THE DEVELOPMENT OF A ZULU SPEECH RECEPTION THRESHOLD TEST FOR ZULU FIRST LANGUAGE SPEAKERS IN KWA ZULU-NATAL (KZN)

BY

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For my parents & my husband, Vic

DECLARATION

I, Seema Panday , do hereby declare that this dissertation which is submitted to the University of Kwa Zulu-Natal for the degree Master of Audiology , represents my own work in conception and execution and that all sources that I have used and quoted have been acknowledged.

Signed ------------------------------ at UKZN ------------------------------ on 15 ------------------------
day of December ------------------------ 2006

Disk Enclosed

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Summary

The measurement of speech reception threshold (SRT) is best evaluated in an individual's first language. Currently there is a paucity of linguistically matched materials to measure the SRT of Zulu First Language Speakers (ZFLS) in Kwa Zulu-Natal (KZN). Therefore, the present study focused on developing and assessing a Zulu SRT word list for Zulu First language Speakers (ZFLS) in KZN, according to adapted criteria for SRT in Zulu. In addition, the application of the developed list was evaluated. The study therefore followed a two phase methodological framework. Phase one focused on the development and assessment of the word list. Phase two focused on the application of the word list in a normal hearing population from KZN. Phase one of the study was realized within a descriptive survey design and Phase two was realized using a within- participant quasi experimental design. Phase one included aims one and two of the study. Phase two included aim three of the study. However, each aim had several objectives which were realized consecutively.

For aim one of the study, three objectives were achieved i.e. for objective one, 131 common bisyllabic words were identified by two Zulu speaking language interpreters and two tertiary educators. Eighty two percent of these words were described as bisyllabic verbs. The outcome of objective two concluded that 58 bisyllabic verbs were rated as being familiar, phonetically dissimilar and low tone verbs by five linguistic experts, using a three point Likert scale. The agreement among the raters was generally good for each criterion, according to the Kendall's co-efficient of concordance at 95% level of confidence. Two objectives were generated to realize aim two of the study. These included, the measurement of homogeneity of audibility of the 58 words selected in aim one and the acoustic analysis of the words. The findings for the homogeneity of audibility were based on a logistic regression analysis. Thirty normal hearing adult ZFLS (18-25 years) participated in this aim of the study. The mean slope of 50% for 28 words was 5.98%/dB. Therefore, 28 words were measured as being most homogenous. The 28 words were also assessed acoustically. The acoustic analysis indicated that the pitch contours confirm the prosodic pattern of the words selected in terms of Zulu linguistic structure, as the majority of the verbs (89%) indicated a difference in the pitch pattern between the two syllables. Furthermore, trends were noted with regard to the energy contours. The acoustical analysis supports the findings of objective one of aim two.

For aim three of the study, twenty six normal hearing adult ZFLS, with functional proficiency in English were assessed. The SRT was measured using the developed Zulu SRT word list. In addition, the SRT was measured using the original CIDW2 list. The Pearson product moment correlation co-efficient was utilized for the measurement of the relationship between the SRT (Zulu) and the

Pure Tone Average (PTA). Similarly, the Pearson product moment correlation between the SRT (English) and PTA was obtained. A good relationship between the SRT scores and PTA was reported when both lists were used. However, a stronger correlation between the Zulu SRT and PTA (r=.76) than with the English SRT and PTA (r=0.62) were noted.

The results in aim one and aim two of the study highlighted the importance of adapting the criteria for SRT to suit the structure of the language. Aim three confirmed this premise as the implication of a stronger correlation may be related to the familiarity of the stimuli to the Zulu First Language Speaker. The study therefore contributed to both research and clinical implications. Some of the important research implications for the study include: the application of the Zulu SRT word list to a varied clinical population with a hearing disorder or loss, the standardization of the developed Zulu SRT word list on a larger sample, the development of SRT materials in other African languages in South Africa. Important clinical implications of the study include that the findings in the study support the need for speech material to be appropriate to the language of the client and the developed SRT word list in Zulu is applicable to adult ZFLS in KZN.

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CHAPTER ONE: OVERVIEW AND RATIONALE FOR THE STUDY

1.1 OVERVIEW

The purpose of this study was threefold i.e.

- To develop a Zulu word list for Speech Reception Threshold (SRT) testing;
- To assess the developed list;
- To evaluate the application of the developed Zulu word list on normal hearing Zulu First Language speakers (ZFLS) in Kwa-Zulu Natal (KZN).

The SRT test is part of the initial conventional audiological test battery. SRT is defined by the American Speech and Hearing Association [ASHA], (1988) as the hearing level in decibels (dB) at which the individual can respond correctly to 50% of the test words presented. However, in order to recognize and understand the test words the individual should be familiar with the words (Lyregaard, 1997). Therefore, Balkisson (2001) suggests that this is best achieved if the test materials used are presented in a language in which the individual is most familiar, i.e. in the first language of the individual. Furthermore, it was reported that testing patients with materials recorded in a language other than their native tongue would "adversely affect performance and interpretation of results" (Nissen, Harris, Jennings, Eggert & Buck, 2005, p. 392).

In considering the above recommendation by Balkisson (2001) and Nissen et al. (2005), there is a need for linguistically matched, easily understandable and highly familiar words for the establishment of SRT in Zulu. The need for linguistically matched speech materials has motivated many researchers to embark on the formidable task of developing word lists in their mother tongue language. Some of these researchers include, Ashoor & Proschazka (1985) who developed test words in Arabic, Plant (1990) who focused on the development of words in Walpiri and Tiwi and more recently, Nissen et al.

(2005), who developed words in Mandarin. Nissen et al. (2005) further strongly argued that to develop a suitable word list in a language other than English requires an in-depth understanding of the linguistic structure of the language because the criteria for the original English SRT materials have been designed around the structure of English. It is also well known that each language has its own linguistic structure and, therefore, the rules governing one language may not always be applicable to other languages. Therefore, it was deemed necessary to develop a word list that was relevant to the Zulu language in KZN.

This chapter elaborates on the rationale for the development of suitable SRT materials for the Zulu First Language Speaker (ZFLS) in KZN. The chapter begins with a description of the current context in KZN with regards to the demographic profile and the present practice of audiologists with regard to speech audiometry for ZFLS. It provides one of the main arguments supporting the current study. In addition, an overview of speech audiometry, its relationship to speech reception testing and how speech is heard, processed or perceived is discussed. This discussion relates to the theoretical reasons for the development of a word list for SRT in an individual's first language. Chapter one concludes with a presentation of the aims of this study, key definition of terms used and a summary of the forthcoming chapters in this dissertation.

1.2 RATIONALE FOR THE STUDY

1.2.1. Current context: Demographics of KZN and the current audiological practice regarding ZFLS

The need for linguistically-matched speech materials for ZFLS is a reality when considering the demographic profile of KZN. Zulu is the first language of 80% of its population (Population Census, 2001). In fact, Zulu is the Nguni language spoken by almost 8.5 million people in the whole of South Africa (Grimes, 1992). Zulu is also one of the eleven official languages of South Africa. The concentration of Zulu speakers is, however, in KZN. In spite of

Zulu speakers being the majority of the population of KZN, the development of linguistically appropriate materials is still lacking. Speech Audiometry, like most other areas of speech, language and hearing services in South Africa, has a paucity of relevant test materials to evaluate the majority of the individuals who do not speak English as their first language (Bortz, 1992). As a consequence the service provided to African first language speakers of KZN is poor (Pillay, Kathard and Samuel, 1997). In order to address this shortcoming, appropriate and relevant tools should be developed and made available for clinical use. The following description of the current practice with regard to assessment of ZFLS in KZN also reinforces the need for the development of a suitable word list.

The lack of carefully developed Zulu materials has resulted in audiologists following one of three trends in current practice in KZN. John (1990) indicates that speech reception testing is omitted from the initial test battery, or that the SRT is obtained using the standard English material viz. Central Institute for Deaf CID WI and W2 spondee word list. Finally, SRT is obtained using modified methods and non-standardized randomly selected bisyllabic words in Zulu. However, according to Nissen et al. (2005), the use of such materials could affect the performance and interpretation of the results. Thus casting doubt on the validity of the test. Audiologists could therefore find themselves providing a highly inappropriate service to the majority of the Zulu first language speaking population if the material used is not linguistically appropriate for their clients. The underlying reason for this is that one of the most important characteristics of SRT materials and SRT testing is familiarity of stimuli to the client (Carhart, 1965).

Furthermore, the use of randomly selected bisyllabic Zulu words for the assessment of ZFLS cannot be seen as a step towards linguistic relevance. Knight (1997) warns that developing linguistically matched word lists should be based on specified criteria such as familiarity of the words in the language.

In addition, "language facility, age and physical conditions" must be taken into account when providing speech audiometry services to a population (ASHA, 1988, p. 4). Rudmin (1987) also stated that each nation's linguistic milieu should be considered when offering speech audiometry services. Therefore, the current practice of using English material or randomly selected bisyllabic words for the assessment of SRT in Zulu is problematic, warranting the need for a more valid tool. Clearly, the inappropriate practice in the current context provides the rationale for the development of a word list in Zulu.

However, prior to the development of the Zulu word list, the theoretical reasons for why questionable results are produced when English materials are used needs to be explored. These reasons are discussed in the section on speech audiometry, its relationship to speech reception testing and how speech is heard, processed or perceived. The discussion is relevant for the choice of appropriate speech materials for Zulu.

1.2.2. Speech audiometry, processing speech and the value of SRT

Speech Audiometry refers to "any method for assessing the state of the auditory system using speech sounds as a response-evoking stimulus" (Lyregaard, 1997, p. 35). Furthermore, the understanding of speech is an important human faculty and the speech signal according to Martin (1997) forms the basis of auditory stimulation that occurs in everyday life. In addition, Davis & Silverman (1978) adds that to understand speech must be considered the most important measurable aspect of the human auditory function. Young, Dudley & Gunter (1982) and ASHA (1988) also assert that speech audiometry evaluates the listener's ability to hear, recognize and understand speech communication in the everyday environment.

Therefore, the measurement of hearing threshold for speech is integral to the comprehensive diagnostic evaluation of hearing (Ramkissoon, Proctor, Lansing, Bilger, 2002; Ashoor and Prochazka, 1985). Speech audiometry including SRT testing complements the other conventional tests of audiometry, such as pure tone audiometry. It is well known that pure tone audiometry provides the 'gold standard' for the initial audiological assessment of hearing (Roeser, Valante & Horsford-Dunn, 2000). Therefore, the pure-tone test serves as the foundation of every audiological evaluation (Roeser, Valante & Horsford-Dunn, 2000). Nonetheless, while pure tone thresholds are important in predicting the hearing patterns at discrete frequencies, the speech threshold test is able to provide a more comprehensive and realistic description of hearing in everyday life. This occurs because the pure tone signal lacks the ability to assess the representative sounds of daily life, which the auditory system is so highly geared to perceive (Martin, 1997). Nissen et al. (2005) explains that speech testing contributes more information about the hearing impairment of an individual than do pure tones. Nissen et al. (2005) adds that the speech testing allows for the analysis of loudness, localization, distortion and, most importantly, speech comprehension. Therefore, the initial audiological test battery is incomplete without an accurate measurement of hearing of speech.

Gelfand (1997) qualifies this by stating that speech is the principle avenue for human communication which warrants the need for it to be evaluated. In addition, many authors (ASHA, 1988; Konkle & Rintleman, 1983; Gelfand, 1997) documented the clinical value of SRT and their studies are summarized below.

The SRT quantifies the listener's hearing level for speech. It also serves as a validity check for pure tone audiometry. Furthermore, SRT provides diagnostic and prognostic value for the total audiometric battery. It is also a reference point for deciding appropriate levels for supra-threshold speech tests. SRT can evaluate the success of medical, surgical or rehabilitative intervention regarding the restoration of auditory function. The above clinical values illustrate that SRT is the initial or primary test within the subgroup of tests for speech audiometry. It is reasonable to suggest that speech discrimination testing (SDT) is also dependent on the results of SRT. The clinical value of speech testing, and more specifically SRT testing, confirms its importance in the test battery. However, in developing materials for the establishment of the SRT in ZFLS, there should be an understanding of how speech is perceived. This highlights the importance of the speech signal being in the individual's first language, which is the focus of this study.

Lyregaard (1997) explains speech perception as a pattern recognition process where the listener hears certain acoustic cues and selects the appropriate category where the item fits. The important aspect of this selection is that it is not only based on acoustic or phonetic factors, but also on the syntax, semantics and the overall context (Lyregaard, 1997). This is further supported by (Bellis, 2003) who states that hearing does not end merely by detecting acoustic stimuli. Bellis (2003) adds that in fact, there are several processes of decoding, perception, recognition and interpretation of the auditory signal that occurs. The details of each of these processes are beyond the scope of this discussion but may be perused in Bellis (2003).

However, it is important to understand that the perception of speech is a complex task. Kent (1992), as cited in Katz (2002) provides an explanation that speech is perceived on the basis of both the acoustic signal and predictions based on contexts and familiarity. Medwetsky (2002) states that the analysis of the acoustic signals, also known as bottom-up processing is based on the extraction of cues from the continuous flowing pattern of speech. The listener is able to determine the discrete units of speech, such as phonemes, syllables and words. However, Medwedsky (2002) argues that the perception and processing of speech is also determined by the predictability of the spoken message. This is known as the top-down processing. The context, semantic, syntactic cues and the cognitive resources of the listener assists in the processing of the signal. Therefore, most listeners are able to perceive the signal under difficult listening conditions. This has implications for the present study in that during threshold estimation for speech, the listener relies on both the top-down and bottom up processing abilities in order to identify the speech signal.

Craig (1997) has provided an argument for the importance of context in the recognition process of spoken words. Criag (1997) reported that the implication of contexts is best seen when words are presented to individuals acquiring a second language. Identical speech signals presented to one group of listeners who are first language speakers and to those who are second language speakers results in latter group being unable to hear subtle sounds segments and prosodic nuances. First language listeners however are able to appreciate these differences (Criag, 1997). Everyday speech occurs within a context, and thus context plays a pivotal role in improving word recognition (Criag, 1997). Words having a higher frequency of occurrence are more easily recognized than those that have a lower frequency of occurrence. Listeners rely on their higher information resources, such as prosodic, semantic, lexical and pragmatic knowledge of the language in order to recognize words.

