CHAPTER THREE

METHODOLOGY AND DATA COLLECTION

3.0 Introduction

This chapter discusses the methods and strategies employed at the various stages of the study. These include the selection of subjects for the study, speech material used for the data collection, recording of data, acoustic analysis and statistical instrumentation.

3.1 Subjects

The subjects for this present study are adult males and females with ages ranging between 24 and 52 years. Subjects selected for this present study were residents born in their respective dialect speaking areas and had lived there for the most part of their life. Subjects have had formal education and were either professional or non-professional teachers teaching other disciplines other than their native language at the basic schools at the time of recording. None of the subjects was a trained teacher of Dagbani. The choice of teachers for this study was not a criterion, but this was the class of people who understood that the recording of their voices was not for any other purpose than educational research. Thirty subjects were selected for the study: these included 5 male 5 female speakers for each of the three dialects under study. Subjects were selected through interaction to ensure that they spoke clearly the dialects for which they were chosen. Subjects spoke their dialects clearly. They were unaware of the exact nature of the data collection although they knew that the research involved an examination of their voices. All speakers were interacted with to ensure that they had no articulation and hearing problems.

3.2 Speech Data

The vowels under this study are the short vowels of Dagbani [i, □, ə, e, ɛ, a, ɔ, o, ɷ, u] and their longer counterparts [i:, e:, a:, o:, u:]. Table 1 shows the contexts in which the vowels were used to elicit information. The vowels of Dagbani were used in monosyllabic consonant vowel (CV) environment to illicit information. This is because Dagbani although not unique has mostly CV syllable structure; and all vowels occur at open syllable monosyllabic word environment.

Table 1: Vowels of Dagbani used in monosyllabic environment to elicit production

Vowel	Word in isolation	Gloss
I	pi [pi]	‘ burry’
□	bi [b□]	‘well cooked’
ə	bɛ [bə]	‘they’
E	be [be]	‘live’
ɛ	tɛ [tɛ]	‘sieve’
A	ba [ba]	‘rid’
ɔ	tɔ [tɔ]	‘ok’(acceptance)
O	po [po]	‘swear’
ɷ	bu [bɷ]	‘beat’
U	tu [tu]	‘insult’
i:	pii [pii]	‘select’
e:	bee [bee]	‘or’
a:	baa [baa]	‘dog’
o:	doo [doo]	‘man’
u:	puu [puu]	‘farm’

The vowels were also used with the plosives [p], [b], [t], and [d] because the vowels conveniently occur before them in the language. These open syllable words of Dagbani constituted the central words of the short sentences on flashcards used for the recording. The sentences on the flashcards, that is, the carrier frame for the study took the form Bɔlimi …X… pahi; meaning, ‘Say…X… again’, where X represents a word with the targeted vowel. Below are the lists of sentences that were used to collect the data.

Sentences with short vowels in the carrier frame (monosyllabic context)

Sentence	Gloss
1. Bɔlimi pi pahi.	‘burry’
2. Bɔlimi bi pahi.	‘well cooked’
3. Bɔlimi bɛ pahi	‘they’
4. Bɔlimi be pahi.	‘act of existence’
5. Bɔlimi tɛ pahi.	‘sieve’
6. Bɔlimi ba pahi.	‘ride’
7. Bɔlimi tɔ pahi.	‘pound’
8. Bɔlimi po pahi.	‘swear’
9. Bɔlimi bu pahi.	‘beat’
10. Bɔlimi tu pahi.	‘insult’

Sentences with long vowels used in the carrier frame (monosyllabic context)

Sentence	Gloss
1. Bɔlimi pia pahi.	'ten'
2. Bɔlimi bee pahi.	'or'
3. Bɔlimi baa pahi.	'dog'
4. Bɔlimi doo pahi.	'man'
5. Bɔlimi puu pahi.	'farm'

3.3 Recording of Data

Speech data was collected in quiet places in subjects' localities (Tamale for Tomosili, Yendi for Nayahili and Bimbilla for Nanuni) by the use of a Sony IC Recorder (ICD-MS252). Subjects were invited individually. Each sentence was read three times aloud and in a careful manner by all subjects. If a word was produced incorrectly, the subject was asked to reread the card. A total of 10 x 3 tokens per speaker were recorded for the short; a sum of 900 vowel tokens was recorded across the 30 subjects. A total of 5 x 3 tokens per speaker were also recorded for the long vowels for this study.

3.4 Acoustic analysis

The recorded data was sampled at 20 kHz with 16 bit resolution and each vowel was labeled using Kay Elemetrics Computerized Speech Lab (CSL model 4500) software. The vowels were segmented on the basis of visual information in a wide band spectrogram. F1 and F2 were determined and measured in Hz in the middle of the target vowel since it can be assumed that the influence of an adjacent segment is minimal and the articulatory target is maximally achieved in this position. The target is the vowel component least influenced by its surrounding phonetic context and is considered to be either a point in the time course of the vowel or else a section of time during which the vowel position remains stable. A single point is often used to provide a representation of the target position, and for most vowels this can be assumed to be approximately midway through the nucleus. Figure 3 shows the spectrogram of a speaker's utterance 'Bolimi ba pahi' with the target vowel [a] selected in three cursors. The mid cursor indicates the middle of the formants at which measurement the formant frequencies are taken in Hertz (Hz) while the two extreme cursors measure the duration of the vowel from the beginning of the sound (left) to the end (right) in seconds.

