speaker's L1, level of education, social network, social motivation among other factors. These factors, especially ethnicity, may vary considering that speakers in a given country may speak related languages or distinctively different ones. Previous studies seem to have overlooked such factors as they generalized regional variations of AfrE. Angogo and Hancock (1984: 74-5) adequately represent this common misperception in the field:

> ... Phonology is perhaps the most distinctive characteristic of [AfrE]... it is quite possible to generalize about the existence of a 'West African English' and 'East African English' despite their respective geographical variant forms, in the same way that we speak of an American English' which in fact consists of many regional and social varieties. Even though ... a Gambian will say "bot" for "but" when a Ghanaian will say "bet", it does not mean that there are many [WAfrE's] rather than one; there is a phonological cohesiveness to all these kinds of English which identify them as African

> rather than, say, West Indian English, and specifically as West African rather than East African.

Considering WAfrE as a homogenous language variety overlooks even the widespread pidgin varieties that many scholars argue may constitute a major input in the formation of Englishes in that region. A similar generalization is echoed by Schmied (1991), who considers the Eastern and Southern African English varieties to be so indistinct as to constitute a common variety referred to as Bantu English.

Most studies identify three broad regional varieties of African English: West African English (WAfrE), East African English (EAfrE), and Southern African English (SAfrE). National varieties such as Nigerian, Kenyan, Ghanaian, Cameroon and Zambian Englishes are also discussed. Only a few studies have discussed the variation of the vowel systems in an attempt to identify the phonological distinctions among these AfrE varieties, but sampling techniques, methods of data collection, and the analysis applied in the research are under described. It is uncertain whether the findings reported in these studies represent distinctions exhibited by a particular social class, age group, gender, or by an entire speech community in the densely multilingual speech communities in sub-Saharan Africa.

The aim of this exploratory study is to remedy such methodological flaws by presenting a methodological framework that will at least partly answer the need for more empirical research in multilingual Africa.

Such a task can be accomplished by maximizing the advantages of the empirical tools of acoustic phonetics and sociolinguistic research. In using computer software designed to extract, measure and plot vowels, we seek to verify the widely documented findings regarding the AfrE vowel systems .

1.2 Background to the study

The English language enjoys institutional support in most African countries that were under British colonial rule. Ngugi wa Thiong'o (1984:13) points out that in the colonial and post-colonial era in these countries, "English was the official vehicle and the magic formula to colonial [and neo-colonial] elitedom." It is still the official language and medium of instruction in schools, colleges and universities. However, English remains a minority language in regard to number of users and frequency of use. African languages remain the dominant languages of informal interactions, even among well-educated AfrE speakers.

In language contact situations, features of native languages are bound to be manifested in the realization of the acquired languages. Non-native speakers of English in Africa may perceive and produce English vowels based on the phonological schema of their first language. Consequently, a new form of English, distinctive to that speech community, grows and over a period of time is institutionalized and accepted. However, although the foregoing assertion assumes that speakers of related L1s may have relatively similar perceptions and production of English, it should be stressed that social factors may also influence production and perception of non-native sounds.

The regular usage and acceptance of such new varieties of English eventually leads to institutionalization of the Africanized variety and a gradual change of linguisitc roles and attitudes in the speech communities. The Africanized English that was a stigmatized non-standard variety at one time has become a prestigious standard variety and a target language for many new learners of English in the speech community.

In an earlier attitudinal study, Mutonya (1997) reported that AfrE speakers readily identify regional varieties of AfrE and attach attitudinal values to sub-varieties of regional AfrE varieties on the basis of degree of accentedness. Kachru (1982:45) reported similar attitudinal judgments among Ghanaian speakers of AfrE:

> ... educated Ghanaian English is acceptable; but as Sey (1973: 1) warns us, it does not entail competence in speaking RP since in Ghana the type that strives too obviously to approximate to RP is frowned upon as distasteful and pedantic. In Nigeria the situation is not different from Ghana or India... Many Nigerians will consider as affected or even snobbish any Nigerian who speaks like a native speaker of English.

However, there is hardly any empirical evidence that teases out the distinctive linguistic characteristics of each one of these varieties. Besides such attitudinal research, detailed linguistic analysis of the varieties will help in teasing out the defining features of those varieties. By utilizing tools of research that will guarantee greater precision, this study begins that work by initially measuring acoustic qualities of vowel production in each regional variety, followed by a methodical measurement of listeners' abilities to identify and discriminate those vowels, and finally, a correlation of production and perception results. Correlating speech production and perception will help determine the most probable vowel system in each region.

1. 3 Theoretical Framework

This study seeks to identify the nature of vowel systems of a homogeneous sample of university students from Kenya, Ghana and Zimbabwe. Measurements of vowel production and perception are correlated to determine the probable vowel system of each sample.

Peterson and Barney (1952) observed that speakers' pronunciations of vowels within words are influenced by their particular dialectal background. Furthermore, they noted, pronunciation of vowels may differ both in phonetic quality and in measurable characteristics from that produced speakers with other backgrounds. Listeners, likewise, are influenced in their identification of a sound by their past linguistic experience.

Lieberman and Blumstein (1993:153) accentuate the importance of psychoacoustic tests in speech perception research:

> Although it is possible to perform precise analyses of speech signals using electronic instruments and computer programs that effect various mathematical transformations of the signal, these analyses are, in themselves, meaningless. We can never be certain that we have actually isolated the acoustic cues that people use to transmit information to each other unless we run psychoacoustic studies in which human listeners respond to acoustic signals that differ with respect to the acoustic cues that we think are relevant

This research is further informed by Lieberman and Blumstein's (1993:170...) phonetic theory (physiological theory for vowels) that is structured in terms of biological mechanisms that are involved in the production and perception of speech.

Contrary to traditional "articulatory" vowel theory that postulate that the phonetic quality of vowels is derived from the position and the height of point of constriction of the tongue, this physiological theory, as demonstrated by Steven and House (1955), postulates that most vowels can be generated by means of many different articulatory patterns, e.g., adjustments of lip opening and total vocal tract length. The only vowels that need particular tongue contours are [i], [u] and [a]. Since that is the case, Jacobson and Ladefoged (1972:93) prefer perception to production in analyzing and synthesizing a speech signal:

> The nature of some vowel targets is much more likely to be auditory than articulatory. The particular articulatory mechanism that a speaker makes use of to attain a vowel target is of secondary importance only

The physiological approach to phonetic theory for vowels recognizes the fact that the shape of the supralaryngeal vocal tract determines the particular acoustic signal, and different speech sounds are specified by different acoustic signals. Since different speakers have different supralyngaeal vocal lengths, human speakers do not attempt to produce the same absolute formant frequency values for the "same" vowel; instead, they produce a set of format frequencies that is frequency-scaled to their approximate supralaryngeal vocal tract length.

In vowel perception, Lieberman argues, a listener approximates the length of a speaker's supralaryngeal vocal tract and normalizes it within the parameters of an appropriate vowel space.

> A human listener has to determine the probable length of the supralaryngeal vocal tract of the speakers he is listening to in order to determine the frequency parameters of the appropriate "vowel" space. Psychoacoustic experiments show that human listeners can make use of various acoustic cues and strategies to effect tract normalization. (1993:179)

Phonetic information produced by the speaker and the phonological knowledge of the listener are inter-linked in a process that reveals to us the authenticity or relevance of the acoustic cues we analyze, in this case, the similarities and differences that we seek to define in the variation of AfrE vowel systems.

The physiological approach further states that, since the quantal vowels, ([i], [u], [a]), are maximally distinct, they help define the vowel space within which speakers differentiate the other vowels of English. The quantal vowels have well-defined spectral peaks because of the convergence of two formant frequencies:

> F1 and F2 converge to yield a central spectral peak at about 1 kHz for [a]. F2 and F3 converge to yield a high frequency peak for [i], F1 and F2 converge to yield a low frequency spectral peak for [u]. (Lieberman and Blumstein 1993:175)

Several psycho-acoustic tests have determined that [i] and [u] produce the lowest errors of all vowels when listeners are asked to identify the vowels. In contrast, the Peterson and Barney (1952) study shows a high rate of confusion occurs between [ɑ] and [ɔ] due to the instability of phonemic /ɑ / and /ɔ / distinctions in many dialects of English . Are these findings manifested in the study of AfrE vowel systems?

Lieberman (1993:182-3) further states that languages do not have the same inventory of peripheral, non-quantal vowels. Speakers of a language may be unable to identify non-quantal vowels of another language with certainty, because vowels seem to be perceived by means of neural acoustic property detectors that respond to particular acoustic signals. Moreover, Lieberman argues, the range of formant frequencies to which these property detectors can potentially respond is delimited by the quantal vowels [i], [u] and [a]. Our response to particular vowel sounds is made possible by neural devices that are "tuned" to particular acoustic signals that reflect the constraints of our speech producing mechanisms. Furthermore, humans partition the possible range of formant frequencies that the human vocal tract can generate differently as they grow up in different linguistic environments. Therefore, the different linguistic and social background of different AfrE speakers will condition the nature of acoustic signals that their neural acoustic devices detect in speech perception.

Other studies have contributed to a better understanding of a physiological approach to phonetic theory. Niedzielski (1999: 63) suggests that listeners use a variety of different factors in their perception and interpretation of a speaker's dialect, including social expectations that are influenced by socially constructed beliefs and stereotypes

Strand (1999:96) states that, beyond the language-specific phonetics, socially constructed information also affects how we perceive and categorize speech sounds. Some of those influencing factors include dialect background or nationality of the speaker. We expect our speakers and listeners from each region to exhibit such socially determined influences in their speech production and perception, and the results of this present study will be interpreted in light of earlier attitudinal work to begin an account of such influences.

1. 4 Scope and Limitations

In this exploratory study, only a representative sample will be chosen from each region. Speech samples will be recorded from a population that is controlled for level of education, mother tongue, region and linguistic evidence to be analyzed. A major criticism leveled against previous research efforts in the region is the glaring overgeneralization that seems oblivious to the multilingual complexities of sub-Saharan Africa. Controlling our sample for homogeneity seeks to avoid such a methodological flaw.

Respondents are chosen from a population of male and female university students from Kenya (EAfrE), Zimbabwe (SAfrE), and Ghana (WAfrE). A comparative study of production and perception of such a sample will enable us to make concrete claims about the vowel systems of educated speakers in those regions.

The implicit target sample of earlier studies was educated AfrE speakers. Angogo and Hancock (1982) categorize the following four types of Englishes spoken Sub-Saharan Africa: Type 1 is the native English of whites and expatriates born or living in Africa; Type 2 is the native English of Africans of racially or linguistically mixed marriages; Type 3 is the non-native English spoken as a second language by well-educated Africans who, by virtue of their academic or professional life, speak English fluently as a second language; Type 4 is pidgin/Creole English, such as Nigerian Pidgin English. Angogo and Hancock conclude that Type 3 is prototypical AfrE. This study focuses on educated AfrE speakers. Although all other varieties mentioned above are relevant in understanding AfrE, the scope of the current study limits us from discussing them comprehensively.

Görlach (1991:24), argues that pronunciation ofAfrE speakers is 'the most reliable test for localizing a speaker.' Schmied (1991:57) concurs:

> .... the pronunciation of English in Africa is of particular importance because (non-standard) pronunciation features seem to be the most persisitent in African varieties i.e., they are retained even in the speech of the most educated speakers.

It is for this reason that we chose phonological evidence over syntactic, lexical, or morphological variation for this study.

Kenya, Zimbabwe, and Ghana were chosen specifically because of their almost identical history of colonization by Britain and for the dominant role that English continues to play in the social relations of the citizens of these countries. The Bantu and Kwa language groups were chosen because they belong to the larger Niger-Congo family group. However, we should note that even among these language group there are subtle dialectal differences, but have minimized the differences among Kwa speakers by choosing respondents from the Akan-dialect cluster.

Kwa languages are a branch of the Niger-Congo language family spoken by the inhabitants of an area extending along the Atlantic coast of Africa from Côte d'Ivoire to the Nigerian border and including the southern parts of Côte d'Ivoire, Ghana, Togo, and Benin. The Kwa languages, Stewart (1984) argue, include the Akan cluster, with 7 million speakers. The principal members of the Akan cluster are Asante Twi, Akuapem

(Akuapim), and Fante in Ghana; Anyi and Baule (2 million) in Côte d'Ivoire; and Ewe (2 million) in southeast Ghana and southern Togo.

Our Ghanaian respondents are L1 speakers of the Akan dialect cluster, which comprises Twi , Asante and Fante languages. Some respondents spoke fluently two or three of these languages.

Bantu languages are spoken by millions of people in sub-Saharan Africa below a line roughly demarcated by the southern boundaries of Nigeria, Chad, Central African republic, Sudan, Ethiopia and Somalia. 15 of the 37 languages of Africa which have a million or more speakers are Bantu languages (Hinnebusch1989: 451)

Kenyan respondents speak the following Bantu languages: Gikuyu, Kikamba, Kitaita and Ekegusii . Most Zimbabweans are Shona and Ndebele speakers although some speak Chinyanja and Chichewa.

Suprasegmental variations such as pitch, tone, Advanced Tongue Root (ATR), are not within the scope of the current study. The study focuses only on the onset (steady state) characteristics of vowels. F1 and F2 frequency measurement is the only criteria used in this study to determine acoustic quality of the vowels. The vowels were elicited by requesting respondents to read stimulus word-list adapted from previous studies.

1. 5 Data Collection

Two sets of data were collected for this study: acoustic data from speakers and psychoacoustic data from listeners.

Acoustic Data:

A questionnaire and interview method was used to collect data. The questionnaire (see Appendix A) comprised four sections: biographical information, word list, reading passage and respondent's data on language use. Every interview was tape-recorded. Having provided the interviewer with biographical information, the respondent was then asked to read a list of nineteen words . The word list was adapted from the lexical items used in previous studies (see Figure 1 below), but other lexical items were added to represent vowels and diphthongs missing from Figure 1. The respondent then read a passage that was constructed to incorporate the lexical items in the word list, in order to give each respondent the chance to produce the lexical item in two styles: formal style for the word list, and less formal for the reading passage. For this particular study, word list productions were heavily relied upon, although in a few cases we relied on reading passage productions in cases of audio problems or misreading of words. Such cases were very rare and did not influence our findings.

Psychoacoustic data

After results of the acoustic analysis were obtained, a perceptual test was carried out. A sample of subjects with the same demographic characteristics as those who read the word list was identified. Speech perception of fifty university students from each region were elicited using Identification Test (IT) and Minimal pair Test (MPT). In each of these two tasks, listeners heard fifty seven minimal pairs of carefully selected monosyllabic words, recorded by an RP speaker. In the IT task, listeners identified each word in every pair, while the MPT entailed determining whether the words in each pair were "same" or "different." (see Appendix D)

1. 6 Data Analysis

The steady state of vowels were extracted from the recordings and frequencies of the first two formants (F1 and F2) calculated using a computer program (SIGNALYZE, version 3.12) designed for acoustic analysis. The F1 and F2 scores were calculated using linear predictive coding (LPC). Labov (1994) argues that LPC increases accuracy and reliability achieved in acoustic analyses through the use of software methods that apply LPC to the digitized speech wave. The formant measurements were subsequently entered into a computer program (PLOTNIK, version 04) designed for plotting and displaying vowel systems.

Results of the psychoacoustic test was calculated to determine the frequency of correct identification of each vowel and discriminations between them in a minimal pair test. Comparisons were made and conclusions drawn.

Chapter 2: Background to the Study

2. 1. 0 Introduction

The background to the study of AfrE regional vowel systems is presented in the form of a review of relevant literature. Previous studies have provided little or no empirical evidence to corroborate observations and conclusions, and subsequently subjecting the studies to accusations of overgeneralizations, methodological flaws and implicit assumption in representation of AfrE vowel systems.

2. 2. 0 Background to the study

2. 2. 1 African English?

The term 'African English' has been used as a theoretical abstraction by the few scholars who have done research on the forms and functions of English in Anglophone Africa. The most notable publications in this field are Todd (1982), Ladham (1982), Angogo and Hancock (1982), Pride (1982), Kachru (1986), Cheshire (1991), Schmied (1991), Görlach (1991), and Adegbija (1994).

Is it presumptuous to conceive of such an idea as 'African English,' taking into account that English-speaking sub-Saharan African countries are densely multilingual and that English is spoken by an educated minority as a second language? Some scholars have attempted to answer this question as follows.

Görlach (1991:123) carried out tests among native English speakers of British and American origins. He found that these students had no great difficulty in identifying a speaker from Nigeria as African. Although this observation does not provide much evidence regarding the existence of an African English, it vaguely points to the fact there are some distinct linguistic features that are uniquely African, at least in the speech perception of other non-African speakers of English.

Schmied (1991:2) defines African English as :

> ... forms of English spoken by African speakers; this does not imply that there is an acknowledged variety or that there are several distinct varieties of the language, nor that these forms are already standardized and codified in any way.

Schmied's definition uses the geographical criterion to identify the English variety. It also groups together all forms of English, from the English-based Creoles and Pidgins in West Africa to other Africanized and non-Africanized English varieties spoken in most English speaking regions. In view of the linguistic diversity of Africa, this is a misleading definition.

Bokamba (1982:78) reiterates Görlach's argument that native speakers of English are able to positively identify an African English utterance. He alludes to distinctive linguistic characteristics that define AfrE:

> ... these Englishes share certain properties that can be identified as Africanisms, in that they reflect structural characteristics of African languages. Specifically, these properties can be discovered at all linguistic levels: phonological, morphological, semantic and syntactic.

Bokamba's study focuses on the syntactic and semantic properties of sentences produced by educated Africans. Our area of concern in this study is phonology.

The Africanisms defined by Bokamba are, in Lanham's (1965:198) words, 'deviations from the authentic English' which arise as a result of the transfer of features and strategies previously known from the mother tongue to the target language. In every major linguistic area of the world where English is learnt as a second or foreign language, Lanham argues, there is a characteristic set of deviations from authentic English, much of which is as a result of transfer from the mother tongue to English. With the passage of time these deviations become institutionalized and give specific identity to the English variety, as is the case for Indian English, African English, Singapore English, and so on.

These early descriptive studies played a very important role in laying a foundation for the study of English in Africa. Although evidence does not point to careful empirical analysis of data, such pioneering studies generated a research interest that has culminated in more studies on varieties of African English. In a much more recent development, the first international dictionary of World Englishes (1999) classifies African English as one of the major varieties of English.

These studies have presented phonological, syntactic, lexical and morphological evidence in support of the distinctness of an African English variety in relation to RP and other Englishes. However, this study is limited only to phonological evidence. Why focus on phonology?

Pronunciation is the 'most reliable test for localizing a speaker' (Görlach 1991:24); Schmied's (1991:57) agrees:

> the pronunciation of English in Africa is of particular importance because (non-standard) pronunciation features seem to be the most persistent in African varieties i.e., they are retained even in the speech of the most educated speakers.

Gimson (1989:318f) notes that the British phoneme system may pose problems for foreign learners of English. The main problems are identified as: the tense-lax opposition of the close vowels /i/-/I/, /u/-/u/; the existence of a long central vowel /ɜ/; and phonemic length.

Schmied, a widely cited authority in the field, makes three contrasting generalizations about the AfrE and RP vowel systems.

(i) There is a length difference in vowels. The African English short vowels are longer and more peripheral than in RP, especially the closed /ɪ/, /ʊ/ or /ʌ/.

(ii) The central vowels /ʌ/ (*but*), and /ɜ/ (*bird*) are avoided and tend towards open positions [i, a].

(iii) Diphthongs tend to be monophthongized.

Schmied's characterization of the AfrE vowel system is broadly acknowledged in the literature, and many studies have followed with similar generalized descriptions of AfrE's regional vowel systems. However, such generalizations are yet to be corroborated by compelling empirical evidence as proposed in this study.

2. 2. 2 AfrE's Regional Vowel Systems

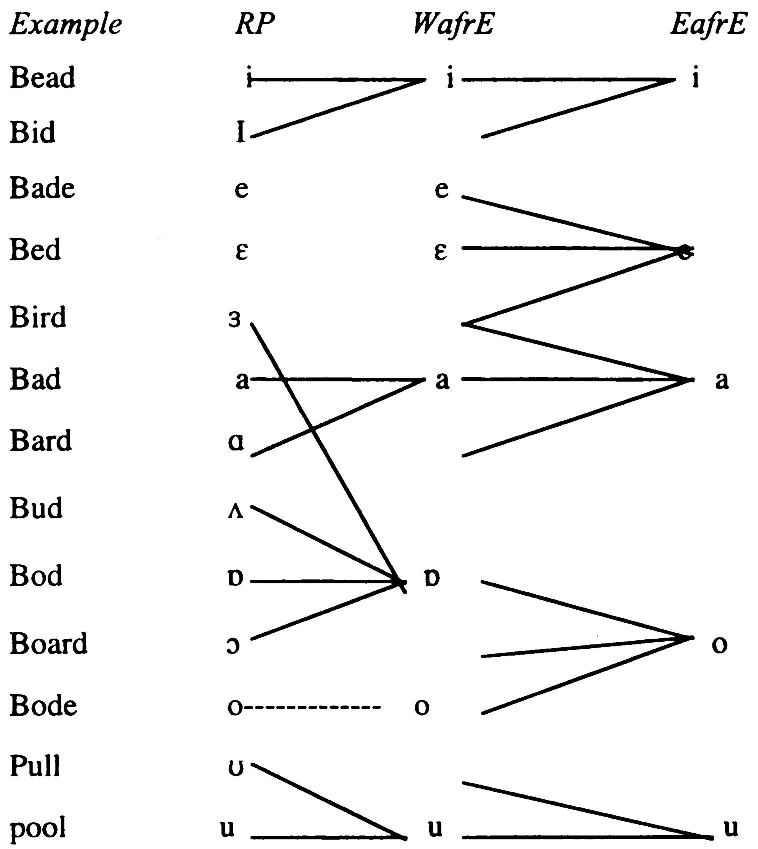

Figure 1 - Adapted[1] representation of Schmied's classical comparison of RP, WAfrE, and EAfrE

[1] Phonetic symbols have been adapted to reflect a more consistent phonetic transcription.

Although not included in Schmied's illustration of vowel systems, the following diphthongs have been investigated; [aI]buy, [aʊ]bout, [ɔi]boy, [ia]year, [ʊa] sure and [ɛə] hair. Schmied's (1991:59) characterization of AfrE diphthongs states with a sense of finality that, "all the centring diphthongs (/iə/, /eə/, /uə/ tend to be pronounced as opening diphthongs or double monophthongs (/ia, ea, ua/)"

Figure 1 contains background information that is essential to this study. The primary literature on AfrE vowel variation utilizes information contained in this illustration.

Figure 1 compares and contrasts WAfrE and EAfrE vowel systems with those of the RP system. AfrE researchers, including Schmied, have made general claims that the SAfrE vowel system is identical to EAfrE, considering the common Bantu substratum of L2 English speakers of these varieties. Whether such conclusions represent every group in this ethnically and linguistically diverse region has yet to be proven empirically.

A quick glance at Figure 1 shows that WAfrE is portrayed as a seven-vowel system whereas EAfrE is a five-vowel system. Previous studies attribute variation in the AfrE vowel systems to such phonological processes as simplification leading to loss of quantity distinction, reduction leading to mergers, and decentralization of the central vowels. Some major claims that have been made in the literature concerning the nature of the vowel systems of AfrE are stated below.

Schmied (1991) attributes a major source of AfrE variation to the 'deviation' in the production of the RP long central vowel [ɜ] (as in *bird*) by speakers of each regional speech community. Schmied claims that [ɜ] backs to [ɔ] in WAfrE, fronts and lowers to [a] or fronts to [e] in EAfrE, while in SAfrE it fronts to [e].

Todd (1984) provides further examples of backing and fronting of the central vowels in the realignment of RP vowels in the WAfrE vowel system, e.g., the /ʌ/ phoneme which occurs in the word *but* is realized as [ɔ]. Additionally, the /a/ phoneme as in *hat, rat, bad* is realized as [ɑ]. Both these claims are consistent with what Schmied presents in Figure 1.

Bokamba (1992:21) also discusses the reduction in the AfrE vowel system to five or seven vowels; /i, e, a, o, u / and perhaps /ɔ/ and /ɛ/ resulting from vowel mergers in such pairs and triplets as *bit/beat, had/hard, full/fool*, and *cut/court/caught.* Bokamba further argues that individual items may be realized variously: *bed* as [bed] or [bɛd], *bird* as [bed] or [bɔd]. These claims are also consistent with Schmied's, as shown in Figure 1.

Angogo and Hancock (1980: 72f) contend that, in discussing regional varieties of African English, it is important to note that each variety consists of several levels of style and acceptability. Nevertheless, like any other regional varieties of English, they contend, AfrE varieties exhibit a homogeneity between English as spoken in West Africa and English as spoken in East Africa. Furthermore, in their judgment, the model for AfrE is the non-native English spoken fluently as a second language by African people who have learnt an African language first in life, but, because of their education or profession, have grown up hearing and using English daily. These social groups speak English as well as, or maybe even better than, their mother tongues.

Angogo and Hancock (1980: 72) are explicit about the phonology:

> [AfrE] phonology is already becoming well established. This is evident from the fact that speakers whose native languages have a wide range of vowel sounds nevertheless retain [AfrE] phonology; Igbo distinguishes between tense and lax [ʊ] and [u], and [i] and [I] ... but Igbo speakers of [WAfrE] will not as a rule differentiate between the pairs *fool/full* or *sheep/ship*. Temne speakers contrast [a], [ə] in their language, but for them, faster will still be pronounced [fasta], not [fa:stə].

These claims about WAfrE, are also consistent with Schmied's.

In short, Angogo and Hancock (74-5) argue specifically that regional varieties exist in spite of considerable internal variation. They argue that phonology is perhaps the most distinctive characteristic of AfrE. Furthermore, as stated earlier in this study, they insist that it is quite possible to generalize about the existence of a 'West African English' and 'East African English,' in spite of their respective geographical variant forms, in the same way that we speak of an 'American English' that consists of many regional and social varieties.

Whether 'phonological cohesiveness' condenses varieties and subvarieties of Englishes spoken in particular regions into one geographical variety (WAfrE, EAfrE, or SAfrE) is an issue that continues to be debated. This paper seeks not to be embroiled in the debate, but proposes extensive empirical studies (analogous to the one carried out in this study), focusing on well-defined homogeneous populations in the regions as a beginning "phonetic" approach to the problem.

Banda (1996) also laments the methodological flaws in research on AfrE, and the paucity of phonological indices of educated Africans, whose speech is the target language of most learners of English as a second language in sub-Saharan Africa. Banda concurs with Jibril's (1986) claim that educated AfrE with a fairly African accent is usually the accepted target language norm for most English learners in Africa, while heavily ethnically marked accents are not.

Consequently, Banda (1996:68) further argues that describing AfrE from the perspective of English phoneme systems, as previous research has done, is not only erroneous, but it also distorts data.

> ... thorough and useful descriptions of New Englishes are unavailable, particularly the phonological indices of the [Target Language] Educated AfrE. Studies that have attempted to do comparative analyses of vowel and consonant systems in African Englishes are usually based on [Non-native English varieties], but even lack the phonological data and sociocultural awareness that is crucial for the sort of analysis required... researchers have yet to identify, let alone describe the distinguishing acoustic correlates in AfrE .

Banda may be criticized for generalizations, but certainly not for identifying the problem that confronts research in AfrE. Our exploratory study addresses the phonological uncertainities and gaps discussed by Angogo and Banda.

Even Josef Schmied, a leading authority in this field, acknowledges these shortcomings when discussing variant forms of the RP long central vowel, which in his opinion, 'is the primary parameter that defines regional variation in AfrE.' He cautions:

> ... but their [RP /ɜ / realizations] tendencies are not uniform in a region, neither across all ethnic groups (Igbo speakers tend towards /e/ and Yoruba towards /a/ ...) nor across the lexicon.

Note that he builds this variation into Figure 1.

The present study begins with the system described in Figure 1 as a basis for reexamining the regional variation of vowel systems of Bantu (in Kenya and Zimbabwe) and Kwa (in Ghana) speakers.

2. 2. 2. 1 West African English (WAfrE)

English is the official language in six West African countries.[2] Todd (1982) identifies the main types of English spoken in the region as:

[2] English is the official language in Gambia, Sierra Leone, Liberia, Ghana, Nigeria and Cameroon.

(i) Pidginized and Creolized variety: other-tongues creoles of Liberia (Merico) and Sierra Leone (Krio) and of the Krio-speaking settlers in Gambia, Nigeria, Cameroon and Equatorial Guinea. Pidgin Englishes of the coastal regions and of many urban communities.

(ii) Second language English that is acquired in schools and strongly influenced by the mother tongue(s) of speakers, also known as " broken English."

(iii) Standard WAfrE, which "... with the exception of Liberia ... " is equated with British (RP) norms. It is spoken as a second language by educated African speakers.

(iv) the English of expatriates (mainly American, British, Indian and Lebanese).

Our interest is in type (iii).

Like others, Todd argues that there are distinct characteristics of WAfrE:

> ... in spite of regional and educational differences, certain generalizations can be made about pronunciations of WAE largely because West African languages are fairly similar in structure.

Similarity of the structure of the West African languages, as claimed by Todd above, is a highly contentious issue. Even among the Niger-Congo languages there are structural differences; some have SOV word order whereas others have SVO; moreover, vowel systems are not uniform in this family group (Williamson 1989). Here we summarize Todd's description of the WAfrE vowel system:

(a) WAfrE has fewer vowel contrasts than RP. It utilizes 7 vowels and 3 or 4 diphthongs.

(b) Central vowels and centring diphthongs are virtually nonexistent. Narrow diphthongs in *bade* and *goat* tend to be monophthongized to /bed/ and /got/.

Words which end in [ə] in RP have [ɑ] in WAfrE, e.g. *hair* [hea].

(c) Long central vowel fronting: *bird* is realized as [bɛd].

(d) [ʌ] is replaced by [ɔ] : [bʌd] is realized as [bɔd]

(e) [a] is realized as [ɑ]

Trudgill and Hannah (1985), identify a WAfrE[3] vowel system that contains seven vowels and three diphthongs. This system has no central vowels and lacks tense/ lax contrasts especially among high and low vowels.

/i/ ————	bid, bead[4]
/e/ ————	bade
/ɛ/ ————	bed, burn
/ɑ/ ————	bad, bard
/ɒ/ ————	bod, bud
/o/ ————	boat
/u/ ————	pool, pull
/ai/ ————	buy
/ɔi/ ————	boy
/au/ ————	bout

Figure 2 - WAfrE Vowel System as presented by Trudgill and Hannah

This analysis is similar to other findings reported in other studies; it can be read as Figure 1 "backwards" - from phonemes to "word classes"

Writing about varieties of English in Cameroon, Todd (1982) argues that vocalic contrasts of the seven-vowel system are reflected in Cameroon English. Consequently, many Cameroonians will hardly distinguish between /i/ and /I/ as in *bead* and *bid*, between /ɔ/ and /ɒ/ as in *board* and *bod*, or between /ɑ/ and /a/ as in *bard* and *bad*. Central vowels and centring dipthongs are avoided with the result that words like *year* and *hair* are realized as /ia/ and /he/. The seven-vowel system for the Cameroonian vernaculars (Lamso and Bulu), and in effect Cameroon English, is shown in the vowel chart in Figure 3.

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[3] By WafrE, the writers stress that they refer to ' varieties that are unambigously English, particularly those spoken in Ghana, Nigeria and Sierra Leone.' (102)

[4] Trudgill and Hannah's lexical items are substituted with Schmied's (Figure 1) without altering the vowels intended. Similar changes have been made whenever different lexical items are used to represent vowels already represented in Shmied's figure.

The vowel chart also reflects the vowel system of West African Pidgin English, as documented by Dwyer (1969) and Schneider (1966).

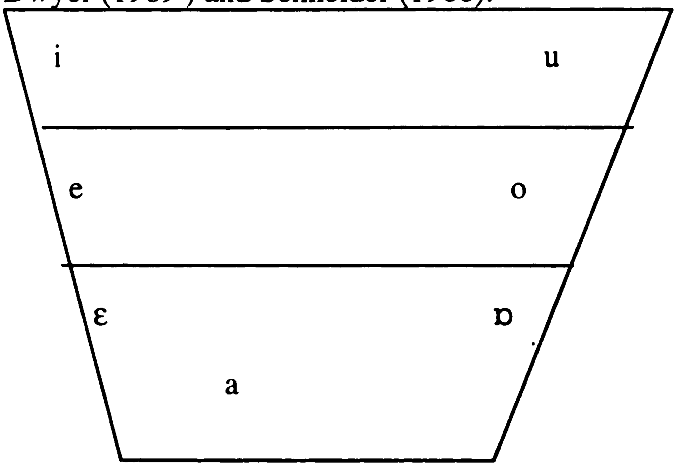

Figure 3 - Todd's representation of the vowel system of Cameroon English

Comparing RP and educated Ghanaian English, Sey (1973) provides the following contrastive evidence:

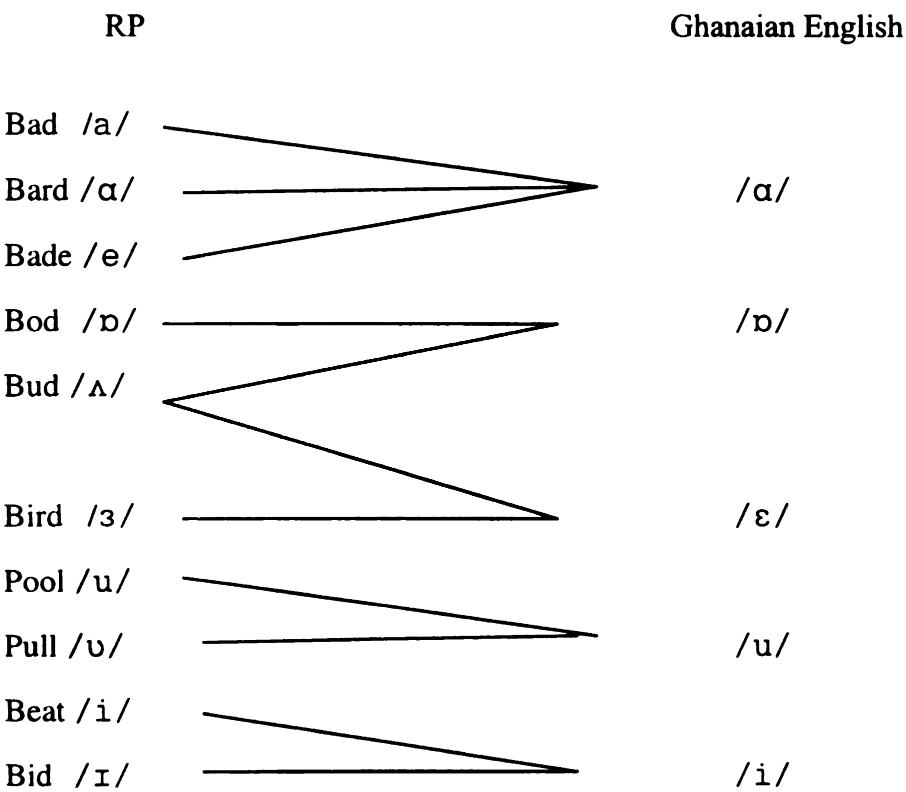

Figure 4 - Sey's Comparison of RP and Ghanaian Vowel Systems

Two claims made by Sey are particularly important to our study :

(a) Sey claims the vowel /ɜ / as in *bird* is fronted and realized as /ɛ/ contrary to claims made in other studies

(b) Sey claims that the vowel /ʌ/ as in the words *bud* is realised as either /ɒ/ or /ɛ/. However, Sey qualifies this observation with another baffling claim:

> /ʌ/ does not occur in L1, but the most likely substitute for it [in L2] would be /ɑ/ and not /ɔ/ or /ɛ/ (147).