It is clear from the above discussion, that the perception of speech is dependent on both acoustic cues and the higher-order-processing of language. For the present study the focus has been on both a combination of both the top-down and bottom-up processing theories suggested above. This is particularly relevant for the development of the materials in Zulu, as the acoustic properties of the Zulu words and the linguistic structure is important. Therefore, the hearing for speech for a ZFLS is best evaluated in Zulu. The Zulu speech material was considered appropriate as it contributes to sound diagnosis (Martin, 1997). The ZFLS would be more familiar with the Zulu words from both the acoustic properties of the words and the prosodic, semantic and lexical aspect. These elements facilitate easier recognition of the words when the stimulus is closer to threshold. Howes (1952) and Owens (1961) have both claimed that unfamiliar words are difficult to identify under difficult listening conditions and when the stimulus is closer to the auditory threshold.

In view of the uniqueness of SRT, its contributing value to the conventional test battery and the theoretical reasons for the perception of speech, the use of a generic word list for all the linguistic populations in KZN was not acceptable. Furthermore, Taylor (1986) advises that the linguistic, cultural and social factors in multilingual societies must be considered important in service delivery. In addition Ramkisson, Proctor, Lansing & Bilger (2002, p. 27) advised that "Audiologists would have to be more astute" to look at the development of relevant materials to address linguistic needs in their client population. Therefore, the following aims of the study were considered.

1.3 AIMS AND OBJECTIVES OF THE STUDY

1.3.1. To develop a SRT word list for ZFLS.

1.3.1.1 To identify commonly used bisyllabic Zulu words.

1.3.1.2 To rate the commonly used bisyllabic Zulu words according to the adapted SRT criteria for Zulu viz.: Familiarity, phonetic dissimilarity, and tone of the words.

1.3.2 To assess the developed Zulu SRT word list.

1.3.2.1 To measure the homogeneity with respect to audibility of the Zulu words selected in aim one.

1.3.2.1 To describe the pitch and energy contours of the most homogenous words selected.

1.3.3 To evaluate the application of the SRT word list on a normative clinical population of ZFLS in KZN.

1.3.3.1 To determine the relationship between the pure tone averages and the Zulu SRT scores and the relationship between the pure tone averages and the English SRT scores for normal hearing ZFLS of KZN.

1.3.3.2 To compare the relationship of the pure tone averages and SRT scores for the Zulu word list versus the pure tone averages and SRT scores for the English word list, when normal hearing participants were tested.

1.4 DEFINITION OF TERMS USED IN THE STUDY

The key definition of terminology used in the study is outlined.

1.4.1 Acoustic Analysis: Refers to a detailed study of a sound stimulus in terms of the pitch patterns, energy contours and intonation patterns.

1.4.2 ANSI: American National Standards Institute

1.4.3 dBHL: Refers to the decibel hearing level, and the decibel notation on the audiogram that is referenced to audiometric zero (Stach, 2003).

1.4.4 Familiarity: The concept of familiarity has been referred to in this study from two perspectives i.e. Familiarity as it relates to the test product (word list) and test process (testing). Wilson & Margolis (1983) explained familiarity as it relates to the test product. The word or vocabulary selected for the establishment of SRT must be based on how often the listener uses the word in everyday speech. To this end, the most commonly used words are considered most familiar. Familiarity as it relates to the testing process has been defined by Tilman & Jerger (1959) as the face to face familiarization of the word list prior to establishing the SRT.

1.4.5 Homogeneity with respect to audibility: Homogeneity with respect to audibility has been explained as the ease with which words are understood when spoken at a constant level of intensity (Silman & Silverman, 1991). Homogeneity with respect to audibility can be achieved in two ways i.e. by selecting only those words that reach the listener's ear at the same intensity level or recording the individual words in such away that all the words are heard at the same level. Homogeneity with respect to audibility is an important criterion in SRT testing as it allows for the 50% level to be obtained precisely.

1.4.6 Performance intensity curve or Psychometric curve: Performance intensity curve has been described by Martin (1997) as the relationship between some measure of performance and a stimulus. The performance intensity curve illustrates how well the speech sample can be correctly identified as a function of intensity levels. In addition the steepness of the performance intensity curve determines the precision with which the threshold can be obtained.

1.4.7 Phonetic dissimilarity: Silman & Silverman (1991) reported that the test material used for the establishment of SRT must consist of stimuli that vary in terms consonant and vowel combinations for the language being used. Phonetic dissimilarity in words prevents confusion between the words.

1.4.8 Pure Tone: A signal in which the instantaneous sound pressure level varies as a sinusoidal function of time (Stach, 2003).

1.4.9 Pure Tone Average (PTA): Refers to the average hearing sensitivity to pure tone signals at 500Hz, 1000Hz and 2000Hz (Stach, 2003).

1.4.10 Pure tone threshold: Lowest level at which the pure tone signal is heard 50% of the time (Stach, 2003)

1.4.11 Speech perception: Refers to the awareness, recognition and interpretation of speech signals received in the brain (Stach, 2003).

1.4.12 Speech Reception Threshold (SRT): The American Speech and Hearing Association, (1988) defines SRT as the hearing level in decibels (dB) at which the individual can respond correctly to 50% of the test words presented to him/her.

1.5 SUMMARY OF CHAPTERS

The present dissertation consists of seven chapters. The following is a summary of each chapter.

1.5.1 Chapter One

Chapter one outlines the overview and focus of the study. A description of the rationale is documented, with reference to the current context of KZN. The chapter discusses the importance of speech audiometry, with reference to clinical value of SRT and how speech is understood. The chapter concludes with the aims, objectives and the definition of terms.

1.5.2 Chapter Two

Chapter two focuses on the theoretical issues pertaining to word list development and the assessment of the developed tool. The chapter begins with a description of the Zulu language and its relevance to word list development. This chapter is divided into two sections i.e. Section A and section B. Section A refers to the word list development and section B refers to the assessment of the tool. The reader is presented with a historical review of SRT word list development, followed by a description and analysis of both the international and local literature. The theoretical elements to consider for the development of SRT materials for Zulu emerge as the literature is reviewed in the chapter. The section on word list development is concluded with the adapted criteria for SRT in Zulu. In addition the literature and theoretical issues regarding the assessment of the tool is presented in Section B.

1.5.3 Chapter Three

Chapter three discusses the theoretical elements relevant to the evaluation of the application of the word list in a normative clinical population. The chapter details the reasons for the procedural method used with reference to the literature.

1.5.4 Chapter Four

This chapter outlines the methodological framework of the study. The motivations for the choices made are presented. Aims and objectives and the methodological approach is explained and supported with references. The study is divided into two phases and this is clearly explained and illustrated. A detailed description of each phase is provided, making reference to participant choices, criteria for selection, instrumentation and analytic measures. The ethical and legal consideration in the study is documented.

1.5.5 Chapter Five

Chapter five presents the results in the study according to aims and objectives. The chapter documents the results of each objective using graphs and tables to enhance the discussion. A brief interpretation of the results is also provided.

1.5.6 Chapter Six

The reader is taken through a careful discussion of the results as presented in terms of the aims and objectives. The discussion chapter makes reference to the literature and comparison to other studies. The controversies and explanation of the results is discussed. In addition, the implications and limitations of the study are included.

1.5.7 Chapter Seven

Chapter seven is the conclusion chapter of the dissertation. The research question is answered in this section of the dissertation and implications for future research are made, clinical implications and limitations are presented.

CHAPTER TWO: THE DEVELOPMENT AND ASSESSMENT OF THE SRT WORD LIST– HISTORICAL AND THEORETICAL REVIEW

2.1. INTRODUCTION

The preceding chapter provided an overview and the rationale for this study as well as an orientation for each chapter. The present chapter is divided into two sections i.e. *Section* A and *Section* B. *Section* A *presents* the historical and theoretical review for the development of SRT material whilst Section B presents a review of the literature and theory on the assessment of the word lists. Within Section A, a description of the Zulu language and its relevance to the criteria for SRT word list development is provided. Thereafter, a detailed historical account of word list development for speech reception testing is given. The historical review highlights the traditional criteria relevant for SRT words. This is followed by a review of both the international and local literature on SRT word list development in other mother tongue languages in the world. In so doing the need for the adaptation and the setting of new criteria specific to the language concerned is raised. Thus, embedded within the literature review are the theoretical elements considered in the development of the Zulu SRT word list. Finally, the section concludes with a description of the criteria relevant to the development of the SRT words in Zulu.

Section B deals with the literature review for the assessment of the developed list. The criteria for the development of SRT words and the assessment of the test words are closely related and tend to overlap. Therefore, for the purposes of this study, these theoretical elements and the literature review relevant to the assessment of the tool is presented.

2.2. STRUCTURE OF ZULU : IMPLICATIONS FOR THE DEVELOPMENT OF SRT WORDS

The development and assessment of a word list for SRT in Zulu requires insight into the language and linguistic structure of Zulu. This is necessary in view of the foregoing argument presented in chapter one on the influence of both language and the acoustic properties of the language on the perception and understanding of speech. Furthermore, the process followed regarding the development and assessment of the SRT word list in Zulu has to be guided by the rules that govern the language.

The following discussion, however, is by no means representative of the depth of the Zulu linguistic structure, but it represents structural issues relating to the development of a SRT word list for the Zulu language. Zulu is an Nguni language. The Nguni languages are part of a larger related group of South Eastern Bantu languages. In terms of structure, Zulu is an agglutinative language, which commonly has roots bound to prefixes and suffixes (Jacobson & Trail, 1986). The root of the word usually carries lexical meaning. The word structure without the prefix and suffix would be purely a bisyllabic word in the consonant vowel, consonant vowel sequence (CVCV), e.g. /hamba/ meaning "to go" in English. This word form only appears as a verb imperative and hardly ever as a noun. Noun classes in Zulu are often trisyllabic in nature because of the prefix formative e.g. /ihashi/ meaning "horse' in English (Jacobson & Trail, 1986). This aspect of the language had to be carefully considered, as the type of stimuli selected for the SRT material in Zulu is dependent on the availability of stimuli in the language.

Moreover, Zulu is a tonal language (Rycroft & Ncgobo, 1979). Tonal variations are lexically significant in Zulu (Rycroft & Ncgobo, 1979), implying that the pitch of the word corresponds to the difference in meaning. To illustrate, the word /inyanga/ can mean "doctor" or "moon or month" depending on where the pitch of the word occurs. The role of tone has three distinct functions in Zulu, i.e. semantic (affecting the meaning of words), grammatical, and emotional (Cope, 1982). These tonal variations may influence the meaning of the stimuli, thus having implications for speech understanding.

Furthermore, Zulu is a "non-stress" language that is stress is not used to indicate emphasis nor is used to differentiate words or syllables as seen in English Cope, 1982). This has implications for the development of SRT words as one of the main historical criteria is that the words must be *equal* in stress within a bisyllabic structure (Hudgins, Hawkins, Karlin & Stevans, 1947). This point is given greater attention in later sections of this chapter. If Zulu does not have this linguistic characteristic, then the criteria for SRT materials needs adaptation or the development of new criteria to suit the language is required. This point of view has been widely supported by studies conducted in languages other than English, e.g. Plant (1990) who developed the Tiwi and Walpiri word lists, and Nissen et al. (2005), who developed Mandarin word lists.

Vowel length and the number of consonants in a language is another factor to be considered in the development of the word list. Vowel length in Zulu is syntactically determined (Cope, 1982). The vowels are lengthened on the penultimate syllable before a pause. This vowel pattern is similar to the Walpiri and Tiwi languages as will be seen later in this chapter (p.28). The vowel system in Zulu is different to English in that Zulu has the basic five vowel system, whereas English has a range of diphthongs adding to the complexity of the vowel system. Fewer vowel patterns in a language may influence the variability of phonemes within the word list. The consonant system in Zulu, on the other hand is perhaps considered more complex than that of English. Apart from the known stops, fricatives, and approximants, Zulu also has three prominent click sounds (Doke, 1930). The click sounds are orthographically transcribed as /c/ (dental click); /q/ (paloto-alveolar click); and the /x/ (lateral click) Doke, (1930). These click sounds appear frequently in the vocabulary of Zulu, which has implications for the development of the word list i.e. inclusion of click phonemes in the word list may influence the variability of phoneme choices in the words.

From the above description of the Zulu language structure, it is clear that Zulu differs markedly from that of English. Therefore, it may be argued that the criteria used in the original English word list for SRT may not be completely applicable to the development of a Zulu word list. Thus, suggesting that the structure of Zulu has its own criteria for the development of an SRT word list. However, prior to the development of a word list for Zulu a critical review of the historical perspective on the development of SRT words, with reference to the original criteria and subsequent research, is warranted. The following discussion highlights the issues and challenges pertaining to word list development both internationally and locally, drawing the attention of the reader to the complexity of developing and assessing a word list for the measurement of SRT. In addition, the importance of adhering to both the linguistic and audiological principles inherent in the process of word list development is reflected.

2.3 SECTION A : DEVELOPMENT OF SRT MATERIAL

2.3.1 Historical development of SRT word lists

The development of SRT test materials and SRT testing can be traced to the early work of (Fletcher, 1929) at the Bell Telephone laboratories (Ramkisson, 2000; Silman & Silverman, 1991; Gelfand, 1997; Brandy, 2002). Fletcher (1929) investigated the use of speech as an auditory signal, to test the use of the newly-developed phonograph equipment in Audiology (Brandy, 2002). The introduction of the phonograph record was achieved. The phonograph produced digit pairs through telephone receivers (Ramkisson, 2000). The test was known as the 4-c test. The test was used widely in most clinical settings.

However, the limitations of the equipment utilized in these earlier studies prompted Hudgins, Hawkins, Karlin, & Stevans (1947) to further improve the phonographic recordings by introducing the forty-two bisyllabic words known as "spondees" (Silman & Silverman, 1991; Gelfand, 1997). Spondees are defined as having equal stress on each syllable, e.g. railroad, airplane and iceberg (Hodgeson, 1980). The spondee words are bisyllabic English nouns.