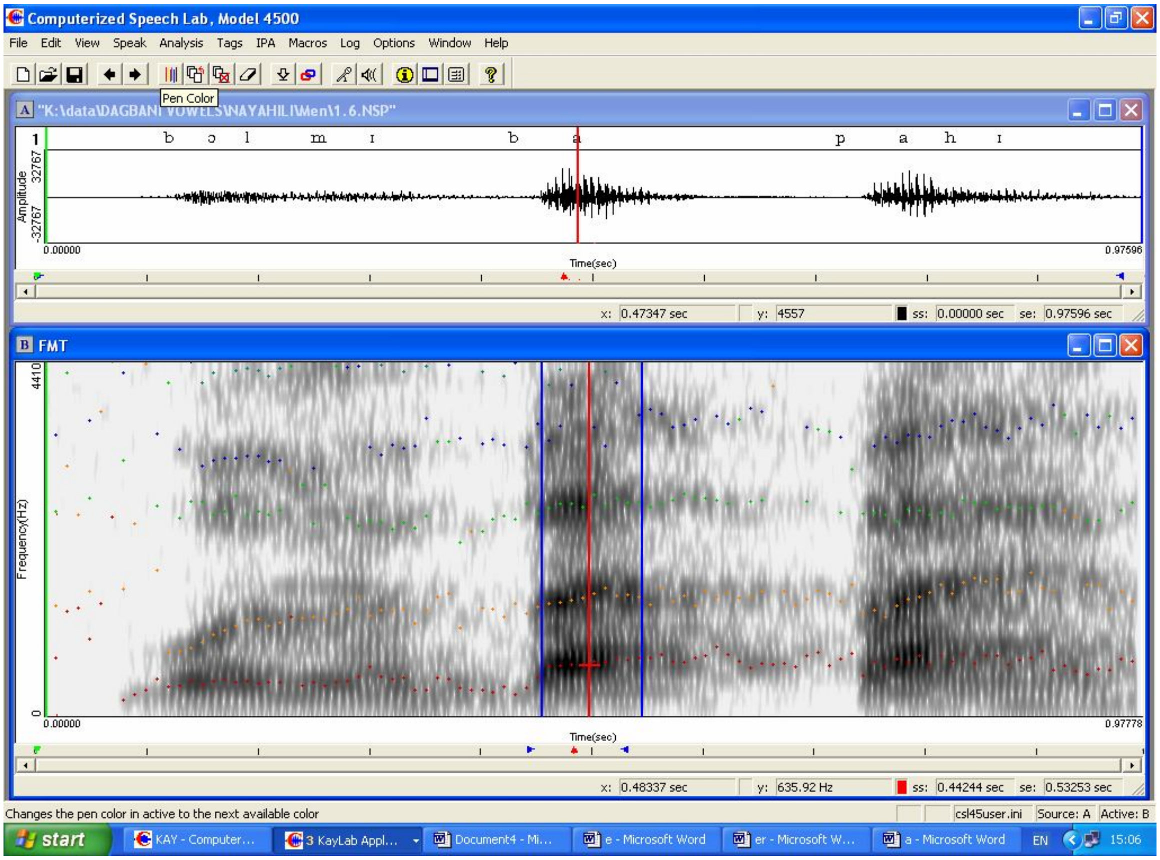

Figure 3: Spectrogram showing the vowel [a] (selected in the cursors) for a Nayahili male speaker marked by three cursors.

The process of identifying targets in the set of data was easy in the sense that the vowels were in the spectrograms. The vowels were relatively long and coarticulatory effects from the surrounding consonants were minimal. The accuracy of each formant trace was checked by hand and manually modified where necessary.

The difference between F1 and F2 (F2-F1) for each speaker's vowels was calculated resulting to F2' and later plotted on the vowel space with F1 on the ordinate (vertical axis) and F2' on the abscissa (horizontal axis) for both short and long vowels. The analysis focused on formant values measured in hertz (Hz) and duration values measured in seconds.

3.5 Data Normalization

There are several methods for reducing speaker related variation in the frequency data. These are discussed in Disner (1980) and Adank (2003) among others. These methods include the baseline condition (formants in Hz), averaging, Lobanv's (1971) z-score transformation, analysis of variance

(ANOVA), log-transformation of the frequency sale, mel-transformation of the frequency scale, Gerstman's (1968) range normalization, Miller's (1989) formant ratio model, etc. A number of these methods were employed in this study. First and foremost, measurement of formant frequencies were calculated Hz followed by averaging of the three repetitions of each vowel (raw frequency data) per speaker, giving rise to one set of F1/F2 frequency data for a speaker per vowel. These averaged data was used to perform statistical analysis. At this stage the analysis of variance (ANOVA) was performed on frequency data to determine the significant relationships between individual and groups of speakers' vowels. Analysis of Variance is a method of testing the null hypothesis that several group means are equal in the population, by comparing the sample variance estimated from the group means to that estimated within the groups.

The ANOVA was also used in the paired vowel tests to determine the significant relationships between some vowels of the language. Z-score transformations were performed on the averaged frequency data before analysis for the scatter plots for the various dialects and that of the overall scatter plot for the language were performed. The z-score transformation positions each vowel of an individual speaker relatively with respect to the other vowels in his system. This can be achieved amongst others a transformation of formant values to z-scores. In this transformation, the vowels of an individual speaker are positioned on a scale with mean 0 and a standard deviation 1.