But he does not speculate on why, in fact, [ɒ] and [ɛ] actually occur.

In a comparative study of nonnative English pronunciations in Cameroon and Nigeria by educated speakers, Bobda (1995) claims that educated Nigerian and Cameroonian Englishes are homogeneous across regional and ethnic boundaries. He argues that speakers of sub-varieties of English usually exhibit norms of the national variety; for instance, speakers of a language which may have vowel contrasts similar to RP's will neutralize the contrasts in their English productions in conformity with the national norm. To support his claim, Bobda gives an example of Hausa language which has contrastive [i] and [I] vowels, and yet speakers will not make a contrast in their production of English *beat* and *bit.*

Bobda illustrates the similarities between Nigerian and Cameroonian Englishes as shown in Figures 5 and 6.

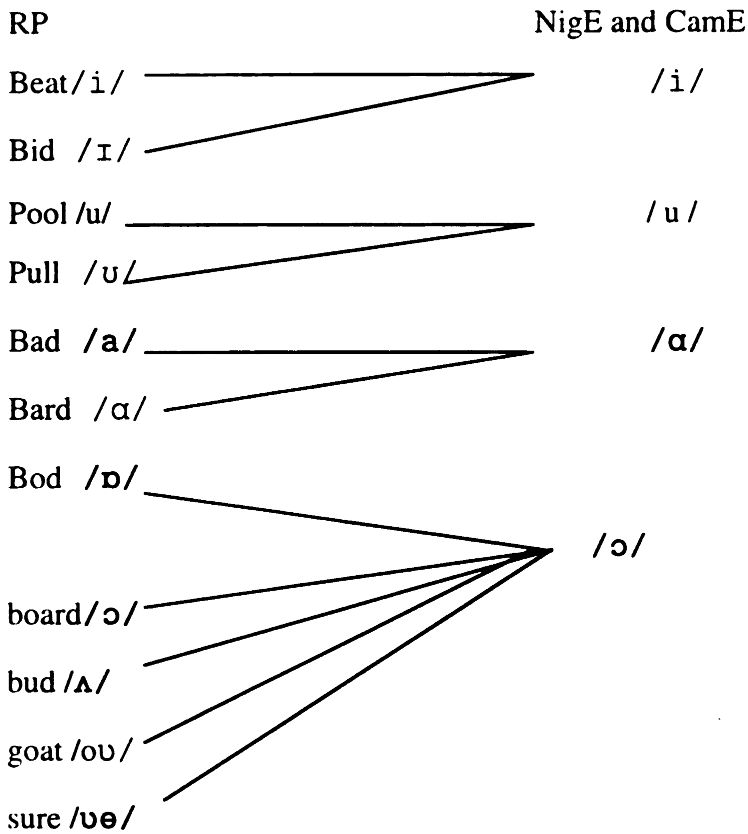

Figure 5 - A comparison of RP, Nigerian and Cameroonian Vowel Systems.

A spelling pronunciation of RP schwa into different segments in both varieties is represented in Figure 6.

Bobda criticizes the overgeneralizations of studies of West African Englishes for apparently misrepresenting the facts. He rejects the claim by Hancock and Angogo, echoed by Görlach (1991:135), Schmied (1991:61) and others, that the pronunciation of *bird* as [bɔd] is a feature of WAfrE. He contends that *bird* has the vowel [ɛ] as in the words *girl* and *shirt*, presumably distinct from [e], as in *made*.

Bobda claims that most of features identified as West Africanisms are indeed Nigerianisms, which have different realizations in CamE. Although Bobda's study distances itself from others, the empirical basis of his findings is as doubtful as the others and continues to illustrate the murky state of research in AfrE.

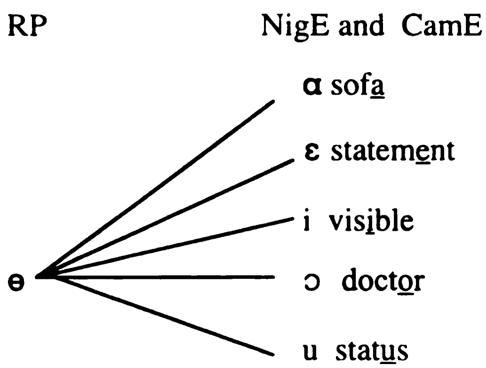

Figure 6 - The Realization of RP Schwa in Nigerian and Cameroonian Englishes

Bobda's assumptions are illustrative of the confusion that non-empirical studies pose to the field. For instance, the claim that Cameroonian English is a " some variety of Nigerianisms" poses more questions than answers. Which Nigerianisms is Bobda referring to? Do these characteristics transcend ethnic, social and linguistic boundaries? Such concerns mitigate for a more empirical investigation of languages in densely multilingual sub-Saharan region.

2. 2. 2. 2 East African English (EAfrE)

Angogo and Hancock (1982) state that while West Africa had little exposure to native speakers of English, East Africa had a considerable number of native speakers who had a greater influence in government and teaching during the colonial and the post-independence era. Due to the continued reinforcement of British standards in the schools, EAfrE never strayed far from the prestige dialect of England . They identify four types of English in the region:

(i) Native English (NE) of whites and expatriates.

(ii) NE of Africans of racially or linguistically mixed marriages.

(iii) Non native English (NNE) spoken fluently as a second language. The speech variety of the educated, mid and higher status Africans, '...it is the speech of this group, which may be taken as the norm of the varieties of EAE.' (308)

(iv) NNE imperfectly used as the foreign language by speakers who have little knowledge of English.

The samples in this study were drawn from type (iii) speakers who are educated and have a higher rate of contact with native speakers of English. The distinct vowel characteristics of EAfrE are:

(a) Vowel raising : *ran* is realized as [rɛn]

(b) Contrast of /a / and / ʌ/ is collapsed to [a]

(c) Tensed and lax vowels are not distinguished.

Hancock and Todd (1987) provide additional cases of vowel mergers in educated EafrE:

(a) Little distinction is made between vowels in:

beat and *bid* (usually realized as [I])

bad and *bed* (usually realized as [e])

Far and *for* and *fore* (realized as [ɑ])

Pool and *pull* (realized as [u])

(b) Diphthongs are monophthongised /ei/ is realised as [e], so that *bade* and *bed* are often indistinguishable.

As stated above, there is no empirical evidence to support the above analysis.

2. 2. 2. 3 Southern African English (SAfrE)

Todd and Hancock (1987) identify nine Southern African English speaking countries: Angola, Zambia, Malawi, Lesotho, Zimbabwe, Mozambique, Namibia, Botswana and Swaziland. However, Angola and Mozambique have a much stronger contact with Portuguese than English to be proper members of the set. Namibia's contact with Afrikaans also disqualifies it.

Todd and Hancock (1987:431) further argue that:

> There are many similarities between the English of east and southern Africa, the most marked of which is the tendency to raise the vowel in *back* so that *back* and *beg* differ mainly in terms of the final consonant.

They also note that SAfrE vowel length distinctions are rarely preserved, leading to such mergers as:

/i/ and /I/ so that *bead* and *bid* are both realized as [bid]

/a/and /ɛ/so that *bad* and *bed* are realized as [bɛd]

/ɒ/ and/ʌ/ so that *bod* and *bud* are realized as [bɒd]

/u/ and /ʊ/ so that pool and pull are realized as [pul]

Moreover, central vowels are avoided. Schwa is replaced by /a/ and /ɜ/ by /e/.

The absence of the SAfrE vowels in Figure 1 is due to the fact that the available literature analyzes the phonological characteristics of native speakers of English in the region. Literature on Black non-native speakers is scarce and sketchy.

Angogo and Hancock (1982) argue that there is a phonological similarity between SAfrE and EAfrE varieties since both varieties are influenced by indigenous languages that share a common Bantu substratum.

This study seeks to verify the assumptions about these broad varieties against vowel production and perception results of relatively homogeneous samples from Ghana, Kenya and Zimbabwe.

Chapter Three: Theoretical Framework

3. 1. 0 Introduction

This chapter discusses some basic theoretical premises that inform this study on issues pertaining to vowel perception and production, and on the definition of phoneme. By adapting some of the theoretical positions that are principally derived from empirical research on monolingual and bilingual populations, this exploratory study seeks to determine whether such assumptions apply to multilingual speakers. The Native Language Magnet Theory, the principal guiding theory of the current research, is particularly relevant, for it considers the perception of non-native speech.

3. 2. 0 Theoretical Framework

Theoretical assumptions discussed in this section are derived from previous research in linguistics and psycholinguistics. Of particular interest to this study are attempts to correlate speech production and perception (the phonetics/phonology interface).

Taking into account the nonexistence of similar empirical research in AfrE vowel systems, this study cautiously adapts theoretical assumptions based on the relationship between speech production and perception which are drawn from studies that have primarily focused on monolingual and bilingual speakers. This exploratory study, as stated above, targets multilingual speakers of English as a non-native language.

Two particular theories are central to our analysis and correlation of AfrE vowel production and perception. The Acoustic Theory of Speech Production provides an overview of some basic assumptions in acoustic analysis as presented in chapter five; the Native Language Magnet Theory, as outlined below, is our principle guiding theory in our understanding and interpretation vowel perception as discussed in chapter four. Prior to outlining these theories, some general theoretical assumptions about speech production and perception are discussed.

3. 2. 1 Some General Theoretical Assumptions

(a) Assumptions about AfrE

Central to this study is the assumption that African English is a very general term that refers to diverse social, regional and ethnic sub-varieties of English in East, West and Southern Africa.

Unlike previous studies that assumed homogeneity of broad regional varieties of AfrE, this study assumes those varieties are diversely influenced by such social and linguistic factors as level of education and ethnicity of these multilingual speakers.

Although RP vowel production is used as stimuli in listeners' speech perception tests in this exploratory study, it is assumed that RP is no longer the primary source of input in the formation of varieties of African English. African Englishes are the predominant target languages for new English speakers in the continent as educational institutions have been Africanized. Unlike in the colonial and early pre-independence era when RP speakers dominated the teaching core in teacher institutions of learning, and RP was the target language for new English learners, AfrE speaking teachers have dominated the classrooms , and consequently varieties of AfrE are target language for English learners. Moreover, RP continues to loose its dominant and prestigious role, as more communities place more emphasis in the growth of indigenous national languages. The expanding roles and social acceptance of Pidgin continues to diminish the dominance of European languages in Africa. For instance, West African Pidgin English (WAPE) has been so much intertwined with English in daily usage that its impact on WAfrE has long been overlooked. Although the impact of WAPE on WAfrE is not within the scope of the current study, Dwyer (1969) and Schneider (1966) have reported that WAPE has a seven vowel system. The similarity of WAPE and WAfrE's seven-vowel system, is an interesting topic worth of serious consideration.

(b) Assumptions about Vowels Systems in Some African Languages

Having conducted extensive research in African languages in western and southern African, including a reputable collaboration with numerous linguists in sub-Saharan Africa, David Westermann and Ian Ward wrote a classic phonetic guide designed for students interested in the study of African languages. Using x-rays to determine tongue position during vowel production, and a Cardinal vowel schema to compare and analysis vowel systems, these phoneticians observed that many African languages have seven-vowel systems, a few have more than seven, while others have five or six vowels only.

Ladefoged (1993) observes that phoneticians have extensively used the arbitrary reference points of cardinal vowel system as a scale for describing a wide variety of languages. He points out that the system consists of eight cardinal vowels, "evenly spaced around the outside of the possible vowel area and designed to act as a fixed reference point for phoneticians" (219). Although critics have noted the seemingly arbitrary nature of the vowel representation and the confusion over whether vowels are described on the chart in terms of tongue height or in terms of acoustic properties, Ladefoged (221) concludes:

> Despite all these problems, the cardinal vowel system works fairly successfully. It has allowed the vowels of a large number of languages and dialects to be described with far greater precision than has any other method.

The methods used by these phoneticians may have been the most appropriate tools to ensure precision in vowel comparisons and characterization, which may not withstand the test of time in modern studies, but may still represent assumptions worth considering, in a field lacking in empirical research. However, these phoneticians have emphasized more on the physical characteristics of the vowel. The non-physical attributes are not investigated as the current study has attempted to in the perception tests.

There are eight cardinal vowel reference points commonly used by phoneticians (see Appendix A'(i)) and Westermann and Ward have shown how the RP vowels fit into the scheme (See Appendix A'(ii)) . The vowel chart points 1 through 8 indicate the limits of possible vowel quality. For example, point 1/i/, represents the highest and most front possible vowel and its relation to the other front vowels.

Westermann and Ward make the following observations about vowels of African languages:

(a) Cardinal vowel No. 1 /i/: They claim that every language contains a vowel of i-type vowel.

(b) /e/ and /ε/: A large number of African languages contain two /e/ sounds ; a close one (Cardinal no. 2) and an open one (Cardinal no. 3). They claim that the English vowel in the word *bed* lies between the two. In some languages, for instances Zulu, the two vowels are allophones.

(c) Most languages have /a/ type vowel; in some languages, they further argue, it is nearer to the front /a/ (Cardinal no. 4) and in others it is nearer the back /ɒ/ (Cardinal No.5) African /a/ is rarely like English /a/ in *man*.

(d) Like /e/ and /ɛ/, /o/ and /ɔ/ are two /o/ sounds; close and open /ɔ/ closer to Cardinal No. 6 and /o/ Cardinal No. 7.

(e) Cardinal No. 8 /u/ can be long or short without changing quality.

These assumptions apply to a wide range of diverse languages, and only empirical research will verifying the conclusions made. In the meantime, they can assumed to be a rough depiction of vowels of L1s discussed in this study. Note that Westermann and Ward explicitly illustrate a peripheral vowel system lacking in central vowels, consistent with the acoustic analysis discussed later in the study. Do the perception results discussed in Chapter five point towards a Native Language Magnet effect?

(c) Assumptions About Speech Production and Perception

Some of the general assumptions concerning the correlation between speech production and perception are outlined below.

Kenstowicz (1994) argues that finding a proper balance between production and perception of speech sounds of any language remains a central concern of linguistic theory. Such a theoretical balance is essential, Kenstowicz further argues, considering the limitations of the vocal and auditory organs in speech production and perception:

> the phonological categories we do find empirically attested are constrained by the vocal tract and the human auditory system anatomical apparatus not specifically evolved for the articulation and perception of language. Phonological distinctions and categorizations display gaps that appear arbitrary from a purely abstract, classificatory point of view but seem to reflect contingencies of the articulatory and acoustic systems that realize language in speech. (1994:136)

Furthermore, generative phonologists have developed a model for the representation of speech sounds that is based on a close relation between phonetics and phonology. The Articulator Model, Kenstowicz argues, postulates that articulators play a central role not only in the production but also in the perception of speech sounds. The underlying assumption is that phonetics represents the physical realization of abstract linguistic categories.

A similar theoretical assumption is contained in Lieberman and Mattingly's (1985) Motor Theory of Speech Perception, which hypothesizes that listeners' interpretations of acoustic signals are guided by articulatory gestures in the sense that a variety of acoustic cues for a given feature point to a particular articulatory gesture. In Lieberman's (1993) term, this is vocal tract normalization, a case in which human listeners (in the case of vowel perception) have to determine the probable length of the supralaryngeal vocal tract of the speakers they are listening to in order to determine the frequency parameters of the appropriate vowel space.

Experiments conducted by speech scientists studying speech perceptual developments among infants have indicated that human beings are innately endowed with special devices for the perception of speech that differ from the neural and cognitive equipment used to perceive other sounds.

Moreover, Lieberman (1990) reports that experiments point to the fact that listeners perceive speech categorically; that is , listeners' ability to discriminate sounds from two different categories, such as /i/ and /e/, should be relatively easy, but discriminating two different tokens of /i/ from the same speaker should be difficult.

Listeners perceive the former as two distinct categories, but as a single sound category in the latter case.

Another theoretical assumption that echos a principal premise of sociolonguistic studies is the fact that perception and production of speech are influenced by linguistic and nonlinguistic factors. Speech perception research has shown that adults have difficulties perceiving and discriminating many nonnative contrasts. Best et al (1988), for instance, argue that language environment influences developmental speech perception, and that adult listeners perceive non-native sound contrasts based on a schema developed from their native language (see the Native Language Magnet theory below).

Language perception and production are intimately related and are, therefore, difficult to separate operationally, considering that every speaker is simultaneously a listener, and every listener is at least potentially a speaker.

3. 3 Assumptions About Non-Native Speech Perception.

Early theories that sought to define the relationship between speech perception and production devoted considerable attention in seeking to explain where in the human brain production and perception of speech took place. While some theorists argued that the functions were completely separated, other theorists, motivated by Broca's and Wernicke's discovery (of the distinct types of aphasia caused by lesions at different sites of the brain), held that production is localized on one part of the brain and perception in another, although the functions were interconnected. However, later studies showed the relationship was more complex than that presented by the classical theorists.

In this section theoretical assumptions relating to the perception of non-native sounds are discussed. Relevant to the current research is the perception of vowels of an acquired second language that are diverse from the first language of multilingual subjects. Identifying a correlation between speakers' production and hearers' perception of vowel variants, will help us determine the phonetic and phonemic properties of AfrE vowel systems.

In discussing perception of non-native speech contrasts, Best et al (1988) propose that any explanation of language-specific effects on speech perception should take into account the relation of phonetic properties to phonemic contrasts. Best and colleagues postulate several hypotheses to explain non-native speech perception. Unlike the general assumptions outlined in the previous section, the following hypotheses provide a more linguistically-oriented explanation of the nature of non-native perceptions.

The central premise of the following hypotheses is that the native phonological system of the listener plays a prominent role in perception of non-native sound contrasts. These hypotheses are reported in Best et al (1988).

The Specific Phonological Relevance Hypothesis, reported in Werker et al (1984), postulates that the more competent infants become in their native language, the less their ability to discriminate contrasting non-native sounds becomes, especially if those sounds do not have corresponding native phonological contrasts.

The Allophonic Experience Hypothesis, presented by Tees and Werker (1984), argues that listeners are able to discriminate contrasting non-native phones if their native language contains such similar allophonic variants. For instance, English-speaking adults are able to discriminate, especially after perceptual training, nonnative contrasts in which members occur as allophonic variants in English, e.g., Hindi [d^h]-[t^h], Spanish utterance initial prevoiced versus voiceless unaspirated [b]-[p]. In contrast, listeners have persistent difficulties with many nonnative contrasts in which one or both members fail to occur allophonically in the (English) native language (Tees & Werker 1984).

Werker and Logan (1985) present the Phonemic Perception Hypothesis, which assumes that during speech perception listeners who have acquired a phonological system of their native language perceive incoming sounds phonemically and assimilate them to phonemic categories of their native language. Best et al argue:

> assimilation may take place regardless of whether those sounds are native or nonnative and regardless of whether they actually occur allophonically or are simply phonetically similar to some native category (1988: 347).

Such non-native speech perceptions, they further contend, reveals that when phonemic perception (assimilation) occurs, it may fall into the following three different categories:

(a) Single-category assimilation: Contrasting phones are assimilated as variants of a single native category.

(b) Opposing-category assimilation: Phones are assimilated as opposing members of a native phonological contrast.

(c) Category-goodness difference assimilation: one member is better assimilated to a more phonetically similar category than the other.

(d) Non-assimilation: both members are phonetically dissimilar from any native categories and therefore not assimilated.

Categories a, b, and c involve perception of phonemically relevant information. Non-assimilated contrasts should be perceived in terms of their auditory or phonetic characteristics. Most contrasts in the world's languages fall under the first three classes.

AfrE speakers learn English as a second or third language after the phonologies of their first languages are well developed. It will interesting to test whether the phonemic perceptions and assimilations outlined in the above hypotheses and assumptions apply to our sample.

3. 4 The Native Language Magnet Theory

The Native Language Magnet theory claims that vowels of the native language are stored as prototypes or ideal exemplars of a given category. Further, these prototypes are said to hold a special status in speech perception in that they act as perceptual magnets, thus minimizing differences between the prototype and surrounding stimuli.

Kuhl (1993) reports on various studies that indicated that infants are innately predisposed with language-general abilities that initially enable them to perceptually partition a series of sounds at the places that the world's languages divide the series of stimuli into phonetic categories, rather than at arbitrary places. Furthermore, these initial abilities do not depend on linguistic experience, since infants have shown the same effect for foreign sounds they have never heard. On the other hand, research shows that linguistic experience transforms the language-general perceptual abilities into language-specific ones, as infants begin to acquire words, or as adults encounter difficulty in discriminating certain foreign-language contrasts. Infants are thus born with an excellent capacity to resolve the acoustic differences between speech sounds.

Studies from laboratory experiments conducted by Kuhl (1993: 125-6) reveal that:

> Prototypes (which, for these purposes, I am defining as exceptionally "good" instances of members of categories, ideal exemplars) play a unique role in speech perception. Phonetic category prototypes function like perceptual magnets for other stimuli... they attract nearby members of the category, rendering them perceptually similar to the category prototype. .. the magnet effect is obtained only for the prototypes of native-language categories.

The results have led to the development of the Native Language Magnet (NLM) theory, which describes how innate factors and experience with a specific language interact in the development of speech perception. Linguistic experiences in different cultures (linguistic environments) result in magnets that differ in number and location of vowel space for speakers and listeners growing up listening to different languages. Kuhl shows that 3 six-month old infants growing up in an English, Swedish, and Japanese environment will have language specific magnets that differ in location and number of vowels in the vowel space.

Of central interest to the current study is the NLM's explanation of adults' acquisition of a second language. Kuhl (1993:131) argues:

> The native-language categories of the listener interfere with the ability to perceive certain phonetic distinctions in the new language. The proximity principle again holds: the nearer a new sound is to a native-language magnet the more it will be assimilated by it, making the new sound indistinguishable from the native-language sound. Phonologists have argued that the phonetic categories of ones' native language form some sort of "sieve" through which phonetic units of newly acquired language must pass (Trubetzkoy, 1939). NLM provides a potential mechanism by which this could come about.

Werker and Polka (1993) report that research with adults has shown that experience with a particular language leads to a decreased perception of at least some non-native phonetic contrasts and an enhanced perception of native phonetic contrasts. Therefore, adults will have difficulties in discriminating phonetic contrasts that are not used in their native language, although they have some ability to do so. Adult speech perception is organized to process the native language with the least effort and greatest efficiency.

In cross-language adult vowel perception, Werker and Polka report, evidence shows that effects of language experience are more apparent in the identification rather than in the discrimination of sounds.

3. 5 Acoustic Theory of Speech Production

Having discussed our guiding theory in speech perception, a theoretical framework for analysis of speech production is presented in this section. Jusczyk's (1986) articulation of the theory is our primary reference in this section.

The human vocal apparatus is a complex system involving many different sets of muscles to control the actions of various articulators involved in the production of speech. Different sets of articulators determine the nature of sound produced. The vocal apparatus generates complex acoustic waveforms. Each speech sound that starts as a pressure wave generated by the lungs has a source that generates an acoustic wave form filtered by the vocal tract as voiced or voiceless.

The supralaryngeal tract varies in size and shape, resulting in different acoustic filtering characteristics. For instance, one can narrow the vocal tract in one location while widening it in another as when producing a vowel resulting in changes in acoustic filtering characteristics. Therefore, the physical sound that is realized is a product of several factors.

Jusczyk (1986:27-3f) defines those factors such as source spectrum S(f), vocal tract transfer function T(f), and the radiation characteristic R(f); all interact in the production of any given speech sound. Source spectrum consists of components at multiples of the fundamental frequency. The amplitude of the components decreases by about 12 dB per octave at high frequencies. T(f) relates to the filtering characteristics of the vocal tract. It changes with the shape of the vocal tract from one articulatory position to another. The shape of the vocal tract will determine which components of the source spectrum will be reinforced and which ones will be suppressed. The resonant frequencies favored by a particular vocal tract configuration are called formants, and they will appear as formant peaks in the transfer function. R (f) describes the relation between the volume velocity at mouth opening and sound pressure at distance from the lips. The radiated sound pressure P(f) is a product of all the three components: P(f) = S(f) x T(f) x R(f).

The acoustic filtering characteristics of the vocal tract are critical in determining which speech sound emerges during an utterance. As the vocal tract is narrowed at some location during articulation, its resonance characteristic changes.

3. 5. 1 Vowels

Vowels can be distinguished by reference to the frequency values for the first two formants. The shared articulatory features of members of a class can be another criteria for distinguishing vowels. Such a division can be made based on the point of the narrowest constriction in the vocal tract, back vowels such as [u], [o], [ɔ] and [a] are produced with the tongue raised or lowered at the back of the oral cavity. For central vowels, tongue height is modified in the midpalate region, whereas for front vowels the tongue is raised or lowered front of the palate.

Degree of closure gives the distinction between open and closed vowels; amount of lip rounding distinguishes rounded and unrounded vowels. There are also monophthongs and diphthongs.

Acoustic analysis of AfrE vowel systems presented in Chapter five is defined and interpreted on the basis of Juscyzk's analysis presented above.

3. 6. 0 Assumptions About Phonemic Identity

3. 6. 1 Introduction

While the previous sub-sections discussed AfrE vowel production, this sub-section attempts to illuminate the phonemic shape of variant vowel systems based on listeners' perception of RP vowels.

Although AfrE vowel perception data is the main concern of this chapter, a sketchy history of efforts towards identifying and analyzing phonemes may help contextualize this study relative to earlier AfrE vowel studies discussed in Chapter Two. Conclusions presented later in this chapter are based on a correlation of empirically derived vowel production and perception results. The overview presented here is far from being a comprehensive account of the development of phonemic theory, but it tries to provide a description of some defining stages in the ongoing attempts to present a precise analysis of variation in both physical and abstract terms.

3. 6. 2 On Defining a phoneme: A brief historical overview

A historical overview of descriptive and analytic attempts over the years at interpreting phonetic and phonological (or phonemic) identity in language studies may provide a better understanding of the phonemic investigation discussed in this chapter.

Outlined below are studies that have significantly contributed to the formulation of phonemic theory and the refinement of methods of phonemic identification.

The relevance of such an overview to this study arises from shared objectives, in a very general sense, that is, interest in the interpretation of phonetic and phonological identity. Moreover, a significant contribution of this study lies in methodology: attempts at identifying L2 (or even L3) phonemic variables from multilingual speakers by adapting methods of analysis traditionally used in the investigation of monolingual speech communities.

3. 6. 2. 1 Phonetic and Phonemic Identity

Trubetzskoy and the Prague school phonologists were instrumental in defining the phoneme as a complex phonological unit realized by the sounds of speech. Earlier scholars had viewed the phoneme as a transcriptional device. A phoneme, argued the Prague school, was composed of a number of separate distinctive features with each distinctive feature standing in opposition to another feature or its absence in at least one other phoneme in the language. Adapting Saussurean theoretical concepts, these scholars defined speech sounds as belonging to the physical *parole* while the phoneme belonged to the abstract *langue.* As a result of the work of the Prague school, R.H. Robins argues, the phoneme concept "became one of the fundamental elements of linguistic theory as a whole, and of the scientific description and analysis of language" (1990: 226).

Ideas postulated by the American structuralists marked the next landmark in the study of phonemes. Leonard Bloomfield's physicalist view of language analysis and Edward Sapir's psychological school marked the early structuralists' attempts at determining the nature of a phoneme. While the psychological school viewed phonemes as abstract concepts; 'ideal sounds;' 'mental equivalents of a speech sound' and 'percepts,' Bloomfieldians considered phonemes as physical constructs of speech sound- ' overt aspects of physical speech event.' Bloomfield's perspective dominated this particular linguistic era.

In his widely cited definition of the phoneme as 'a minimal unit of distinctive sound' (Language:1933: 79), Bloomfield, as Stephen Anderson observes, implies that a phoneme has a phonetic identity composed of distinctive and non-distinctive physical (phonetic) properties. The first mentioned properties, Bloomfield contented, belong to the phoneme while the latter properties, though present in actual realization of a phoneme, are not significant for the linguistic study of speech.

Phoneme features are present in sound waves and have linguistic significance in that speakers are trained to produce and respond to these features while ignoring the rest of gross acoustic mass reaching the ear (1933: 79)

Bloomfield's analysis lacked a method that would unequivocally recover phonemic representations (distinctive properties) from phonetic data as defined.

In the 1940s, while linguists seemed to have reached a consensus on the definition of a phoneme, there were still disagreements on methods of identifying them, Anderson reports. Consequently, more linguists concentrated on formulating methods of extracting phonemes from language. Morris Swadesh's formulation of basic principles of phonemic analysis (the inductive procedure) is widely cited as the groundbreaking analytical procedure whose refinement was the crux of subsequent statements on phonemic analysis in the post-Bloomfieldian era. The following two principles were central to post-Bloomfieldians' analysis of the phoneme.

Post-Bloomfieldians made the assignment of phones to phonemes subject to what is now generally referred to as the principle of bi-uniqueness. The principle stipulates that if two words or utterances are pronounced alike, then they must receive the same phonemic description; conversely, two words or utterances that have been given the same phonemic analysis must be pronounced alike. The principle of bi-uniqueness was also held to imply that, if a given phone was assigned to a particular phoneme in one position of occurrence, then it must be assigned to the same phoneme in all its other positions of occurrence; it could not be the allophone of one phoneme in one context and of another phoneme in other contexts.

A second important principle of the post- Bloomfieldian approach was its insistence that phonemic analysis should be carried out prior to and independently of grammatical analysis. Neither this principle nor that of bi-uniqueness was at all widely accepted outside the post-Bloomfieldian school, and they have been abandoned by generative phonologists In short, the behaviorist approach of American structuralism contended that phonemic structure could be adduced from information present in overt speech.

By the 1950s, Anderson further reports:

> Science in general was becoming more concerned with the extent to which theories taken as a whole had explanatory and predictive power within a given domain, bringing coherence and clarity to it, rather than with the mannner in which individual statements within a theory can be operationally verified. With this turn, much of the philosophical rationale for the specific conceptual foundations of structuralism crumbled. (312)

Morris Halle and Noam Chomsky's generative phonology revolutionalized phonemic analysis by showing the inadequacies of the structuralist school. They rejected the behaviorist approach in favor of a mentalist perspective similar to the one that Sapir advocated. The bi-uniqueness principle, the cornerstone of structuralism, was shown to be counterintuitive. Halle emphasized the centrality of rules in phonological description. Halle's presentation marked a major shift from a concentration on the properties of phonological representation and their elements to a much greater stress on rules of grammar. Chomsky, Halle and Lukoff (1956) had shown that phonological structure was not independent from grammar as structuralists proposed.

Generative phonologists, Kenstowicz (1994) argues, interpret phonetic and phonemic identity as two different conceptualizations or representations for phonological information. On the one hand is surface (phonetic) representations which indicate how sounds are actualized in speech-'the instructions sent to the vocal apparatus to articulate the sounds and acoustic properties that are isolated in order to decode the speech signal' (7). Underlying (phonological) representation, on the other hand, contain the more abstract information structures that an individual speaker has stored in the brain after acquiring a language. The two representation are however 'systematically related by phonological rules' (7).

Interest in establishing an interface between phonetics and phonology has been widespread in recent years. In seeking to identify social and linguistic factors that account for language variation, sociolinguists are increasingly seeking more precise methods of extracting and analyzing phonetic and phonemic data. Such concerns for precision have for instance led to development of computer software (as detailed in the previous chapter) that provide detailed acoustic characteristics of sounds to enable researchers to identify even subtle variations in speech production. Researchers interested in the American Northern Cities Vowel Shift have made great inroads in refining methodology in phonetics. Phonemic analysis continue to attract interest and generate more refinements from interdisciplinary research.

Labov (1994) has noted that the Minimal Pair Test (MPT) for the identification of phonemes continues to be a preferred method of analysis. This method of determining whether a single sound difference distinguishes the meanings of two words and classifies as separate phonemes the sounds that are responsible for a difference in meaning in such a minimal pair. In other words, sounds are separate phonemes if they contrast in identical environments; that is, if the choice of one sound over another in a particular environment alters the meaning in a word then the two sounds are different phonemes.

Labov argues that the MPT as an empirical method for determining the contrastive status of phonemes in a speech community takes into account that listeners perceive and respond to sounds in categorical terms. The test requires a native speaker of a language variety to determine whether two utterances are 'the same' or 'different.' The pairs of words are identical except for one element, which is represented as one type of sound in one member of the pair and another type in the other member. This method has been widely used in the extraction of phonemes discussed in this chapter.

Psycholinguists have shown evidence that points to the fact that the way in which people speak greatly influences their perception of what is said to them. For example, experiments have shown that speakers are unable (prior to training) to pronounce lax and tense vowels if such a distinction is not realized in their language. It is further reported that such people also have difficulty in hearing the difference between such distinctly defined vowels. The basic premise of this motor theory of speech perception is that the perception of speech is structured in terms of linguistic categories. Such a presumption is made in this study.

Language acquisition research among bilingual adults and children has shown that native language vowels are stored as prototypes. During speech perception such prototypes act as magnets that 'pull' the non-native sound closer to the native prototype, and as a result, spectral differences between the native and non-native sounds are minimized. This is the central premise of the Native Language Magnet Theory; the guiding theoretical framework of this study

Chapter Four: Methodology

4. 1 Introduction

This chapter describes the methods used in the collection and analysis of acoustic and perception data. The study focuses only on the onset (steady state) characteristics of vowels, while at the same time being cognizant of the fact that other phonetic features distinguish the vowels within and across varieties.

The first half of this chapter describes the respondents and the procedures of collection and analysis of acoustic data.

4. 2 Collection of Acoustic Data

4. 2. 1 The Production-Sample

All respondents were carefully selected based on their country of origin (i.e., sub-Saharan African countries with a long tradition of English language usage), level of education (i.e., university or college students) and their first language (i.e., speakers of Kwa and Bantu languages). Male respondents were initially selected for purposes of our preliminary study, and female respondents were later incorporated into the schema of this broader study. Appropriate respondents for this study were identified by the 'friend of a friend' network method, as described in Milroy (1980). Initially, I contacted my friends at three African universities[1] who identified a network of friends that made up our sample.

Data was collected from male and female university students in Ghana, Kenya and Zimbabwe. The age range, of these native speakers of Kwa and Bantu languages, was between 19-45 years. (See Appendix A for respondents' profiles). Speakers of the Akan dialect cluster languages were chosen in Ghana (These include speakers of Fanti, Twi, Ashanti and Ewe languages). Shona and Ndebele speakers in Zimbabwe, and the largest Bantu language groups in Kenya: Gikuyu, Gikamba, Lubukusu, and Ekegusii.