The main advantage of using spondee words is centered on the need for the words to have equal stress on each syllable. Earlier researchers held the opinion that equal stress on each syllable allowed for uniformity and precise testing for SRT (Egan, 1948).

On the contrary, Hodgeson (1980) stated that spondee words were not so common in English since the stress of bisyllabic words is usually placed on the first syllable. Many words such as, "baseball", "hotdog", "cowboy' easily satisfied the criterion if care was taken to stress the first syllable. The change in stress pattern is permissible in English and does not alter the meaning of the word. Therefore, several words of this structure were selected for the original word list. The spondee test became known as the Psychological Acoustic Laboratory (PAL) Auditory Test No. 9 and has been used clinically to determine the individual's thresholds for speech, i.e. the SRT.

Thus, the introduction of this test was certainly more than just an attempt at improving technological advancement in Audiology. It can be seen as the introductory effort to construct a list of words that was perhaps more relevant for the assessment of individuals hearing for speech than the original tests suggested by (Fletcher, 1929). The introduction of a word list suggested that the test material was more representative of speech and communication, than the original recordings. However, while the earlier researchers supported the criterion of spondees in the development of SRT words, this criterion appears to suit the linguistic structure of English as described above. In contrast, Zulu is one of the many languages in the world that does not have spondee words (R. Bailey, personal communication, February, 2003). The implication is that satisfying this criterion would not be possible in Zulu and requires adaptation.

The first consideration therefore, with regard to the development of the word list, relates to the type of stimuli to be considered. As discussed in section 2.2 above, Zulu is able to satisfy the criterion of bisyllabic words, but the use of equally stressed words is unavailable structurally. Unlike English, the introduction of artificial stress patterns on each syllable in Zulu could possibly alter the meaning of the words. This is so since Zulu is a tonal language and variation in pitch and stress would influence the meaning of the words. Adaptation of this criterion with regard to the type of stimuli has been widely supported in relevant literature (Nsamba, 1979; Ashoor & Proschazka, 1985; Plant, 1990; Chetty, 1990; Nissen et al., 2005). Further examination of the historical criteria used by researchers raises the need to make adaptations with respect to the development of the Zulu word list.

Hudgins et al. (1947) carefully constructed the PAL Auditory 9 word list according to very specific criteria of English. These criteria are considered as the original criteria for the development of SRT test material and include familiarity, phonetic dissimilarity, normal sampling of the English language and homogeneity with respect to audibility or intelligibility. The discussion that follows provide an explanation of each of these criteria as specified in the original study by Hudgins et al. (1947) as well as in subsequent literature. Furthermore, the role and value of these criteria in determining appropriate words to be included in a list for SRT is also discussed. To this end, the discussion also focuses on the implications of the following criteria in relation to the present study.

2.3.2 Historical criteria for SRT word lists

2.3.2.1 Familiarity

According to Silman & Silverman, (1991) familiarity refers to the choice of vocabulary used. However, on perusal of the literature the concept of familiarity is explained on the basis of two perspectives viz, Familiarity as it relates to the *test product (word list)* and familiarity as it relates to the *test process (Testing)*, (Kruger & Kruger, 1997). For the purpose of this discussion an acceptance of both these concepts are considered. Wilson & Margolis (1983) explained familiarity as it relates to the test product. These authors explain that words selected for the SRT test must be based on the number of times the listener uses the word in everyday speech. To this end, the above authors claim that the most commonly used words are considered to be the most familiar words. Thus, familiarity has remained an important criterion for the development SRT words. There is both historical and current acceptance amongst researchers to include familiarity as a criterion

In fact, it has been repeatedly reinforced in the literature (Hirsh, Silverman, Reynolds, Eldert & Benson, 1952; Wilson & Margolis, 1983; Olsen & Matkin, 1991; Young et al, 1982; ASHA, 1988; Ramkisson, 2000; Nissen et al., 2005). Furthermore, familiarity is "arguably one of the most important criterion to be considered in word list development" (Nissen et al., 2005, p. 1). This position is also supported in the present study, as common and familiar words are available in the Zulu language.

In addition Tillman & Jerger (1959) have reported on the influence of familiarity as it relates to the testing process. Better thresholds for speech were found when the listener was familiarized with the test items prior to the testing process (Tillman & Jerger, 1959). Kruger & Kruger (1997) stated that face to face familiarization of the word list prior to testing is mandatory, as this not only improves the thresholds, but reduces variability in the test results.

2.3.2.2 Phonetic dissimilarity

Hudgins et al. (1947) as cited in Silman & Silverman (1991), suggests that the test material must consist of stimuli that vary in terms of consonant and vowel combinations within the language being used. Phonetic dissimilarity in a word list prevents confusion between words (Silman & Silverman, 1991). Words such as minimal pairs are similar phonetically and may result in the client identifying the words due to their good discrimination ability. However, this criterion has not received the attention that other criteria such as familiarity and homogeneity of audibility has received. This could perhaps be related to the difficulty in satisfying this criterion in languages that have fewer consonant and vowel combinations. For the purposes of this study, the simple vowel system in Zulu could possibly influence the criterion of phonetic dissimilarity and may require adaptation accordingly. However, the complex consonant system, with the addition of the click sounds as discussed in section 2.2 previously, may introduce more variability in the phoneme structure.

2.3.2.3 Normal Sampling of the (English) speech sounds

It was stated by Hudgins et al. (1947) that the word lists must be representative of the English speech sound system. All speech sounds must, therefore be represented on the word list. Silman & Silverman (1991) states that the occurrence of various speech sounds in everyday conversation must be essentially the same as the proportion of the speech sounds in the word list. Researchers have placed varying degrees of importance on this criterion. Perhaps it is reasonable to state that this criterion was not deemed as important as that of familiarity and homogeneity of audibility, (Hirsh et al. 1952; Beattie, Svihovee & Edgerton, 1975; Young, Dudley & Gunter, 1982; Ramkisson et al. 2002; Nissen et al. 2005). Ramkisson et al. (2002) confirmed that this criterion is important for a discrimination test rather than for a threshold test. Therefore, for the present study, the researcher strived to represent the phonemes of Zulu. However, other criteria and linguistic features of the language may not allow normal representation of the Zulu phonemes completely.

2.3.2.4 Homogeneity with respect to audibility:

The criterion of homogeneity of audibility/intelligibility is achieved by allowing the selected words to reach the listener's ear at the same intensity (Beattie et al. 1975). Furthermore, homogeneity has been explained as the "ease at which the words are understood when spoken at a constant level of intensity" (Silman & Silverman, 1991). Beattie et al. (1975) elaborated that homogeneity can be achieved in two ways, i.e. by selecting only those words that reach the listener's ear at the same intensity or by recording the individual words in such a way that they all tend to be heard at the same level of production. Homogeneity has been stressed as an important criterion, as it allows for the precision in obtaining the 50% of the items that the individual must identify correctly (Hudgins et al. 1947).

Ramkisson (2000) stated that the criterion of homogeneity of audibility is significant in developing materials. It allows for an accurate measurement of hearing for speech. Schill (1985) explained that in order to meet the criterion of homogeneity with respect to audibility, the percentage of words correctly recognized must increase rapidly with a relatively small increase in intensity. This is usually illustrated through the use of the principle of performance-intensity function or what is traditionally known as the articulation gain curve (Chetty, 1990; Silman & Silverman, 1991; Brandy, 2002). The performance intensity curve is the more recent terminology used for the psychometric function, which simply describes the relationship between some measure of performance and a stimulus (Kruger & Kruger 1997). The performance intensity or psychometric function illustrates to researchers and audiologists how well the speech sample can be correctly identified as a function of intensity levels. This information is 'fundamental to the understanding of speech audiometry" (Brandy, 2002, p. 97). The steepness of the curve determines the precision with which the threshold can be obtained (Hudgins et al. 1947). Nissen et al. (2005) more recently added that the steepness or slope of the psychometric curve and the homogeneity of the words are important factors to consider in word list development.

Researchers have reported that the steepness of the psychometric curve reduced the test / re-test variability and the test time (Young et al. 1982; Wilson & Strouse, 1999; Harris, Goffi, Pedalini, Gygi & Merrill, 2001; Wilson & Carter, 2001; Nissen. et al. 2005). The steepness of the slope has also been reported in the literature to be influenced by the type of stimuli selected. A "steeper psychometric curve results when the task is simple, the stimuli are familiar, and most homogeneous"(Kruger & Kruger, 1997, p. 234). Moreover, stimuli that are redundant would produce steeper psychometric curves because of the acoustic cues that are present in the stimulus. This has implications for the choice of stimuli in terms of the number of syllables.

Thus the argument for the inclusion of homogeneity of audibility or intelligibility as a criterion is grounded in the historical literature for SRT word list development. In fact subsequent research in the field of word list development for SRT in English focussed primarily on improving the homogeneity of audibility of the original word list suggested by Hudgins et al. (1947) and on the familiarity of the words selected (Schill,1985). From the above it is also plausible to assume that the criterion of homogeneity of audibility can be viewed as being relevant to word list development and also as a means of assessing the developed word list. The choice of materials for the SRT word list influences the measurement of homogeneity with respect to audibility. The concept of homogeneity with respect to audibility is therefore inextricably linked to both the development of the list and the assessment of the list. This point is elaborated on later in the review of studies relating to the criterion of homogeneity of audibility (see section 2.4 p. 36).

However, historically the emphasis that was placed on the criterion of homogeneity of audibility in the 1960's and 1970's resulted in little attention being placed on other criteria necessary for SRT word list development. In fact, the homogeneity of audibility of the Standard English word list underwent revision by several researchers (Hirsh et al. 1952; Bowling & Elpern, 1961; Curry & Cox, 1966; Beattie et al. 1975 and Young et al. 1982). Perhaps one could argue on the basis of the above that the traditional criteria for word list development has remained fixed over the 1960's, 1970's and to some extent the early 1980's. This is confirmed by the guidelines stipulated by ASHA (1988) who maintain that familiarity, homogeneity with respect to audibility and phonetic dissimilarity remains as set criteria for SRT materials.

Ramkisson (2000), however, argues that while many researchers consistently agree with maintaining the traditional criteria for SRT word list development, all the criteria may not be necessary. She adds that this view has implications for the development of speech threshold tests in languages other than English. The emerging trend in the literature in the late 1980's and into the millennium was that while the original criteria for word list development may have been applicable to the development of words in English, it may not be completely relevant to that of other languages. The reason for this is the structure of most languages of the world is different to that of English. Therefore, a word list should be developed according to criteria specific to each language (Nissen et al. 2005).

The move towards the development of SRT word lists for languages other than English was based on the observation that English materials served the needs of approximately 340 million people around the world (Knight, 1997). This represented only 8.5% of the population of the world. Researchers began to question the audiological needs of more than half of the world's population that are non-English speakers (Knight, 1997). In this context Smith, Tipping & Bench (1987) compared monolingual Greek speakers living in Australia to bilingual Greek/Australian English speakers and with Australian monolingual speakers using English material for SRT (Martin, 1997). Poorer SRT scores were found with the ethnic Greek speakers and the bilingual speakers compared to the English Australians. This was attributed to a decrease in the familiarity of the English consonants and vowels for the ethnic Greek speakers. This study underscored a national need to develop standardized test procedures for the different languages spoken in Australia (Bench, 1997).

Based on the above, the argument that emerges is that even for the second language speaker of English, it is important to consider how familiar the individual is to the structure of the language. Clearly in the example cited above, the poorer performance by both the monolingual Greek speakers and the bilingual speakers supports the need for word lists to be developed for mother tongue languages. It is therefore, relevant to study both international and local literature regarding word list development in various languages around the world.

2.3.3. The development of SRT materials in mother tongue languages

The theoretical considerations raised by researchers who developed SRT materials in their mother tongue, with particular reference to the way words are selected in terms of syllable structure and linguistic considerations, have had implications for the present study. Therefore, the process towards the development of a suitable SRT word list for ZFLS in KZN hinges very much on these theoretical considerations. Figure 2.1 below illustrates the theoretical considerations relevant to the development of a Zulu SRT word list.

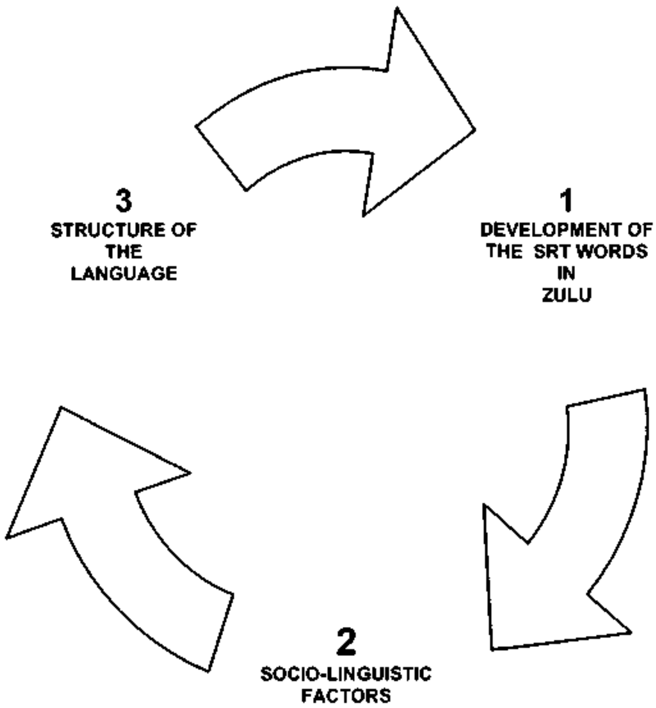

Figure 2.1: Diagram illustrating the theoretical considerations underlying the development of an SRT word list in Zulu

Table 2.1 on p.25 presents a summary of the studies done in various languages of the world. The table reflects the language considered in the study and appropriate findings and recommendations. In addition a detailed review of some of these studies is made. The theoretical considerations referred to in figure 2.1 for word list development are also discussed.

Table 2.1 Review of studies done in mother tongue languages

RESEARCHERS	COUNTRY & TYPE OF MATERIAL	ESSENTIAL FINDINGS AND RECOMMENDATIONS
1.Liden (1954)	Sweden, Stockholm, Swedish SRT	24 bisyllabic spondees developed. Revision of items indicated that some of the words were too difficult semantically.
2.Smith,et al (1987)	Australia, SRT words.	Results indicated poorer performance on English SRT with native Greek speakers, thus recommending the need for indigenous speech tests for monolingual speakers
3. University of London (Knight,1997)	Romanian, Chinese, Castilian And Arabic SRT words.	24 Castilian words developed for SRT. The slope at 50% was 8%/dB when homogeneity with respect to audibility was measured.
4. ALL India Institute of Medical Sciences (1966,1973)	Hindi PB words and Spondees	Developed spondee words that were comparable to English spondees.
5. Nsamba (1979)	Luanda	Recommended that new avenues for the selection of SRT materials be used Nsamba, (1979) suggested that tone in African languages must be considered.
7. Myunga(1974)	Central Africa- Lingala world lists SRT	Bisyllabic words recorded.
8.Plant,(1990)	Walpiri,Tiwi Languages Aboriginal - SRT	Developed speech materials in both these languages using bisyllabic nouns.
9. Nissen et al (2005)	Mandarin	Developed 24 trisyllabic words for SRT. The slope at 50% was 9.9%/dB.

Liden (1954) developed Swedish bisyllabic words, which were presented and tested according to the standard method for SRT testing. Arlinger, (1997), as cited in Martin, (1997) however, stated that minor revisions to the original lists were made in 1965 by the Department of Technical Audiology institute in Stockholm. The revision required that some of test items be discarded. Many of the words were semantically too difficult. Furthermore, the words were developed some thirty years ago and the familiarity of these words was questioned. While, the original lists may have been applicable to the original historical criteria for SRT, it needed review in terms of the familiarity of the words. Words considered familiar in the 1950's for the adult population would have changed in the present times. This study highlighted an important theoretical consideration for SRT word list development in Zulu i.e.: socio-linguistic considerations.

2.3.3.1 Socio-linguistic considerations for word list development

Familiarity of words appears to be a strongly supported criterion amongst the early as well as current researchers i.e. Hirsh et al. (1952) and the more recently Nissen et al. (2005). However, current researchers must be cognizant of what makes a word list familiar. The "inherent flexibility of the human language causes it to be extremely variable and changes over time", (Akamajian, Demers, Farmer & Harnish, 1990, p. 265). Therefore, it is reasonable to suggest that the *shelf life* of the words chosen must be considered. Vocabulary within a language is ever changing and expanding according to the influences of a changing society (Fromkin & Rodmin, 1993).

The above statement is particularly relevant to the present study. As stated earlier in this chapter, the criterion of familiarity was applicable in the Zulu language. In spite of this however, considerations of how words are selected to represent this criterion in a language is important. Jacobson & Trail (1986) stated that the concept of familiarity within the English language was addressed by merely looking at a formal list such as the list of word frequency compiled by

Thorndike and Lorge, (1944). This method of selecting words has assisted researchers such as Hirsh et al. (1952) to apply to this criterion. There is a paucity of adequate tools for the Zulu language (Jacobson & Trail, 1986). Therefore, the need for alternative methods of selecting common familiar words is advisable. Jacobson & Trail, (1986) suggested the utilization of informal methods, such as consulting language educators and linguists. This method is well supported in the literature as demonstrated in the Plant (1990) study. Plant (1990) advocated the use of highly-skilled linguists in the field to assist with complexities that existed in the Walpiri language when the word list was being developed. Consequently, the use of speakers of the language and linguistic experts allows for words to be more representative of the language at any given time as compared with reference merely to the dictionary.

In addition to the way words are selected, the criterion of familiarity is also influenced by other linguistic aspects e.g. dialectical issues. Jacobson and Trail (1986) warned that persistent difficulties arise when devising materials for African languages, because of the prevalence of dialectical variations. Many of these dialects have not been standardized, thus posing another difficulty for the present study. Consulting an array of linguists on the varying degrees of dialects would appear beyond the scope of the present study. Dialect has been addressed by other researchers in the field such as Ashoor and Prochazka (1985). They recognized that there is a variety of dialects spoken in the world for any given language, and that it would be impractical to develop a "pure" word list for each dialect. Thus, it would seem logical therefore, to develop a word list that has application to Zulu in the greater Durban- Pietermarizburg regions of the Kwa-Zulu Natal. This notion is based on a study conducted in the Spanish-speaking population. Schneider (1992) was concerned about the influence of dialect in constructing a suitable SRT word list for the Puerto Rican population. He assessed the SRT and PTA correlations of the three dialects of Spanish on Puerto Rican participants and concluded that no clinically significant differences among SRT values and PTA existed.

Apart from the possible influences of dialectical issues on the familiarity of the word list, borrowed words within the language must be considered. Many of the African languages spoken in South Africa have been historically influenced by dominant languages such as English and Afrikaans. These languages were predominantly spoken in the educational, technical, commercial and industrial spheres (Jacobson & Trail, 1986). It is usually difficult to estimate the range of borrowed words in Zulu. Therefore Jacobson & Trail (1986) suggest unless very common, these should be omitted from the final list.

The converse argument however could be acceptable because there are urban Zulu speakers who demonstrate an extensive multilingual repertoire, and because there are rural Zulu speakers who have a purely indigenous vocabulary (Jacobson &Tail, 1986). The selection of a word list should therefore be acceptable to both sectors especially in the light of developing a familiar word list that is clinically applicable to the majority of the Zulu - speaking people in KZN. Familiarity as a criterion is relevant, but the socio-linguistic factors relevant to each language, such "shelf life" of vocabulary, dialect and borrowed words must also be considered.

2.3.3.2 The structure of the language

Plant (1990) addressed the need for appropriate word lists for the Aboriginal communities in Northern Australia. He developed two word lists in the Walpiri and Tiwi languages. It was apparent from this study that significant differences existed between the structure of the Aboriginal languages and that of English. Some of the difficulties he noted were that at a lexical level as many of the words was unfamiliar. Further, the English word list presented different phonological contrasts which were not present in the individual's first language. Studies such as this emphasize the important theoretical considerations regarding the structure of the language at a lexical, phonological and syllable level. He developed a word list that "recognized the primacy of the listener's mother tongue". Furthermore, for the Walpiri language each syllable begins with a consonant and ends with a vowel (Plant, 1990). All words within the language have at least two syllables. A further observation was that stress is placed only on the first syllable of the word. The Tiwi language was also reported to have a different stress pattern to that of English i.e. the stress of the word is usually placed on the penultimate syllable, (Plant, 1990). These structural differences in the Walpiri and Tiwi languages therefore required adaptation of the original SRT criteria.

As a result Plant (1990) developed two lists for each of the languages discussed by carefully considering the structure of the language. The Tiwi word list has trisyllables as opposed to the English bisyllables. Thus, while the historical criteria for SRT, is that the words should be bisyllabic and equal in stress, many studies in other languages altered this criterion to suit the linguistic structure within the language. This study therefore has implications for the present study. The theoretical description of Zulu outlined in section 2.2 of this chapter highlights the difference in syllable structure between Zulu and English. Furthermore, the Plant's study provides a clear example of how languages like Walpiri and Tiwi are able to address the hearing needs of their population by changing the criteria of the words list and assessing the hearing for speech accurately. The Zulu language should be no different.

In keeping with the above theoretical claim, the Spanish speaking countries of the world appeared to be in forefront in so far as the development of SRT word lists is concerned. Researchers in the field focused their attention also on the revision of the criteria for SRT to suit the linguistic characteristics of their language. These studies were perhaps the most aggressive in challenging this phenomenon. The argument was also around syllable structure in the language.
Cardenas & Marrero (1994) selected 24 words that were three and four syllables for SRT test materials. This approach was supported by subsequent studies done by Cancel (1993). The word lists were evaluated using the traditional

psychometric curve functions and the results compared favourably to the words developed for English. The slope of the psychometric curve was almost 8% per decibel (Knight, 1997). While the results of these studies illustrate the similarities between the original spondee words and the words developed using other syllabic structures, the results may have been influenced by the redundancy inherent in the use of trisyllabic words. Three and four syllable words result in a steeper psychometric slope, due to the abundance of acoustic cues. Thus, homogeneity of audibility is influenced by the redundancy of the stimuli and the type of the stimuli used. Nevertheless, the findings of the study have implications for the present study, both from the perspective of choice or development of materials and the assessment of homogeneity of audibility.

The idea of "criteria specific to the language " seemed to be a common thread among the Eastern countries as well. Mandarin is now the national language in China which is spoken by three times the number of people who speak English, (Martin, 1997). Cantonese is a dialect of Mandarin, and is spoken by 33 million people. Cantonese is different to English in that it is a tonal language. There are six contrasting lexical tones and the root words are usually monosyllabic (Lau & So, 1988). The variation in the pitch of the word influences the tonal information or meaning that is carried. Forty percent of the words are monosyllabic in structure. Kam (1982) developed monosyllabic words for the testing of SRT in the Cantonese dialect of Mandarin. The lists were tested on normal hearing adults and their speech audiograms were highly comparable to that of the pure tone averages. The findings in Kam study indicate speech materials based on adapted criteria can produce valid results. Kam's work also has implications for the present study, as the aims of the present study was not only to develop the word list for SRT, but to assess the developed tool and assess the application of the tool on clinical normative population. Furthermore, the influence of tone in the Kam (1982) study has relevance to the development of the Zulu words. Similar issues pertaining to tonal variations are operative in Zulu. Change in pitch or stress of the words can alter the meaning of the words in Zulu. Hence, very careful considerations of this has been made in the present study.

In addition the Indian languages like Hindi, Tamil, and Telegu and Malayanam received attention with regard to the development of specific word lists. In fact, languages like Hindi were able to develop spondee or bisyllabic words (Kapur, 1971). While languages have specific linguistic characteristics, there are some languages in the world that are comparable to English in certain respects. Therefore, researchers in the field must be knowledgeable with respect to language structure before the development of word lists. This emphasizes the need for collaboration with linguistic experts in the field, so that a good understanding of the language structure is achieved.

More recently, Nissan et al. (2005) supported the notion of developing linguistically-appropriate SRT materials. Their research focused on the Standard Mandarin dialect. Nissan et al. (2005) concluded that 24 trisyallbic Mandarin words could be utilized to measure an individual's SRT if the native language was Mandarin. Their study showed highly favorable results when the trisyllabic words were assessed, thus, indicating yet another example of adaptation of the criteria according to the structure of the language, with results comparable to those of English.

The studies described above have developed criteria that were adaptations of the stringent criteria suggested by pioneers in the field. The key theoretical issues centered on the selection of words according to the structure of the language. The African and certainly the South African experience with regard to the development of word lists is in its infancy. Nevertheless, it is important to review this. The issues raised are specific to African languages and these are relevant to the present study. Myunga (1974) developed speech materials for the Lingala language spoken by the people of Zaire. Bisyllabic words were recorded. These results compared well with the results of the traditional English words.

Moreover, Nsamba (1979) motivated for the need to develop SRT materials for the Luganda language. He reported that there was a need to develop speech materials for Bantu languages generally. He recommended that new avenues or criteria for modifying the basic principles of the Indo-European model must be looked at. Therefore, he also supported the idea of using varying syllable structures for SRT word list development.

Nsamba, however, cautioned researchers about the influence of tone in many of the Bantu languages. He explained that in order to cope with the intonation patterns and variations, the words should be recorded by speakers of the region. The findings in this study are therefore critical to the present study. Nsamba (1979) demonstrated that the articulation curve or performance curve of the bisyllabic words in tonal language would be slightly less steep than the original spondee words. This confirms earlier claims that the performance intensity curves are very closely linked to the choice of stimuli. This standpoint is expanded in later sections when the assessment of developed words is discussed (see section 2.4 p.38). Nsamba (1979) articulated that, irrespective of the difference in the steepness of the curve, the results were suitable for clinical use. His study suggests that the selection of the speaker for the recorded materials can influence the accuracy of measurements. The production of the words need to be accurate and in accordance with the tonal aspect of the language in order to maintain a standard recording.

In view of the above findings and the preliminary work conducted in Zulu by Chetty (1990), the choice of bisyllabic words and the tone of the words appear to be critical to the overall development of the list. In fact, the abundance of commonly used bisyllabic verb imperatives with low -high tones in Zulu was considered a suitable option for SRT in Zulu as described in the Chetty (1990) study.

Chetty (1990) addressed the issue of appropriate service delivery to the Zulu speaking population of KZN, specifically bilingual speakers. This study focused on comparing bisyllabic low tone verbal commands with that of trisyllabic nouns within this population. The conclusion drawn is relevant, as the study found better performance using the trisyllabic nouns than the bisyllabic verbs.

Chetty (1990), however, made several recommendations and provided explanations for the findings, some of which relate to earlier discussions. This included that the trisyllabic nouns may have performed better due to the redundancy factor. Further, the sample size for testing was small and a recommendation for a larger sample size was made. As consequence of Chetty's work it was considered necessary to evaluate the low tone, bisyllabic verbs under more stringent conditions.

John (1990) reported that the original English list used on Zulu speaking people produced poor results. She offered an alternative for the Zulu speaking population, i.e. use of digits rather than words for SRT. Her study was supported by work done by Ramkisson et al. (2002) in the USA. One can argue that digits are a suitable alternative for the assessment of SRT for individuals who do not speak English as a first language, but everyday human communication involves speech. Therefore, the present study is based on the idea of developing a tool that is more representative of speech containing familiar words that individuals use in their environment. The contributions of the Ramkissoon et al. (2002) and John (1990) are a step towards offering a more valid service to the people who do not speak English as a first language.