4. 2. 2 Data Collection

Speech samples were elicited using the questionnaire method. In the first section of the questionnaire, respondents were asked to answer brief biographical questions that elicited age, gender, residence and language background information. Subsequently, the subjects were requested to read a randomized list of 21 monosyllabic words that contained vowels and diphthongs that are relevant to this study. The list included the following words: *bead, here/year, hair, hid, caught, bout, good, hard, sod/nod ,boat/goat, tour, buy/pride, sure, board/saw, boy, mud, bad, bird, mood, bet/bed, hue made/name.* The word list was adapted from the lexical items used in previous studies on AfrE (see Figure 1). A reading passage specifically constructed to incorporate lexical items already presented in the wordlist was also presented to the subjects. The procedure allowed us to analyze both casual and formal styles of production, on the stylistic continuum, for each vowel under investigation. Each interview was tape recorded.

4. 3. 0 Data Analysis

4. 3. 1 Acoustic Measurement

The collected data was subjected to two kinds of analysis: quantitative and qualitative. The most fundamental data, the vowels contained in the word-list, was extracted and frequencies of the first two formants (F1 and F2) calculated using a computer program (SIGNALYZE version 3.12) designed for acoustic analysis. The extraction procedure involved digitizing sound by way of sound input from tape to

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[1] Collection of data in Africa was conducted by Dr. Harry Akussah of University of Ghana, Dr. Sawasawa Kambewa of Malawi, Maina Mutonya of University of Witwatersrand, S.A.and Dr.

computer. Consequently, each word is saved as an acoustic waveform on a Signalyze screen, from which the relevant vowel is identified, isolated, and F1/F2 scores calculated. Formant measurements were calculated by locating the cursor at an appropriate point of a waveform, using linear predictive coding (LPC). The F1 frequencies are inversely associated with the height dimension, and the F2 frequencies are associated with the front-back dimension.

A data file for each respondent was subsequently prepared showing F1, F2 scores, vowel class, stress and word (see Appendix B). These scores were subsequently loaded into a computer program (PLOTNIK (version 04)), a vowel system analysis program developed by William Labov for plotting vowel systems from formant measurements (see Appendix C 1). The data is recoded, a procedure that reads the orthography of the word and adds phonetic information of the vowel, indicating, in code form, the manner, place of articulation, and voicing of preceding segments and following sequences.

A preliminary accuracy evaluation task was performed after tokens were plotted on a PLOTNIK vowel chart. When formant values of the same vowel and subject showed wide variation, we double-checked them by listening to and comparing the spectrograms of the tokens. In cases where a respondent clearly misread a word (e.g. read the word *bout* as *boot*, *made* as *mad*, or *sod* as *sad*) on the word list, the correct word was extracted from the reading passage and measurements of the correctly read vowel replaced the misread one. After data from each group and region is recoded, a group mean is calculated, and all files are normalized. Labov (1998:23) explains the need to normalize data:

Abraham Ndungu of Kenyatta University, Kenya.

> [Normalization transforms] all measurements into a single reference grid which will show vowels which sound the same with the same formant values. Ideally, this would duplicate the normalizing process of the human ear and neural network...it has proven to be more successful than others in eliminating effects due to differences in vocal tract length, while preserving those social differences of age and sex that are inherent characteristics of the speech community .

Having reduced linguistically irrelevant differences in the production of speech signals through normalization, the resultant acoustic vowel chart becomes an accurate representation of the linguistic aspects of the vowels, facilitating both across-speaker and across-language comparison as B.G. Yang, (1996) demonstrates in his comparative study of American English and Korean vowels.

4. 4 Vowel Perception Data

Two perception tests were conducted to determinate listeners ability to identify and discriminate RP vowels: The minimal pair test (MPT) and the identification test (IT).

4. 4. 1 Data Collection Methods

Data was collected using a tape recorded stimulus voice and questionnaire as the main data elicitation tools. A minimal pair test (MPT) and identification test (IT) were carefully designed to elicit perceptual responses of lexical items (and vowels indirectly) used in the acoustic analysis presented in the previous chapter (see questionnaire and minimal pair list in Appendix D). In the MPT, respondents were requested to mark whether the each of the fifty-seven pairs of English words recorded on tape were the same words or not. The IT entailed listening to the same fifty -seven pairs and writing on the questionnaire provided what each word was.

The minimal pair list was adapted from a randomized list of 21 monosyllables used earlier in the elicitation of acoustic data (see 3.2.2). However, in this case other monosyllabic words were carefully added in order to create minimal pairs, while in some instances words were simply reduplicated to test for a particular vowel. The list included the following pairs: *beat/bit, weed/wed, bid/bird, hid/hid, wade/word, bit/bet, meet/meet, mad/mud, hay/hair, bid/beard, made/made, he/hue, bed/bad, bay/beer, bet/bet, bird/bird , beat/bait, don/dawn, bird/bad, bird/bud, wade/wed, bed/bird, bat/bat, had/hard, heard/hoed, bait/bat, bird/board, dam/dime, bat/bout, rug/rug, mud/mad, cat/cot, hut/hurt, gut/got, mud/mode, land/lend, bud/board, got/goat, wooed/wood, law/lure, sod/soy, call/call, but/bought, hot/hot, bought/bout, call/coil, walk/work, boot/boat, caught/cot, cod/cured, cook/coke, good/good, got/gout, he/here/book/book, who/hue, cot/caught.*

An RP speaker carefully read the list for recording. All respondents listened to the same list read by the same speaker. Subsequently, a correlation of acoustic and perception results was done to determine the vowel systems.

4. 4. 2 The Perception-Sample

Responses were elicited from one hundred and sixty students (undergraduate and graduate) from universities in Ghana, Malawi and Kenya. The demographic characteristics of this perception-sample is similar to the production-sample discussed above. In a nutshell, the age range of the sample is 19-45, both male and female respondents participated, Kwa and Bantu speakers were identified to participate in the survey. Respondents were identified using Leslie Milroy's friend of friend network method.

The RP speaker who read the stimulus words is a thirty year old graduate student at Michigan State University. By the time of the recording, he had lived in the United States for less than two years.

Acoustic and perception data is discussed in the following chapter.

Chapter 5: Data Analysis

5. 1 Data Presentation and Discussion

In this section, vowel production among male and female speakers of AfrE is analyzed using Signalyze and Plotnik computer software.

As stated above, the current study focuses on vowel production among educated male and female members of Kwa (in Ghana) and Bantu (in Kenya and Zimbabwe) language groups, who have acquired English as a second or third language. This narrowed focus takes cognizance of social and linguistic factors that are bound to affect a non-native speaker's production and perception of foreign language phones (i.e. English).

English in sub-Saharan Africa has varied degrees of contact with diverse indigenous African languages in different language settings. In many settings, dominant indigenous languages compete strongly with English in societal perception and assignment of roles. Apart from the dense multlingualism of the speech communities in question, our study takes account of the diversity of multilingual backgrounds among individual AfrE speakers and its assumed effect on production and perception. As postulated in our guiding theoretical assumption, the NLM theory (see chapter 3), non-native speakers will perceive, and presumably produce, foreign vowels in terms of native phonological categories and as exemplars of native vowel types. Considering further that many sub-Saharan countries have a diversity of L1 speakers (Nilotic, Semitic, Cushitic, Bantu, Kwa and others), it was necessary to seek a homogeneous sample. Earlier studies seemed to overlook this linguistic diversity.

The following analysis and discussion is based on acoustic measurements of the physical qualities of vowels. In the next section, the non-physical qualities of the vowels are measured using the vowel perception tests.

AfrE vowel variation is illustrated in Schmied's comparison of RP vowel realization with those of WAfrE and EAfrE speakers (Figure 1). The illustration shows how the RP thirteen-vowel system is realized as a seven-vowel system among WAfrE speakers and a five-vowel system among EAfrE speakers through such phonological processes such as mergers, lowering and fronting. The reduction in the AfrE vowel systems may be a clear testimony of the influence of phonological systems of indigenous African languages in the production of RP vowels by AfrE speakers. Such a claim would reflect the primary tenet of the Native Language Magnet Theory (see Chapter 3)

According to earlier studies in the field, the WAfrE vowel system contrasts lax and tense front and back central vowels /e/, /ɛ/ and /o/, /ɔ /, while EAfrE does not. Both systems merge their lax and tense high vowels /i/, /I/ and /u/, /U/.

5. 1. 1 Schmied's Analysis of AfrE Vowel Systems

Figures 7, 8, and 8 recreate RP and AfrE vowel systems presented in Figure 1 in a vowel chart configuration, highlighting suggested phonological processes that occur in the production of AfrE vowels. Lowering, backing and fronting, are the major processes that result from decentralization of RP central vowels.

Since F1 and F2 scores are generally unavailable in the literature, Figures 7, 8, and 9 are not acoustic representations of the vowel systems, but extracts intended to display relations among the vowel systems as represented in Figure 1. Therefore, unlike

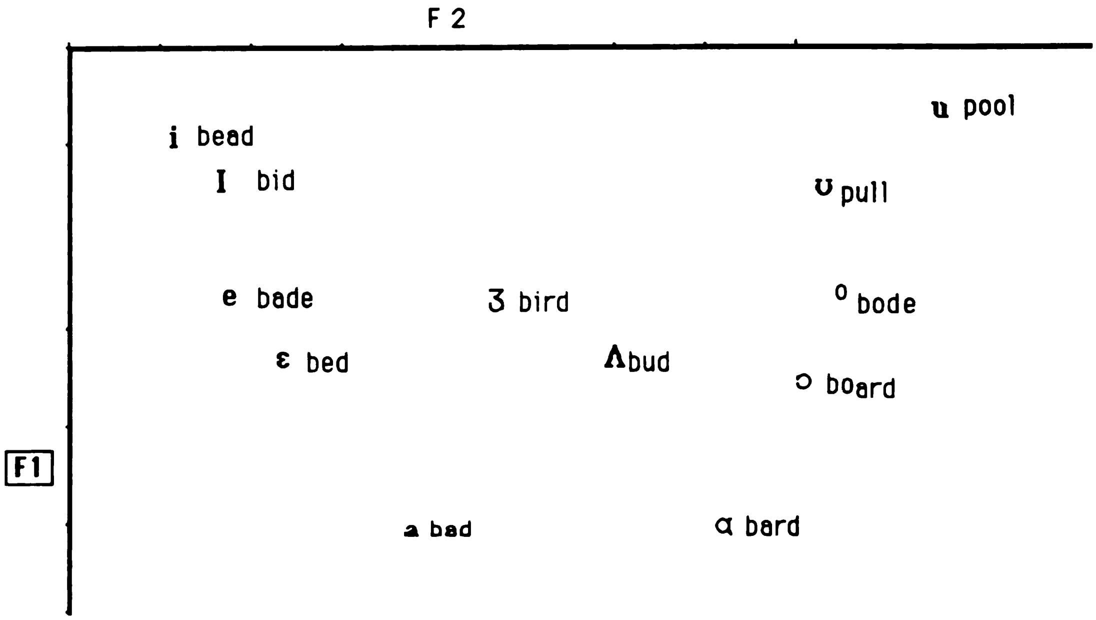

Figure 7 - representation of the RP vowel system as illustrated in Figure 1

our later vowel charts, which are based on instrumental measurements of F1 and F2 scores of each vowel nucleus, such scores are not indicated.

At this juncture, we should note that throughout this study vowel charts are presented in a two-formant illustration , irrespective of whether the presentation is based on approximations (Figures 7, 8, 9) or precise instrumental measurements of vowel nuclei. First formant frequencies (F1) are plotted on the ordinate (vertical axis), indicating the height of the tongue in the oral cavity. Second formant frequencies (F2) are plotted on the abscissa (horizontal axis) indicating the position of the vowel along the front/back dimension of the oral cavity.

Figure 7 shows the configuration of an RP vowel system. On the front/back (F2) dimension, three types of vowels are identified: front vowels [i, I, e, ɛ, a], central [ɜ, ʌ], and back vowels [u:, ʊ, ɒ, o, ɑ]. On the height dimension (F1), RP vowels are distinguished as high [i: I, u, ʊ], mid [e, ɛ, ɜ, ʌ, o, ɒ] or low [a, ɑ]. A tense/lax

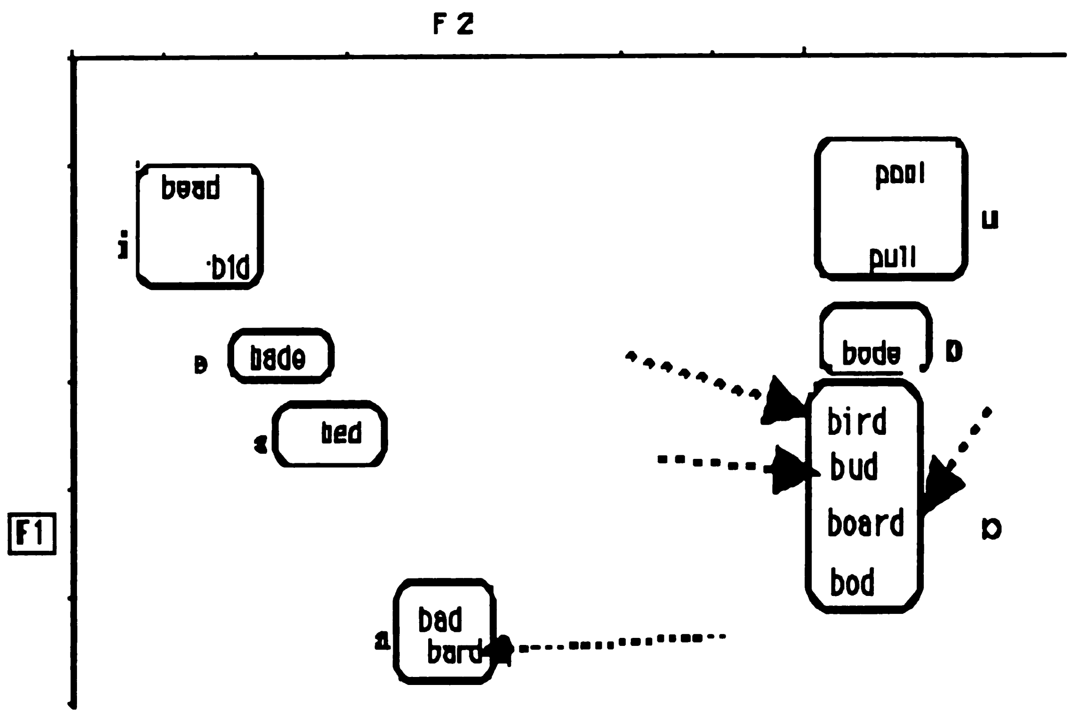

Figure 8 - A representation of WAfrE as illustrated in Figure 1.

(close/open) distinction is evident in the vowels [e/ ɛ] [i/I], [u:/ ʊ] [ɒ /ɔ]. Moreover, RP has a vowel length distinction in [i:/I, u:/ ʊ, and ɒ /ɔ]. In the discussion to follow, it is necessary to consider the arrangement of the phonological space among AfrE speakers, particularly in regard to RP's central vowels, vowel length, and tense/lax distinction.

In the WAfrE seven-vowel system that Schmied suggests (Figure 8), RP central vowels [ɜ and ʌ] are backed to [ɒ]. [ɔ] is lowered to [ɒ]. The tense/lax distinction is maintained in the front mid vowels [e/ɛ].

Figure 9 illustrates Schmied's EAfrE five-vowel system which (like WAfrE) has no central vowels. RP's central vowels [ɜ and ʌ] are lowered to [a]. In the discussion to follow, our dissension with Schmied on this issue is not in the characterization of the EAfrE system, but in the assumption that the EAfrE and SAfrE vowel systems are

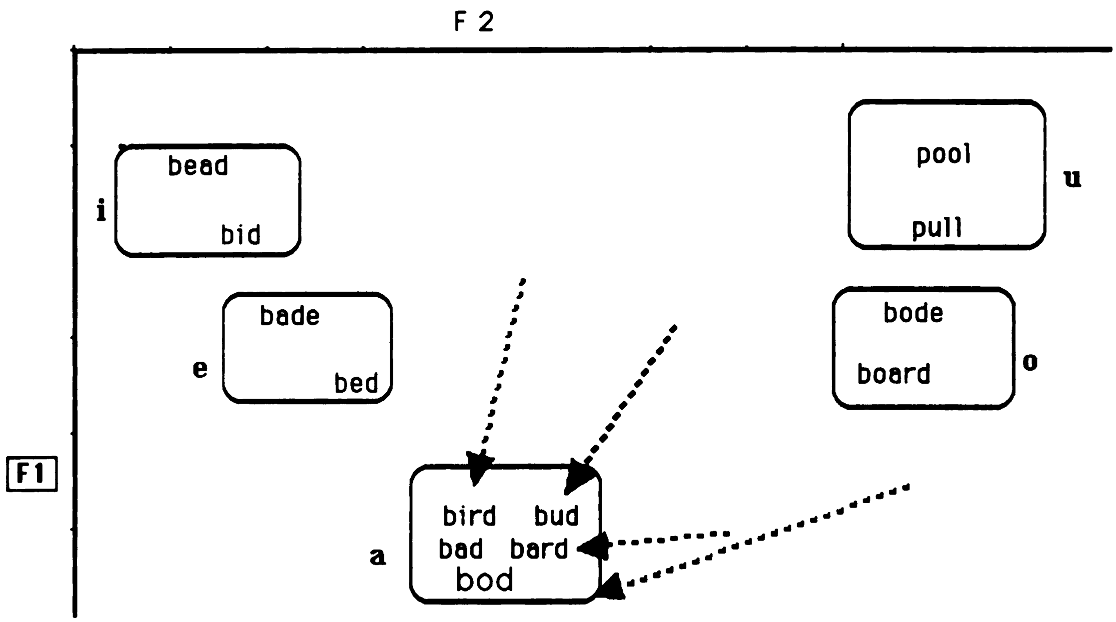

Figure 9 - A representation of EAfrE as illustrated in Figure 1

identical. RP's tense/lax distinction, evident in the WAfrE mid vowel system above, is lost in the mergers of high, mid, and low vowels in EAfrE, and, by inference, SAfrE.

Schmied's discussion of diphthongs is limited to the following observation that other studies have echoed throughout the literature:

> Diphthongs tend to have only marginal status and to be monophthongized. This is certainly true for the closing diphthongs /ei/ and /'u /, where the second element is hardly heard in many African varieties, thus almost coinciding with the /e/ and /o/ phonemes. Diphthongs with a longer glide are preserved, but they are not really pronounced as falling diphthongs, i.e., with less emphasis on the second element than the first, but rather as double monophthongs (e.g. /oi/, /au/). All the centering diphthongs (/i'/ , /e'/, /u'/ tend to be pronounced as opening diphthongs or double monophthongs (/ia, ea, ua/) (Schmied, 1991:59).

In the following subsections, we compare our findings with Schmied's and, by implication, the vast majority of others who have commented on AfrE vowel systems.

5. 2 An Empirical Analysis of AfrE vowel systems

In this section, we present and discuss vowel production among respondents from Kenya, Zimbabwe and Ghana, based on the results derived from Signalyze and Plotnik analysis. The results for each region are presented in three phases. First, an overview of vowel production by all respondents in each region is presented by combining all data files into one. The file is then analyzed using Plotnik, resulting into vowel charts in Figures 10, 11, and 12. Secondly, each general vowel plot is followed by individual sample charts that exemplify the general trend in the majority of cases among male and female respondents. Finally, observations are made and conclusions drawn.

It is important to nte at this juncture that the plot for "all tokens" in each region is supposed to confirm the general picture and to justify the token groupings made in the illustrative individual plots. For the instance, the token groupings shown in the individual plots in each region and gender, is based on the emerging clustering of tokens when all individual vowel plots in each region and gender are considered. The two individual plots were chosen as the exemplars of the entire group. All F1/F2 scores are shown in Appendix B2.

5. 2. 1 Kenyan Speakers

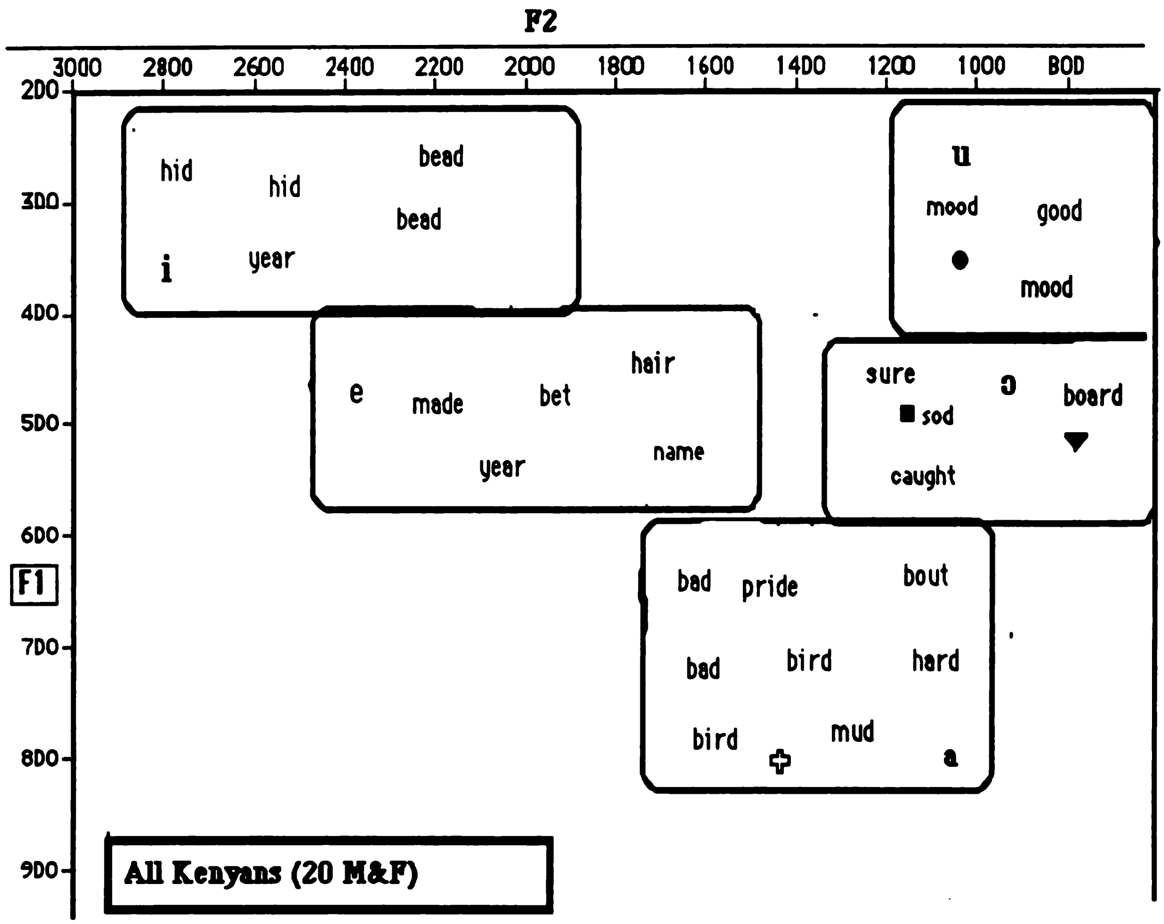

Figure 10 - Vowel Plot of all Kenyan Respondents

Figure 10[1] represents the overall vowel production of 20 male and female university students from Kenya. Based on the evidence presented, the vowel system is evidently a peripheral five-vowel system that lacks central vowels. Vowel clustering in Figure 10 can be summarized as follows:

/i/ bead,[hid, year]

/e/ made, bet, hair, name, [hid, year]

/a/ bad, bird , hard, pride, bout, mud

/o/ sod, goat , board, caught, boy, sure.

/u/ good, mood

Considering that such general plots may obscure finer details in the vowel production, this study analyzes each vowel production in each individual system, and assumes that patterns recurring in a majority of cases represent vowel production of the entire sample.

5. 2. 2 Kenyan Male Respondents

The following two normalized vowel charts are representative of the vowel production among eleven Kenyan male respondents. The collection, analysis and acoustic measurements of the vowels is explained above. The normalized F1/F2 scores of all respondents are shown in Appendix C2.

Figure 10.1 illustrates a plot of the F1 and F2 frequencies for the 22 tokens produced by Njenga-a 24 year old Kenyan male university student. Njenga's vowel system, like all other AfrE vowel systems analyzed in this study, is a peripheral system that, unlike the RP system, contains no central vowels. Central vowels are fronted,

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[1] Figures 10, 11 and 12 were carefully edited in order to reduce dense clustering of the 400 tokens and labels that would otherwise have obscured the details in the chart.

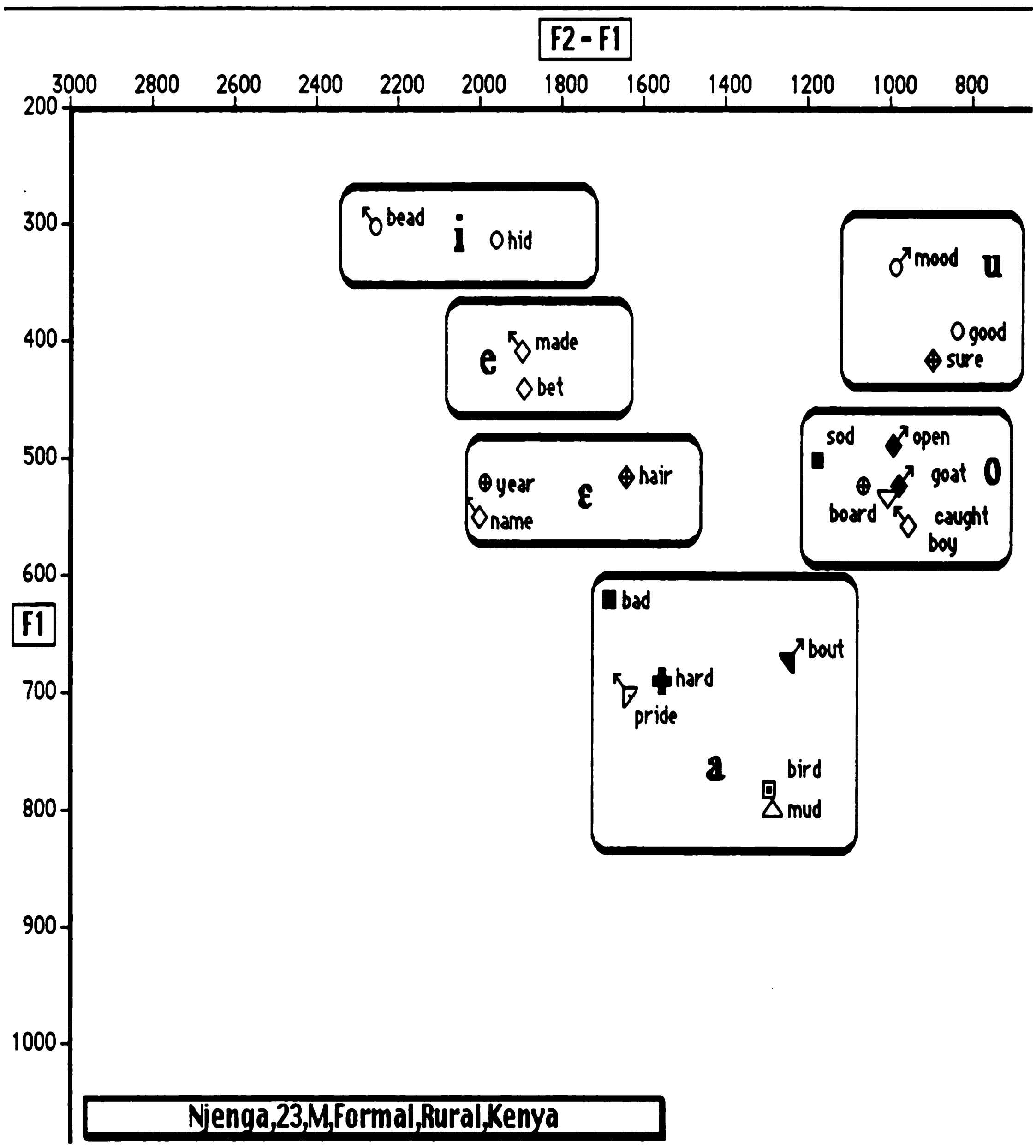


Figure 10.1 - Njenga's Vowel Plot

backed or even lowered to merge with non central vowels. In Figure 10.1, vowels contained in the tokens *bead* and *hid* are realized as [i]; vowels in the words *made* and *bet* as [e]; *year*, *hair*, and *name* , are produced as [ɛ]; *bad*, *hard*, *pride*, *bout*, *bird* and *mud* [ʌ] are pronounced as [a]; *sod*, *open*, *goat*, *caught*, *board* and *boy* as [o]; while

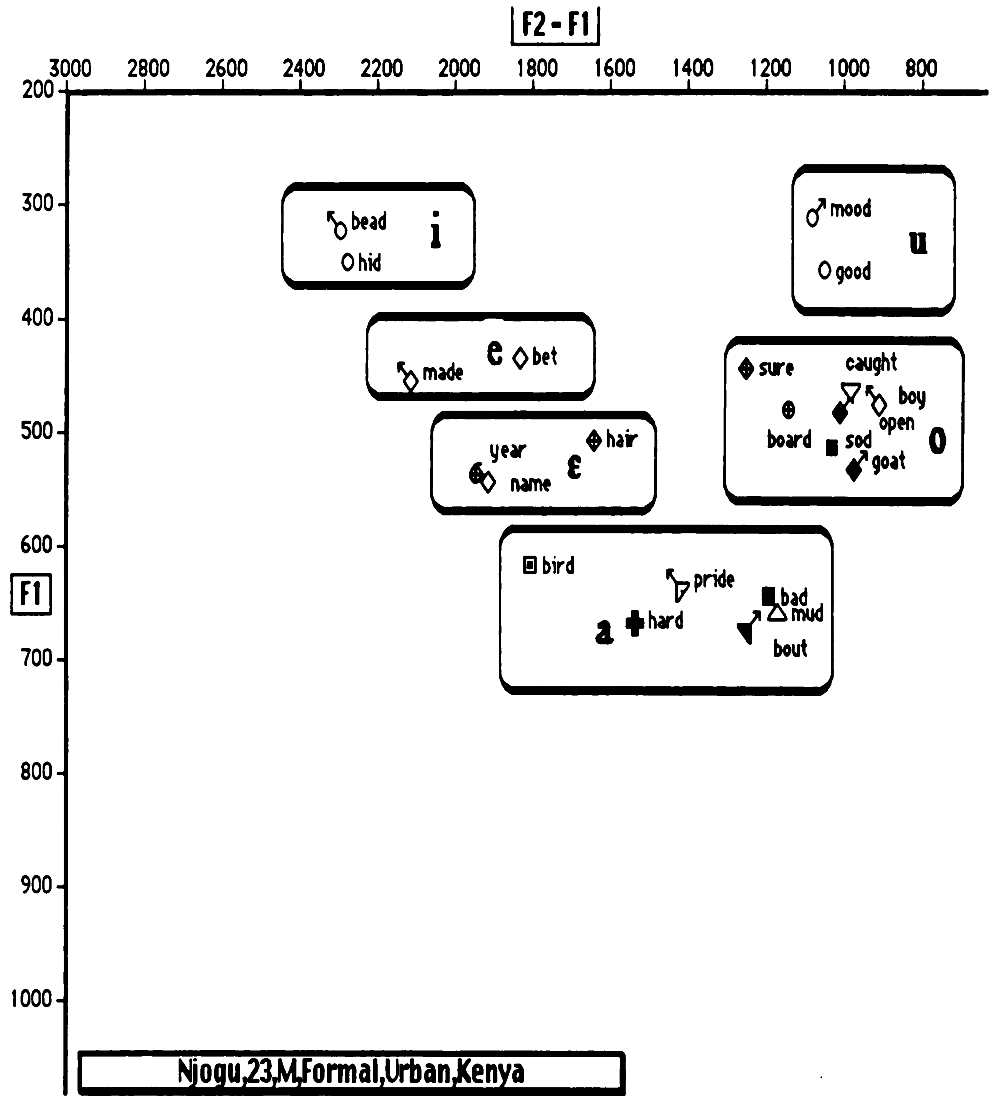


Figure 10.2 - Njogu's Vowel system (a Kenyan Male)

mood , good and sure are realized as [u].

Njogu's vowel production (Figure 10.2) is almost identical to Njenga's (Figure 10.1).The only discernible difference is that while Njenga realizes the vowel in *sure* as [u], Njogu realizes it as [o]. Few other Kenyan male respondents realize the vowel in question as [o].

Based on acoustic data analyzed from our Kenya male sample (as represented in the two vowel plots above), AfrE vowel production among Kenyan males may be summarized in the representation shown below. Tokens in parentheses indicate across-speaker variations identified in the plots. For instance, parenthesized [*hair, bet*] indicate that there exist a difference in the respondents pronunciation of vowels in those tokens, such that some respondents will realize vowels contained in these words in an identical manner to other vowels of the cluster that they belong to. For example [*hair* and *bet*] are pronounced as either /e/ or /ɛ/.

/i/ bead, hid
/e/ made, [bet, hair]
/ɛ/ year, name, [hair, bet]
/a/ bad, bird , hard, pride, bout, mud
/o/ so, open, goat , board, caught, boy, [sure]
/u/ good, mood, [sure]

5. 2. 3 Kenyan Female Respondents

Now let us examine the vowel production among educated female respondents from Kenya. Figures 10.3 and 10. 4 are representative of other individual vowel charts of this homogenous sample of 11 respondents. The variation in the production of [ou] as in the word *boat* is the only distinct difference in production among these speakers.

Based on acoustic measurements of F1 and F2 frequencies, Mukami (Figure 10.3) realizes the English vowels under investigation as follows: Vowels contained in the tokens *bead* and *hid*, *hue* and *here* are realized as [i]; *made*, *hair*, *bed* are produced as

[e]; *hard*, *bird* ,*bad*, *buy* , *mud*, and *bout* are realized as [a]; while *saw*, *nod*, *boy*, and *boat* are pronounced as [o] and *good*, *mood*, *tour*, and *sure* are produced as [u]. Note, however, how close some of the "o" (or mid-back) tokens are to the "low" set (e.g. nod, hard).