Researchers also realized that the need for relevant materials were not limited to SRT but were required for the development of SDT materials. De Bufanos (1994) developed a speech discrimination word list for adult Zulu speakers. Other such studies included work done by Madden (1996) and Ratshumela (1997) who produced a word list in Xhosa and Chivenda respectively. In addition

Olivier (2001) focused on developing sentence material for the assessment of speech perception of hearing impaired Xhosa speaking clients.

A more recent contribution to the field has been the development of a speech discrimination list for the paediatric population by Balkisson (2001). Balkisson (2001) was able to critically look at speech discrimination criteria for the Zulu speaking population and in fact supported the idea of different criteria for the different languages. The syllable structure considered was bisyllabic verbs rather than monosyllabic nouns, familiarity of words was maintained and phonemic balancing was achieved.

Finally, Roets (2005) reviewed the practice of audiologist with regard to speech audiometry. The study reported discrepancies between what the ideal criteria for speech audiometry are, compared to clinical practice. Perhaps one of the most important findings in this study is that South African audiologists continue to offer speech audiometry services that are not in the first language of the client. This study was viewed as a starting point towards the development of material that meets ideal criteria for conducting speech audiomtery (Roets, 2005). The present study however, undertook to address the aforementioned challenges and difficulties faced by South African audiologists by developing and assessing a suitable word list for Zulu speakers in KZN.

Therefore, the foregoing discussion provides a review of literature both internationally and locally for the development of a word list for SRT. It is apparent from the above discussion that key theoretical considerations have been raised and these have implications for the development of a Zulu word list. The word list development in this study however was based on the interaction of both the socio-linguistic and structural aspects of the language. Moreover, the need to adapt the original criteria for SRT words to suit these theoretical principles was warranted and was supported in the literature. After careful consideration of these factors, the word list development in the present study was based on the following adapted criteria, as illustrated in Figure 2.2 below.

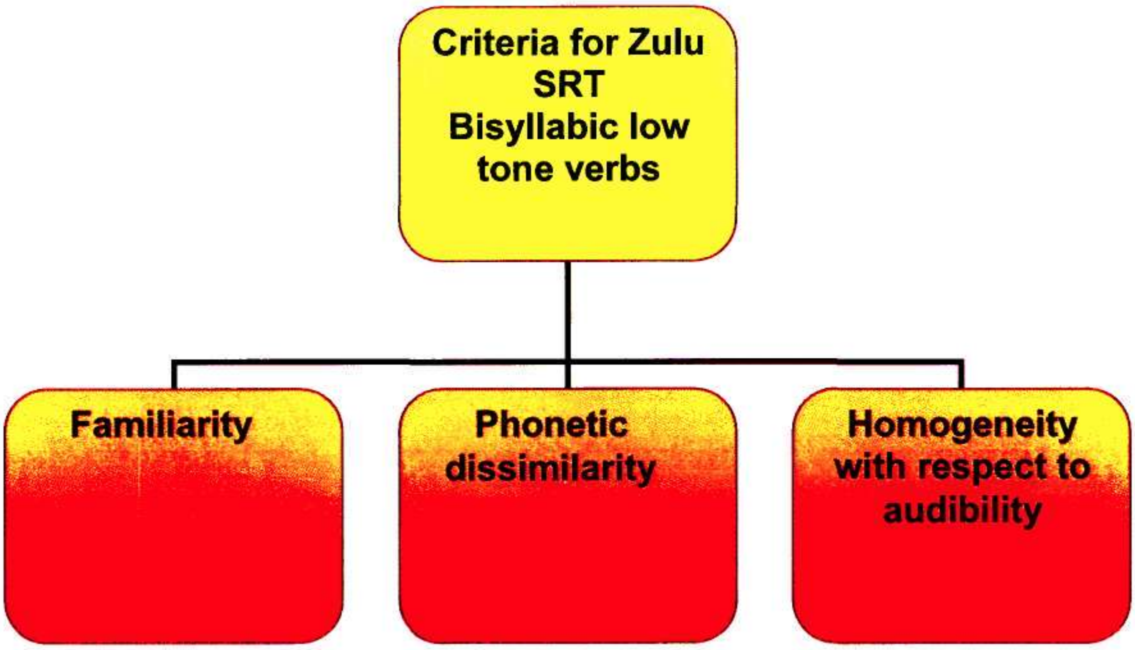

Figure 2.2 Block Diagram illustrating the adapted criteria for word list development in Zulu.

In summary, therefore, the development of the word list for Zulu SRT was dependent on the review of previous studies of wordlist development internationally and locally. Researchers have traditionally focused much of their attention not only on developing the SRT word lists but evaluating the performance of these words audiologically. Brandy (2002) reported that one way of evaluating how well various lists perform in terms of hearing, is to assess how normal hearing participants listen to the words at varying intensity levels. In so doing, the performance intensity function described earlier in this chapter is documented. The results of the performance curve indicate how well individual words are heard as a function of intensity. Thus, the most homogeneous words can be easily identified. Therefore, one of the most important criteria for word list development is accomplished. In measuring homogeneity with respect to audibility the words are assessed for use as a clinical tool. Therefore, for the present study, the development of the word list was considered as important as the assessment of the words audiologically.

2.4 SECTION B: THE ASSESSMENT OF THE WORD LIST

Section A of this chapter focused on the development of the SRT materials. However, this section provides the theoretical aspects and literature review regarding the assessment of the word list through the measurement of homogeneity with respect to audibility. As stated in Section A. above, researchers focused historically much of their attention on the homogeneity of audibility of the words. In fact the original English word list underwent several revisions before the word lists could be used to measure SRT. The measurement of homogeneity with respect to audibility therefore became one of the most important criteria to satisfy, together with familiarity of the words. Words were traditionally included or excluded for the measurement of SRT depending on whether the words were considered homogenous or not (Nissen et al. 2005).

The following discussion presents a review of studies, with reference to the methodological considerations in the measurement of homogeneity of audibility. This aspect is relevant for the present study in so far as the difficulties and challenges experienced in other studies achieving homogeneity of audibility are concerned. Furthermore, the factors influencing homogeneity of audibility are also discussed.

Hirsh et al. (1952) evaluated the original spondee words on normal hearing listeners at six different sensation levels i.e. +4, +2, 0,-2,-4,-6dBSL (Silman & Silverman, 1991). Hirsh et al. (1952) argued that only 36 words of the original 84 words were considered most familiar and homogenous. Hirsh et al. (1952) found that the easy words tended to peak at higher levels on the VU meter than the more difficult words. These discrepancies were addressed by boosting the difficult words by 2dB and decreasing the intensity of the easier words. The researchers were confident that this correction factor improved the overall homogeneity of the words.

Bowling & Elpern (1961) investigated the original CID W2 list and documented performance intensity curves for each of the spondaic words in the list (Silman & Siverman, 1991). The original list was reduced to 22 words when normal hearing subjects were tested. It was found that the range of intelligibility was too large between some of the words (10dB). Bowling & Elpern (1961) were supported by research conducted by (Curry & Cox, 1966) who found similar results. The range of intelligibility between the words in the Curry & Cox (1966) study for normal hearers was 8dB. Thus, the above authors felt that the efficiency of the speech procedure would be improved if 27of the words were used exclusively. The homogeneity of the words suggested in the above studies was challenged by Beattie et al. (1975). Beattie et al. (1975) questioned whether the word differences noted in the Bowling & Elpern (1961) study were either due to inconsistencies in the recording process or selection of the words.

Doubts were further raised when many of the words selected in the Bowling & Elpern (1961) study demonstrated differences in intelligibility during random clinical use. An investigation conducted by Beattie et al. (1975) confirmed that through the use of monitored live voice testing, all of the 27 words suggested earlier were not completely homogenous. These researchers suggested a sub sample of 18 words to be considered (Beattie et al. 1975; Silman & Silverman, 1991).

There was little agreement amongst earlier researchers about the homogeneity of the original 36 words suggested by Hirsh et al. (1952). Young, et al. (1982) attempted to explain these discrepancies by presenting a more stringent methodological framework for the assessment of homogeneity of audibility. Young et al. (1982) explained that previous studies were possibly confounded by the learning effect within the word lists. Previous research studies tested the same randomized words at several intensity levels using a 2dB step increase in the intensity. Young et al. (1982) regarded this as a confounding factor as the participants were possibly performing better because of having learnt the words in the list rather than using hearing acuity to determine the words.

These researchers further stated that earlier studies did not consider the rate at which spondaic words became audible (Silman & Silverman, 1991). Young et al. (1982) accounted for these methodological constraints by determining the sound pressure levels at which 50 % intelligibility was achieved for each spondaic word. Further, they reported on the percentage of participants who correctly identified every spondaic word at each of the sensation levels (Silman & Silverman, 1991). The outcome of this study was the documentation of individual performance intensity curves for each word and a range of threshold levels of 6.4 dB. Furthermore, the mean slope at 50% was determined as 10%/dB. Words were considered homogenous if they were one standard deviation away from the mean slope at 50% and if there was an equal rate of growth of intelligibility (Silman & Silverman, 1991). A final list of 15 words met both of the above criteria. Young et al. (1982) claimed that the list of 15 words could quickly and accurately determine individual's SRT scores, with minimum influence of non-auditory effects like memory or the leaning effect.

More recently, however Nissen et al. (2005) utilized a detailed mathematical model for the assessment of homogeneity of audibility for 138 Mandarin words. The author provided a detailed motivation for the use of the logistic regression model for the assessment of homogeneity of audibility. This model provided a description of the slope @ 50%, the estimated threshold of intensity and individual psychometric curves for the words were described. This allows the researcher to quickly identify those words that are being heard easily compared to the words that were not. The advantage of using this model is that the rate of change in terms of intelligibility is available instantly and the accuracy of the data is also apparent. It certainly appears to be a more suitable model for homogeneity than the previous methods described by earlier researchers such as Beattie et al. (1975) and Bowling and Elpern (1961).

In addition Nissen et al. (2005) described favourable results with regard to the slope at 50%, indicating an almost equivalent performance with that of the English words. However, the 9.9%/dB that is compared to the 10%/dB is the result of a correction factor that has been introduced after variability in the homogeneity was noted. The introduction of the correction factor is based on original studies such as (Hirsh et al. 1952). This simply allows the words to be more homogenous than when originally assessed. While this is accepted in the literature, the important aspect would be to use the most homogenous words originally selected and to evaluate the SRT on a clinical normative population. Nissen et al. (2005) in fact made this recommendation. For the present study, apart from merely assessing the homogeneity with respect to audibility using the above mathematical model, the study also focused on measuring the application of the word list on a clinical normative population as seen in aim three of the study.

Therefore, from both the historical and current perspective , the measurement of homogeneity with respect to audibility can pose difficulties to researchers. The achievement of homogeneity with respect to audibility is dependent on several factors. Figure 2.3 below provides a description of the factors. A brief description of the factors follows.

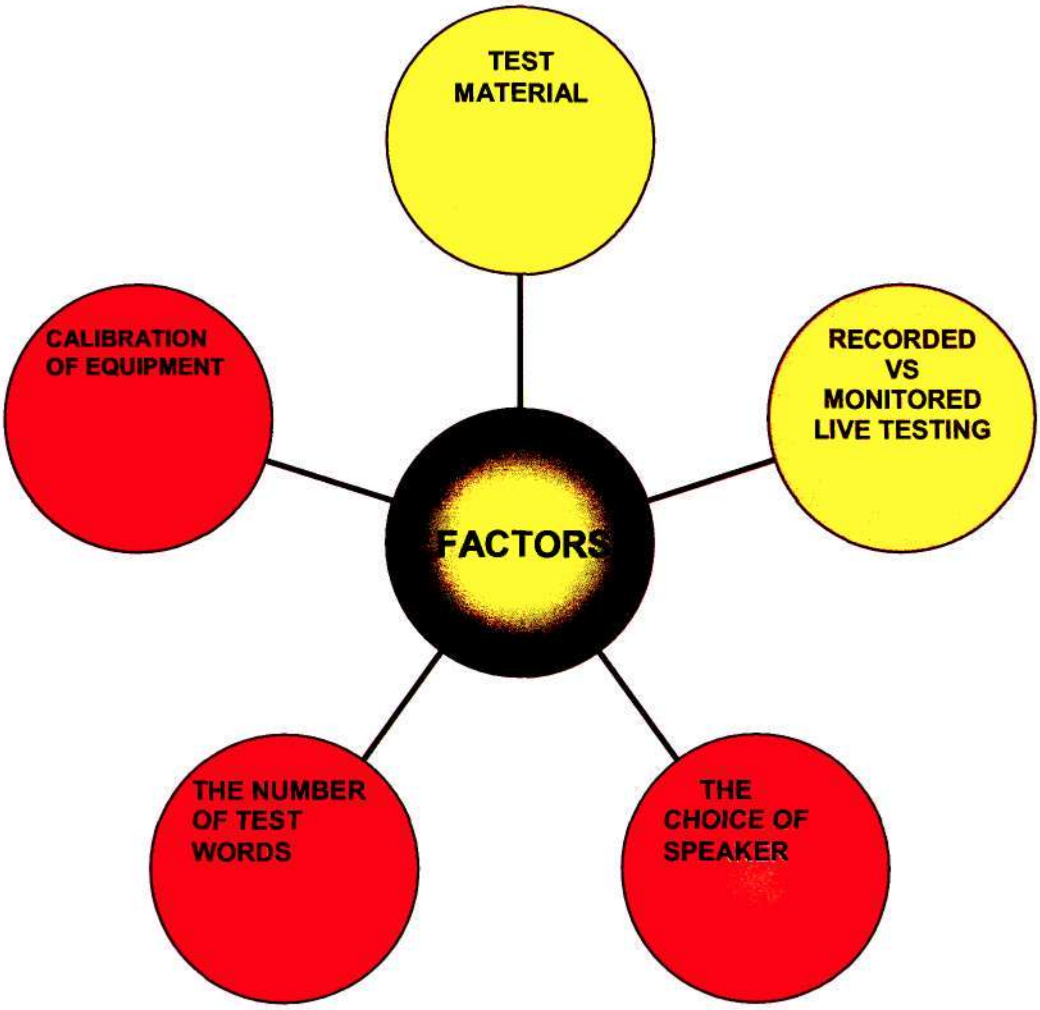

Figure 2.3 Diagram illustrating the factors that must be considered in the measurement of homogeneity with respect to audibility.