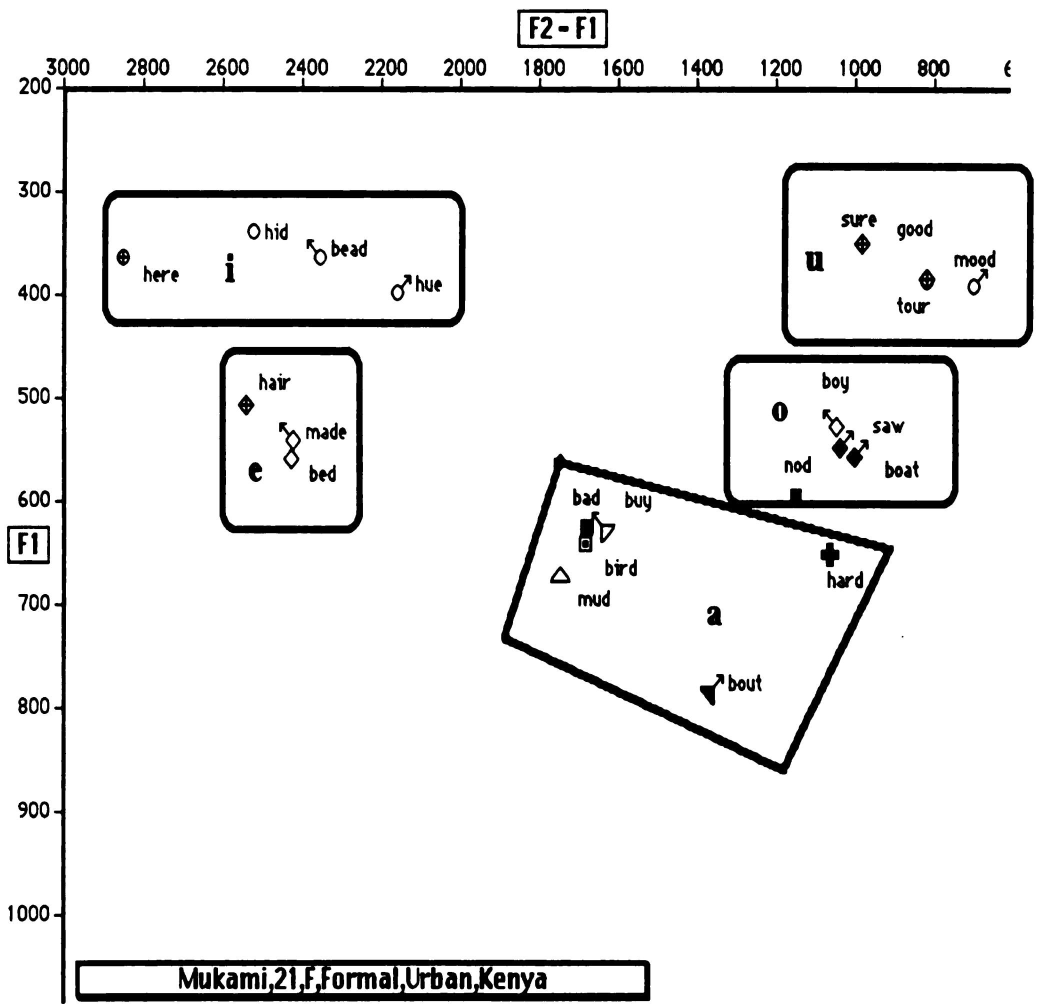


Figure 10.3 - Mukami's Vowel System (a Kenyan female)

Kamba's vowel system (Figure 10.4) is almost identical to Mukami's (Figure 10.3) except for the production of [au] as in *bout,* which in Kamba's system is realized as [o]. Kamba's low vowels are also more compact (in a back position).

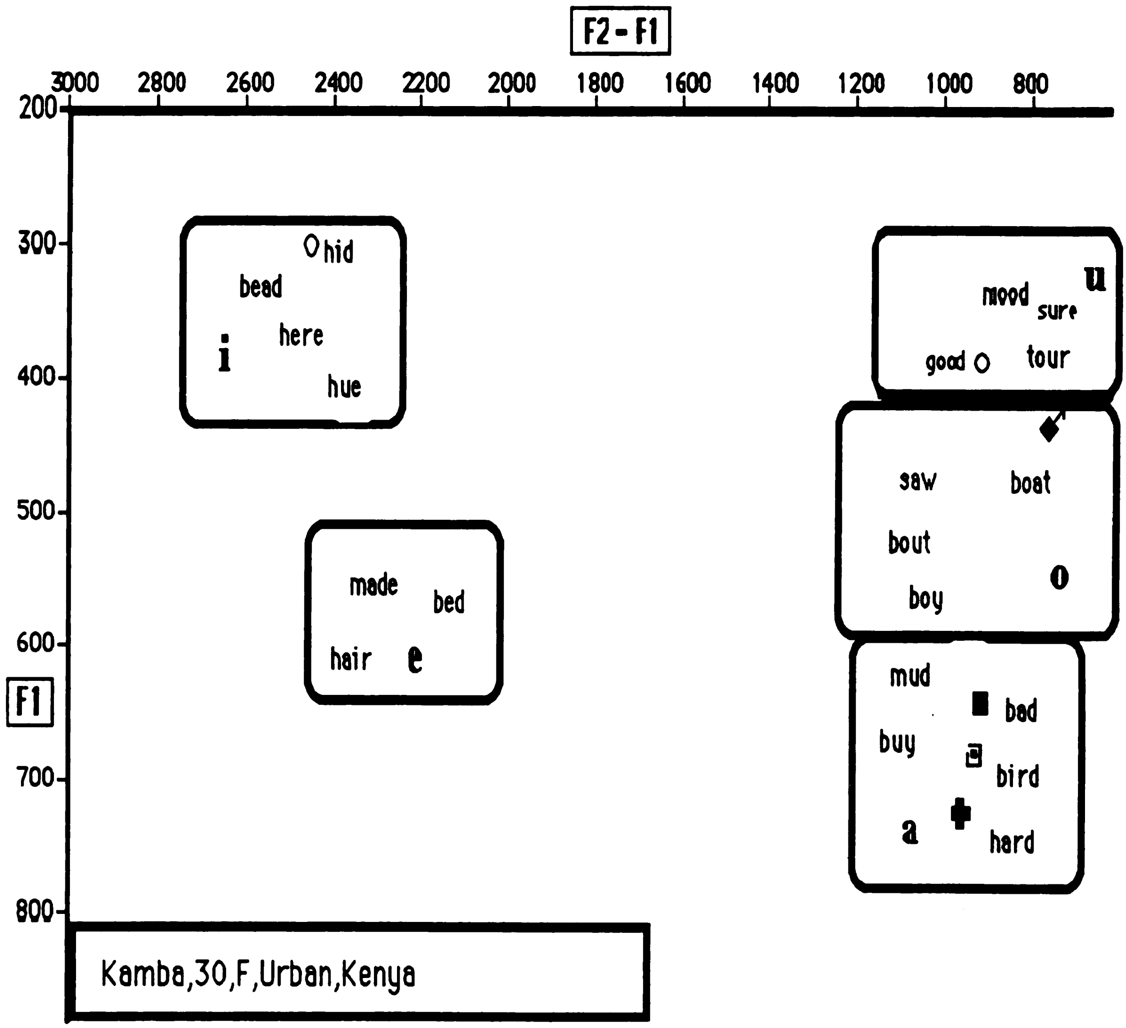


Figure 10.4 - Kamba's Vowel System (a Kenyan Female)

Acoustic analysis of vowel production among educated female respondents in Kenya can be summarized as follows:

/i/ hue, bead, hid, here

/e/ mad, hair, bed

/a/ hard, bird , bad, buy , mud, bout

/o/ saw, nod , boy, boat, bout

/u/ good, mood, tour , sure

An analysis of both male and female respondents from Kenya shows a clear pattern of vowel clustering which varies only in the respondents' realization of the front mid vowel as both tense and lax. It should be noted that only a few of the respondents do not make this distinction. The only other significant variation is that while male respondents realize [Iə] as /e/, female speakers produce it as /i/. As might be expected, there is more range to the targets in low-vowel territory. The gender distinction noted here is worth of serious investigation in future studies. Previous studies have lumped the speaker together and no gender distinctions have been reported.

5. 3 Zimbabwe Respondents

Figure 11 represents an edited plot of F1 and f2 frequencies for over 400 tokens produced by 20 respondents in Zimbabwe. Like the EAfrE vowel chart in Figure 10, this is also a peripheral system with no central vowels (although it can be argued that /ε/ is fairly central relative EAfrE and WAfrE systems).

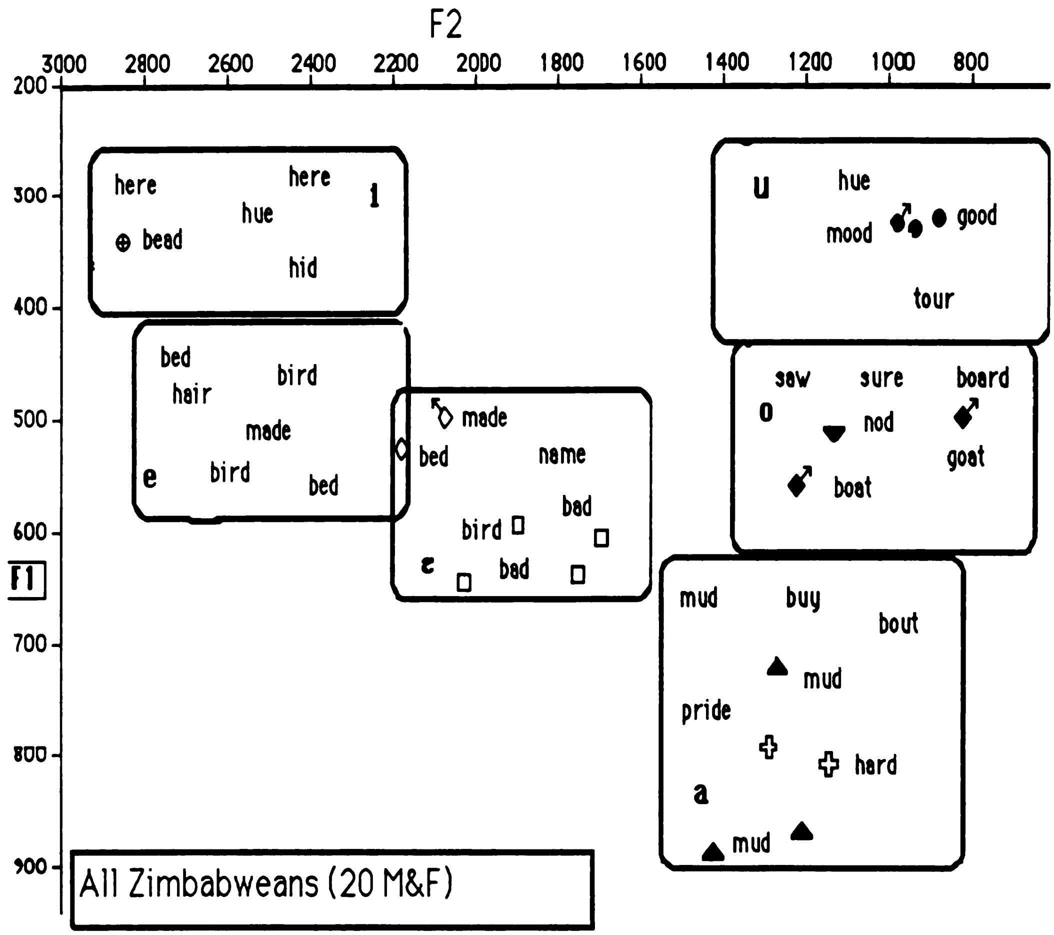


Figure 11 - A vowel plot for all Zimbabwean Respondents

However, unlike EAfrE, this is a six-vowel system. The results can be summarized as follows:

/i/ bead, hid, here, [hue]

/e/ hair, [bird, name, made, bed]

/ε/ bad,[bird, name, made, bed]

/a/ hard, pride, bout, mud

/o/ sod, nod , goat, boa

/u/ good, mood, tour, [hue]

5. 3. 1 Zimbabwean Male Respondents

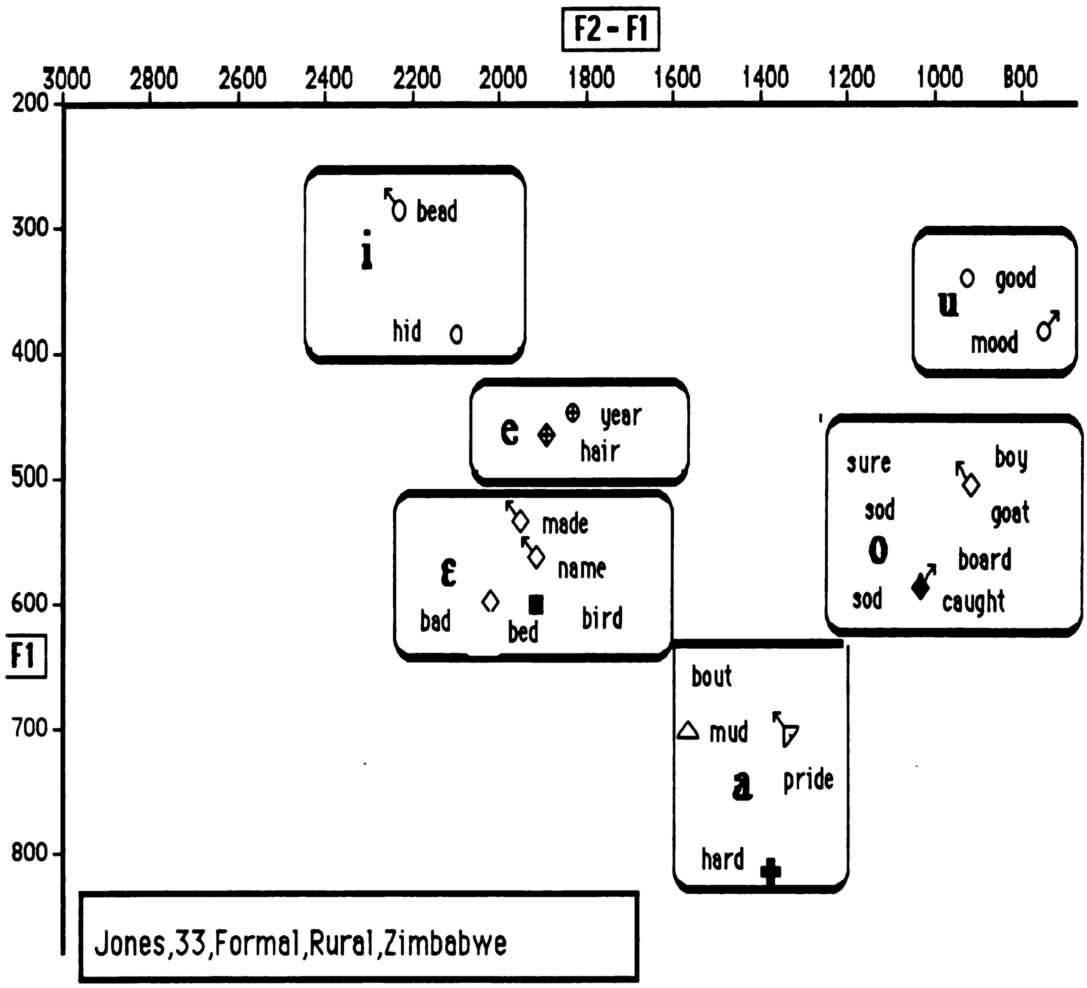


Figure 11.1 - Jones' Vowel System (a Zimbabwean Male)

Figure 11.1 illustrates a plot of the F1 and F2 frequencies for the 22 tokens produced by Jones-a 35 year old Zimbabwean male university student. In this chart , vowels contained in the tokens *bead* and *hid* are realized as [i]; *year* and *hair* as [e];

made, *bet*, *name*, *bad* , *bird* as [ɛ]; *hard*, *pride*, *bout*, and *mud* as [a]; *sod*, *open*, *goat*, *caught*, *board*, *sure*, and *boy* as [o]; while *mood* and *good* are realized as [u].

Ndanga's vowel systems (Figure 11.2) shows minor variations from Jones' (Figure 11.1). Inversely, Ndanga realizes the onset of the diphthong in *name* as [e], and the vowel onset in *hair* as [ɛ], unlike Jones who realize them as [ɛ] and[e] respectively. Furthermore, Ndanga realizes the vowel in *caught* as [a], while the other Jones realizes it as [o]. These variations are evident among other respondents in our Zimbabwe sample.

Zimbabwean male respondents English vowel production may be summed up as follows:

/i/ bead , hid

/e/ year, name, hair

/ɛ/ made, bed, bad, bird

/a/ hard, pride, bout, mud, [caught]

/o/ sod, open , goat, board, boy, sure, [caught]

/u/ good, mood

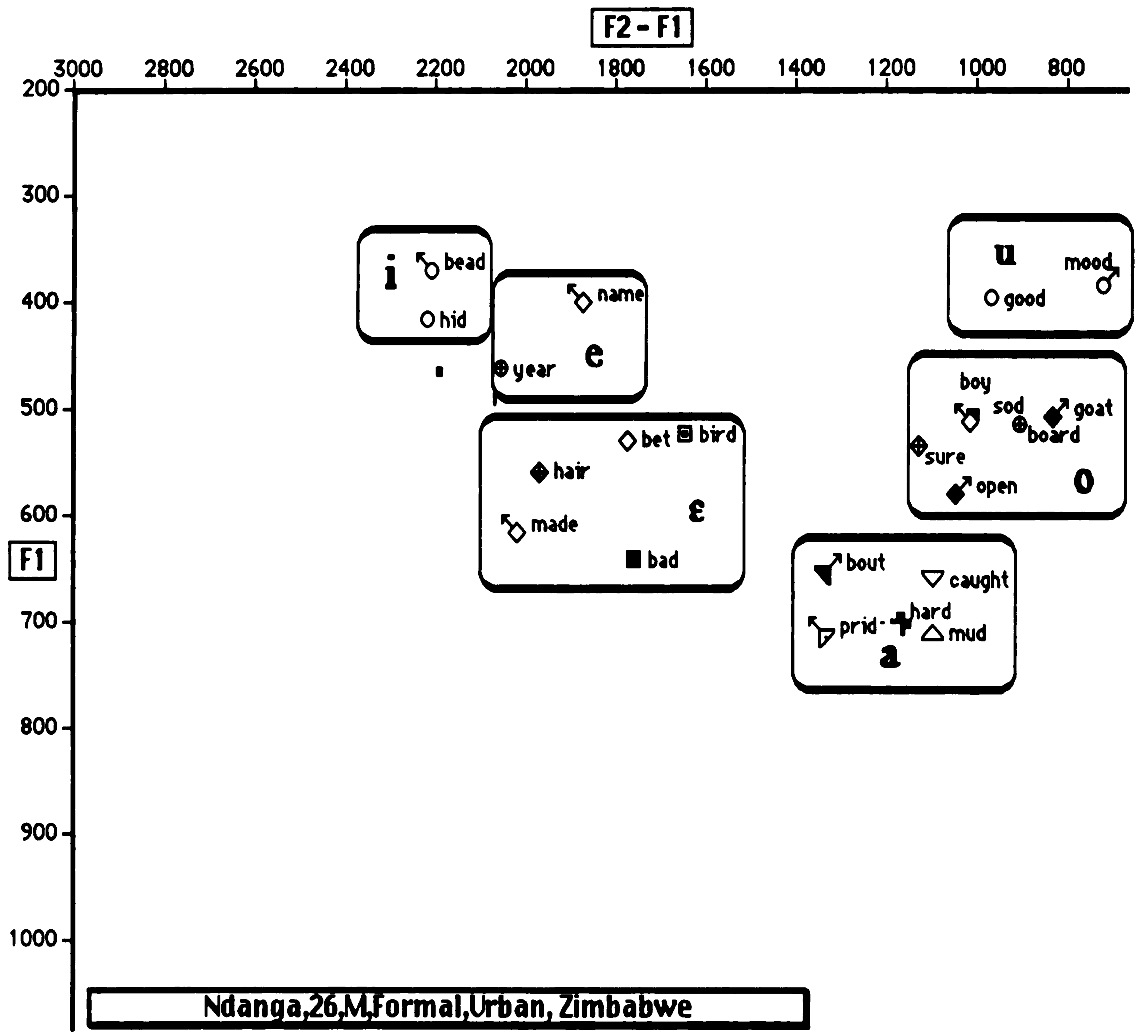


Figure 11.2 - Ndanga's Vowel System (a Zimbabwean Male)

5. 3. 2 Zimbabwean Female Respondents

Turning our attention to vowel production among educated AfrE female speakers from Zimbabwe, another peripheral vowel system is evident. Figures 11.3 and 11.4 are representative charts of all individual speakers in a sample of eleven speakers.

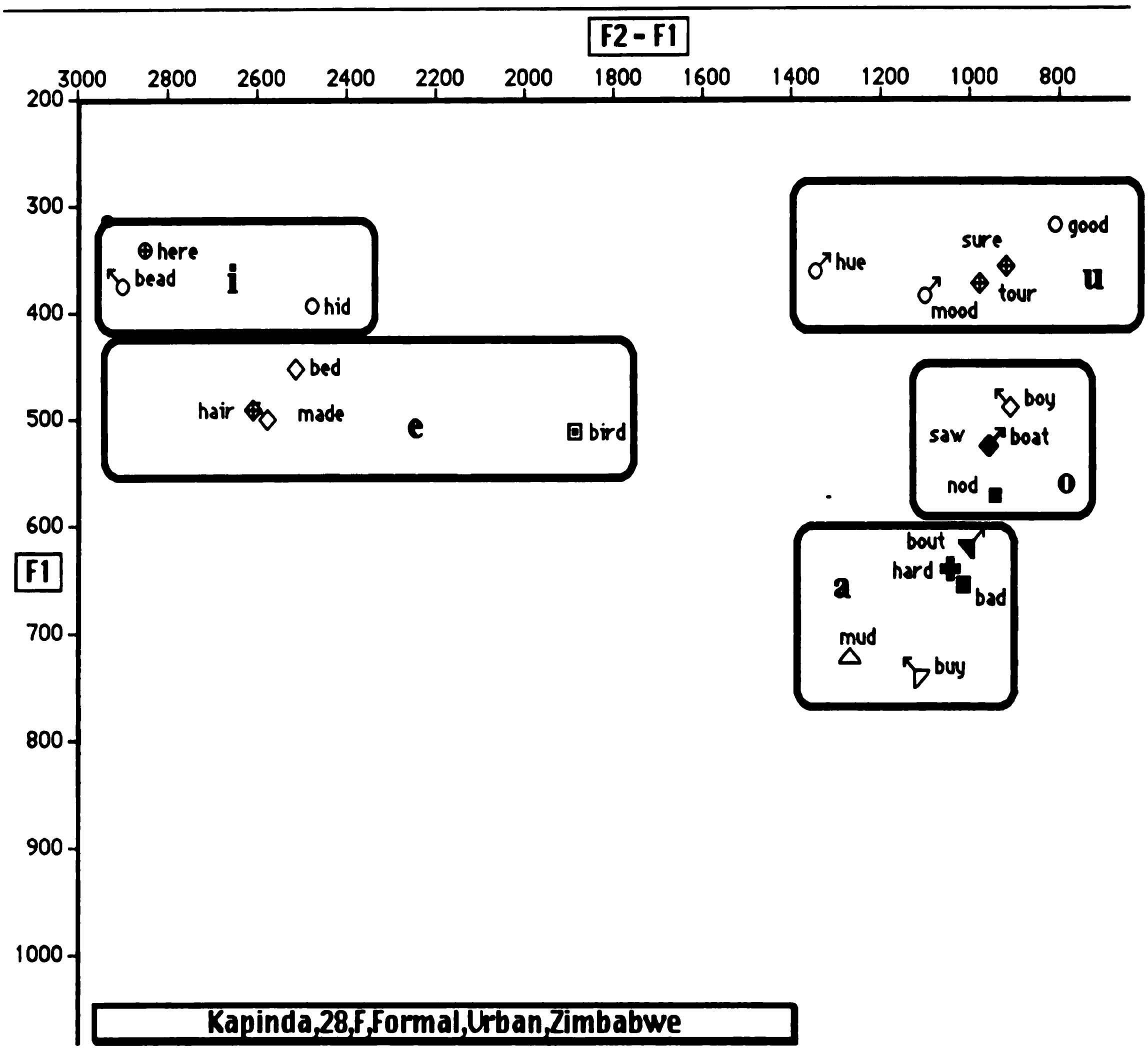


Figure 11.3 - Kapinda's Vowel System (a Zimbabwean Female)

Kapinda's normalized F1 and F2 scores are presented in Figure 11.3. Like all other Kapinda realizes the English vowels presented in word list form as follows: Vowels contained in the tokens *bead* and *hid* and *here* are realized as [i]; *made*, *hair*, *bed* and *bird* are produced as [e], although *bird* seems fairly central; *hard*, *bad*, *buy*, *mud*, and *bout* are realized as [a]; while *saw*, *nod*, *boy*, and *boat* are pronounced as [o]; and *good*, *mood*, *tour*, *sure*, and *hue* are produced as [u].

Tamika's (Figure 11.4) vowel production is similar to Kapinda's (Fig. 11.3) except for *bead* which is realized as [e], and *sure* and *tour*, which are produced as [o]. Most female respondents realize *tour* as [o]. Again, *bird* is fairly central.

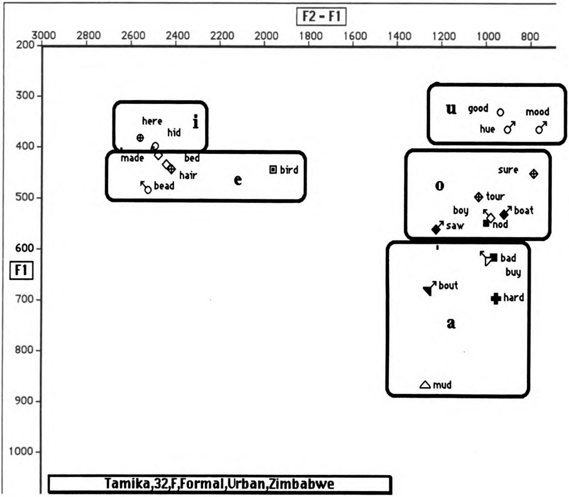


Figure 11.4 - Tamika's Vowel System (a Zimbabwean Female)

Vowel production among Zimbabwean female respondents may be summarized as follows:

/i/ hid, here,[bead]

/e/ made, hair, bed, bird, [bead]

/a/ hard, bad, buy , mud, bout

/o/ saw, nod , boy, boat, tour ,sure

/u/ hue, good, mood,[sure, tour

A gender distinction similar to the one already identified in discussion of the Kenyan sample is also evident among the Zimbabwean AfrE speakers. Male respondents have a lax and tense distinction for the front mid vowel while female speakers do not. Moreover, while male respondents front RP's central vowel [ɜ] as in *bird* to [ɛ], and raise the low back vowel [a] to [ɛ], female respondents barely front [ɜ] as in *bird* to [ɛ], but they do not raise [a]. It is worth emphasizing that gender distinction is not confined to the Kenyan sample as the Zimbabwean data shows. Further research into the variation should illuminate more characteristics of vowel variance within and across English varieties spoken in sub-Saharan Africa.

It is worth mentioning at this juncture that the fronting of the central vowel [ɜ] to [ɛ] seems to be the major variation between Bantu speakers of Eastern Africa (Kenya) and Southern Africa (Zimbabwe). Moreover, [ʊə] as in *tour* and *sure* is consistently realized as [u] by Kenyan respondents, but some Zimbabweans realize the monophthongized diphthong as either [o] or [u]. This finding casts doubt on earlier claims that AfrE speakers consistently produced [ʊə] as [u].

5. 4 Ghanaian Respondents

Figure 12 represents vowel frequencies of all the token produced by 20 Ghanaian university students. This five-vowel system is peripheral and contains no central vowels.

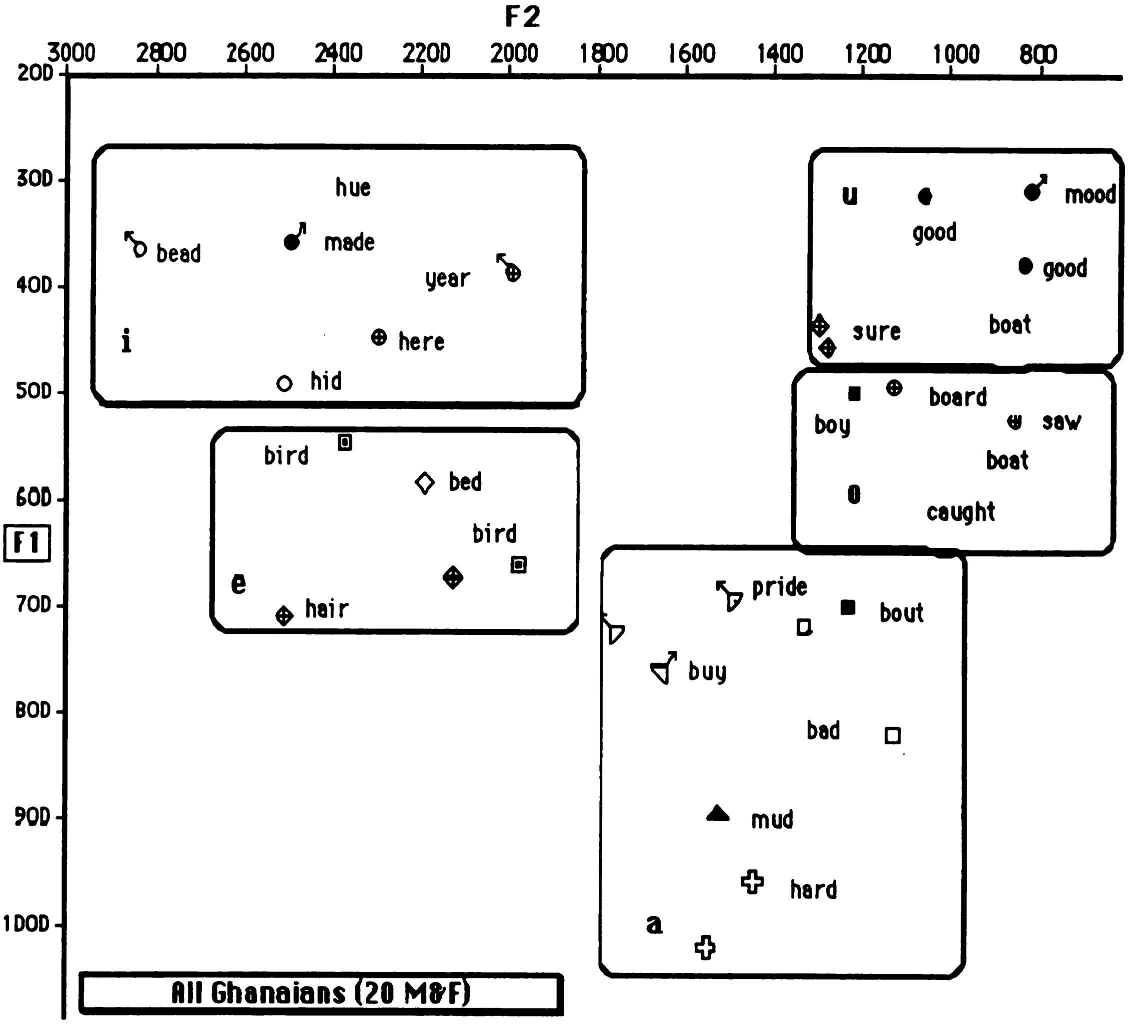


Figure 12- Vowel Plot of All Ghanaian Respondents

The results may be summarized as follows:

/i/ hue, made, bead , hid , here

/e/ hair, bird, bed

/a/ hard, bad, buy, mud, [bout], pride

/o/ saw, nod, boy, tour, [boat], caught

/u/ good, mood, sure, [boat], [bout]

5. 4. 1 Ghanaian Male Respondents

Figure 12.1 illustrates a plot of the F1 and F2 frequencies for the 22 tokens produced by Kwame , a 27 year old male university student from Ghana. In this chart,

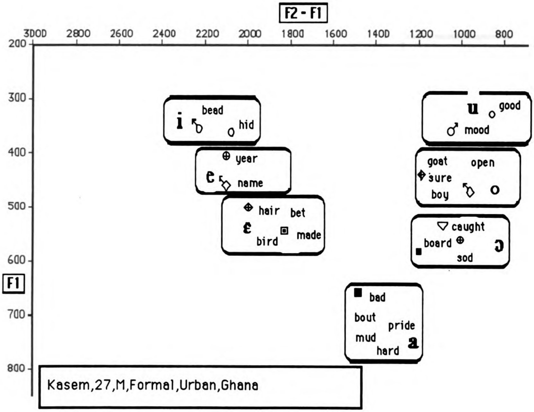


Figure 12.1 - Kwame Vowel System (a Ghanaian Male)

vowels contained in the tokens *bead* and *hid* are realized as [i]; *year* and *name*

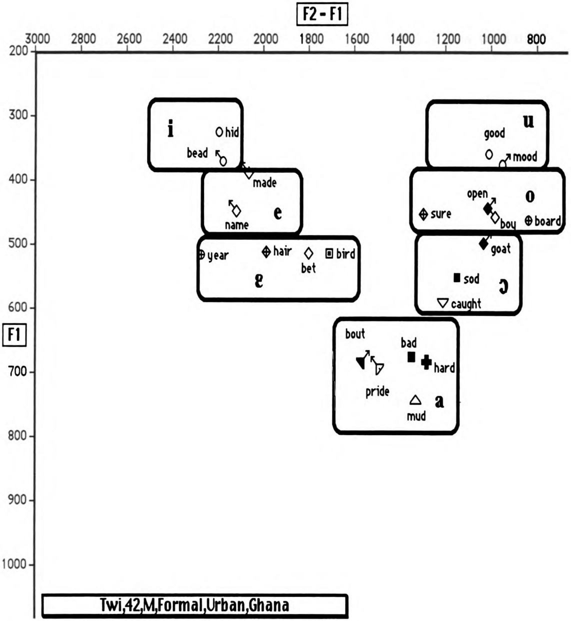


Figure 12.2 - Kojo's Vowel System (a Ghanaian Male)

as [e]; and *hair,, bet, made* and *bird* as [ɛ]; *hard, pride, bout, bad* and *mud* as [a]; *sod, caught* and *board* are pronounced as [ɔ]; *open, goat, sure,* and *boy* are realized as [o]; while *mood* and *good* are realized as [u].

In comparison to Kwame's vowel production (Figure 12.1), Kojo's system (Figure 12.2) represents other individual systems in the sample that vary from those that resemble Kasem's in their inverse realizations of *made* and *year* as either [e] or [ɛ], and *goat* and *board* as [o] or [ɔ]. This calls into question, of course, the idea of a seven (rather than five) vowel system. The clustering of [i, u, a] is also identical in a majority of cases. AfrE vowel production among educated male Ghanaians may be summarized as follows:

/i/ bead, hid

/e/ name, [year, made]

/ɛ/ hair, bet, bird, [year, made]

/a/ hard, bad, pride, bout, mud

/ɔ/ caught, sod , [board, goat]

/o/ open , boy, sure, [board, goat]

/u/ good, mood

5. 4. 2 Ghanaian Female Respondents

Let us examine AfrE vowel production among educated Ghanaian women, based on a controlled sample of eleven Kwa language speakers. Figures 12.3 and 12.4 were identified as representative Ghanaian speakers.