2.4.1 Factors considered in the measurement of homogeneity with respect to audibility.

2.4.1.1 Test material

The type of test material can influence the measurement of homogeneity with respect to audibility. The test materials should consist of speech stimuli which are familiar items to the listener. Items are used as fundamental units of speech tests similar to isolated tone bursts in pure tone audiometry (Lyregaard, 1997). It is suggested that the repeated presentations of one speech item may not be a viable option. This is so since memory effects would result in the score being meaningless. Therefore, the alternative would be to develop a set of items that are equal in all respects but would yield a similar score if a single item were used. This warrants the need for the development of a list of different, yet fairly similar speech stimuli. Therefore, the development of the word lists as described in section 2.3 above according to adapted criteria for the language satisfies this requirement. A list according to (Lyregaard , 1997, p.38) is a "set of items necessary to obtain a stable score" The list of items is therefore similar to a set of pure tone stimuli that is required to obtain a threshold for a given frequency (Lyregaard,1997).

However, while this viewpoint has been historically based on the acoustic–phonetic considerations in the stimuli (Chermack & Musiek, 1997), the "set of items" also needs to represent the real world. Chermack & Musiek (1997) have reported that in the real world speech occurs in a rapidly ongoing temporal sequence. These authors contend that the types of word choices are influenced by the contextual factors inherent in real world speech recognition. The above contention appears relevant to the measurement of homogeneity of the words in Zulu. This so, since the test materials used should be contextually relevant to the language. This argument has been discussed in-depth in chapter one and in the earlier section of this chapter. Furthermore, acoustic phonetic characteristics and the lexical processes, such as the semantic, syntactic and lexical content of the words, influence the way words are heard. It is, therefore, important that the stimuli used to measure homogeneity with respect to audibility are familiar to the listener.

Nevertheless, the type of material used could be phonemes, syllables, words or sentences (Lyregaard, 1997; Stach, 1998). Selection of the type of materials would be dependent on the concept of redundancy in hearing. The hearing and processing of speech communication is influenced by redundancy to a large extent (Stach, 1998). Redundancy is described in terms of intrinsic and extrinsic redundancy. Intrinsic redundancy refers to that which is built within the central auditory system. This permits the processing of different auditory signals (Stach, 1998).

The extrinsic redundancy has an influence on the stimuli used for speech audiometry. Therefore, extrinsic redundancy refers to the abundance of information present within the speech signal (Stach, 1998). Extrinsic redundancy increases with an increase in the content of the speech signal. Thus, phonemes can be regarded as least redundant and sentences as most redundant (Lyregaard, 1997). The higher the redundancy, the more the acoustic cues are for recognition. It is logical to assume that sentences would probably be the most highly recommended stimulus for achieving speech reception scores relating to everyday speech because of the very nature of the stimulus. However Stach (1998) explains that the more redundant a stimulus is, the more immune that signal is to detecting a hearing loss. Further, Lyregaard (1997) suggests when considering the test duration during the use of sentences and when obtaining a compounded score, the use of words would be more efficient than sentences.

In the light of the above redundancy argument, most researchers seem to rely on the use of words for speech audiometry tests. In relation to the literature on the development of speech reception materials for other languages, the use of words was the popular choice as indicated in section 2.3 above. This was supported by researchers such (Ashoor & Proshazka, 1985; Plant, 1990; Cardenas & Marreco, 1994; Lau and So, 1988; Nissan et al. 2005). The popular choice of word lists over sentence lists has also been used widely. According to a survey conducted in the USA on 218 audiologists, 92% of the respondent's reported the use of word lists rather than sentence lists (Thibodeau, 2000).

However, the number of syllables within the words used can also have an influence on the measurement of homogeneity. Historically, bisyllabic words were found to produce steep psychometric curves. Studies conducted in languages other than English, such as the Nissen et al. (2005) study reported steep psychometric curves with trisyllabic words. One could however, argue that the increase number of acoustic cues in the trisyllabic words can affect the steepness of the curve. Thus, the measurement of homogeneity with respect to audibility in the present study could be influenced by the number of syllables in the words used.

2.4.1.2 Number of test words

ASHA (1988) further added that a minimum number of 18 test items must comprise the final SRT list. This has been documented because a small number of test items or a restricted set size of the test items would result in improved scores for SRT (Punch and Howard, 1985). Improved SRT scores overestimate the person's speech reception abilities (Ramkisson, 2000). Therefore, the number of test items measured for homogeneity of audibility need to be sufficiently large.

The number of test items varies in most of the studies conducted historically. The majority of the studies that developed word lists for languages other than English produced a final word list that was more than the minimum number suggested by (ASHA, 1988). Most word lists are limited to twenty-five items. The number of test items selected finally is also dependent on the methodological process used for the selection of the items. Cardenas & Marrero (1994) produced a 24-item test for SRT in the Castilian language. This was done after careful examination of the phonetics of the language (Knight, 1997).

Ashoor and Proschazka (1985) had an original word pool of 217 words, which were subsequently reduced to eighty words. Nsamba (1979) developed a word list for SRT testing that included 3 lists of 25 words each. This can be considered to be a more appropriate number of items for the assessment of SRT. The articulation gain curve for each of the lists was found to be similar. Perhaps one of the more stringent studies with regard to the selection of a number of test items would be the Nissen et *al.* (2005) study. Nissan et *al.* (2005) introduced 138 trisyllabic words for the measurement of SRT. However, only ninety words were considered for recording purposes, as judges within their study indicated that 48 of the words were unsuitable for inclusion in the recording process.

Further, the evaluation of the homogeneity with respect to audibility of these 90 words resulted in only 24 words being considered for the final list. While, Nissen et al. (2005) were able to produce a 24-word list for the Mandarin language, future research in the development of a SRT word list for other languages should aim at increasing the number of test items in the final list. An increase in the number of items has implications for the validity of the SRT score and its relationship to the overall hearing sensitivity of the individuals it is used to test.

2.4.1.3 Recorded Vs monitored live voice presentations of test materials

Recorded or monitored live voice testing may used in the testing of SRT (ASHA, 1988; Sliman & Silverman, 1991; Stach, 1998; Roeser, Valante & Horsford-Dunn 2000; Brandy, 2002). However, ASHA, (1988) recommended that the recorded method is favoured. The recommendation for recorded materials is made even though authors and clinicians have claimed that monitored live voice testing is more flexible and is quicker to administer (Roeser, Valante & Horsford-Dunn, 2000). The use of the recorded method standardizes the composition and presentation of the test list. It allows for control of uniformity of intensity of the test words. Recorded materials ensure that the test words are presented in the same manner for each individual. Nissan et al. (2005) add that there is inherent difficulty for even trained speakers to produce test items at an equal hearing level and in the same manner. Thus, monitored live voice testing could produce SRT scores that are inconsistent from one study to the next and from one clinical setting to the next. Recorded materials, on the other hand allow for better control of the presentation of the test words (Nissan et al. 2005). The use of recorded materials for assessing the clinical applicability of a developed word list is a preferred option due to the advantages described.

Historically the original word list has been recorded on magnetic tapes. These studies would include the (Bowling & Elpern, 1961; Curry and Cox, 1966; Young et al. 1982). The development of word lists in the Arabic language was limited to very basic form of recording process. Ashoor and Proshaka (1985) used a simple tape recorder to record the productions made into the microphone of the Madsen audiometer. This influenced the peaking of each of the words on the VU meter. The recordings were accepted at a level of +5dB. Plant (1990) also recorded the SRT materials for Aboriginal languages on magnetic tape. The use of recorded materials became a common practice in speech audiometry research. With the advent of improved technology, researchers found that speech audiometry was also moving from the analogue era into the digital phase of audiological recording. As early as 1988 Swedish speech material was available on compact disc recordings. Nissan et al. (2005) has added that there are numerous advantages of using digital technology for the recording of a SRT word list. These would include " increased channel separation, wider dynamic range, and an improved signal to noise ratio, elimination of wow and flutter and longer storage life" (Nissen et al. 2005, p. 392) The shift in thinking amongst researchers is not only to the development word lists in other languages, but to the improvement of the overall quality of the list. The high quality recording produces more valid presentations of the test items and the assessment of the tool is improved.

A review of two of the more recent studies conducted by Ramkisson et al. (2002) and Nissan et al. (2005) indicates that recorded materials using digital technology should include a description of the technical specifications of equipment used for the recording. These include a description of the digital converter used. The sampling rate employed for each recording must also be specified. Ramkisson et al. (2002) described that Tascam DA-P1 digital recorder was used with a sampling rate of 44.1 kHz using a16 bit wave format. Nissan et al. (2005) reported the use of the Apogee AD 8000 digital converter and a similar sampling rate as that of (Ramkisson et al. 2000). Both studies report that the recordings must be conducted in an anechoic chamber. Stimuli have to be recorded and transferred to a computer system which would allow for editing of the individual items. The use of specific software packages enables the word list to be randomized. Each word or item is edited and calibrated using the 1000Hz-calibration tone. A high quality recording would influence the performance on the word list and must be considered when assessing the words.

Therefore, Nissan et al. (2005) also reported that the word list should not only be developed according to robust linguistic principles, but should be recorded with a high level digital recording. This has implication for the present study, as the recording process required astute knowledge and resources to achieve the outcome that is desired. Limitations with the recording process can influence the results. The quality of the recording is dependent on adequate hard and software resources as already described above. Nissen et al. (2005 p.393) advise that the recording process requires a "great deal of time and effort" in order to evaluate the accuracy of the recording. Therefore, in early developmental work such as the present study several revisions may be required before accuracy is achieved. The development of recorded materials for SRT also adds to the gap in the market with regards to audiological materials on digital CD for languages other than English (Nissen et al. 2005). The quality of the recording is also influenced by the choice of speaker used and this is explained below.

2 .4.1.4 The choice of speaker

There is a serious impediment to the standardization of results if a listener obtains two different scores for speech testing when the list is presented by two different speakers (Lyregaard , 1997). Further, the problem is exacerbated if the speakers and listeners are from different linguistic backgrounds. The recording of material is recommended when developing word lists in other languages, but it is imperative that the recording is made using the standard dialect of the language. While full generality is not achievable with regard to dialect, researchers should be cognizant of the choice of speaker used in the recording. This suggests that not only must the stimuli be presented in the language of the listener, but also a speaker of the similar linguistic background should read the items to the listener.

A further debate in the literature is on the use of female and male voices for the recording. On the one end of the argument, Lyregaard (1997) have indicated that there are differences in scores when female vs male talkers are used. Wilson, Zizz, Shanks & Causey (1990) has reported that there are spectral differences between the female and male voice. This sometimes accounts for the difference in the intensity of the production of the test items. However, subsequent research in the field addressed the use of female and male voices differently. Several studies conducted in speech audiometry by the National Acoustic laboratories have reported utilizing male speakers for their recordings (Demody & Lee, 1997). Cambron, Wilson & Shanks (1991) assessed the psychometric curve for both male and female talkers. The word lists were presented to normal hearing participants. The results of the study indicated that female and male recordings indicate equivalent recognition functions when both the recordings were used.

Clinically, these authors have claimed that either female or male speakers could be used for the assessment of SRT.

More recently Nissan et al. (2005) measured the psychometric function of trisyllabic words using both male and female talkers. The results of this study indicate that for the 24 trisyllabic words used, a range of 9.2 to 17.6 % / dB was obtained when the male speaker was used. The range of 9.4 to 18.1 % /dB was obtained with the female recording used. Nissan et al. (2005) claimed that there was minimal difference between the results when the recording of a male speaker versus that of female speakers was compared. In fact there was close agreement in the results. Therefore, it would appear that gender of the speaker does not have a significant role in the recoding of the materials.

For the presents study the use of a male speaker who shares a similar linguistic background to that of the listeners in the study was considered. In addition to the choice of speaker, careful attention to the choice of equipment and environment in which the assessment takes place must be made. Lyregaard (1997) emphasizes that these factors could also influence measurement of the homogeneity of audibility of the words.

2.4.1.5 Calibration, test instrumentation and test environment

In the development of a word list for speech audiometry, Sherwood & Fuller (1997) have stated that it is important to measure the response, and relate the outcome to that of normal hearing performance. At each stage of application there is control, measurability and reproducibility, (Sherwood and Fuller, 1997). In order to achieve this, equipment and the environment used must meet minimal standards.

The use of a complex signal like speech stimuli for the assessment of hearing requires very specific calibration methods (Roeser, Valante & Horsford-Dunn, 2000). A precise level cannot be determined for speech, because it is a dynamic signal. Therefore, a 1000Hz tone is used to set the audiometer so that the output signal from the earphone is 20dB above the hearing level dial value when standard earphones are used. Further, it is common practice to have the calibration tone precede the stimuli of recorded material, (Roeser, Valante & Horsford- Dunn, 2000). The standard ISO 8253-3 requires that the calibration signal must be set for duration of no less than 60 seconds. The tone must use a frequency modulation of 1 KHz and is usually recorded at a level that is equivalent to the frequency peaks of the speech signal. The calibration tone should be set at a level of 0dBHL on the VU meter. This recommended standard appears to be followed and maintained in most of the studies on developing and assessing lists for SRT. These would include (Nsamba, 1979; Lau & So, 1988; Schneider, 1992; Ramkisson, 2002; Nissan et al. 2005).

Apart from the calibration of the stimuli used, speech audiometry must be accomplished using a calibrated speech audiometer according to Standard specifications for Audiometers ANSI S3.6 -1996. The test environment must meet the criterion for background noise in audiometric soundproof booths. Testing would be conducted via standard earphones. Nissen et al. (2005) described that all testing should be conducted in a double-walled soundproof booth and the suite should meet the ANSI S3.1-1977 standard for maximum permissible ambient noise. A review of the literature indicated that, while the choice of equipment varied amongst most studies, minimum standards were maintained. The present study too complies with the stipulated guidelines of ASHA (1988) and that which is recommended by Lyregaard (1997).