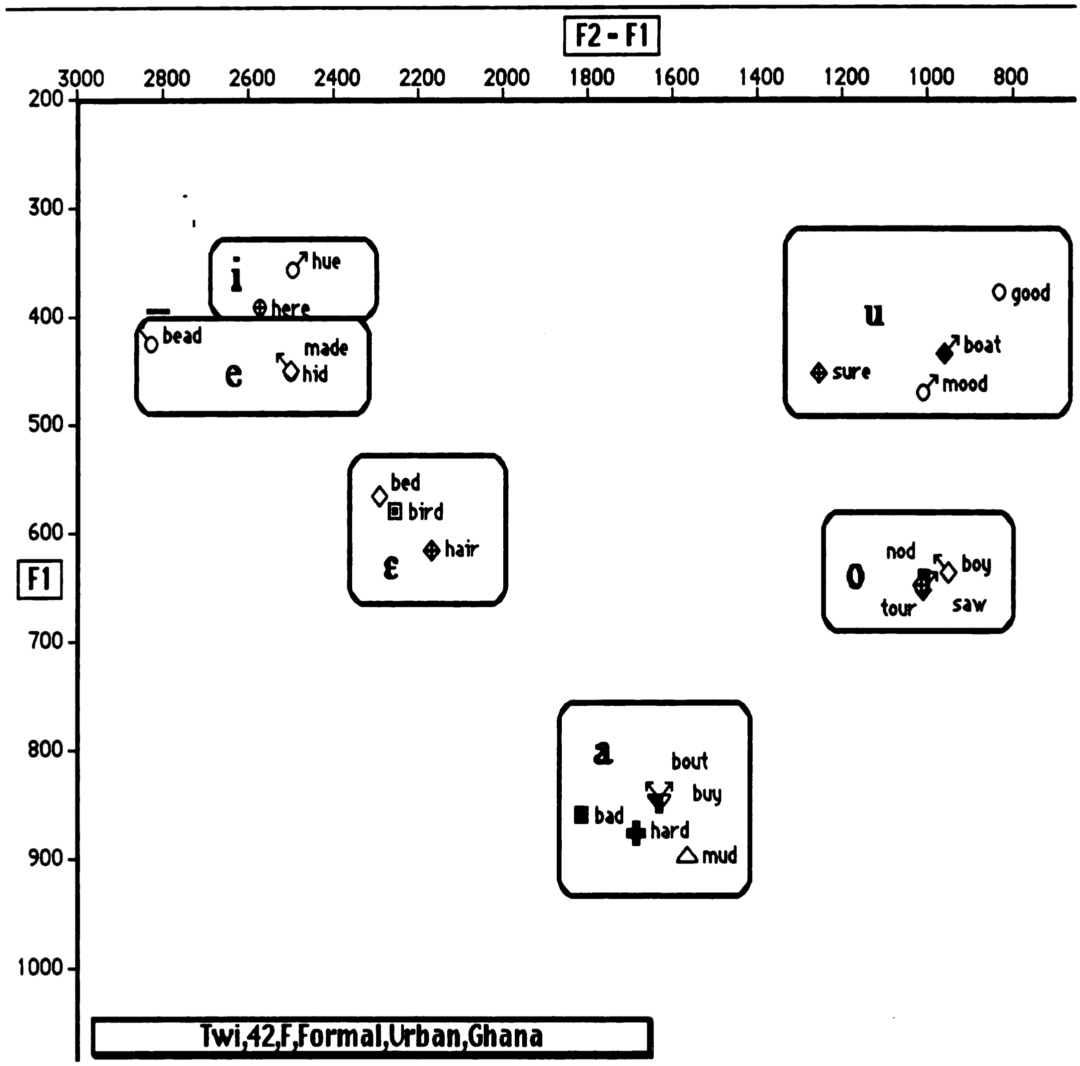


Figure 12.3 - Akosua's Vowel System (a Ghanaian Female)

Akosua (Figure 12.3) realizes the English vowels presented in tokens shown in the chart as follows: Vowels contained in the tokens *hue* and *here* are realized as [i]; *bead* , *hid* and *made* are produced as [e]; *hair*, *bed* and *bird* are realized as [ɛ]; *hard*, *bad*, *buy*, *mud*, and *bout* are realized as [a]; while *saw*, *nod*, *boy* and *tour* are pronounced as [o], while vowels in *good*, *mood*, *sure* and *boat* are produced as [u].

In contrast to Akosua (Figure 12.3) Efua (Figure 12.4) produces vowel in *hid* and *bead* as /i/, *bed* as /e/ and *boat* as [o]. The differences across female speakers seem to be in vowel height in such tokens as *hid, bead*, and *here*. There seem to be differences in the tense/lax distinction of the vowel in *bed*. Some respondents pronounce*boat* with an

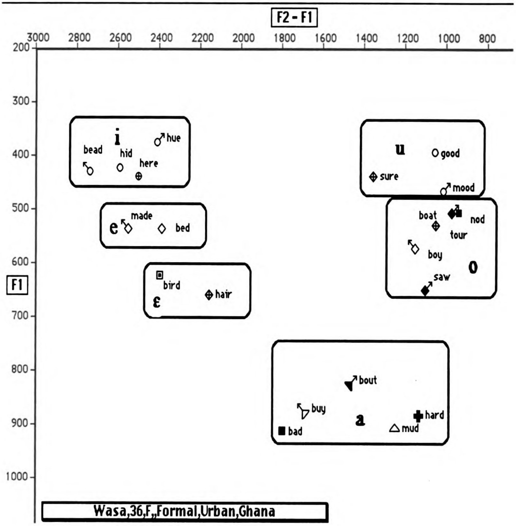


Figure 12.4 - Efua's Vowel System (a Ghanaian Female)

[o] and some with an [u]. Such variations merit further detailed acoustic measurements. A summary of Ghanaian female vowel production contained in charts discussed above is as follows:

/i/ hue, [bead , hid , here]

/e/ made, [bead, hid, here], [bed]

/ɛ/ hair, bird, [bed]

/a/ hard, bad, buy, mud, [bout]

/o/ saw, nod, boy, tour, [boat]

/u/ good, mood, sure, [boat], [bout]

An overview of Ghanaian sample shows that both male and female vowels systems have a lax and tense front middle vowel, front RP's central vowel [ɜ] as in *bird* to [ɛ], but differ in the realization of [ua] as in *sure*. While male respondents realize the monophthongized diphthong as [o], females pronounce it as [u].

5. 5 A Comparative Analysis of Acoustic Results

The primary aim of this study is to verify conclusions drawn in previous studies pertaining to variation in AfrE vowel systems. Conclusions drawn in the current study are based on empirical analysis of data collected from a relatively homogeneous population of well-educated male and female AfrE speakers from Ghana, Kenya and Zimbabwe. Our Ghanaian sample is made up of native speakers of Kwa languages, while Kenyan and Zimbabwean AfrE speakers are native speakers of Bantu languages. All respondents speak English as their second or even third language.

Let us compare results of our acoustic analyses presented in this chapter with some primary results documented in earlier studies in the field. The results are discussed in more detail in the literature review section (1.4.0.).

Schmied (1991) attributes AfrE variation to the 'deviation' in the production of the RP long central vowel [ɜ] (as in *bird*) by speakers of each regional speech community. He concludes that [ɜ] backs to [ɔ] in WAfrE, fronts and lowers to [a] or fronts to [e] in EAfrE, while in SAfrE it fronts to [e]. The two possibilities in EAfrE are not elaborated. This variation is presented in Schmied's illustration as shown in Figure 1.

This primary hypothesis, which is widely echoed in the literature, is not corroborated in the evidence from the acoustic analysis presented in this study. Ghanaian and Zimbabwean speakers front the RP central vowel /ɜ/ to / ɛ/ while Kenyans lower it to /a/. The central vowel /ʌ/ as in *bud* is lowered by Kenyans and Ghanaians speakers while Zimbabweans front it to /e/.

Furthermore, evidence from our male and female respondents from Ghana clearly shows that /ʌ/ is realized as [a] and not as [ɔ], as Todd (1984) claims (see 2. 2. 2. 1). Moreover, other previous claims not supported by our evidence from acoustic analyses include Bokamba's (1992:21) observation that /ʌ/ as in *bud* is produced as [ɔ], and [ɜ] as in*bird* is realized as [ɔ] and Schmied's (1991:59) claim that all the centring diphthongs (/iə/, /eə/, /uə/ tend to be pronounced as opening diphthongs (/ia, ea, ua/). Our analysis, however, shows variation in realization of /ia/ and /ea/ as either /i/ or /e/ and /ua/ as /o/ or /u/, while /au/ is realized as /a/ or /o/. These variations occur in all three varieties.

5. 6. 1 Kenyans

Acoustic analyses of Kenyans English vowel production generally support previous characterizations of the EAfrE vowel system as shown in Figures 1 and 4.

However, contrary to earlier claims, acoustic evidence presented above shows that some male respondents make a tense and lax distinction in the front mid vowel area.

5. 6. 2 Ghanaians

Acoustic analysis of vowel production among our Ghanaian respondents does not concur with Todd's claim that [ʌ] backs to [ɔ] in WAfrE .

Trudgill and Hannah's (1985) illustration (Figure 5), makes identical claims to Schmied's (Figure 1), and therefore disagrees with ours in the same way.

Sey (1973) compares RP and educated Ghanaian English (Figure 4) and claims that the vowel /ɜ/ as in bird is fronted and realized as /ɛ/ contrary to Schmied's claims.

Sey claims that the vowel /ʌ/ as in the word *bud* is realised as either /ɔ/ or /ɛ/. The significance of Sey's observations to this study lies in the fact that it is the only study we know of in the previous literature that claims that RP's central vowel /ɜ/ is fronted to [ɛ] by WAfrE speakers. All other studies claim that the vowel is backed to [ɔ]. Our analysis concurs with Sey's observation. However, like other studies mentioned in this study, Sey claims that educated Ghanaians realize /ʌ/ as /ɔ/. Sey goes a step further and notes that /ʌ/ is realized as /ɔ/ or /ɛ/. Empirical evidence from a diverse population of male and female Kwa language speakers at the University of Ghana unequivocally shows, however, that /ʌ/ is realized as [a].

Based on our analysis, it is clear that our sample of educated Ghanaian speakers does not realize the vowel in *bird* as [ɔ], but rather as [ɛ]. Moreover, the RP central vowel /ʌ/ as in the word *mud* is not realized as [ɔ], but as [a].

Therefore, that broad generalization from earlier research regarding the nature of WAfrE vowel system does not hold, particularly among our Ghanaian male respondents

5. 6. 3 Zimbabweans

Based on our analysis, Zimbabwean speakers do not make a vowel quality contrast; the only discernible lax/tense distinctions is among male respondents who make a distinction between lax and tense front mid vowel. The vowels in the words ***bet/bird/bad/made*** are realized as /e/. The vowels in ***hard/mud*** are realized as [a], while those in ***board/sod/caught*** are realized as [o].

Suffice it to say, the phonological systems proposed in earlier studies fairly represent the phonetic reality, but the problem lies in grouping.

In conclusion, the strength and significance of our findings lies in the evidence we presented to contradict major claims presented in primary studies in the field. Generalizations about the realignment of RP's central vowels by diverse multilingual AfrE speakers residing in broadly defined linguistic boundaries may be true in some cases, but certainly not wholly representative of the homogeneous samples that we analyzed.

This section has focused on variation in the production of AfrE vowels. Although empirical methods of analysis have carefully been applied to ensure a precise presentation of data, our study will be more meaningful if we correlate acoustic cues with phonemic representations through perception tests. As Lieberman and Blumstein (1993: 170) argues:

> Although it is possible to perform precise analyses of speech signals using electronic instruments and computer programs that effect various mathematical transformations of signal, these analyses are in themselves meaningless. we can never be certain that we have actually isolated the acoustic cues that people use to transmit information to each other unless we run psychoacoustic studies in which human listeners respond to acoustic signals that differ with respect to the acoustic cues that we think are relevant.

This is the task we seek to accomplish in the following section.

5. 7 AfrE Listeners' Vowel Perception

5. 7. 1 Data Analysis

Data from each region was calculated separately in order to determine how each vowel was perceived in the IT and MPT. The former entailed calculation of correct and incorrect identifications of every vowel by each respondent. After accounting for all responses in each region, frequency scores were calculated to establish any trends or patterns of identification. Similarly, MPT analysis sought to calculated and subsequently identify any patterns in the correct and erroneous discrimination of the pairs.

Suffice it to say, the focus in the analysis of IT data is the onset (steady state) characteristics of the vowels and not the word. For instance, if a stimulus pair *bed/bad* was identified as *bent/ bird*, the first vowel in the pair was marked as correctly identified in spite of the error in matching the word, while the error in identifying the vowel of the second word was counted as such. Although the entire raw data is shown in Appendix E, Table 1 is an example of such vowel perception in each region.

The first column contains the pairs of words that listeners heard on the tape, and vowels tested. The other columns show the percentage of respondents who identified the intended vowel, or an alternative one. The former is represented in the first line of each cell, while any additional scores in each cell represent the latter.

For example, the first score box in the last column shows that 84 % of listeners from the EAfrE speaking region correctly identified in their questionnaires that the first word of the stimulus pair *meat/meat* contained the vowel [i]. 63% of those listeners also identified the second word as containing [i]. The second line in the same box shows that 5 % and 21% of EAfrE listeners misidentified the first and second words respectively, as containing [I] instead of [i]. Data in the table should be interpreted in that manner unless otherwise stated.

Table 1- Identification Results of Vowel [i]

Stimulus minimal pairs words played to	Ghanaians respondents perception of stimulus	Zimbabweans respondents perception of stimulus	Kenyan respondents perception of stimulus vowels (in %)
i ~ i meat/meat	i ~ i 94-94 a ~ e 06-06	i ~ i 98-100	i ~ i 84-63 I ~I 05-21
i ~ I beat/bit	i ~ I 68-48 I ~ i 32-38	i ~ I 41-24 I ~ i 59-41 ε 26	i ~ I 75-21 I ~ i 21- 28 ε 49
i ~ e beat/bait	i ~ e 64-43 I ~ ʌ 31-17	i ~ e 43-59 I ~ ai 47-13 a 13	i ~ e 57-14 a ~ a 60-60

i ~ ɛ weed/wed	i ~ ɛ 100-22 ɜ 61	i ~ ɛ 98-67 ia ~ɔ 02-19	i ~ ɛ 93-65 ai ~ ai 07-19
i ~ ia he/here	i ~ ia 74-100 ia 17	i ~ ia 79-76 ia ~ i 21-24	i ~ ia 68-100 ia 32
i ~ ju he/hue	i ~ ju 85-73 ju ~ i 15-17	i ~ ju 94-58 ia ~ i 06-39	i ~ ju 82-69 ia ~ i 09-32

Having calculated the frequency scores for each vowel in each pair as shown above, an effort was made to determine the overall perception of each vowel in each region. Towards this end, mean values of identification responses to each vowel were calculated by adding up frequency scores and dividing them by the total number of responses. For instance, to determine the mean value [i], all frequency scores for correct identification and misidentifications are added up separately and divided appropriately.

5. 8 Identification Results and Discussion

Two types of charts are presented in the discussion of some vowels or groups of vowels. The bar charts seeks to represent visually respondents' identification of stimulus vowel in percentages, while the vowel charts reflect the same information on a simulated vowel space.

Identification of [i], [e], [ɔ], and [u]

Figure 13.1 shows that over 60% of respondents in each region correctly identified vowels [i], [e], [ɔ], and [u]. It is worth noting the high intelligibility score of

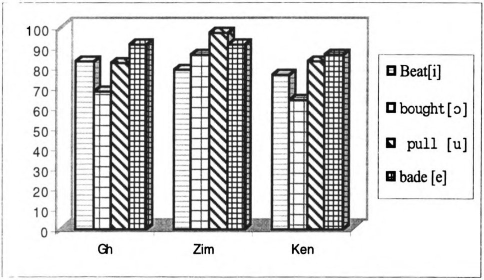


Figure 13.1 - AfrE Listeners' Identification of [i], [ɔ], [u], and [e]

middle vowels [e] and [ɔ] in all three regions.

Earlier perception studies have concluded that listeners easily identify high vowels [i] and [u], and in many cases the low vowel [a]. For instance, Lieberman and Blumstein's (1993) physiological theory for vowels (see section 1.3), argue that quantal vowels [i] and [u] are easy to identify because the F1 and F2 of each of these vowels converge to yield well-defined spectral peaks, making them maximally distinct. Furthermore, Bladon and Lindblom (1981) report that experiments in vowel perception have shown that listeners use spectral information to access vowel quality. They argue that listener's are capable of approximating the length of a speaker's supralaryngeal vocal based on spectral information, and to consequently normalize the vocal tract within the parameters of an appropriate vowel space. The detailed mechanism of vowel perception

perception are not within the purview of this study, but it worth noting the high intelligibility rate of these vowels may point towards a maximal distinctness of these vowels.

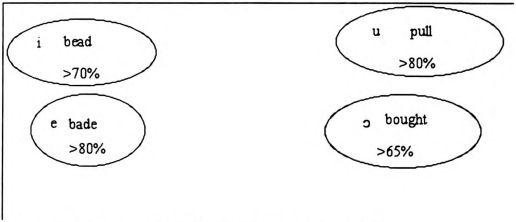


Figure 13.1: AfrE Listeners' Identification of [i], [ɔ], [u], and [e]

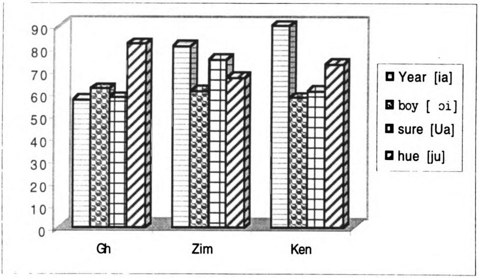


Figure 13.2 - AfrE Listeners' Identification of [i], [ɔ], [u], and [e]

However, this study shows middle vowels [e] and [ɔ], and not the lower vowel [a], as the other easily identified vowel, besides the documented [i] and [u]. Moreover, Figure 14 - AfrE Listeners' Identification of [ia], [ɔi], [ʊa] and [ju]

Over 50% of listeners correctly identified diphthongs containing vowels [i], [ɔ] , and [u] as Figure 14 shows. The data here, seems to corroborate earlier evidence in Figure 13.1 that the vowels [i], [ɔ], and [u] are easily identified for AfrE listeners; but not [e

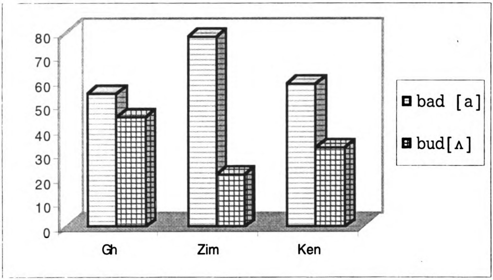


Figure 15.1 - AfrE Listeners' Identification of [a]

Identification of [a]

Figures 15 and 16 show that AfrE listeners often confuse [a] with [ʌ], and [ʌ] with [a].

Figure 15.1 shows that 55% of Ghanaian respondents correctly identified [a], but 45% misidentified the vowel as [ʌ] . Eighty percent of Zimbabwean respondents correctly identified [a], while 20% thought it was[ʌ] . 55% of Kenyans had the correct identification, but 35% erred. Figure 15.2 illustrate the vowel identification pattern in Figure 15.1

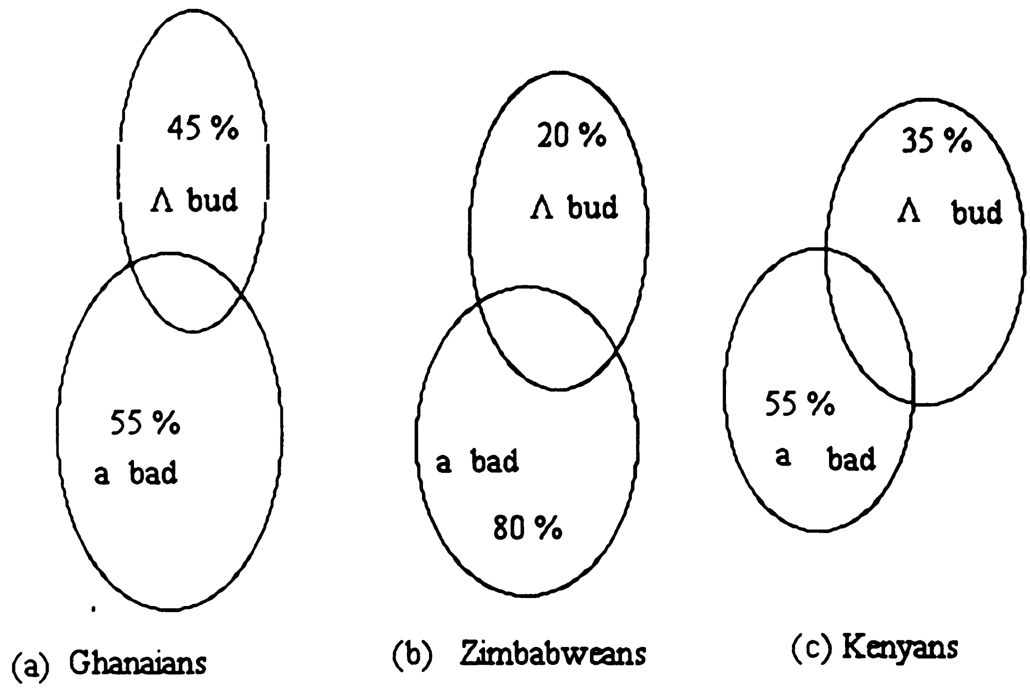


Figure 15.2 - AfrE Listeners' Identification of [a]

Identification of [ʌ]

It is hardly surprising that IT results shown in Figure 16 are almost identical to the ones in Figure 15. After all , these are results of an identical pair of words tested twice with the only difference being in the ordering of the pair that is, in the previous results,

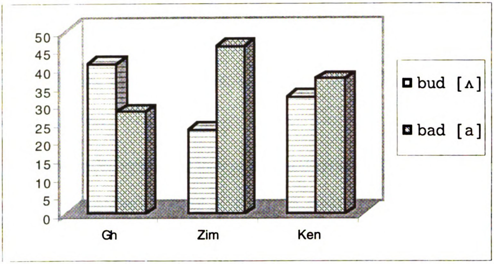


Figure 16.1- AfrE Listeners' Identification of [ʌ]

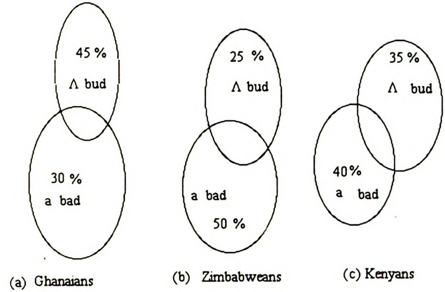


Figure 16.2 -- AfrE Listeners' Identification of [ʌ]

the tested minimal pair was *bad, bud* , while in this case the listeners heard the word *bud* first. In spite of that slight change identification of [ʌ] as low as in the first pair.

Only 45%, 25%, and 35% of Ghanaians, Zimbabweans, and Kenyans respectively correctly identify the vowel. 30%, 50%, and 40% of respondents, in the same order, confuse [ʌ] with [a].

Considering the peripheral nature of L1 vowel systems of the current sample, and in particular the non-existence of central vowels, two plausible arguments can be made to account for the misperception of the two vowels. First, [ʌ] is confused with [a] when the native-language magnet "pulls" the non-native RP vowel [ʌ] towards the native phoneme prototype [a]. Secondly, language contact and exposure to RP in the course of educational pursuit makes these university students more conscious of such a non-native sound as [ʌ]. It would be interesting to test whether respondents with a lower level of education would exhibit similar vowel perceptions.

Identification of [ɜ]

A similar native language effect may be anticipated in the perception of RP's central vowel [ɜ], another non-existent vowel in the L1s of the present sample. However, an overview of the results presented in Figure 17 seem to invalidate such expectations in view of the fact that a majority of Ghanaians and Zimbabweans seem to

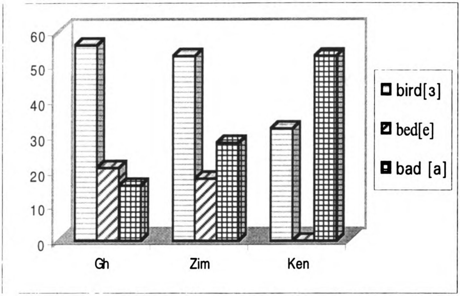


Figure 17.1 - AfrE Listeners' Identification of [з]

correctly identify the vowel. The bar chart shows that over 55% of respondents in west and southern Africa correctly identify the vowel. 20-28% of respondents in these two regions confuse the vowel with either [ɛ] or [a]. However, upon closer scrutiny, it is evident that respondents who confuse [з] with either [ɛ] or [a], are almost as many as those who correctly identify it, particularly among Zimbabweans. For instance, note that while 52% of Zimbabweans correctly identify [з], the total percentage of Zimbabweans who confuse the vowel with [ɛ] and [a] is 50%.

Kenyan respondents present particularly interesting results in this case. While over 50% respondents confuse [з] with [a], no respondent confused [з] with [ɛ].

Similar to the observation given above regarding the perception of [ʌ], NLM may account for the variants in this case, but the identification of the non-native vowel [ɜ] may be as a result of perceptual experience through language exposure, or through

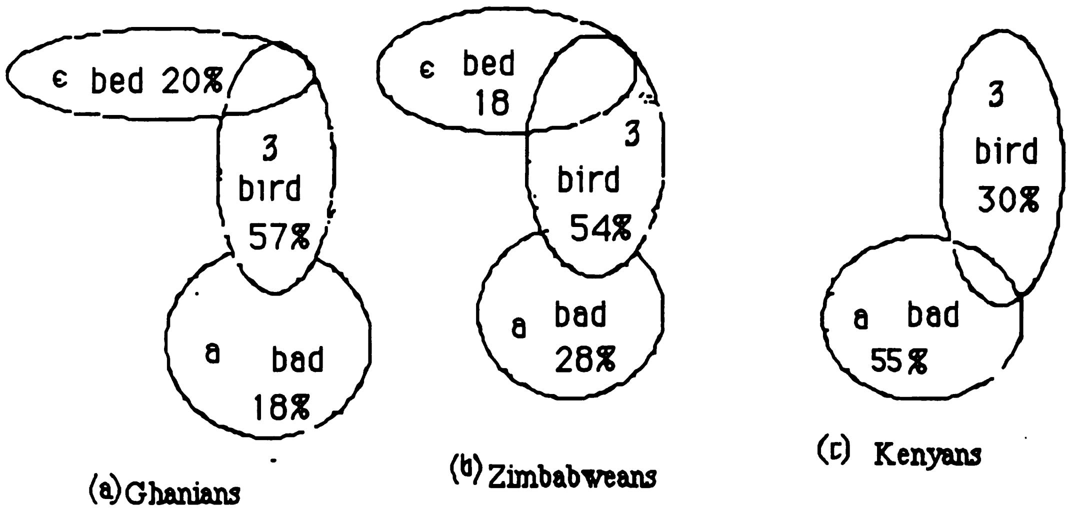


Figure 17.2 - AfrE Listeners' Identification of [ɜ]

an association of the sound with similar L1 allophonic variants. A correlation of production and perceptual results will verify these assumptions. Figure 17.2 shows the strong identification of the vowel among Ghanaians and Zimbabweans, and lowering of the vowel to /a/ by a majority of Kenyans.

Identification of [I]

In another case of misperception, the RP vowel [I] is confused with [i] and [e],

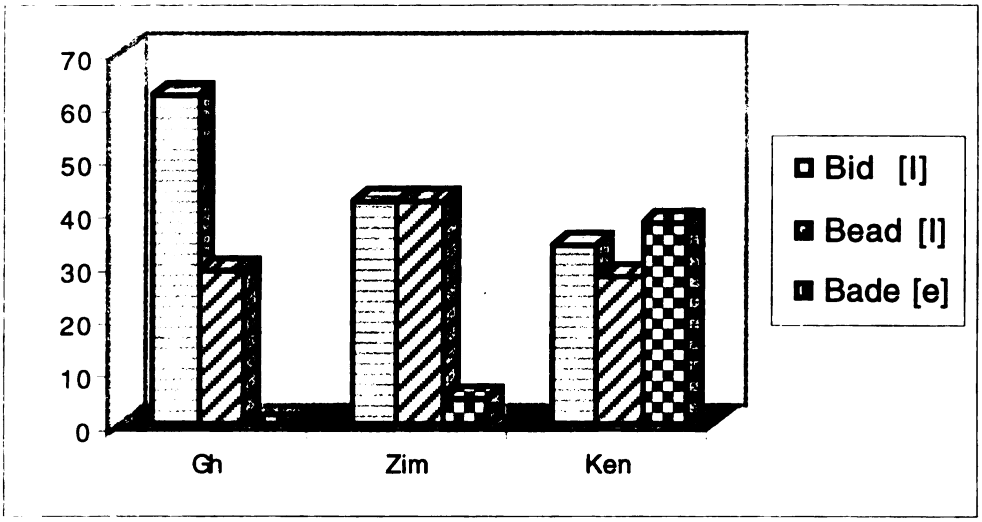


Figure 18.1 - AfrE Listeners' Identification of [I]

more evidently by Kenyans and Zimbabweans than Ghanaians as Figure 18 shows.

Among Kenyan listeners, 38% correctly identify [I], 42% confuse it with [e],

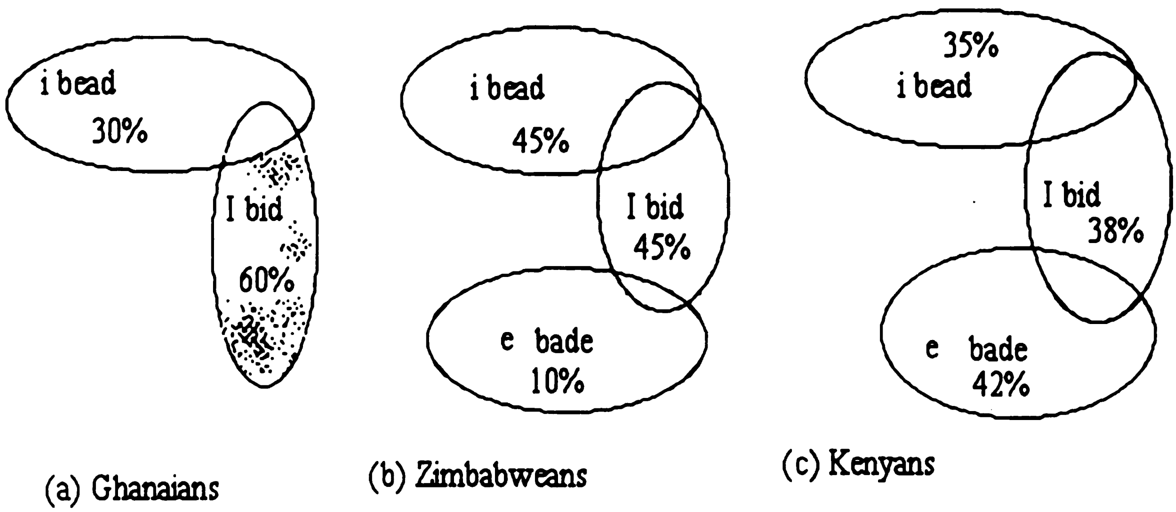


Figure 18.2- AfrE's Listeners' Identification of [I]

while 35% identify it as [i]. 45% of Zimbabwean listeners correctly identify [I], 45% mistake it for [i], and 10% heard it as [e]. On the other hand, over 60% of Ghanaian speakers easily identified the vowel, 30% confused it with [i], and no respondent incorrectly identified [I] as [e], as respondents from other regions did.

Identification of [ɒ]

In all three regions, a majority of listeners confuse RP vowel [ɒ] with [ɔ], as illustrated in Figure 19.1. A low score of 36% (Ghanaians), 38% (Zimbabweans), and 38%(Kenyans) correctly identified [ɒ], compared to 45%, 60%, and 42% (in the same order as above) who confused the vowel with [ɔ].

Considering results of some earlier perception tests conducted in other English-

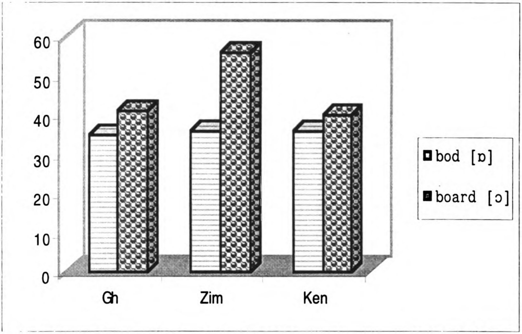


Figure 19.1 - AfrE Listeners' Identification of [ɒ]

speaking settings, it may hardly be surprising to find such a confusion among AfrE speakers. But Peterson and Barney (1953), Preston (1994) have reported such confusion only minimally among American respondents. Lieberman and Blumstein (1988:179) have argued that the confusion of these two vowels even in languages or dialects where the vowels are distinct in production, is due to close proximity of these vowels in the vowel space. Such a confusion among our multilingual sample may be considered a case of categorial perception of non-native sounds. The low percentage of respondents who

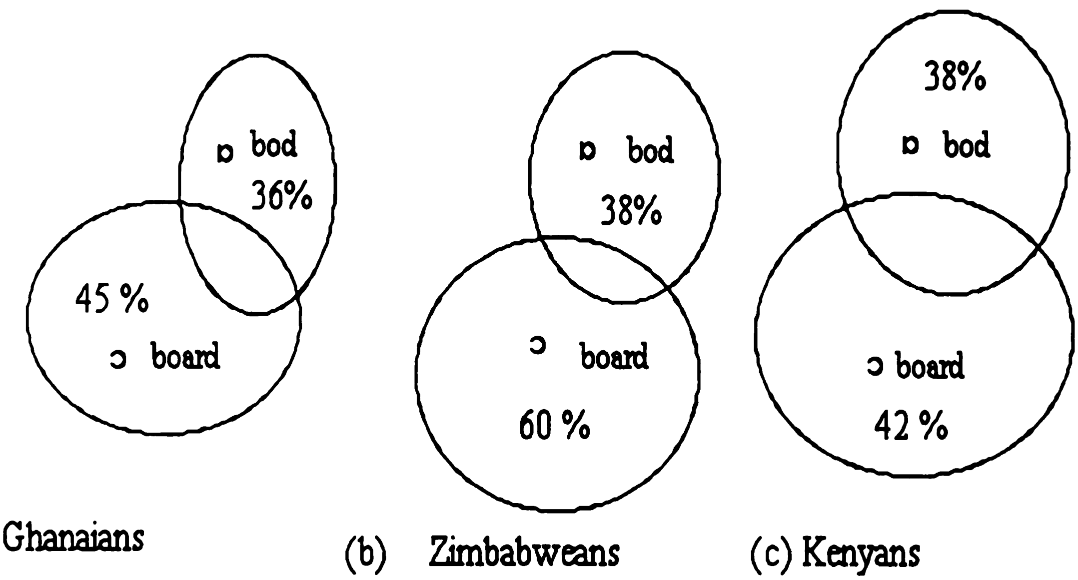


Figure 19.2 - AfrE Listeners' Identification of [ɒ]

correctly identify RP's [ɒ], and the relatively higher number of the highly recognized quantal vowel [ɔ], is discussed above.

Identification of [ɛ]

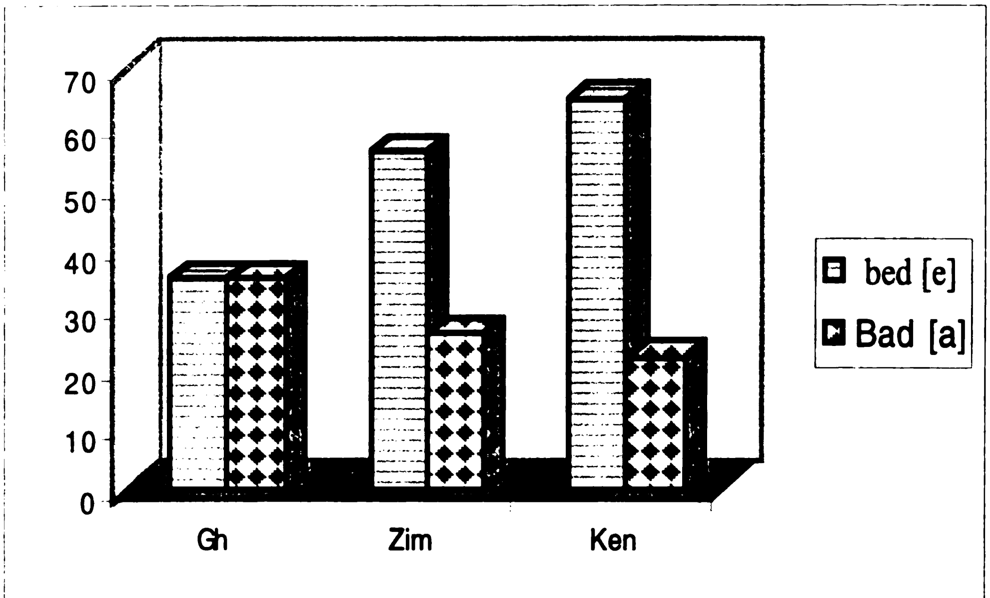


Figure 20.1 - AfrE Listeners' Identification of [ɛ]

Figure 20 shows over 60% of respondents from eastern and southern Africa correctly identify [ɛ], while less than 30% of respondents in both regions confuse the vowel with [a]. Less than 40% of the West African sample correctly identified [ɛ], while 38% confused it with [a]. [ɛ] appears to be quite distinct among Kenyans and Zimbabweans.

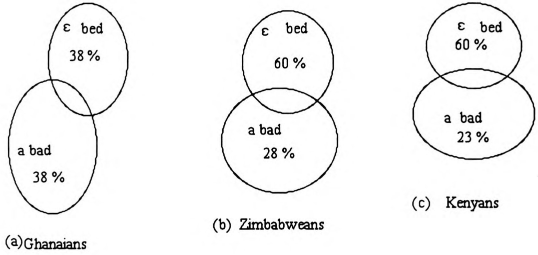


Figure 20.2 - AfrE Listeners' Identification of [ε]

Identification of [ai], [au], and [oʊ]

Although a majority of Ghanaians confused [ai] with [a], and [au] with [a] as did

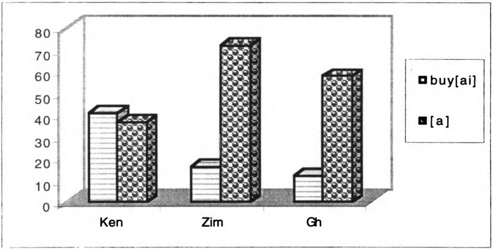


Figure 21 - AfrE Listeners' Identification of [ai]

the Zimbabweans, diphthong [oʊ] was, however, correctly identified by most of

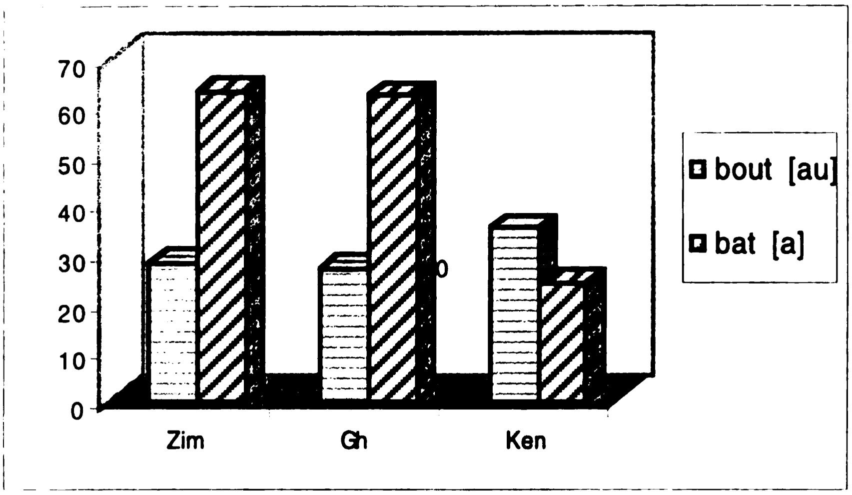


Figure 22 - AfrE Listeners' Identification of [au]

Ghanaian respondents as shown in Figures 21, 22 and 23.

On the other hand, Kenyan respondents confused [ai] and [au] with [a], and a majority mistook [ou] for [o] as shown in Figure 21 through Figure 23.

Schmied's (1991:59) conclusion that all AfrE's centring diphthongs tend to be pronounced as opening diphthongs or double monophthongs (/ia,ua) (see 2.2.2) is not

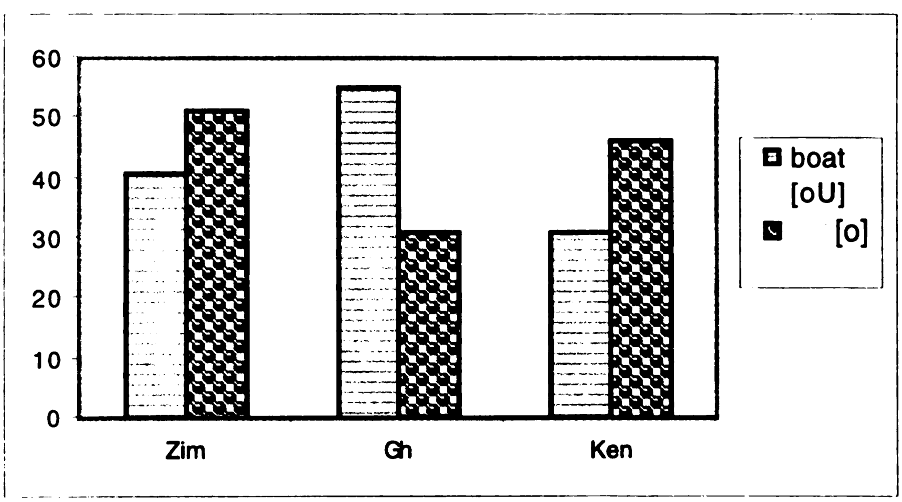


Figure 23 - AfrE's Listeners' Identification of [ou]

supported by these perceptual results.

Conclusion

In conclusion, vowel identification results from the MPT show that vowels [i], [e], [ɔ] and [u] are reliably identified by all AfrE respondents, including diphthongs containing these vowel onsets.

In general, all respondents had difficulties identifying the RP vowels [ʌ], [ɜ], [ɒ], and [I]. Regional variations are particularly evident in the perception of [ɜ], [ɪ], [ɛ]. For example, a majority of Kenyans identify [ɜ] as [a], while among Ghanaians and Zimbabweans, [ɜ] is correctly identified by a majority of respondents. Likewise, many Kenyans and Zimbabweans correctly identify [ɛ], although a few confuse it with [a], but among Ghanaians, only a small percentage of respondents identified RP vowel [ɛ]. Other variations are discussed above, but it is worth noting that these vowels are non-native to the L1s of the respondents. This is further proof that the generalized vowel systems in earlier studies are not accurate representations of the systems of the present sample.

Errors evident in the perception of non-native vowels may be attributed to the native language magnetic effect postulated in the NLM theory. Social factors such as ethnicity, level of education, and age, may also account for the variation. For instance, results in the perception of RP vowels [ʌ], [ɜ] , [ɒ], and [I], vowels that are generally absent in vowel systems of Kwa and Bantu language are perceived variously in the tests.

Suffice it to say, IT results reflect acoustic analysis discussed in chapter 3. Note for instance that RP vowel [ɜ] as in *bird* is produced as [a] by Kenyan respondents, but Zimbabweans and Ghanaians produce it as [e].

However, we should hasten to reiterate that level of education is an important factor in the production and perception of an L2. A sample of well-educated respondents, like the present sample, may produce and perceive L2 sounds differently than the less-educated considering the inclination to RP exposure.

Results of MPT task, discussed below, will provide us with a more complete picture of vowel perception.

5. 9 **<u>Results of the MPT</u>**

Respondents were asked to listen to fifty-eight minimal pairs and determine whether the words were similar or not. Responses were marked on questionnaire (see Appendix D). Results were tallied and percentages calculated to determine which pairs were easily discriminated, and which ones were not (see the discrimination results in Appendix E).

At this juncture, a highlight of some presuppositions of the Native Language Magnet theory will help with the analysis. Liberman (1990) observes that sounds from distinct categories are relatively easier to discriminate in MPT than non-distinct ones. The latter may be perceived as one sound. Moreover, L1 vowel categories may interfere with multilingual listeners' ability to perceive certain phonetic distinctions of non-native L2 sounds.

Consequently, it is assumed in the following analysis that AfrE listeners will have difficulties discriminating vowels that are non-distinct and non-native to their L1. These adult respondents, we presume, will use their already developed L1 vowel schema in discriminating RP vowels present in the MPT. However, we hasten to add that these university students have had ample exposure to RP, but needless to say, not as much as exposure as to either AfrE or their respective L1s. This study focuses on vowels that were difficult to discriminate.

Results of the MP task are illustrated in Figures 24, 25 and 26. Each figure shows the vowel pairs erroneously identified by approximately 40-50% of respondents as

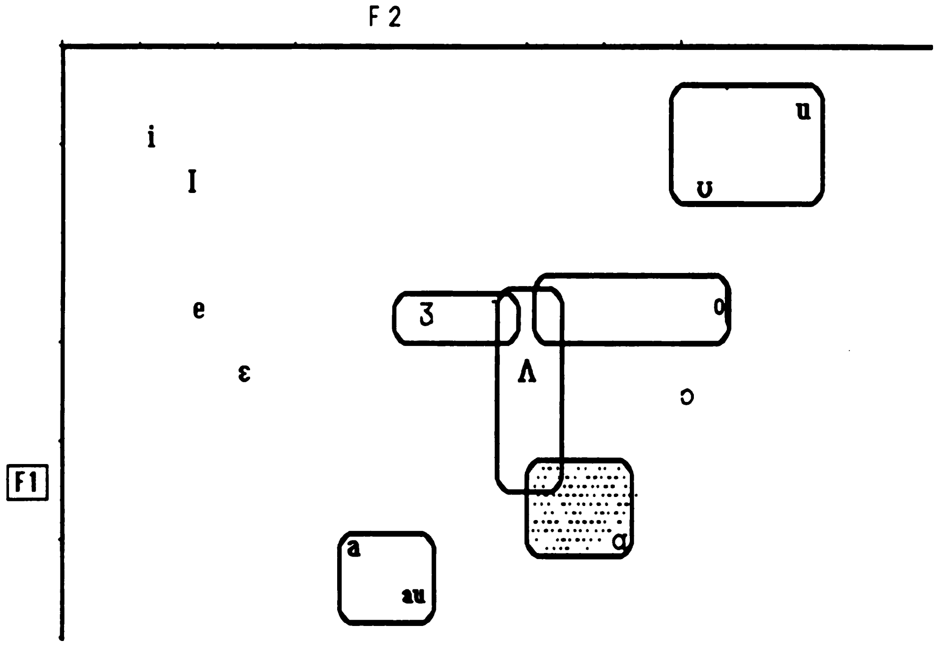


Figure 24 - Ghanaians Discrimination of Minimal Pairs

"same", and correctly identified as "different" by a similar percentage of respondents. Shaded areas represent cases in which over 55% of respondents thought different vowel pairs were the same.

Figure 24 shows that Ghanaians had difficulty discriminating pairs involving vowel [ʌ] and [ɜ] (*bud/bird*); [ʌ] and [ɑ] (*hut/hurt*); [ʌ] and [o](*gut/got*); [a]and [au] (*bat/bout*); and [u] and [ʊ] (*wood/wooed*)

Figure 25 shows that Kenyans, on the other hand, had difficulties discriminating vowel pairs [e] and [ɛ], (*wade/wed*); [ɜ] and [ʌ] (*bird/bud*); [ʌ] and [a] (*mud/mad*); [ʌ] and [o] (*gut/got*); [a] and [au] (*bat/bout*); [ɑ] and [ɔ](*cot/caught*), [au], [ua], and [ou], (*got/goat, bought/bout, caught/cot, law/lure*).

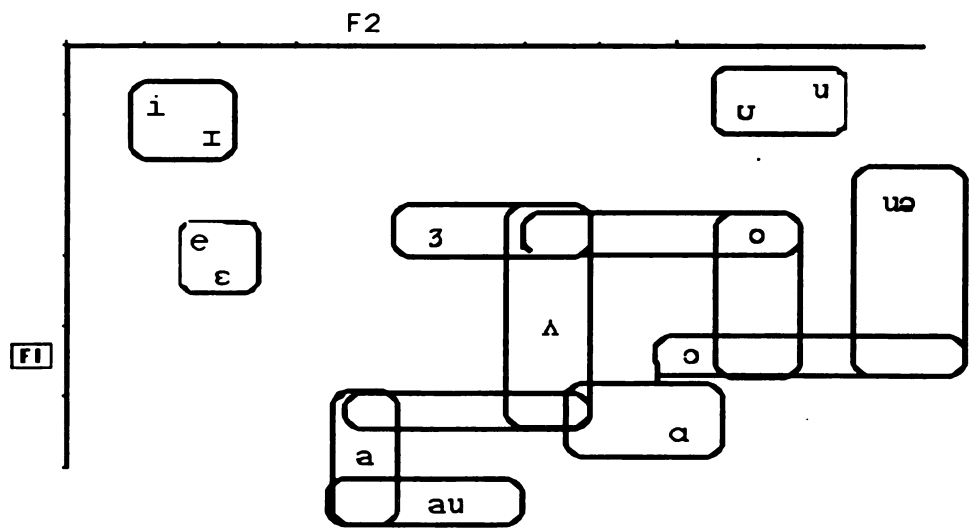


Figure 25 - Kenyans Discrimination of Minimal Pairs

Lastly, as shown in Figure 26, Zimbabweans had difficulties with pairs containing vowels [ɜ] and [ʌ] [*bird/bud*]; [ʌ] and[a] (*mad/mud*); [o], (*mud/mode*); [e] and [ɛ], (*wade/wed*); [ɑ], [ɔ],[au], [ua], and [ou], (*hot/hot, gut/got, got/goat, cot/caught, call/call, bought/bout, law/lure*).

Beyond the apparent obscurity of discrimination results, there appears a clear pattern of perceptions which mirrors identification results to some degree. Consider for instance the recurrence of [ɑ] and [ɔ] in the lists of confused pairs in all regions, and recall the misidentification of these two vowels in the IT task.

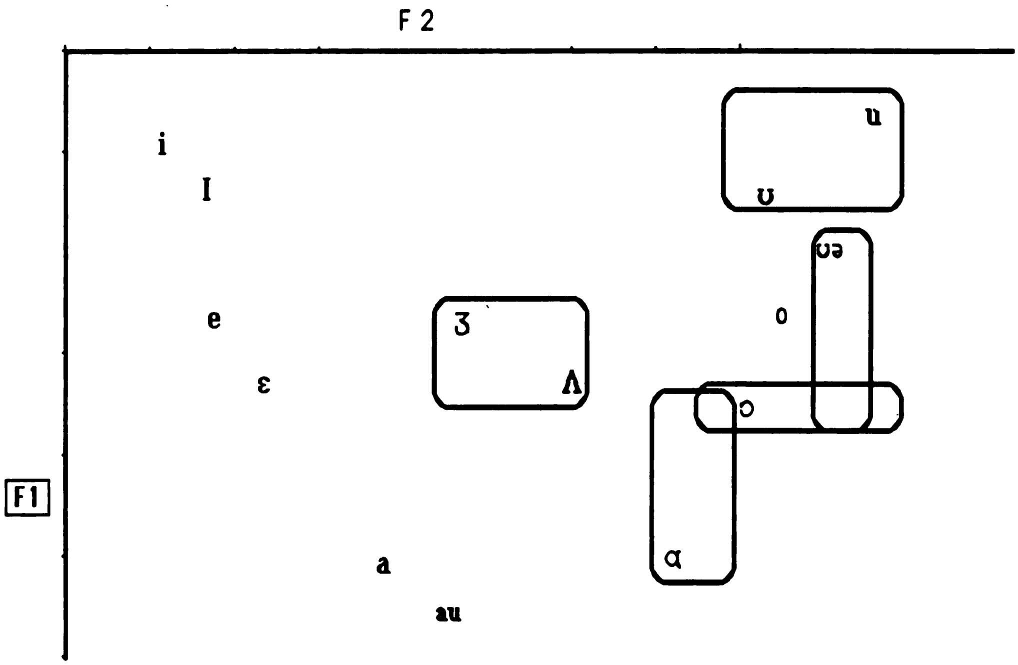


Figure 26 - Zimbabweans Discrimination of Minimal Pairs

Furthermore, RP central vowels [ɜ] and [ʌ] are also prominent recurrences in various pair combinations. The fact that minimal pairs containing these vowels (bird/bud, hut/hurt) are confused by many respondents in all regions, and taking cognizant of results of identification task and acoustic analysis, reaffirm that AfrE speakers and listeners realign RP central vowels in accordance with their respective L1 systems. The Westermann and Ward illustration of African L1s (see Appendix A') affirms these observation.

Chapter 6: Conclusions

6. 1 Introduction

This study has utilized empirical tools of investigation and analysis to identify phonetic and phonemic qualities of AfrE vowel systems. Acoustic analysis has been done to determine speakers' production of AfrE vowels. Speech perception tests have been conducted to determine listeners' abstract realization of those vowels. Several theoretical assumptions guided us in the present analysis of the data.

This concluding chapter seeks to tease out a probably phonemic interpretation of these vowel systems by correlating vowel production and perception results presented in the previous chapters. Although it is difficult to state categorically that the results represent the actual phonemes of the vowel systems of a given multilingual region, acoustic and perceptual analysis indicate, among other things, a variance in vowel production and perception across regions and ethnic groups studied. The results contradict some of the regional variations widely documented in previous studies. For example, Schmied (1991) and other scholars, have consistently argued that the major source of AfrE variation is due to regional variance in the production of the RP central vowel [ɜ] (as in *bird*). As stated earlier, these scholars claims that [ɜ] backs to [ɔ] in WAfrE, fronts and lowers to [a] or fronts to [e] in EAfrE, while in SAfrE it fronts to [e]. As discussed in the following sections, data from this sample does not corroborate this theoretical premise, especially in regard to what the acoustic and perceptual realizations of the central vowels are in each region. Furthermore the identical vowel production among eastern and southern Africa speakers, that is claimed to constitute Bantu English, is also not corroborated .

This study also found a distinction between male and female vowel system, particularly in the acoustic analysis. Such a distinction merits further investigation with a view to understanding vowel variance within and across social groups in each region. For instance, what are the social factors that account for these gender distinctions? Is the distinction indicative of any changes in progress in the vowel production of the varieties we examined? And what is direction of the change, if any?

On the theoretical front, the current study has corroborated assumptions that there indeed is an underlying AfrE vowel system, as well as distinct regional variations. Furthermore, comparing Westermann and Ward's illustration of L1 vowel system and the results derived in this study, it is apparent that the tenets of the Native Language Magnet theory apply in our respondents' perception of non-native vowels.

Let us attempt to correlate production and perception results, and determine how we reached these conclusions.

6. 2 Correlating Acoustic and Perceptual Results

Vowel production and perceptual data has unequivocally shown that vowels / i/, /ɔ/, and /u/ and diphthongs that contain similar onsets are contrastive, easily identified and discriminated without difficulties across the board. AfrE speakers and listeners realized these phones as allophonic variants; [i]/[I], [u]/[ʊ], [ʌ]/[a] and [ɒ]/[ɔ]. Applying Lieberman's physiological theory for vowels, we can assume that these vowels have well defined spectral properties, and are therefore, AfrE's quantal vowels which define the vowel space within which AfrE speakers and listeners (represented in this study) differentiate other English vowels. Moreover, based on principles of Native

Language Magnet theory, we can further argue that these and other identified regional phonemes (discussed below), are in effect influenced by the L1 of these multilingual speakers. However, we should hasten to add regional differences are evident in the production and/or perception of [ɜ], [ɪ], [e], [ɛ] and other diphthongs .

In the following sections, we will seek to correlate production and perception results by restating the main results and subsequently discussing them.

Ghanaians

Although there were gender variations in vowel quality, vowel production among Ghanaians was such that vowels in tokens *bead* , *hid* , *hue,* and *here* were realized as [i]; *year* and *hair* as [e]; and *bed*, *name*, *bird* as [ɛ]; *hard*, *pride*, *bout*, *bad* and *mud* as [a]; *sod*, *caught* and *board* are pronounced as [ɔ]; *open*, *goat*, *sure*, and *boy* were realized as [o]; while *mood* and *good* were realized as [u]. The only apparent gender distinction in vowel production among our sample lies in the realization of [ua] as in *sure*. While male respondents realize the monophthongized diphthong as [o], females pronounce it as [u].

Speech perception tests reflect production results, considering in particular the high identification rate of vowels [i], [ɔ], and [u], and diphthongs that contain similar onsets. For example, in the acoustic analysis, F1 and F2 scores of diphthongs contained in *hue, year* load in the phonetic space of /i/.

As stated above allophonic variants [a]/[ʌ] and [ɑ]/[ɔ] pairs are not clearly identified, and are not easily discriminated, because, as the production results indicate, they are not distinct vowels. [ʌ]is produced as [a] while [ɑ] is produced as [ɔ]. The first mentioned change is particularly interesting considering that earlier studies claimed that WAfrE speakers realized RP's [ʌ] is as [ɔ].

RP central vowel [ɜ], is produced as [ɛ], identified as such by 23% of respondents, perceive as [a] by 20%, and difficulties were evident in discriminating [ɜ]/[ʌ] pair. We have already established that [ʌ] is indeed realized as [a], so in the last mentioned pair it should be read as such. Again, what is particularly interesting in this finding is that, production and perceptual evidence does not corroborate widely documented claim that WAfrE respondents back the central vowel to [ɔ], at least not with this sample.

Based on production and perceptual evidence, RP / ɜ/ may be considered an allophone of /ɛ/ among our Ghanaian respondents.

Monophthongized /ai/ and /au/ are allophones of /a/.

Zimbabweans

Zimbabweans produce vowels contained in the tokens *bead*, *hid* as [i]; *year* and *hair* as [e]; *made*, *bet*, *name*, *bad* , *bird* as [ɛ]; *hard*, *pride*, *bout*, and *mud* as [a]; *sod*, *open*, *goat*, *caught*, *board*, sure, and *boy* as [o]; while *mood* and *good* are realized as [u]. Male respondents have a lax and tense distinction for the front mid vowel while female speakers do not. Moreover, while male respondents front RP's central vowel [ɜ] as in *bird* to [ɛ], and raise the low back vowel [a] to [ɛ], female respondents barely front [ɜ] as in *bird* to [ɛ], but they do not raise [a].

Results of the identification task indicate that an equal number of Zimbabwean listeners confused [e] with [ei]. Moreover, 66% of the respondents perceived *made/made* pair as different words in the discrimination task. Gender distinction is also evident in male respondents' lax/tense distinction of the front mid vowel. Moreover, while male respondents front RP's central vowel [ɜ] as in *bird* to [ɛ], and raise low back vowel [a] to [ɛ], female respondents only front [ɜ] as in *bird* to [ɛ], but they do not raise [a]. The distinction may account for the identification results which shows that 30% of respondents perceive [ɜ] as [a] and 20% as [ɛ]. The variation is also reflected in the difficulties in discriminating *bat/bat* and *bird/bud* pairs. Previous studies have categorically stated that SAfrE speakers front [ɜ] to [ɛ], and [e] is realized as [e]. It is plausible that /e/ has many variants in the English variety spoken by our Zimbabwean sample, including /e/, /ɛ/, and /ea/.

Monophthongization of [ai] and [au] to [a], and [ou] to [o], is evident in production and discrimination results.

Kenyans

The Kenyan sample produced vowels contained in the tokens *bead* and *hid* as [i]; vowels in the words *made* and *bet* as [e]; *year*, *hair*, and *name* , as [ɛ]; *bad, hard, pride, bout*, *bird* and *mud* as [a]; *sod, open*, *goat*, *caught*, *board* and *boy* as [o]; while *mood* , good and sure are realized as [u]. It should be noted that while males make [e] – [ɛ] distinction, females do not. The only other significant variation is that while male respondents realize [Iə] as /e/, female speakers produce it as /i/.

The production of [ɜ] as [a] is reflected in identification task where 52% of respondents mistake [ɜ] for [a], a variation quite distinct from Ghanaians' and Zimbaweans'. Moreover, unlike in the other two varieties, no Kenyan respondent identified [ɜ] as [ɛ]. /ɜ/ in Kenyan English is an allophone of /a/, and not /e/ as the case among Zimbabweans and Ghanaians.

It is also interesting to note that, unlike identification responses from the other regions, over 63% of Kenyan respondents perceive RP [ɛ] as [a]. The distinctions between varieties spoken by Zimbabweans and Kenyans are worth noting considering earlier claims that the varieties are almost identical except for variation in the realization of [ɜ]. Is it possible then to argue that /ɛ/ is an allophone of /a/?

Monophthongization of [ai] and [au] to [a], and [ou] to [o], is reflected in production and discrimination results.

We should hasten to add, these results do not represent the vowel systems of speakers of national or regional varieties of AfrE. Our sample was drawn from well-educated, Kwa and Bantu language speakers, and can only be considered to represent that particular sample. Whether the results represent the broader population of Kwa and Bantu speakers, or national varieties, will be determined after similar studies have been conducted covering other social, ethnic and language omitted in this study. Future research should utilize empirical tools of research adapted in this study to determine AfrE vowel production and perception among respondents of different ethnic, social and linguistic backgrounds.

6. 3 Theoretical Assumptions Revisited

Based on our empirical findings, several observations can be made regarding theoretical assumptions about AfrE, speech production and perception, and about the Native Language Magnet (NLM) theory.

(a) Assumptions about AfrE

In this study African English was regarded as a very general term that refers to divergent social, regional and ethnic sub-varieties of English in East, West and Southern Africa. The regional varieties of AfrE (EAfrE, WAfrE, SAfrE) were also perceived in very general terms as diverse sub-varieties that have distinct regional characteristics, as Mutonya's (1997) attitudinal study of AfrE varieties showed.

Results of acoustic measurements and perception tests discussed in this study, show that although each regional vowel system has its own distinctive (marked) elements, there are some basic similarities (unmarked) in all regional vowel systems that presuppose an underlying AfrE vowel system.

The marked elements account for the individual Kenyan-Bantu, Zimbabwean-Bantu, and Ghanaian-Kwa (Akan) vowel systems, while the unmarked ones represent the underlying AfrE vowel system.. For instance, the acoustic analyses shows that Ghanaian and Zimbabwean speakers of English front the RP vowel [ɜ] to [e] , while Kenyan speakers lower it to [a]. Furthermore, the central vowel [ʌ] as in *bud* is lowered by Kenyans and Ghanaian speakers, but Zimbabwean speakers realize it as [e]. These are regional variations.

However, in spite of such regional variations , it is evident that all speakers have a peripheral vowel system that consists of /i/, /e/ (and /ɛ/ in some instances), /a/, /o/ and /u/, similar to Westermann and Ward's illustration of African L1 vowels. RP's central vowels /ɜ/ and /ʌ/ are lowered or fronted, while RP vowel contrast is lost in /i/-/I/, /a/-/ʌ/, /a/-/ɑ/, /ɔ/ - /o/, and /u/-/ʊ/. These are general characteristics that transcend all three samples in this study.

Similarly, vowel perception results in this study reflect both general and region specific traits. For example, in the IT task all listeners confused words containing the vowels /ɜ, ʌ, ɔ, ɛ, ɑ /. The misidentification pattern is almost identical in all regions, except for the specifics of whether a particular vowel was strongly or weakly. Consider for instance that while RP /ɜ/ is also misidentified as /e/ and /a/ in all regions, 58% of Ghanaians and 55% of Zimbabweans positively identify the vowel, while only 32% of Kenyan identified it correctly. 55% of Kenyans misidentified the vowel as /a/ while only 30% and 18% of Zimbabweans and Ghanaians respectively, identified it as such.

In order to avoid methodological shortcomings in analyzing AfrE varieties, use of controlled samples and empirical tools of research is the best way of determining the regional characteristics of AfrE .

(b) Assumptions Concerning Speech Production and Perception

Lieberman (1990) reports that experiments point to the fact that listeners perceive speech categorically; that is , listeners' ability to discriminate sounds from two different categories, such as /i/ and /e/, should be relatively easy, but discriminating two different tokens of /i/ from the same speaker should be difficult.

The findings in this study support the assumption that vowels are perceived categorically, considering that results of the MPT task reflect difficulties in discrimination of non-distinct sounds. For example, Kenyan listeners had difficulties discriminating sounds that are non-distinct in Bantu languages [ʌ]/[ɜ], [ʌ]/[a], [ʌ]/[ɑ], and [a]/[au]. Acoustic analysis suggests the Kenyan sample realize all these phones as variants of /a/. Furthermore [e]/[ɛ] and [u]/[ʊ] are also difficult to discriminate because, as the acoustic analysis points out, they are variants, and presumably allophones of /e/ and /u/ respectively. Similar examples from other respondents can be cited. The non-distinct vowels that are difficult to discriminate in the perception tests are also non-distinct vowels in acoustic analysis.

Correlating speech production and perception is based on the consideration that every speaker is simultaneously a listener, and every listener is at least potentially a speaker.

Suffice it to say, the scope and design of this study does not provide us the evidence to verify the main assumptions of the Motor Theory of Speech Perception: that listeners' interpretation of acoustic signals are guided by articulatory gestures . Similarly, we cannot empirically determine whether listeners use vocal tract normalization during vowel perception, although categorical perception of speech, discussed above, points towards that direction.

(c) Assumptions about Non-native Speech Perception

Recall that the NLM theory postulates that adult listeners perceive non-native sound contrasts based on a schema developed from their native language. The native phonological system of the listener presumably plays a prominent role in perception of non-native sound contrasts.

Several factors make it difficult for us to ascertain whether listeners' L1 vowel systems affect their perception of RP vowels. The lack of empirically defined vowel systems of Kwa and Bantu languages denies us reliable comparative evidence. However, based on widely documented information, including Westermann and Wards' study (discussed in Chapter 3), Bantu and Akan vowel systems are peripheral and symmetrical. The L1 systems have five to seven vowels and no central vowels (Welmers:1988). Such characteristics are reflected in the perception of RP vowels in this study. Furthermore, results of the perceptual tests indicating RP's contrastive vowels are perceived as non-contrastive may be indicative of the L1 effect. The reduction in number of the RP vowels in production and perception by these AfrE respondents may point towards the same conclusion.

However, although it is logical to assume an L1 influence in production and perception of non-native sounds, considering that adult speech perception is organized to process L1 with the least effort and greatest efficiency, it is equally appropriate to argue from a sociolinguistics standpoint that social and other linguistic factors may play significant roles in speech perception besides L1 effect. For example, in multilingual sub-Saharan Africa, level of education is closely related to degree of exposure and usage of English, just as much as social status is.

Evaluating speech perception of multilingual respondents in sub-saharan Africa, leaves us wondering how factors such as language contact, listener's exposure and attitude to RP, level of education, multi-lingualism, influence respondents' perception besides the L1 effect.

Since most of our respondents are fluent in other local languages, It would be interesting to determine whether the indigenous L2s and L3s of these multilingual listeners affect their perceptions as much as L 1 does. Would a similar sample, with a relatively lower level of education have similar vowel perception? How about a respondent who has a lower level of education but a higher degree of exposure and interaction with RP speakers? Would a respondent who has a strong negative attitude towards English perceive RP vowels any different from his counterpart who is positively inclined towards English? Only further research can help us answer these and other lingering questions .

Finally, this study has shown that the maximally distinct AfrE vowels are [i], [e], [o] and [u]. Studies among English monolinguals had identified [i], [u] ad [a] as the quantal vowels.

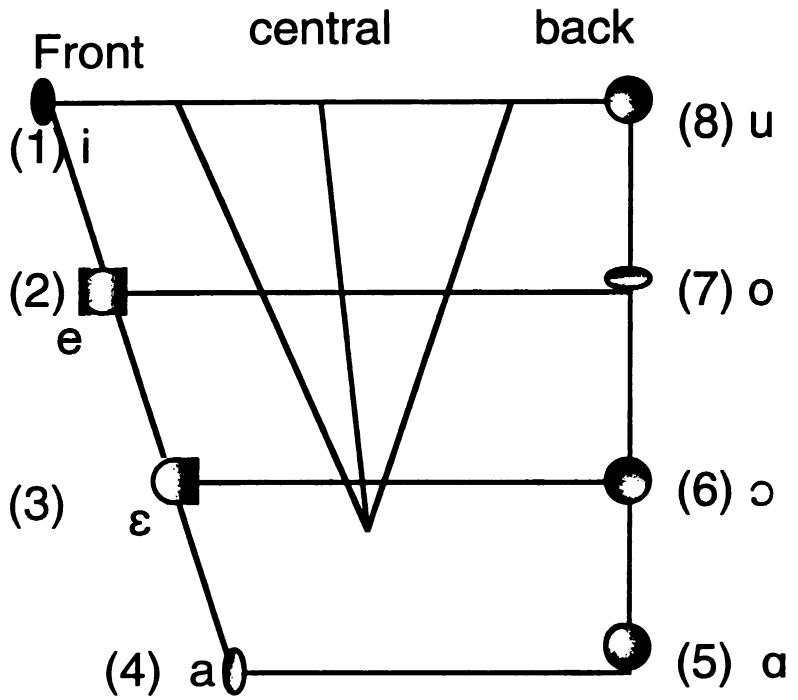
Future studies should build on the foundations of this research in the seeking to determine whether empirical evidence supports the broad definitions of varieties of African Englishes. Furthermore, the tools of investigation and analysis used in this study can be utilized in the empirical research of African languages.