In summary, the above factors provided the framework for the assessment of the developed words via the measurement of homogeneity of audibility. Evidence in the literature supports such a framework. However, in reviewing many of the studies it is apparent that the measurement of homogeneity with respect to audibility could possibly be influenced by factors outlined above. As discussed earlier, the linguistic structure of Zulu dictates the type of material that can be used for SRT. Therefore, the structural variation and the fact that Zulu is tonal language could possibly influence the accuracy of the measurement.

Therefore, Plant (1990) introduced a new concept into the methodological issues regarding word list development. Traditionally word lists were usually evaluated for its performance at an audiological level through a performance intensity curve (Schill, 1985). Plant (1990), however suggested an acoustical analysis of the word list via an objective spectrographic analysis of the time wave that existed for each of the words selected. The Tiwi word list has trisyllables as opposed to the English bisyllables and through spectrographic analysis Plant (1990) was able to demonstrate the penultimate stress that is required on each word to achieve homogeneity of audibility.

Similarly, the prosodic features of Zulu indicate that bisyllabic verbs are low and high tone and that the verbs do not have equal stress. Acoustic analysis of the verbs could confirm the tonal patterns of the verbs selected. While the Plant (1990) study used spectrograms to illustrate the stress on the penultimate syllable, the use of pitch extraction and energy values of the vowels is also a plausible option. The specific use of pitch extraction allows the examiner to visualize intonation patterns in the production of the words. Kent & Read (1992) explain that intonation and prosody in a language are similar. However; intonation often refers to the patterns of pitch rises and falls and the stress in a language. Prosody on the other hand includes these factors, but also describes pause and lengthening. Prosodic cues vary across languages (Kent & Read, 1992). For the purposes of this study the evaluation of the prosodic patterns of the Zulu verbs via pitch extraction introduces a unique way in which the selected words for SRT in Zulu could be evaluated.

A difference in pitch and energy between each syllable may confirm the notion that the two syllables in the bisyllabic Zulu verbs are not equal in stress and vary respect to audibility, words were selected for clinical use. However Young et al. (1982) investigated the application of the CIDW2 test on normative clinical population. They measured the SRT using the entire CIDW2 list. The methodological approach followed in this study with regard to application to a normative clinical sample is important for the present study. Young et al. (1982) ensured that participants were young adults who were screened for normal hearing. Furthermore, the procedure used for measuring SRT included familiarization of the test material before the testing process. The SRT-PTA correlations were examined using the Pearson Product moment correlation statistic.

However, while Young et al. (1982) was able to demonstrate the importance of measuring the SRT on a clinical population, there was a dearth of studies that followed this practice. Nevertheless, of relevance to this study were some findings by Schneider (1992), who measured the SRT for two groups of Spanish speaking children, using a developed Spanish word list. The study drew comparisons between the SRT scores and pure tone averages of the sample tested. A correlation co-efficient was calculated to demonstrate the relationship. This study focused on whether the developed Spanish SRT materials would produce different measurements when participants were selected from different dialectal groups. The correlation co-coefficients between the SRT and PTA were used to evaluate the application of the developed list to a clinical population. The findings in the study showed significant difference in the SRT and PTA scores for the different dialectical groups. This study therefore is one example of the importance of measuring the SRT using the developed word list in order to evaluate its effectiveness on clinical population

Furthermore, Ramkisson et al. (2002) demonstrated the importance of digit SRT materials when the developed digit list was measured on a normative clinical population. Ramkisson et al. (2002) outlined a detailed methodological framework within this study. In this study, normal hearing participants were assessed using the digit list and the original CID W1 list. The SRT scores from both lists were compared statistically to the PTA. The findings in this study clearly indicate a stronger correlation between the digit SRT and PTA vs. the CIDW1 and the PTA for non-native speakers of English

Therefore, the above studies have implications for the present study in terms of evaluating the application of the developed word list. In order to demonstrate the application of the developed tool, the SRT should be evaluated using the Zulu SRT word list compared to the individual's PTA. In addition to confirm the standpoint that SRT in the individual's first language produces more reliable results, it is imperative that comparisons to the English word list are made.

The process towards assessing the application of the test tool requires insight into certain procedural factors that could influence the outcome of the results and has implications for the theoretical basis for this aim of the study. Relevant factors are the selection of participants for the measurement of the SRT, the procedure for obtaining SRT, familiarization stimuli and evaluation of PTA vs. SRT correlation.

3.3 FACTORS INFLUENCING THE APPLICATION OF THE SRT TEST TOOL

3.3.1 Considerations regarding the choice of participants

In order to demonstrate the application of a developed word list on a normative population, the sample of participants should present with normal hearing. This is widely supported in the literature by several authors i.e. (Chetty, 1990; Schneider, 1992; Ramkisson et al. 2002). The use of normal hearing participants when assessing the application of a new tool allows the researcher to draw conclusions about the test independent of any other confounding factors such as hearing loss.

However, of particular importance for the present study is the possible confounding factor of language proficiency. Hagerman (1984) warned that auditory research in speech audiometry must be aware of the influence of language proficiency on the data obtained. Hagerman (1984) based these concerns on the basis of research conducted in Spanish. The criticism levelled against the Spanish studies was that there was a lack of information of the participant's characteristic relating to language proficiency. Hagerman (1984) reported that in describing linguistically diverse populations, it is important to describe the language status and the functional use of the languages. This is particularly important for the South African context, as there is a large percentage of the population who are multi-lingual. The transition in South Africa within the last 12 years has also resulted in many individuals who speak Zulu as a first language, being exposed to English as a second language for functional communication purposes. However, acquisition of a second language is difficult and to achieve native proficiency is often not very common (Ramkissoon, 2000).

Therefore, it is important to describe the proficiency of the individual in the second language. The description of language proficiency in the second language is particularly important when conclusions are drawn on the basis of comparing SRT performance using a native word list versus the original English word list. Gopaul-McNicol &Thomas – Presswood (1998) describe two aspects to proficiency i.e. the theoretical aspects of the language and the practical language proficiency. The practical or functional language proficiency often occurs in the everyday communicative situations. Second language learners usually acquire these skills in their social situations with peers, teachers, bank clerks, and others (Ramkissoon, 2000). Hence, a clear description of the language proficiency of participants is needed.

3.3.2 Procedure for obtaining SRT scores

Researchers and clinicians have adopted a number of methods in obtaining an SRT, several methods have been recommended. ASHA (1988) approves the descending procedure for obtaining an SRT. This method is an adaptation of the Tillman and Olsen (1973) method. Chaiklin & Ventry (1964) also described a descending method. These methods described employ different decreasing or increasing attenuator settings (Schill, 1985). These included

2dB, 4dB, 5dB and 10dB increments. The ASHA (1988) method is now widely used in most clinical settings. However, this method utilizes the 2dB descending method. Researchers have compared the popular methods described in the literature (Chaiklin & Ventry, 1964; ASHA, 1988). No significant differences in scores have been found to occur. The descending methods were found to be most sensitive (lowest threshold) and was equivalent in terms of testing time. Therefore, the choice of method is not bound by any specific guideline. The early Chaiklin & Ventry (1964) method is suitable for the present study as it utilizes 5dB step and this is also the popular choice in most of the local clinics in Kwa Zulu-Natal. Furthermore, the procedure is less time consuming in research settings.

A possible theoretical reason for the preference for the descending method over the ascending method could be related to the way words are perceived at higher intensity levels. A descending method would begin the test signal at supra-threshold levels and this would activate the decoding process involved in understanding the signal. It has been postulated that perhaps achieving the reliability of the response using a descending method could be related to higher order information processing models. A parallel-distributed information model as suggested by Medwedsky (2002) who states that once the stimulus is heard, several memory structures and processing stages are activated simultaneously.

His model explains that the processing mechanism starts from deriving the phonetic structure, decoding and matching the acoustic stimulus to representations of the corresponding lexicon, determining the semantic content in the linguistic stimulus and interpreting the relationship between the syntactic structure and the semantic content. This is accomplished in real time with great efficiency. For this complex task to be carried out, stimuli presented at higher levels proceeding to threshold levels would allow for the processing mechanism to be activated much faster and produce more reliable results.

In addition, the adaptation to the Chaiklin & Ventry method (1964) includes the familiarization process which contributes to more reliable results based on the understanding of how words are processed. The theoretical reason for familiarization was raised earlier in chapter two. Finally, ASHA (1988) recommends that familiarization process should precede any SRT procedure.

3.3.3 Familiarization of the participants to the test items

The ASHA (1988) method emphasizes the importance of familiarizing the participants to the word list face-t-o face. Tillman and Olsen (1973) have reported that the SRT score is improved by 4 to 5dB when familiarization is conducted (Silman & Silverman, 1991). Familiarization ensures that the participant knows the words being tested and that an appropriate response would be obtained. Chapter One and Two provided a detailed description of the concept of familiarization in SRT testing. Familiarization of the test product adds to the credibility of the assessment process. Most researchers developing or assessing word lists have included the familiarization process prior to the testing of the words. This is supported by (Schneider 1992; Cambron, Richards & Shanks, 1991). While, Nissan et al. (2005) support the notion of familiar materials and familiarization as an important criterion for SRT, the procedure described in their study lack familiarization process. Nevertheless, the present study deems it important to consider familiarization in terms of test materials and the test product. The SRT score is influenced by these procedural variables. The application of the tool to the evaluation of the SRT and PTA relationship, as described in the review of studies is important.

3.3.4 Pure tone Vs SRT correlation

The historical correlation co-efficient obtained when SRT in the indigenous language is compared to that of the PTA is pertinent for assessing the application of the tool on a normative population. The clinical value of SRT and its correspondence to PTA is well known. Carhart (1965) stated that the simple averaging of the thresholds from 500Hz, 1000Hz, and 2000Hz is both adequate and clinically expedient for estimating the patient's sensitivity for speech. These three frequencies are regarded as the speech frequencies because the bulk of the speech spectrum occurs between 500Hz and 2000Hz

(Brandy, 2002). In view of this, the relationship between the SRT score and the PTA is generally agreed to be +/- 6dB (Carhart, 1965). Carhart (1965) based much of his findings on the use of English material.

Therefore, it is imperative that the assessment of the application of the Zulu SRT word list be evaluated. This would add to the body of knowledge for word list development in languages other than English. Furthermore, the paucity of information regarding the application of SRT materials to a normative population further motivated this phase of the study. The present study addressed this gap by investigating a larger sample of participants as compared to the previous studies that investigated the relationship between SRT and PTA correlation in other languages or using different test materials.

3.4. CONCLUSION

Chapter Three highlighted the key theoretical elements regarding the application of the Zulu SRT on a clinical normative population. It is evident that this aspect of word list development and assessment is clearly limited in the literature. Minimal attempts to evaluate the application of developed test materials have been reported with the exception of some of the more recent work with digit SRT. Hence, this phase of the study, with the factors presented provides the guidelines for the execution of this phase.

In summary, Chapter One, Two and Three have provided the rationale, theoretical and literature review towards the development, assessment and application of SRT words in Zulu. The ensuing chapter explores the methodological process followed in this study.

CHAPTER FOUR: METHODOLOGY

4.1 INTRODUCTION

This chapter explores the methodological framework followed in the study. Appropriate motivations for the methodological choices are advanced. The chapter begins with an outline of the aims and objectives of the study. A description of the overall study design is presented and discussed. The presentation of this study is divided into two phases, which is illustrated in Figure 4.1 below. A detailed description of each phase and the specific objectives within each phase is provided. Included within the discussion are references to the participants, criteria for selection of the participants, instrumentation, procedures and the analytic measures adopted. Ethical and legal issues are also presented and discussed.

4.2 AIMS

Three aims were formulated towards achieving the development and assessment of a Zulu list for the establishment of speech reception thresholds in ZFLS in KZN. These aims were as follows;

4.2.1 To develop a Zulu word list for SRT testing

4.2.2 To assess the developed Zulu SRT word list.

4.2.3 To evaluate the application of the Zulu SRT word list within a clinical normative population of KZN.

The following objectives were generated to achieve the above aims.

4.3 OBJECTIVES

To realize aim one, the following objectives were generated;
4.3.1 To identify commonly used bisyllabic Zulu words.
4.3.2 To rate the commonly used bisyllabic Zulu words according to the adapted SRT criteria for Zulu viz.: Familiarity, phonetic dissimilarity, and tone patterns of the words.

To realize aim two, the following objectives were generated;
4.3.3 To measure the homogeneity with respect to audibility of the Zulu words selected to fulfill aim one
4.3.4 To describe the pitch and energy contours of the most homogenous words selected in objective 4.3.3.
These objectives also served to assist in the assessment of the developed word list in Zulu.

To realize aim three the following objectives were generated;
4.3.5 To determine the relationship between the pure tone averages and the Zulu SRT scores established using the Zulu word list and also to determine the relationship between the pure tone averages and the SRT scores established using the CIDW2 English word list in normal hearing ZFLS of KZN.
4.3.6 To compare the relationship of the pure tone averages and SRT scores for the Zulu word list versus the pure tone averages and SRT scores for the English word list, when normal hearing ZFL participants were tested.

4.4 STUDY DESIGN

The present study followed a two-phase methodological framework, as the data collection methods and analysis occurred in specific steps within each phase. Each phase had several objectives and each objective was dependent on the outcomes of the analysis of the results in the preceding objective. The execution of aim one and two of the study was included in Phase 1, while aim three was handled in Phase two of the study.

The design strategy adopted for this study was thus two fold viz. a Descriptive-survey design for aim one and aim two of the study and a Within - participant quasi-experimental design for aim three of the study. The following discussion provides the rationale for the choice of the design for each aim

A descriptive-survey design was considered a suitable choice for aim one and aim two of the study because it focused on describing the process involved in the establishment of appropriate criteria relevant to the development of a SRT word list in Zulu and the assessment thereof. Hence, a survey approach and a rating strategy was adopted to realize aim one and two of the study. The descriptive design "describes a situation as it is" in order to gain more information (Leedy & Ormrod, 2005, p. 179). Thus, for aim one and aim two of the study the researcher was concerned with describing the development and assessment of an SRT word list for Zulu. In the process relevant language specific information about the suitability of criteria to be used in the selection of Zulu words was explored.