APPENDICES

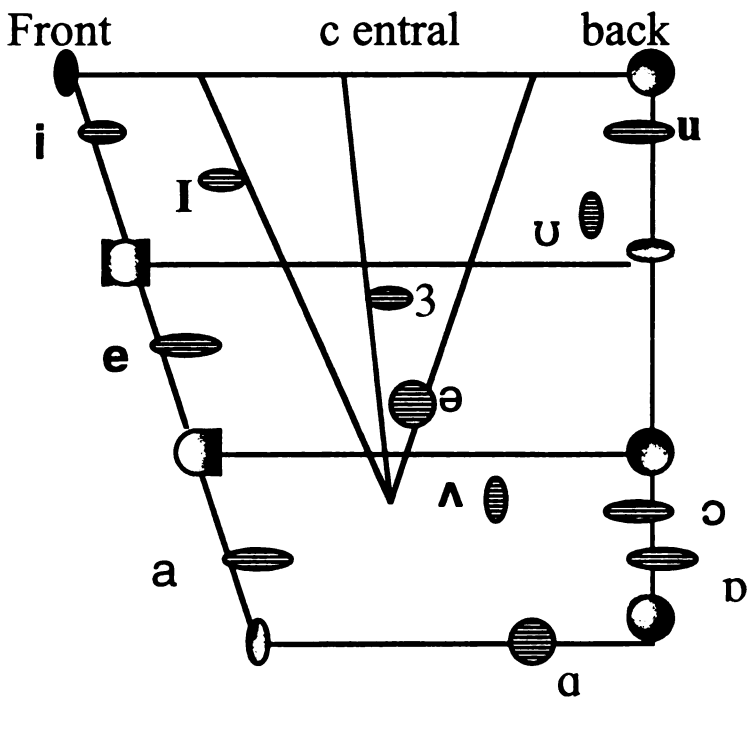
APPENDIX A'

APPENDIX A'

(i): Cardinal Vowel Chart



APPENDIX A'(ii): Westerman's Illustration of RP vowels



APPENDIX A

TABLE 1: A PROFILE OF RESPONDENTS

Name	Gender	Age	L1	country
Kimani	Male	22	Gikuyu	Kenya
Mutunga	Male	22	Kikamba	Kenya
Njogu	Male	23	Kimeru	Kenya
Mbugua	Male	22	Gikuyu	Kenya
Njenga	Male	23	Kiembu	Kenya
Maina	Male	20	Ekegusii	Kenya
Mwendwa	Male	21	Kiswahili	Kenya
Karani	Male	23	Kitaita	Kenya
Ngigi	Male	23	Gikuyu	Kenya
Muchangi	Male	25	Lubukusu	Kenya
Mutia	Male	24	Kikamba	Kenya
Mukami	Female	21	Gikuyu	Kenya
Wanja	Female	35	Gikuyu	Kenya
Wangui	Female	32	Gikuyu	Kenya
Bukusu	Female	19	Lubukusu	Kenya
Embu	Female	22	Kiembu	Kenya
Kisii	Female	26	Ekegusii	Kenya
Luhya	Female	24	Lumaragoli	Kenya
Meru	Female	25	Kimeru	Kenya
Taita	Female	28	Kitaita	Kenya
Wanjiru	Female	30	Gikuyu	Kenya
Kamba	Female	30	Kikamba	Kenya
Jones	Male	33	Shona	Zimbabwe
K. Nenziwe	Male	25	Shona	Zimbabwe
E.Nenziwe	Male	28	Shona	Zimbabwe
Ndanga	Male	26	Ndebele	Zimbabwe
Mafumo	Male	35	Chichewa	Zimbabwe
Bengo	Male	22	Tonga	Zimbabwe
Takawira	Male	27	Shona	Zimbabwe
Kambasha	Male	20	Ndebele	Zimbabwe
Ngovele	Male	20	Shona	Zimbabwe
Chenza	Female	25	Shona	Zimbabwe
Mukulu	Female	19	Chichewa	Zimbabwe
Chinya	Female	28	Shona	Zimbabwe
Eda	Female	29	Ndebele	Zimbabwe
Ndetanya	Female	24	Ndebele	Zimbabwe

Tamika	Female	32	Shona	Zimbabwe
Wamaka	Female	23	Setswana	Zimbabwe
Nguwe	Female	26	Shona	Zimbabwe
Kamanga	Female	27	Chichewa	Zimbabwe
Kapinda	Female	28	Ndebele	Zimbabwe
Mwangela	Female	26	Tonga	Zimbabwe
Kwame	Male	35	Ewe	Ghana
Kojo	Male	43	Ewe	Ghana
Kwasi	Male	48	Ewe	Ghana
Yao	Male	33	Fante	Ghana
Kweku	Male	25	Ga	Ghana
Efiada	Male	33	Ga	Ghana
mmeneda	Male	48	Ga	Ghana
Anane	Male	27	Twi	Ghana
baako	Male	34	Twi	Ghana
Duko	Male	42	Twi	Ghana
Manu	Male	40	Asanti	Ghana
Akosua	Female	24	Asanti	Ghana
Afua	Female	42	Twi	Ghana
Yaa	Female	36	Fante	Ghana
Abenaa	Female	25	Fante	Ghana
Mansa	Female	39	Ewe	Ghana
Badu	Female	22	Fanti	Ghana
Mensa	Female	45	Ewe	Ghana
Nsoa	Female	33	Asanti	Ghana
Piesie	Female	35	Fanti	Ghana
Nsia	Female	24	Ga	Ghana
Du	Female	22	Twi	Ghana

APPENDIX B

APPENDIX B1

AN EXAMPLE OF A NORMALIZED DATA FILE

Maina,20,M,Formal,Urban,
Kenya

22,6.677709
314,2289,,1.142,1,hid
283,2207,,11.1421,1,bead
453,2333,,14.00091,1,year
415,1812,,2.1411,1,bet
456,1750,,21.1422,1,made
493,2094,,21.4124,1,name
565,1731,,24.6,1,hair
663,1480,,3.1421,1,bad
683,1273,,42.1411,1,bout
678,1563,,44.6,1,hard
655,1716,,47.1428,1,pride
534,1114,,5.1423,1,sod
469,996,,53.1416,1,caught
670,1508,,6.1422,1,mud
547,1008,,61.0001,1,boy
472,915,,62.1416,1,goat
503,996,,63.11101,1,open
470,913,,64.6001,1,board
297,865,,7.1426,1,good
317,823,,72.1422,1,mood
426,915,,74.6003,1,sure
670,1334,,94.6001,1,bird

APPENDIX B2

ALL F1/F2 SCORES

Ghanaians

All Ghanaians (20 M&F)
473
372,2073,,1.142,1,hid
380,2003,,11.1421,1,bead
387,1988,,14.00091,1,year
640,1952,,2.1411,1,bet
566,1877,,21.1422,1,made
439,2152,,21.4124,1,name
506,1930,,24.6,1,hair
841,1564,,3.1421,1,bad
640,1449,,42.1411,1,bout
789,1191,,44.6,1,hard
655,1580,,47.1428,1,pride
500,1213,,5.1423,1,sod
633,946,,53.1416,1,caught
767,1266,,6.1422,1,mud
484,968,,61.0001,1,boy
365,1058,,62.1416,1,goat
439,1024,,63.11101,1,open
528,789,,64.6001,1,board
314,1058,,7.1426,1,good
305,805,,72.1422,1,mood
455,1275,,74.6003,1,sure
603,1787,,94.6001,1,bird
478,2894,,1.142,1,hid
494,2694,,11.1421,1,bead
424,2825,,14.6,1,here
670,2331,,2.1421,1,bed
463,2725,,21.1422,1,made
617,2523,,24.6,1,hair
810,1173,,3.1421,1,bad
787,1335,,41.0001,1,buy
525,941,,42.1411,1,bout
988,1282,,44.6,1,hard
701,1223,,5.1424,1,nod
887,1319,,6.1422,1,mud
648,1103,,61.0001,1,boy
470,1065,,62.1411,1,boat
602,1041,,63.0003,1,saw
455,1046,,7.1426,1,good
378,1073,,72.1422,1,mood
563,1266,,74.6003,1,sure
578,1119,,74.6003,1,tour
463,2040,,82.,1,hue
663,1976,,94.6001,1,bird
309,2724,,1.142,1,hid
426,2607,,11.1421,1,bead
382,2430,,14.6,1,here
603,2407,,2.1421,1,bed
463,2547,,21.1422,1,made
662,2407,,24.6,1,hair
832,1077,,3.1421,1,bad
721,1760,,41.0001,1,buy
758,1641,,42.1411,1,bout
964,1561,,44.6,1,hard
730,967,,5.1424,1,nod
880,1308,,6.1422,1,mud
603,949,,61.0001,1,boy
522,1082,,62.1411,1,boat
603,1178,,63.0003,1,saw
434,1031,,7.1426,1,good
476,995,,72.1422,1,mood
453,1207,,74.6003,1,sure
625,1126,,74.6003,1,tour
471,2229,,82.,1,hue
546,2371,,94.6001,1,bird
413,2797,,1.142,1,hid
429,2859,,11.1421,1,bead
444,2629,,14.6,1,here
581,2452,,2.1421,1,bed
406,2598,,21.1422,1,made
574,2537,,24.6,1,hair
950,1188,,3.1421,1,bad
864,1141,,41.0001,1,buy
886,1177,,42.1411,1,bout
1019,1547,,44.6,1,hard
602,1072,,5.1424,1,nod
851,1238,,6.1422,1,mud
620,1019,,61.0001,1',boy
528,989,,62.1411,1,boat
574,1088,,63.0003,1,saw
421,1111,,7.1426,1,good
368,1088,,72.1422,1,mood
505,1402,,74.6003,1,sure
543,1004,,74.6003,1,tour
375,2721,,82.,1,hue
628,2414,,94.6001,1,bird
515,2529,,1.142,1,hid
393,2668,,11.1421,1,bead
422,2885,,14.6,1,here
597,2055,,2.1421,1,bed
437,2572,,21.1422,1,made
611,2368,,24.6,1,hair
802,1683,,3.1421,1,bad
918,1522,,41.0001,1,buy
757,1174,,42.1411,1,bout
779,1261,,44.6,1,hard
743,1166,,5.1424,1,nod
765,1347,,6.1422,1,mud

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611,1014,,61.0001,1,boy
437,815,,62.1411,1,boat
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453,966,,72.1422,1,mood
435,1294,,74.6003,1,sure
685,1075,,74.6003,1,tour
459,2471,,82.,1,hue
662,2318,,94.6001,1,bird
468,2352,,1.142,1,hid
389,2583,,11.1421,1,bead
447,2294,,14.6,1,here
592,2265,,2.1421,1,bed
432,2425,,21.1422,1,made
649,2234,,24.6,1,hair
715,1060,,3.1421,1,bad
772,1082,,41.0001,1,buy
830,1414,,42.1411,1,bout
959,1443,,44.6,1,hard
728,1046,,5.1424,1,nod
894,1522,,6.1422,1,mud
605,880,,61.0001,1,boy
541,1002,,62.1411,1,boat
618,1024,,63.0003,1,saw
455,902,,7.1426,1,good
411,959,,72.1422,1,mood
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426,2388,,82.,1,hue
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472,2316,,2.1421,1,bed
442,2950,,21.1422,1,made
711,2507,,24.6,1,hair
789,1180,,3.1421,1,bad
840,1180,,41.0001,1,buy
738,1335,,42.1411,1,bout
862,1220,,44.6,1,hard
759,1141,,5.1424,1,nod
831,1318,,6.1422,1,mud
701,1061,,61.0001,1,boy
487,893,,62.1411,1,boat
612,1055,,63.0003,1,saw
408,974,,7.1426,1,good
465,975,,72.1422,1,mood
465,1299,,74.6003,1,sure
671,1055,,74.6003,1,tour
450,2583,,82.,1,hue
585,2359,,94.6001,1,bird
440,2761,,1.142,1,hid
360,2841,,11.1421,1,bead
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639,2452,,2.1421,1,bed
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785,1212,,42.1411,1,bout
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778,1167,,5.1424,1,nod
815,1182,,6.1422,1,mud
675,1087,,61.0001,1,boy
417,829,,62.1411,1,boat
698,1123,,63.0003,1,saw
410,1020,,7.1426,1,good
465,969,,72.1422,1,mood
498,1301,,74.6003,1,sure
690,1064,,74.6003,1,tour
359,2724,,82.,1,hue
682,2496,,94.6001,1,bird
493,2507,,1.142,1,hid
440,2772,,11.1421,1,bead
479,2203,,14.6,1,here
585,2187,,2.1421,1,bed
511,2630,,21.1422,1,made
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805,1192,,3.1421,1,bad
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766,1557,,42.1411,1,bout
896,1298,,44.6,1,hard
736,1101,,5.1424,1,nod
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576,1033,,63.0003,1,saw
440,934,,7.1426,1,good
450,995,,72.1422,1,mood
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622,2218,,94.6001,1,bird
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860,1812,,3.1421,1,bad
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649,1012,,74.6003,1,tour
354,2483,,82.,1,hue
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427,2743,,11.1421,1,bead
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875,1690,,41.0001,1,buy
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503,965,,62.1411,1,boat

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953,1900,,3.1421,1,bad
873,1430,,41.0001,1,buy
408,983,,42.1411,1,bout
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680,1180,,74.6003,1,tour
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589,2406,,94.6001,1,bird
354,2261,,1.142,1,hid
325,2255,,11.1421,1,bead
517,2329,,14.00091,1,year
517,1804,,2.1411,1,bet
458,2114,,21.1422,1,made
445,2047,,21.4124,1,name
509,1942,,24.6,1,hair
739,1485,,3.1421,1,bad
694,1161,,42.1411,1,bout
658,1471,,44.6,1,hard
576,1457,,47.1428,1,pride
531,1042,,5.1423,1,sod
557,1094,,53.1416,1,caught
820,1434,,6.1422,1,mud
463,968,,61.0001,1,boy
481,1064,,62.1416,1,goat
435,858,,63.11101,1,open
495,1124,,64.6001,1,board
458,880,,7.1426,1,good
413,805,,72.1422,1,mood
443,1086,,74.6003,1,sure
517,1779,,94.6001,1,bird
326,2193,,1.142,1,hid
288,2382,,11.1421,1,bead
531,2028,,14.00091,1,year
531,1755,,2.1411,1,bet
303,2481,,21.1422,1,made
457,2192,,21.4124,1,name
523,1966,,24.6,1,hair
647,1095,,63.0003,1,saw
395,1054,,7.1426,1,good
463,1002,,72.1422,1,mood
440,1353,,74.6003,1,sure
530,1046,,74.6003,1,tour
372,2398,,82.,1,hue
624,2393,,94.6001,1,bird
423,2883,,1.142,1,hid
370,2989,,11.1421,1,bead
431,2935,,14.6,1,here
560,2520,,2.1421,1,bed
438,2921,,21.1422,1,made

614,1834,,3.1421,1,bad
713,1273,,42.1411,1,bout
773,1404,,44.6,1,hard
713,1381,,47.1428,1,pride
508,956,,5.1423,1,sod
577,948,,53.1416,1,caught
827,1366,,6.1422,1,mud
493,986,,61.0001,1,boy
493,1078,,62.1416,1,goat
429,836,,63.11101,1,open
552,1292,,64.6001,1,board
448,971,,7.1426,1,good
351,873,,72.1422,1,mood
475,1079,,74.6003,1,sure
531,1548,,94.6001,1,bird
371,2108,,1.142,1,hid
386,2282,,11.1421,1,bead
393,2375,,14.00091,1,year
454,1835,,2.1411,1,bet
364,2214,,21.1422,1,made
447,2101,,21.4124,1,name
515,1847,,24.6,1,hair
720,1326,,3.1421,1,bad
659,1510,,42.1411,1,bout
811,1394,,44.6,1,hard
690,1342,,47.1428,1,pride
478,1213,,5.1423,1,sod
546,1206,,53.1416,1,caught
819,1228,,6.1422,1,mud
500,1008,,61.0001,1,boy
436,1067,,62.1416,1,goat
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409,909,,63.11101,1,open
470,894,,64.6001,1,board
350,1106,,7.1426,1,good
345,925,,72.1422,1,mood
453,1308,,74.6003,1,sure
530,1888,,94.6001,1,bird
429,2231,,1.142,1,hid
370,2105,,11.1421,1,bead
416,2194,,14.00091,1,year
497,1831,,2.1411,1,bet
422,2105,,21.1422,1,made
441,2148,,21.4124,1,name
506,2001,,24.6,1,hair
734,1393,,3.1421,1,bad
667,1527,,42.1411,1,bout
768,1400,,44.6,1,hard
655,1528,,47.1428,1,pride
555,1118,,5.1423,1,sod
607,1141,,53.1416,1,caught
711,1149,,6.1422,1,mud
465,1046,,61.0001,1,boy
416,989,,62.1416,1,goat
437,1019,,63.11101,1,open
540,1037,,64.6001,1,board
303,904,,7.1426,1,good
318,948,,72.1422,1,mood
451,1196,,74.6003,1,sure
440,2315,,21.1422,1,made
426,2116,,21.4124,1,name
503,2043,,24.6,1,hair
705,1266,,3.1421,1,bad
645,1484,,42.1411,1,bout
712,1294,,44.6,1,hard
687,1328,,47.1428,1,pride
494,1197,,5.1423,1,sod
588,941,,53.1416,1,caught
661,1455,,6.1422,1,mud
487,970,,61.0001,1,boy
481,1034,,62.1416,1,goat
536,955,,63.11101,1,open
511,992,,64.6001,1,board
413,950,,7.1426,1,good
370,1018,,72.1422,1,mood
451,1197,,74.6003,1,sure
603,1911,,94.6001,1,bird
361,2064,,1.142,1,hid
349,2220,,11.1421,1,bead
402,2086,,14.00091,1,year
520,1871,,2.1411,1,bet
550,1880,,21.1422,1,made
452,2095,,21.4124,1,name
497,1983,,24.6,1,hair
653,1470,,3.1421,1,bad
683,1448,,42.1411,1,bout
733,1433,,44.6,1,hard
684,1317,,47.1428,1,pride
578,1188,,5.1423,1,sod
532,1077,,53.1416,1,caught
504,1979,,94.6001,1,bird
391,2346,,1.142,1,hid
391,2339,,11.1421,1,bead
434,2224,,14.00091,1,year
523,1793,,2.1411,1,bet
427,2184,,21.1422,1,made
446,2089,,21.4124,1,name
457,2044,,24.6,1,hair
774,1210,,3.1421,1,bad
690,1476,,42.1411,1,bout
848,1291,,44.6,1,hard
578,1458,,47.1428,1,pride
568,1070,,5.1423,1,sod
576,974,,53.1416,1,caught
716,1188,,6.1422,1,mud
484,979,,61.0001,1,boy
460,1012,,62.1416,1,goat
442,929,,63.11101,1,open
508,855,,64.6001,1,board
413,958,,7.1426,1,good
413,807,,72.1422,1,mood
444,1263,,74.6003,1,sure
532,1904,,94.6001,1,bird
375,2227,,1.142,1,hid
395,2279,,11.1421,1,bead
381,1958,,14.00091,1,year
508,1943,,2.1411,1,bet
720,1419,,6.1422,1,mud
465,960,,61.0001,1,boy
435,1006,,62.1416,1,goat
430,928,,63.11101,1,open

556,995,,64.6001,1,board
327,854,,7.1426,1,good
354,1032,,72.1422,1,mood
437,1175,,74.6003,1,sure
542,1813,,94.6001,1,bird
346,2117,,1.142,1,hid
323,2048,,11.1421,1,bead
401,2052,,14.00091,1,year
570,1770,,2.1411,1,bet
392,2062,,21.1422,1,made
453,2215,,21.4124,1,name
537,2054,,24.6,1,hair
754,1424,,3.1421,1,bad
723,1532,,42.1411,1,bout
723,1331,,44.6,1,hard
599,1362,,47.1428,1,pride
561,1047,,5.1423,1,sod
588,862,,53.1416,1,caught
685,1200,,6.1422,1,mud
491,1097,,61.0001,1,boy
490,1089,,62.1416,1,goat
484,1025,,63.11101,1,open
523,854,,64.6001,1,board
396,1009,,7.1426,1,good
339,961,,72.1422,1,mood
483,1312,,74.6003,1,sure
592,1801,,94.6001,1,bird
325,2191,,1.142,1,hid
368,2182,,11.1421,1,bead
518,2269,,14.00091,1,year
515,1796,,2.1411,1,bet
386,2069,,21.1422,1,made
444,2125,,21.4124,1,name
512,1982,,24.6,1,hair
675,1342,,3.1421,1,bad
680,1558,,42.1411,1,bout

Kenyans

All Kenyans (20 M&F)
242
271,2616,,1.142,1,hid
244,2438,,11.1421,1,bead
542,1973,,14.00091,1,year
531,1877,,2.1411,1,bet
452,1728,,21.1422,1,made
548,1956,,21.4124,1,name
512,1660,,24.6,1,hair
694,1607,,3.1421,1,bad
683,1249,,42.1411,1,bout
714,1177,,44.6,1,hard
633,1445,,47.1428,1,pride
557,1007,,5.1423,1,sod
466,1025,,53.1416,1,caught
762,1500,,6.1422,1,mud
475,918,,61.0001,1,boy
535,971,,62.1416,1,goat
465,971,,63.11101,1,open
427,789,,64.6001,1,board

682,1281,,44.6,1,hard
690,1494,,47.1428,1,pride
553,1145,,5.1423,1,sod
591,1206,,53.1416,1,caught
743,1326,,6.1422,1,mud
454,987,,61.0001,1,boy
494,1025,,62.1416,1,goat
439,1008,,63.11101,1,open
462,834,,64.6001,1,board
361,1008,,7.1426,1,good
371,939,,72.1422,1,mood
453,1292,,74.6003,1,sure
515,1706,,94.6001,1,bird
300,2203,,1.142,1,hid
354,2203,,11.1421,1,bead
508,2201,,14.00091,1,year
544,1897,,2.1411,1,bet
393,1968,,21.1422,1,made
441,2030,,21.4124,1,name
502,1918,,24.6,1,hair
733,1459,,3.1421,1,bad
684,1458,,42.1411,1,bout
720,1459,,44.6,1,hard
641,1328,,47.1428,1,pride
541,1022,,5.1423,1,sod
583,1123,,53.1416,1,caught
662,1101,,6.1422,1,mud
486,955,,61.0001,1,boy
465,1041,,62.1416,1,goat
511,948,,63.11101,1,open
483,1160,,64.6001,1,board
381,1025,,7.1426,1,good
388,948,,72.1422,1,mood
451,1241,,74.6003,1,sure
496,1897,,94.6001,1,bird

353,878,,7.1426,1,good
326,810,,72.1422,1,mood
434,1238,,74.6003,1,sure
598,1518,,94.6001,1,bird
314,2289,,1.142,1,hid
283,2207,,11.1421,1,bead
453,2333,,14.00091,1,year
415,1812,,2.1411,1,bet
456,1750,,21.1422,1,made
493,2094,,21.4124,1,name
565,1731,,24.6,1,hair
663,1480,,3.1421,1,bad
683,1273,,42.1411,1,bout
678,1563,,44.6,1,hard
655,1716,,47.1428,1,pride
534,1114,,5.1423,1,sod
469,996,,53.1416,1,caught
670,1508,,6.1422,1,mud
547,1008,,61.0001,1,boy
472,915,,62.1416,1,goat
503,996,,63.11101,1,open

470,913,,64.6001,1,board
297,865,,7.1426,1,good
317,823,,72.1422,1,mood
426,915,,74.6003,1,sure
670,1334,,94.6001,1,bird
311,1931,,1.142,1,hid
311,1877,,11.1421,1,bead
563,1924,,14.00091,1,year
536,1871,,2.1411,1,bet
469,1924,,21.1422,1,made
535,1982,,21.4124,1,name
411,1657,,24.6,1,hair
717,1267,,3.1421,1,bad
674,1226,,42.1411,1,bout
707,1468,,44.6,1,hard
656,1653,,47.1428,1,pride
577,1140,,5.1423,1,sod
529,992,,53.1416,1,caught
764,1253,,6.1422,1,mud
474,930,,61.0001,1,boy
483,966,,62.1416,1,goat
488,961,,63.11101,1,open
494,858,,64.6001,1,board
375,972,,7.1426,1,good
390,918,,72.1422,1,mood
394,887,,74.6003,1,sure
691,1281,,94.6001,1,bird
479,2101,,1.142,1,hid
315,2239,,11.1421,1,bead
373,2085,,14.00091,1,year
485,1791,,2.1411,1,bet
459,2219,,21.1422,1,made
484,1949,,21.4124,1,name
524,1616,,24.6,1,hair
735,1582,,3.1421,1,bad
640,1209,,42.1411,1,bout
748,1445,,44.6,1,hard
671,1650,,47.1428,1,pride
551,1254,,5.1423,1,sod
556,932,,53.1416,1,caught
643,1299,,6.1422,1,mud
474,955,,61.0001,1,boy
473,887,,62.1416,1,goat
502,890,,63.11101,1,open
554,715,,64.6001,1,board
310,682,,7.1426,1,good
347,610,,72.1422,1,mood
432,975,,74.6003,1,sure
794,1555,,94.6001,1,bird
347,2095,,1.142,1,hid
308,2148,,11.1421,1,bead
353,2158,,14.00091,1,year
542,1833,,2.1411,1,bet
636,1854,,21.1422,1,made
474,1939,,21.4124,1,name
522,1648,,24.6,1,hair
636,1150,,3.1421,1,bad
647,1223,,42.1411,1,bout
685,1198,,44.6,1,hard
688,1567,,47.1428,1,pride
522,1077,,5.1423,1,sod
568,1030,,53.1416,1,caught
702,1191,,6.1422,1,mud
543,1157,,61.0001,1,boy
471,930,,62.1416,1,goat
485,971,,63.11101,1,open
535,923,,64.6001,1,board
381,843,,7.1426,1,good
407,756,,72.1422,1,mood
450,1020,,74.6003,1,sure
648,1097,,94.6001,1,bird
369,1950,,1.142,1,hid
313,2096,,11.1421,1,bead
492,2043,,14.00091,1,year
480,1615,,2.1411,1,bet
431,1755,,21.1422,1,made
515,2036,,21.4124,1,name
531,1714,,24.6,1,hair
682,1275,,3.1421,1,bad
1120,1306,,4.1422,1,mud
696,1281,,42.1411,1,bout
647,1072,,44.6,1,hard
672,1580,,47.1428,1,pride
515,1037,,5.1423,1,sod
487,898,,53.1416,1,caught
500,957,,61.0001,1,boy
542,1004,,62.1416,1,goat
496,1021,,63.11101,1,open
439,820,,64.6001,1,board
320,856,,7.1426,1,good
405,954,,72.1422,1,mood
418,966,,74.6003,1,sure
620,1372,,94.6001,1,bird
274,2732,,1.142,1,hid
267,2767,,11.1421,1,bead
372,2003,,14.00091,1,year
464,2460,,2.1411,1,bet
443,2726,,21.1422,1,made
557,2090,,21.4124,1,name
537,1756,,24.6,1,hair
788,1570,,3.1421,1,bad
686,1284,,42.1411,1,bout
746,1612,,44.6,1,hard
664,1270,,47.1428,1,pride
441,859,,5.1423,1,sod
517,781,,53.1416,1,caught
684,944,,6.1422,1,mud
574,1249,,61.0001,1,boy
546,934,,62.1416,1,goat
558,1027,,63.11101,1,open
491,866,,64.6001,1,board
253,908,,7.1426,1,good
225,718,,72.1422,1,mood
406,854,,74.6003,1,sure
731,1718,,94.6001,1,bird
294,2502,,1.142,1,hid

276,2425,,11.1421,1,bead
356,2266,,14.00091,1,year
463,1936,,2.1411,1,bet
473,2655,,21.1422,1,made
557,2230,,21.4124,1,name
522,1705,,24.6,1,hair
710,1597,,3.1421,1,bad
600,1295,,42.1411,1,bout
800,1433,,44.6,1,hard
666,1387,,47.1428,1,pride
553,1148,,5.1423,1,sod
537,772,,53.1416,1,caught
684,948,,6.1422,1,mud
573,995,,61.0001,1,boy
542,1010,,62.1416,1,goat
556,1022,,63.11101,1,open
455,779,,64.6001,1,board
259,906,,7.1426,1,good
259,759,,72.1422,1,mood
402,844,,74.6003,1,sure
843,1503,,94.6001,1,bird
308,1916,,1.142,1,hid
292,2216,,11.1421,1,bead
511,1943,,14.00091,1,year
432,1851,,2.1411,1,bet
397,1864,,21.1422,1,made
535,1963,,21.4124,1,name
505,1604,,24.6,1,hair
609,1645,,3.1421,1,bad
656,1209,,42.1411,1,bout
674,1519,,44.6,1,hard
683,1606,,47.1428,1,pride
492,1148,,5.1423,1,sod
524,982,,53.1416,1,caught
782,1253,,6.1422,1,mud
541,942,,61.0001,1,boy
508,950,,62.1416,1,goat
476,965,,63.11101,1,open
512,1041,,64.6001,1,board
382,815,,7.1426,1,good
327,957,,72.1422,1,mood
409,875,,74.6003,1,sure
765,1260,,94.6001,1,bird
346,2240,,1.142,1,hid

Zimbabweans

All Zimbabweans (20 M&F)
440
371,2096,,1.142,1,hid
298,2096,,11.1421,1,bead
438,1783,,14.00091,1,year
553,2002,,2.1411,1,bet
495,2081,,21.1422,1,made
540,1870,,21.4124,1,name
550,1548,,24.6,1,hair
509,1830,,3.1421,1,bad
637,1309,,42.1411,1,bout
808,1143,,44.6,1,hard
718,1451,,47.1428,1,pride

315,2271,,11.1421,1,bead
530,1915,,14.00091,1,year
428,1802,,2.1411,1,bet
443,2089,,21.1422,1,made
531,1894,,21.4124,1,name
501,1616,,24.6,1,hair
634,1170,,3.1421,1,bad
661,1220,,42.1411,1,bout
657,1513,,44.6,1,hard
625,1400,,47.1428,1,pride
506,1008,,5.1423,1,sod
457,965,,53.1416,1,caught
647,1148,,6.1422,1,mud
464,901,,61.0001,1,boy
520,953,,62.1416,1,goat
471,986,,63.11101,1,open
474,1121,,64.6001,1,board
353,1034,,7.1426,1,good
303,1054,,72.1422,1,mood
437,1230,,74.6003,1,sure
607,1777,,94.6001,1,bird
351,2374,,1.142,1,hid
318,2302,,11.1421,1,bead
516,1843,,14.00091,1,year
453,1751,,2.1411,1,bet
450,2620,,21.1422,1,made
487,1843,,21.4124,1,name
484,1577,,24.6,1,hair
675,1248,,3.1421,1,bad
649,1190,,42.1411,1,bout
705,1483,,44.6,1,hard
616,1169,,47.1428,1,pride
501,884,,5.1423,1,sod
592,1118,,53.1416,1,caught
708,1502,,6.1422,1,mud
530,917,,61.0001,1,boy
502,932,,62.1416,1,goat
557,935,,63.11101,1,open
506,1229,,64.6001,1,board
326,980,,7.1426,1,good
318,715,,72.1422,1,mood
372,781,,74.6003,1,sure
754,1483,,94.6001,1,bird

539,997,,5.1423,1,sod
597,939,,53.1416,1,caught
734,1448,,6.1422,1,mud
519,968,,61.0001,1,boy
495,818,,62.1416,1,goat
552,946,,63.11101,1,open
487,923,,64.6001,1,board
400,997,,7.1426,1,good
429,873,,72.1422,1,mood
494,1060,,74.6003,1,sure
560,1995,,94.6001,1,bird
428,2327,,1.142,1,hid
379,2714,,11.1421,1,bead

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308,2808,,14.6,1,here
476,2552,,2.1421,1,bed
572,2713,,21.1422,1,made
528,2544,,24.6,1,hair
718,1203,,3.1421,1,bad
637,1034,,41.0001,1,buy
651,995,,42.1411,1,bout
592,894,,44.6,1,hard
586,989,,5.1424,1,nod
667,1056,,6.1422,1,mud
410,645,,61.0001,1,boy
549,799,,62.1411,1,boat
543,953,,63.0003,1,saw
395,968,,7.1426,1,good
413,876,,72.1422,1,mood
351,960,,74.6003,1,sure
418,902,,74.6003,1,tour
353,894,,82.,1,hue
564,2516,,94.6001,1,bird
398,2580,,1.142,1,hid
387,2783,,11.1421,1,bead
398,2805,,14.6,1,here
444,2588,,2.1421,1,bed
407,2550,,21.1422,1,made
531,2281,,24.6,1,hair
644,983,,3.1421,1,bad
605,1056,,41.0001,1,buy
605,940,,42.1411,1,bout
663,1006,,44.6,1,hard
531,874,,5.1424,1,nod
654,991,,6.1422,1,mud
546,874,,61.0001,1,boy
510,969,,62.1411,1,boat
546,1056,,63.0003,1,saw
388,911,,7.1426,1,good
385,697,,72.1422,1,mood
420,1027,,74.6003,1,sure
415,932,,74.6003,1,tour
401,983,,82.,1,hue
517,2340,,94.6001,1,bird
445,2681,,1.142,1,hid
437,2563,,11.1421,1,bead
400,1934,,14.6,1,here
430,2288,,2.1421,1,bed
408,2481,,21.1422,1,made
516,2481,,24.6,1,hair
693,946,,3.1421,1,bad
686,972,,41.0001,1,buy
605,988,,42.1411,1,bout
603,987,,44.6,1,hard
586,1270,,5.1424,1,nod
868,1206,,6.1422,1,mud
589,1077,,61.0001,1,boy
553,965,,62.1411,1,boat
507,1070,,63.0003,1,saw
341,713,,7.1426,1,good
422,947,,72.1422,1,mood
430,951,,74.6003,1,sure
438,876,,74.6003,1,tour
324,1031,,82.,1,hue
467,2407,,94.6001,1,bird
395,2474,,1.142,1,hid
372,2906,,11.1421,1,bead
342,2847,,14.6,1,here
454,2511,,2.1421,1,bed
496,2585,,21.1422,1,made
491,2608,,24.6,1,hair
655,1013,,3.1421,1,bad
737,1117,,41.0001,1,buy
617,993,,42.1411,1,bout
640,1043,,44.6,1,hard
573,939,,5.1424,1,nod
722,1265,,6.1422,1,mud
485,916,,61.0001,1,boy
521,947,,62.1411,1,boat
521,954,,63.0003,1,saw
320,805,,7.1426,1,good
380,1088,,72.1422,1,mood
373,975,,74.6003,1,tour
358,916,,74.6003,1,sure
358,1334,,82.,1,hue
513,1886,,94.6001,1,bird
404,2661,,1.142,1,hid
404,2555,,11.1421,1,bead
351,2646,,14.6,1,here
526,2173,,2.1421,1,bed
549,2067,,21.1422,1,made
472,2578,,24.6,1,hair
643,1053,,3.1421,1,bad
682,976,,41.0001,1,buy
633,984,,42.1411,1,bout
580,1044,,44.6,1,hard
549,1260,,5.1424,1,nod
686,1213,,6.1422,1,mud
442,762,,61.0001,1,boy
549,999,,62.1411,1,boat
541,1042,,63.0003,1,saw
348,828,,7.1426,1,good
395,1053,,72.1422,1,mood
401,960,,74.6003,1,sure
450,1053,,74.6003,1,tour
396,923,,82.,1,hue
556,1891,,94.6001,1,bird
402,2384,,1.142,1,hid
401,2816,,11.1421,1,bead
402,2504,,14.6,1,here
521,2303,,2.1421,1,bed
551,2511,,21.1422,1,made
539,2616,,24.6,1,hair
618,894,,3.1421,1,bad
618,976,,41.0001,1,buy
641,993,,42.1411,1,bout
700,1028,,44.6,1,hard
588,953,,5.1424,1,nod
886,1422,,6.1422,1,mud
566,723,,61.0001,1,boy
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513,924,,62.1411,1,boat
469,990,,63.0003,1,saw
365,857,,7.1426,1,good
402,865,,72.1422,1,mood
343,782,,74.6003,1,sure
469,857,,74.6003,1,tour
432,990,,82.,1,hue
483,1722,,94.6001,1,bird
301,2435,,1.142,1,hid
306,2675,,11.1421,1,bead
360,2308,,14.6,1,here
511,2352,,2.1421,1,bed
517,2617,,21.1422,1,made
493,2454,,24.6,1,hair
610,911,,3.1421,1,bad
595,955,,41.0001,1,buy
659,1084,,42.1411,1,bout
793,1290,,44.6,1,hard
396,889,,5.1424,1,nod
644,1230,,6.1422,1,mud
580,1014,,61.0001,1,boy
506,896,,62.1411,1,boat
521,904,,63.0003,1,saw
322,881,,7.1426,1,good
388,728,,72.1422,1,mood
407,900,,74.6003,1,sure
447,874,,74.6003,1,tour
327,2419,,82.,1,hue
435,1896,,94.6001,1,bird
412,2605,,1.142,1,hid
381,2480,,11.1421,1,bead
358,2457,,14.6,1,here
450,2473,,2.1421,1,bed
482,2659,,21.1422,1,made
428,2551,,24.6,1,hair
664,1057,,3.1421,1,bad
637,995,,41.0001,1,buy
640,1052,,42.1411,1,bout
691,972,,44.6,1,hard
428,1150,,5.1424,1,nod
660,1136,,6.1422,1,mud
524,941,,61.0001,1,boy
521,1019,,62.1411,1,boat
521,1019,,63.0003,1,saw
365,863,,7.1426,1,good
346,972,,72.1422,1,mood
365,762,,74.6003,1,sure
551,948,,74.6003,1,tour
322,972,,82.,1,hue
544,1921,,94.6001,1,bird
398,2489,,1.142,1,hid
481,2528,,11.1421,1,bead
382,2558,,14.6,1,here
436,2437,,2.1421,1,bed
413,2482,,21.1422,1,made
444,2415,,24.6,1,hair
614,962,,3.1421,1,bad
616,993,,41.0001,1,buy
676,1247,,42.1411,1,bout
694,953,,44.6,1,hard
548,993,,5.1424,1,nod
865,1264,,6.1422,1,mud
533,985,,61.0001,1,boy
526,910,,62.1411,1,boat
556,1218,,63.0003,1,saw
330,932,,7.1426,1,good
360,752,,72.1422,1,mood
451,782,,74.6003,1,sure
496,1030,,74.6003,1,tour
360,894,,82.,1,hue
444,1956,,94.6001,1,bird
411,2460,,1.142,1,hid
395,2857,,11.1421,1,bead
426,2625,,14.6,1,here
433,2736,,2.1421,1,bed
414,2550,,21.1422,1,made
425,2594,,24.6,1,hair
684,950,,3.1421,1,bad
687,972,,41.0001,1,buy
657,1076,,42.1411,1,bout
698,912,,44.6,1,hard
511,1203,,5.1424,1,nod
680,1128,,6.1422,1,mud
523,1047,,61.0001,1,boy
530,920,,62.1411,1,boat
486,1092,,63.0003,1,saw
381,935,,7.1426,1,good
366,1064,,72.1422,1,mood
386,778,,74.6003,1,sure
448,964,,74.6003,1,tour
403,1039,,82.,1,hue
486,1869,,94.6001,1,bird
416,2207,,1.142,1,hid
364,2207,,11.1421,1,bead
459,2041,,14.00091,1,year
527,1762,,2.1411,1,bet
610,2014,,21.1422,1,made
394,1869,,21.4124,1,name
557,1957,,24.6,1,hair
639,1747,,3.1421,1,bad
647,1318,,42.1411,1,bout
698,1159,,44.6,1,hard
706,1333,,47.1428,1,pride
505,996,,5.1423,1,sod
658,1086,,53.1416,1,caught
706,1086,,6.1422,1,mud
504,1015,,61.0001,1,boy
500,822,,62.1416,1,goat
572,1033,,63.11101,1,open
512,899,,64.6001,1,board
394,959,,7.1426,1,good
378,708,,72.1422,1,mood
533,1120,,74.6003,1,sure
520,1635,,94.6001,1,bird
357,2182,,1.142,1,hid
330,2645,,11.1421,1,bead
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659,1174,,44.6,1,hard
647,1389,,47.1428,1,pride
614,1158,,5.1423,1,sod
515,1128,,53.1416,1,caught
630,1367,,6.1422,1,mud
591,952,,61.0001,1,boy
504,860,,62.1416,1,goat
498,1013,,63.11101,1,open
491,1059,,64.6001,1,board
373,1097,,7.1426,1,good
360,767,,72.1422,1,mood
447,1204,,74.6003,1,sure
484,1419,,94.6001,1,bird
364,2200,,1.142,1,hid
363,2177,,11.1421,1,bead
489,1985,,14.00091,1,year
486,1168,,2.1411,1,bet
553,2038,,21.1422,1,made
445,1948,,21.4124,1,name
597,1789,,24.6,1,hair
697,1517,,3.1421,1,bad
666,1353,,42.1411,1,bout
804,1388,,44.6,1,hard
644,1371,,47.1428,1,pride
515,986,,5.1423,1,sod
682,1039,,53.1416,1,caught
811,1381,,6.1422,1,mud
584,1066,,61.0001,1,boy
442,834,,62.1416,1,goat
538,986,,63.11101,1,open
543,1039,,64.6001,1,board
360,1039,,7.1426,1,good
337,756,,72.1422,1,mood
465,1013,,74.6003,1,sure
553,1578,,94.6001,1,bird
349,2078,,1.142,1,hid
337,2234,,11.1421,1,bead
469,2258,,14.00091,1,year
418,1991,,2.1411,1,bet
416,2227,,21.1422,1,made
470,1900,,21.4124,1,name
538,2006,,24.6,1,hair
580,1812,,3.1421,1,bad
667,1380,,42.1411,1,bout
721,1223,,44.6,1,hard
635,1461,,47.1428,1,pride
572,1168,,5.1423,1,sod
563,898,,53.1416,1,caught
698,1529,,6.1422,1,mud
556,1115,,61.0001,1,boy
466,849,,62.1416,1,goat
454,898,,63.11101,1,open
507,917,,64.6001,1,board
405,1024,,7.1426,1,good
410,784,,72.1422,1,mood
510,1042,,74.6003,1,sure
470,1949,,94.6001,1,bird
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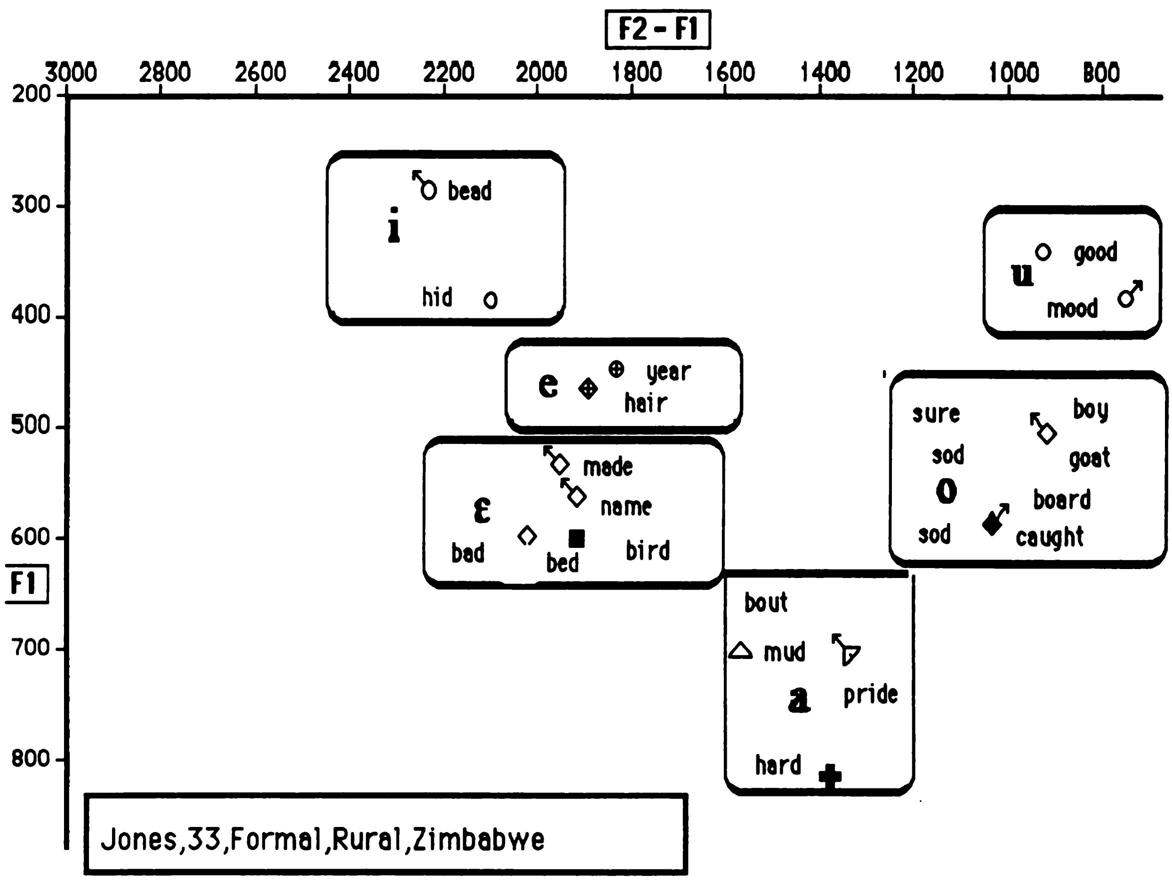
APPENDIX C

APPENDIX C

An Example of a Plotnik Vowel Chart



APPENDIX D

APPENDIX D

QUESTIONNAIRE USED TO ELICIT VOWEL PERCEPTIONS

Gender: ___________
Age: ___________
Mother Tongue: ___________________________

Please listen carefully to the following pairs of words. For each pair indicate whether the two words you hear are the same or different by marking (√) appropriately. For example if words in pair 1 sound the same to you, mark:

Pair 1: (a) Same √ (b) different

What we mean by 'same' or 'different' is :- is the speaker pronouncing the same words in each pair or is he pronouncing different words? You are simply judging the speaker's pronunciation and your judgement is correct.

Pair 1 : (a) Same (b) different
Pair 2 : (a) Same (b) different
Pair 3: (a) Same (b) different
Pair 4 : (a) Same (b) different
Pair 5: (a) Same (b) different
Pair 6: (a) Same (b) different
Pair 7: (a) Same (b) different
Pair 8: (a) Same (b) different
Pair 9: (a) Same (b) different
Pair 10: (a) Same (b) different
Pair 11: (a) Same (b) different
Pair 12: (a) Same (b) different
Pair 13: (a) Same (b) different
Pair 14: (a) Same (b) different
Pair 15: (a) Same (b) different
Pair 16: (a) Same (b) different
Pair 17: (a) Same (b) different
Pair 18: (a) Same (b) different
Pair 19: (a) Same (b) different
Pair 20: (a) Same (b) different
Pair 21: (a) Same (b) different
Pair 22: (a) Same (b) different
Pair 23: (a) Same (b) different
Pair 24: (a) Same (b) different
Pair 25: (a) Same (b) different
Pair 26: (a) Same (b) different

Pair 27:	(a) Same	(b) different
Pair 28:	(a) Same	(b) different
Pair 29:	(a) Same	(b) different
Pair 30:	(a) Same	(b) different
Pair 31:	(a) Same	(b) different
Pair 32:	(a) Same	(b) different
Pair 33:	(a) Same	(b) different
Pair 34:	(a) Same	(b) different
Pair 35:	(a) Same	(b) different
Pair 36:	(a) Same	(b) different
Pair 37:	(a) Same	(b) different
Pair 38 :	(a) Same	(b) different
Pair 39:	(a) Same	(b) different
Pair 40:	(a) Same	(b) different
Pair 41:	(a) Same	(b) different
Pair 42:	(a) Same	(b) different
Pair 43:	(a) Same	(b) different
Pair 44:	(a) Same	(b) different
Pair 45:	(a) Same	(b) different
Pair 46:	(a) Same	(b) different
Pair 47:	(a) Same	(b) different
Pair 48:	(a) Same	(b) different
Pair 49:	(a) Same	(b) different
Pair 50:	(a) Same	(b) different
Pair 51:	(a) Same	(b) different
Pair 52:	(a) Same	(b) different
Pair 53:	(a) Same	(b) different
Pair 54:	(a) Same	(b) different
Pair 55:	(a) Same	(b) different
Pair 56:	(a) Same	(b) different
Pair 57:	(a) Same	(b) different
Pair 58:	(a) Same	(b) different

Please continue with section B

B. Please listen carefully to the following pairs of words and write down each word that the speaker pronounced. This should work like a dictation exercise. Once again whatever you hear is correct, it is an individual judgement and that is all that counts. So don't hesitate to write exactly what you hear.

Pair 1: (a) __________ (b) __________

Pair 2: (a) __________ (b) __________

Pair 3: (a) __________ (b) __________

Pair 4: (a) __________ (b) __________

Pair 5: (a) __________ (b) __________

Pair 6: (a) __________ (b) __________

Pair 7: (a) __________ (b) __________

Pair 8: (a) __________ (b) __________

Pair 9: (a) __________ (b) __________

Pair 10: (a) __________ (b) __________

Pair 11: (a) __________ (b) __________

Pair 12: (a) __________ (b) __________

Pair 13: (a) __________ (b) __________

Pair 14: (a) __________ (b) __________

Pair 15: (a) __________ (b) __________

Pair 16: (a) __________ (b) __________

Pair 17: (a) __________ (b) __________

Pair 18: (a) __________ (b) __________

Pair 19: (a) __________ (b) __________

Pair 20: (a) __________ (b) __________

Pair 21: (a) __________ (b) __________

Pair 22: (a) __________ (b) __________

Pair 23: (a) __________ (b) __________

Pair 24: (a) __________ (b) __________

Pair 25: (a) __________ (b) __________

Pair 26: (a) __________ (b) __________

Pair 27: (a) __________ (b) __________

Pair 28: (a) __________ (b) __________

Pair29: (a) __________ (b) __________

Pair 30: (a) __________ (b) __________

Pair 31: (a) __________ (b) __________

Pair 32: (a) __________ (b) __________

Pair 33: (a) __________ (b) __________

Pair 34: (a) __________ (b) __________

Pair 35: (a) __________ (b) __________

Pair 36: (a) __________ (b) __________

Pair 37: (a) __________ (b) __________

Pair 38: (a) __________ (b) __________

Pair 39: (a) __________ (b) __________

Pair 40: (a) __________ (b) __________

Pair 41: (a) __________ (b) __________

Pair 42: (a) __________ (b) __________

Pair 43: (a) __________ (b) __________

Pair 44: (a) __________ (b) __________

Pair 45: (a) __________ (b) __________

Pair 46: (a) __________ (b) __________

Pair 47: (a) __________ (b) ______________

Pair 48: (a) __________ (b) ______________

Pair 49: (a) __________ (b) ______________

Pair 50: (a) __________ (b) ______________

Pair 51: (a) __________ (b) ______________

Pair 52: (a) __________ (b) ______________

Pair 53: (a) __________ (b) ______________

Pair 54: (a) __________ (b) ______________

Pair 55: (a) __________ (b) ______________

Pair 56: (a) __________ (b) ______________

Pair 57: (a) __________ (b) ______________

Pair 58: (a) __________ (b) ______________

Thank you very much for your participation.

APPENDIX E

APPENDIX E

IDENTIFICATION TASK RESULTS

(a) Stimulus [a]

Stimuli minimal pairs words played to respondents	Gh[1]. Respondents' perception of stimuli vowels (in %)	Zim. Respondents' perception of stimuli vowels (in %)	Ken. Respondents' perception of stimuli vowels (in %)
a ~ a bat/bat	a ~ a 23-33 ʌ ~ ʌ 75-63	a ~ a 47-84 ʌ ~ ʌ 50-16	a ~ a 46-50 ʌ ~ ʌ 50-41
a ~ ʌ mad/mud	a ~ʌ 79-53 ʌ ~ a 15-36	a ~ ʌ 85-41 ʌ ~ a 10-47	a ~ ʌ 67-42 ʌ ~ a 26-51
a ~ ɑ had/hard	a ~ ɑ 74-50 ɑ ~ a 15-41	a ~ ɑ 81-88 ɑ ~ a 19-09	a ~ ɑ 56-28 a: ~ ɜ 21-49 ɜ ~ a 19-16
a ~ ai dam/dime	a ~ ai 65-12 au ~ a 17-58	a ~ ai 84-16 ʌ ~ a 06-72	a ~ ai 70-41 ʌ ~ a 22-37
a ~ au bat/bout	ʌ ~ ʌ 74-48 a ~ a 29-35 *au=o*	a ~ a 50-53 ʌ ~ ʌ 47- 16 *au=0*	a ~ au 51-31 ʌ ~ a 42 –20 ai ~ ai 06-18
a ~ ɒ cat/cot	a ~ ɒ 73-12 a ~ ɔ 73-54 ʌ ~ ʌ 27-27	a ~ ɒ 84-65 ʌ ~ ʌ 10-19	a ~ ɒ 73-00 ʌ ~ 15-63 a: ~ a 06-17
ɔ: ~ ɑ caught/cot	ɔ: ~ ɑ 70-28 ʌ ~ a 23-47 ɑ ~ ɔ 05-16	ɔ: ~ ɑ 98-56 ʌ ~ ɔ 02-34	ɔ: ~ ɑ 61-41 ou ~ ɔ: 24-47
ɔ ~ ɜ walk/work	ç ~ Œ 92-96	ç ~ a: 97-91	ç ~ Œ 98-93
ç ~ ua law/lure	ç ~ ua 54-20 o ~ o 37-59	ç ~ ua 100-100	ç ~ ua 15-30 o ~ o 84-43 ç ~ ç 01-18

[1] Gh denotes Ghanaian, Zim , Zimbabwean , and Ken. Kenyan

(c) Stimulus [u]

Stimuli minimal pairs words played to	Gh's respondents perception of stimuli vowels (in %)	Zim's respondents perception of stimuli vowels (in %)	Ken's respondents perception of stimuli vowels (in %)
u ~ u good/good	u ~ u 96-96	u ~ u 100-73 u ~ o -do- 27	u ~ u 75-74 ou ~ ou 15-15
u ~ U wood/wooed	u ~ U 58-52 ʊ ~ u 33-48	u ~ ʊ 94-76 ɔ ~ o 03-27	u ~ ʊ 86-30 ʊ ~ u 14-45
u ~ ju who/hue	u ~ ju 64-91 ju ~u 36-09	u ~ ju 94-76 ʊ ~ u 03-15	u ~ ju 83-83
u ~ ou boot/boat	u ~ ou 66-61 ʌ ~ ʌ 25-18	u ~ ou 100-49 u ~ ɔ -do- 35	u ~ ou 79-26 ʌ ~ ɔ 10-50
ʊ ~ ʊ book/book	ʊ ~ ʊ 96-98	ʊ ~ ʊ 100-100	ʊ ~ ʊ 93-93
ʊ ~ ou cook/coke	ʊ ~ ou 96-49 u ~ ʊ 03-47	ʊ ~ ou 98-33 u ~ ɔ 02-67	ʊ ~ ou 92-35 ɔ ~ ɔ: 08-45

(d) Stimulus [I]

Stimuli minimal pairs words played to respondents	Gh's respondents perception of stimuli vowels (in %)	Zim's respondents perception of stimuli vowels (in %)	Ken's respondents perception of stimuli vowels (in %)
I ~ I Hid/hid	I ~ I 60-45 i ~ i 22-14	I ~ I 39-30 i ~ i 39-42	I ~ I 25-20 e ~ e 63-60
ɪ ~ ɛ Bit/bet	ɪ ~ ɛ 68-36 i ~ ʌ 30-32	ɪ ~ ɛ 61-61 i ~ a 36-16	ɪ ~ ɛ 52-63 i ~ I 41-17
ɪ ~ ɜ Bid/bird	ɪ ~ ɜ 83-66 I~ ɛ 19-34	ɪ ~ ɜ 39-63 i ~ e 48-20	ɪ ~ ɜ 40-25 i ~ a 25-66 ɛ ~ ʌ 21-06

I ~ ia Bid-beard	I ~ ia 50-36 i ~ i 29-19	I ~ ia 49-61 i ~ i 46-29	I ~ ia 35-80 i ~ i 30-14 e ~a 16-04
i ~ I beat/bit	i ~ I 68-48 I ~ i 32-38	i ~ I 41-24 I ~ i 59-41 i ~ε -do- -36	i ~ I 75-21 I ~ i 21- 28 I ~ ε -do-–49

(e) Stimulus [e]

Stimuli minimal pairs words played to respondents	Gh's respondents perception of stimuli vowels (in %)	Zim's respondents perception of stimuli vowels (in %)	Ken's respondents perception of stimuli vowels (in %)
e ~ e made/made	e ~ e 96-95	e ~ e 97-96	e ~ e 48-49 ai ~ ai 43-49
e ~ ε wade/wed	e ~ ε 83-13 ~ ɜ 53 ɜ 19	e ~ ε 73-46 ~ ɔ -37	e ~ ε 31-70 ai 77-13 ai 06
e ~ ɜ wade/word	e ~ ɜ 85-78 ɜ ~ ε 10-09	e ~ ɜ 83-06 ~ a: -94	e ~ ɜ 23-79 ai ~ a: 77-13 ~ e -08
e ~ a bait/bat	e ~ a 36-34 ε ~ ʌ 20-61	e ~ a 84-84 ~ ʌ -13	e ~ a 56-52 ai ~ ʌ 33-44
e ~ ia bay/beer	e ~ ia 37-61 ε~ea 26-34	e ~ ia 55-100 ia ~ ia 23- -do- ɜ ~ ia 16- -do	e ~ ia 45-100 ai ~ ia 26- -do-
e ~ ea hay/hair	e ~ ea 53-39 a ~ ɜ 21-24	e ~ ea 83-38 ~ e -25 a: ~ ɜ 13-22	e ~ ea 57-57 ai ~ ɜ 29-18
i ~ e beat/bait	i ~ e 64-43 I ~ ʌ 31-17	i ~ e 43-59 I ~ ai 47-13 i ~ a -do- -13	i ~ e 57-14 a ~ a 60-60

(f) Stimulus [ε]

Stimuli minimal pairs words played to respondents	Gh. respondents perception of stimuli vowels (in %)	Zim. respondents perception of stimuli vowels (in %)	Ken. respondents perception of stimuli vowels (in %)
ɛ ~ ɛ bet/bet	ɛ ~ ɛ 51-42 a ~ a 40-40	ɛ ~ ɛ 55-58 a ~ a 22-27 e ~ e 15-10	ɛ ~ ɛ 71-60 e ~ e 13-18 a ~ a 13-11
ɛ ~ ɜ bed/bird	ɛ ~ ɜ 31-38 ɜ ~ a 31-27 a ~ ea 20-24	ɛ ~ ɜ 55-62 ɜ ~ a 15-21	ɛ ~ ɜ 56-16 a ~ a 36-73
ɛ ~ a bed/bad	ɛ ~ a 26-42 ɜ ~ ʌ 36-42 ʌ ~ a: 28-08	ɛ ~ a 44-84 a~ ʌ 34-16 e ~ 22-	ɛ ~ a 72-83 a ~ ɜ 28-07
i ~ ɛ weed/wed	i ~ ɛ 100-22 ~ ɜ - 61	i ~ ɛ 98-67 ia ~ɔ 02-19	i ~ ɛ 93-65 ai ~ ai 07-19

Stimulus [ɜ]

Stimuli minimal pairs words played to respondents	Gh. respondents perception of stimuli vowels (in %)	Zim. respondents perception of stimuli vowels (in %)	Ken. respondents perception of stimuli vowels (in %)
ɜ ~ ɜ bird/bird	ɜ ~ ɜ 68-57 a ~ ɛ 13-17 ɛ ~ a 09-11	ɜ ~ ɜ 73-50 a ~ a 23-27 ɛ - - -14	ɜ ~ ɜ 32-28 a ~ a 60-60
ɜ ~ a bird/bad	ɜ ~ a 45-62 ɛ ~ ʌ 22-31 ʌ ~ ɛ 18-04	ɜ ~ a 45-91 a ~ ɛ 27-03 e ~ ʌ 21-03	ɜ ~ a 27-73 a ~ a: 56-15 a: ~ ʌ 10-12
ɜ ~ ʌ bird/bud	ɜ ~ ʌ 40-33 ɛ ~ a 22-44 a ~ ɜ 20-11	ɜ ~ ʌ 42-16 a ~ a: 35-61 ɔ ~ ɔ 10-13	ɜ ~ ʌ 46-15 a ~ a 54-78
ɜ ~ o heard/hoed	ɜ ~ o 84-84 a ~ ɜ 09-05	ɜ ~ o 53-65 a: ~ ɛ 38-24	ɜ ~ o 41-63 a: ~ ɔ: 32-20 a ~ au 17-17
ɜ ~ ɔ: bird/board	ɜ ~ ɔ: 50-32 a ~ oi 18-45 ɛ ~ a 16-11	ɜ ~ ɔ: 34-84 ɔ: ~ oi 34-16 a ~ 22	ɜ ~ ɔ: 39-61 a ~ o 60-21

ɛ ~ ɜ bed/bird	ɛ ~ ɜ 31-38 ɜ ~ a 31-27 a ~ ea 20-24	ɛ ~ ɜ 55-62 ɜ ~ a 15-21	ɛ ~ ɜ 56-16 a ~ a 36-73
ɪ ~ ɜ Bid/bird	ɪ ~ ɜ 83-66 I~ ɛ 19-34	ɪ ~ ɜ 39-63 i ~ e 48-20	ɪ ~ ɜ 40-25 i ~ a 25-66 ɛ ~ ʌ 21-06

Stimulus [ʌ]

Stimuli minimal pairs words played to respondents	Gh. respondents perception of stimuli vowels (in %)	Zim. respondents perception of stimuli vowels (in %)	Ken. respondents perception of stimuli vowels (in %)
ʌ ~ ʌ rug/rug	ɔ ~ ʌ 08-04 ɔ ~ ɔ 83-83	ʌ ~ ʌ 13-13 ɔ ~ ɔ 87-87	ʌ ~ ʌ 13-13 ɔ ~ ɔ 54-50 a ~ a 13-16
ʌ ~ a mud/mad	ʌ ~ a 48-73 a ~ ʌ 41-25	ʌ ~ a 52-91 a ~ e 31-07	ʌ ~ a 57-60 a ~ ʌ 45-38
ʌ ~ ɜ hut/hurt	ʌ ~ ɜ 07-78 ɜ ~ ɔ 68-11	a: ~ a: 49-57 o ~ o 43-20 e ~ ʌ 09-11	ʌ ~ ɜ 24-48 ɜ ~ ʌ 62-26 a ~ a 22-26
ʌ ~ ɛ land/lend	ʌ ~ ɛ 92-37 a ~ ʌ 04 -37 i ~ i 02-14	ʌ ~ ɛ 06-57 a ~ a 94-40	ʌ ~ ɛ 57-50 a ~ a 33-35
ʌ ~ ɑ gut/got	ʌ ~ ɑ 04-76 ɑ ~ ou 62-13 ɛ ~ ɔ 22-07	ʌ ~ ɑ 4- 42 ɔ ~ ou 79-45 ou ~ e 21-12	ʌ ~ ɑ 20-57 ɔ ~ ou 63-21
ʌ ~ o mud/mode	ʌ ~ o 41-68 a ~ ʌ 24-12	ʌ ~ o 18-64 a ~ a: 36-21 o ~ ɔ 45-15	ʌ ~ o 34-20 a ~ ou 40-48 ou ~ a 14-10
ʌ ~ ɔ: bud/board	ʌ ~ ɔ: 45-31 ɔ ~ oi 24-36 ɜ ~ ɔ 10-26	o ~ ɔ: 59-78 a ~ou 19-12	ʌ ~ ɔ: 15-40 a ~ ɔ 30-23 ɔ ~ o 23-17
ɜ ~ ʌ bird/bud	ɜ ~ ʌ 40-33 ɛ ~ a 22-44 a ~ ɜ 20-11	ɜ ~ ʌ 42-16 a ~ a: 35-61 ɔ ~ ɔ 10-13	ɜ ~ ʌ 46-15 a ~ a 54-78
a ~ ʌ mad/mud	a ~ʌ 79-53 ʌ ~ a 15-36	a ~ ʌ 85-41 ʌ ~ a 10-47	a ~ ʌ 67-42 ʌ ~ a 26-51

ɔ ~ ʌ Bought/but	ɔ ~ ʌ 46-80 ou ~ a 30-11 ʌ ~ ɔ 15-07	ɔ ~ ʌ 73-42 ou ~ ɔ 27- 35	ɔ ~ ʌ 61-59 ou ~ ɔ 36-30 au ~ a 16-23

Stimulus [ɑ]

Stimuli minimal pairs words played to respondents	Gh. respondents perception of stimuli vowels (in %)	Zim. respondents perception of stimuli vowels (in %)	Ken. respondents perception of stimuli vowels (in %)
ɑ ~ ɑ hot/hot	ɑ ~ ɑ 50-38 a ~ a 15-22 ɜ ~ ɜ 15-22	ɑ ~ ɑ 57-55 a ~ a 14-39	ɑ ~ ɑ 38-35 a ~ a 24-24 ɜ ~ ɜ 24-24
ɑ ~ au got/gout	ɑ ~ au 77-63 ɔ ~ ɑ 12-21 ou ~ ɔ 07-16	ɑ ~ au 58-31 ɔ ~ ɛ 41- 50	ɑ ~ au 75-35 ou ~ ou 25-38
ɑ ~ ɔ: cot/caught	ɑ ~ ɔ: 14-71 ɔ ~ ou 52-17 ʌ ~ʌ 29-14	ɑ ~ ɔ: 6-85 ɔ ~ ʌ 94-06	ɑ ~ ɔ: 15-70 ɔ ~ ou 61-19
ɑ ~ oi sod/soy	ɑ ~ oi 11-56 ɔ ~ ɔ: 60-29	ɑ ~ oi 4-24 ɔ ~ ɔ: 88-70	ɑ ~ oi 38-27 ɔ ~ ɔ: 23-33 ɔ: ~ ɔ 17-21
ɑ ~ ua cod/cure	ɑ ~ ua 17-95 ʌ ~ ɔ 37-05 ɔ ~ ua 10--do-	ɑ ~ ua 37-50 ɔ ~ ju 60-47	ɑ ~ ua 14-91 ɔ: ~ ɔ 37-08 a: ~ ua 31--do-

i ~ ia he/here	i ~ ia 74-100 ia ~ ia 17- -do-	i ~ ia 79-76 ia ~ i 21-24	i ~ ia 68-100 ia ~ ia 32- -do-

i ~ ju he/hue	i ~ ju 85-73 ju ~ i 15-17	i ~ ju 94-58 ia ~ i 06-39	i ~ ju 82-69 ia ~ i 09-32

ɑ ~ oi sod/soy	ɑ ~ oi 11-56 ɔ ~ ɔ: 60-29	ɑ ~ oi 4-24 ɔ ~ ɔ: 88-70	ɑ ~ oi 38-27 ɔ ~ ɔ: 23-33 ɔ: ~ ɔ 17-21

ɑ ~ ua cod/cure	ɑ ~ ua 17-95 ʌ ~ ɔ 37-05 ɔ ~ ua 10--do-	ɑ ~ ua 37-50 ɔ ~ ju 60-47	ɑ ~ ua 14-91 ɔ: ~ ɔ 37-08 a: ~ ua 31--do-

ɑ ~ au got/gout	ɑ ~ au 77-63 ɔ ~ ɑ 12-21 ou ~ ɔ 07-16	ɑ ~ au 58-31 ɔ ~ ɛ 41- 50	ɑ ~ au 75-35 ou ~ ou 25-38

APPENDIX F

APPENDIX F

DISCRIMINATION RESULTS

Table 1- Results of Minimal Pair Tests administered to Kenyan, Ghanaian and Malawian University students.

	Ghanaian Discrimination		**Zimbabwean Discrimination**		**Kenyan Discrimination**	
Vowel pairs tested	**S %**	**D %**	**S %**	**D %**	**S %**	**D %**
I ~ ia Bid/beard	**50**	**50**	40	60	35	65
e ~ e made/ made	68	32	**34**	**66**	**49**	**51**
e ~ ε wade/wed	26	74	13	87	**51**	**49**
ɜ ~ ʌ bird/bud	**46**	**54**	**50**	**50**	**57**	**43**
a ~ a bat/bat	88	12	**48**	**52**	78	22
a ~ ʌ mad/mud	24	76	37	67	**55**	**45**
a ~ au bat/bout	**46**	**54**	27	73	**57**	**43**
ʌ ~ ʌ rug/rug	96	4	**57**	**43**	78	22
ʌ ~ ɜ hut/hurt	**64**	**36**	**53**	**47**	**49**	**51**
ʌ ~ ɑ gut/got	**50**	**50**	35	65	**67**	**33**
ʌ ~ o mud/mode	26	74	22	78	**47**	**53**
ɑ ~ ɑ hot/hot	**52**	**48**	**50**	**50**	**57**	**43**
ɑ ~ ou got/goat	32	68	33	67	**57**	**43**
ɑ ~ ɔ: cot/caught	36	64	37	63	**53**	**47**
ɔ ~ ɔ call/call	66	34	**52**	**48**	63	37
ɔ ~ ɑu bought/bout	12	88	8	92	**57**	**43**

ɔ: ~ ɑ caught/cot	20	80	**42**	**58**	39	61
ɔ ~ ua law/lure	**42**	**58**	**50**	**50**	**47**	**53**
u ~ u good/good	74	26	**45**	**55**	65	35
u ~ ʊ wood/wooed	**44**	**56**	25	75	37	63
ʊ ~ ou cook/coke	**52**	**48**	**45**	**55**	**49**	**51**

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