The overall design for aim three of the study was a within - participant quasi experiment design (Leedy & Ormrod, 2005). This design was suitable, as aim three focused on assessing the application of the developed word list realized in aim one and two of the study. A within -participant design according to Leedy & Ormrod (2005) refers to assessing the participants performance on the basis of two different treatments i.e. the assessment of SRT in Zulu compared to the pure tone average and the assessment of SRT in English compared to the pure tone average. Essentially, the researcher was concerned with observing the potential effects or differences in SRT scores when each word list was used to measure SRT. The within-participant strategy however, was used within a quasi-experimental approach, as all confounding variables could not be controlled for (Leedy & Ormrod, 2005). Thus, variables that were not controlled for were considered in the interpretation of the results.

While the present study was based on two different approaches, each phase of the study occurred consecutively. The study had several objectives within each phase, which utilized several methods of data collection and analysis. This study also required several participants and sources to be considered and these would be presented later. Validity and reliability of results were established within the study, as the various participant choices, data collection methods and analysis methods in the each objective verified the results.

4.4.1 Phases of the study

The study was divided into two phases so as to facilitate data collection.
Phase 1: included aim one and aim two of the study. Each aim was realized through distinct objectives. Aim one of the study included objective one and two. Objective one and two incorporated the criteria for selecting SRT words i.e. identifying bisyllabic Zulu words that were common and ensuring that the words met the criteria of familiarity, phonetic dissimilarity and low tone verb imperatives. Aim two included the assessment of homogeneity of audibility of the words and the acoustic analysis of the words.

Phase 2: involved assessing the application of the developed Zulu list (the product) on a normative clinical population. Each of the phases would be discussed in detail below.

The discussion of each phase is preceded by Figure 4.1 (overleaf), which illustrates the phases and objectives graphically.

Figure 4.1: Process Flowchart: Two-Phase Methodology

PHASE 1

AIM ONE: THE DEVELOPMENT OF THE WORD LIST

Objective 1: identification of commonly used bisyllabic Zulu words

↓

Participants : Two Zulu language educators and two ZFL interpreters, familiar with ZFL in KZN
Method : Identification and categorization of words in terms of criteria (selection of Bisyllabic words)
Analysis : Descriptive statistics (bar graphs, pie charts, percentage counts)
Outcome : 131 Preliminary words selected

Objective2: Selection of words

↓

Participants : Five linguistic experts of Zulu
Method : Each linguist completed a rating scale to ascertain suitability of the words
Analysis : Mean scores and Kendall's w score for inter-rater reliability
Outcome : 58 words selected for aim two of the study

Continued.....

AIM TWO: THE ASSESMENT OF THE WORD LIST

⇩

Objective1: Homogeneity of audibility

Participants : Thirty normal hearing ZFLS from KZN
Method : Measured the homogeneity with respect to audibility of the 58 words
Analysis : Logistic regression analysis
Outcome : 28 words assessed as most homogenous.

Objective 2: Acoustic analysis

Sample : 28 Zulu SRT words
Method : Acoustic Analysis using the computerized speech laboratory
Analysis : Descriptive statistics (frequency counts).
Outcome : Pitch contours and energy contour results were obtained.

PHASE 2

AIM 3: APPLICATION OF ZULU SRT WORDS

Objective 1 and 2

Participants : Twenty six normal hearing adult ZFLS from KZN
Method : Administered the SRT Zulu word list and the English SRT wordlist.
Analysis : Pearson r correlation co-efficient
Outcome : Correlation between the SRT values and pure tone averages were calculated

4.5 PHASE 1: THE DEVELOPMENT AND ASSESSMENT OF THE WORDS

4.5.1 Aim one: To develop the Zulu SRT word list.

This aim consisted of two objectives, which occurred consecutively.

4.5.1.1 Objective 1: The identification of commonly used bisyllabic Zulu words for adult ZFLS in KZN

4.5.1.1.1 Participants for the identification of the Zulu words

There were two categories of participants that were considered for obtaining data to realize this objective. These included two Zulu language educators from a tertiary institution and two Zulu language interpreters. Four participants were considered adequate because the word pool generated at this stage of the study was rated and validated by linguistic experts in objective 2 of the study. The educators were selected through purposive sampling, as they were most familiar with the use of the Zulu language by the adult population on whom the new word list would be used. The educators were also familiar with Zulu as a language, since it is their subject of specialty. The interpreters were also selected through purposive sampling, as they used the language daily and are familiar with Zulu as a language in the KZN community specifically the dialect spoken in the Greater Durban and Pietermarizburg region.

4.5.1.1.2 Selection criteria for the participants

The criteria for the selection of the Zulu language educators were;

- The educators had to speak Zulu as a First language
- The educators needed to have at least five years of tertiary teaching experience.

The following motivation is provided for the above criteria.

The experience of the educators had to include teaching Zulu as a first language and interacting with Zulu First Language speaking adults in a tertiary environment in KZN. Jacobson & Trail (1986) suggested utilizing alternative methods for developing lists of common words. One such method is to access individuals who speak the language and individuals who have expertise in the language. Therefore, at this preliminary level of word selection, the educators with five years of tertiary education experience in Zulu suited the selection process. Furthermore, adherence to these criteria outlined above, ensured that the decisions made by the educators regarding the choice of commonly used words by adult ZFLS were informed decisions.

The criteria for the selection of the Zulu language interpreters were:

- The interpreters had to be Zulu First language speakers.
- They had to reside in Kwa Zulu-Natal (Durban, Pietermarizburg region) for more than five years.
- The language interpreter had to have passed Grade 12 as a minimum academic qualification.

The above criteria ensured that the participants had sufficient experience with the language. Their experience would thus favorably influence the word choices made in terms of the commonality of the words. The inclusion of Zulu First language interpreters ensured that the identification of the words represented a wider choice in terms of common words. This was possible as the interpreters were residents of the greater Durban-Pietermarizburgh region. Thus, suggesting that words identified were more likely to be the common words spoken in this dialect of Zulu. More importantly, the likelihood of vocabulary representing everyday communication in this community was also expected.

4.5.1.1.3 Sampling method used for the selection of the participants

The purposeful sampling technique was used to select the participants for this objective of the study. Purposive sampling allowed the researcher to choose a sample that represented some feature or process in which the researcher was interested in (McMillan & Schumacher, 2001; Leedy & Ormrod, 2005). Therefore, this method was selected, as the participants chosen were representative of the linguistic group for which this word list would be relevant to i.e. ZFLS in KZN. Furthermore, the participants were informed of the topic of interest i.e. Zulu word selection. Purposive sampling was considered suitable, as it is less time consuming and it assured the highest participation rate from the participants to obtain the information required (Mcmillan & Schumacher, 2001).

4.5.1.1.4 Selection criteria for the words

The criteria for selection of the words included, commonly used bisyllabic words in Zulu. For the purposes of this study, common words refer to the most frequently used bisyllabic words in Zulu in the Durban, Pietermarizburg region of Kwa-Zulu-Natal. The linguistic structure of Zulu permitted the selection of bisyllabic words (refer to section 2.2). Further, Zulu has many bisyllabic words that can be considered common and would satisfy the requirements of an SRT word list (Chetty, 1990). The words considered as being common had to also be identified by two or more participants.

4.5.1.1.5 Data collection instrument

A modified word identification schedule (Appendix D) adapted from (Balkisson, 2001) was provided to each participant to record the chosen words. The use of the word identification schedule ensured that a standard method of recording the words was maintained across all four participants.

4.5.1.1.6 Data collection process

The researcher received ethical clearance from the University of Kwa Zulu-Natal Ethics Department to conduct the study (see Appendix A). The researcher sought permission from the Head of the Zulu Department of a tertiary institution (Appendix B) to gain access to Zulu language educators.

The interpreters, however, were approached personally with regards to their participation, outside of their formal work time. Informed consent from the language educators and interpreters was obtained regarding their willingness to participate in the study. The language educators and interpreters were advised on the nature of the study via a meeting with each participant independently. An instructional letter (Appendix C) concerning objective 1 was provided to each participant. Each participant was asked to identify a separate list of bisyllabic Zulu words commonly used by ZFLS in KZN (Durban, Pietermarizburg region). A minimum of one hundred words per participant was required at this phase of the study. The researcher selected a minimum number of one hundred words per participant in order to ensure that the final list is not too small in terms of the set size. This decision is in keeping with the suggestion made by (Punch & Howard, 1985) who stated that if the final list is too small in the size, this would improve the speech reception score of the participants being evaluated. The underlying reason for the improved score in SRT could be related to a 'learning effect' that influences the participant's responses due to fewer number of items on the list.

4.5.1.1.7 Analysis of data for objective one

The words were extracted from the identification schedules and captured onto an Excel spread sheet. The spreadsheet was designed to represent each participant's response in terms of the words identified. All words were arranged alphabetically on the spreadsheet. The researcher manually extracted those words that met a fifty- percent or more inclusion criteria. This implies that if a word was suggested by two or more of the participants, the word was included for the next objective of the study. The fifty- percent or more criterion is also known as the two -word selection criteria. This method of inclusion and exclusion has been recommended for word selection by (Madden, 1996). Those words that did not meet the 50% inclusion criterion were excluded from the study.

Descriptive statistics were used to analyse the most common words suggested by the respondents. Frequency counts, bar graphs and pie charts were among the tools utilized. These techniques indicated the most and least commonly identified words (Mcmillan & Schumacher, 2001). A second level of analysis included the categorization of the words into different word classes selected i.e. nouns, verbs, adjectives, pronouns etc. Percentage counts were used to describe the word class distribution.

Objective one, therefore represented the identification stage of the study, whereby the word pool was generated and analysed for the first criteria of SRT testing in Zulu i.e. commonly used bisyllabic words for the Durban-Piertermarizburg regions of KZN. After careful analysis of the words using the inclusion and exclusion criteria stipulated above, the common bisyllabic words selected were included in objective two of the study viz.: selection of the words according to the adapted SRT criteria for Zulu (refer to section 2.3.3.2 p.35).

4.5.1.2 Objective 2: Selection of words according to the SRT criteria suited to the Zulu language.

4.5.1.2.1 Participants:

Five linguists from two tertiary institutions in KZN participated in objective two of the study. For this objective, the linguists rated the words selected in objective one according to the following criteria i.e. a) familiarity, b) phonetic dissimilarity and c) low tone bisyllabic verb imperatives. The literature does not specify the number of judges to be considered. However, a recent study conducted by Nissen et al. (2005) utilized only three judges for the selection of familiar words for SRT in Mandrin. Therefore, five linguists within the present study were deemed adequate.

4.5.1.2.2 Selection criteria for participants

The participants had to be linguists who were knowledgeable in Zulu phonology and the linguistics of Zulu. They had to be familiar with the dialect of Zulu spoken in Durban-Piertermarizburg region of KZN. The linguists had to have a masters degree in linguistics as a minimum qualification. Plant (1990) reported the use of highly skilled linguistic experts in the development of a word list in Tiwi and Walpiri. Like wise, in the development of a word list for Zulu, the linguists selected had to satisfy the criterion of being highly skilled and knowledgeable of the language. Therefore, the criterion of a minimum of a masters degree stipulated above ensured this level of skill.

4.5.1.2.3 Sampling method for the selection of the participants:

Purposeful non-probability sampling was also used for this objective of the study. Purposive sampling allowed the researcher to select a sample that is representative and informative of the topic of interest.

Therefore, for this objective the linguists chosen were represented as experts in the field of Zulu. Purposive sampling according to (Mcmillian & Schumacher, 2001) was most suitable for the kind of data that was required.

4.5.1.2.4 Data collection instrument

An instructional letter (Appendix E) accompanied with the three rating scales i.e. rating scale for familiarity, low tone , phonetic dissimilarity (Appendix F) of the hundred and thirty one words (131) selected in objective one in aim one of the study were presented to each of the linguists. The three point Likert scale was used. The scaling system chosen was similar to most studies of this nature (Hirsh et al. 1952; Madden, 1996). This Likert scaling method represented e.g. the most familiar, fairly familiar and very unfamiliar words in the list. The scaling system was rank ordered and could also be described as a graphic numerical scale. This scale allowed for accurate description of beliefs and opinions in terms of familiarity (Mcmillan & Schumacher, 2001). The three point scale as opposed to a five point or seven point scale was considered due to the nature of the task. The researcher was concerned with identifying the most familiar words versus the most unfamiliar words in the list. Therefore, the limited rating options provided to the linguists prevented the linguists from providing too many unsure responses.

Further, Leedy & Ormrod (2005) have reported that this rating scale is useful when the behaviour, attitude or phenomenon of interest has to be evaluated along a continuum. Therefore, this method was relevant for the study, as beliefs and opinions of the linguists need to be evaluated. The items on the scale were presented down the left-hand side of the scale with 1, 2, and 3 in the column adjacent to each word (see Appendix F). This format allowed for uncomplicated and relatively quick completion of the task, whereby the participants had to tick in the appropriate column or merely selected the number that represented their opinion. Madden (1996) described several other advantages in choosing a rating scale. These include:

a) The absence of a time limit minimizes pressure on the subjects.
b) The subjects anonymity makes the task less threatening
c) The scale provides the subjects with direction.
d) Rater bias is eliminated since subjects place themselves on a continuum.

However, Leedy & Ormrod (2005) indicated that the one disadvantage of using a rating scale is that, in the process of simplifying and easily quantifying people's beliefs and opinions the researcher may loose valuable information. Nevertheless, for this study the advantages outlined and the task required, warranted the use of a rating scale.

4.5.1.2.5 Data collection process

The researcher obtained informed consent from each of the linguists in order for them to participate in the study. A meeting was held with all linguists to provide them with an instructional letter (Appendix E) informing them of the nature of the study and the requirements for step two. Each linguist was presented with the rating scale of the one hundred and thirty one words selected in objective one of Phase A. The words were rated according to chosen criteria. The linguists worked independently so that personal judgements could be made. In order to control for procedural variables the same set of instructions were presented to all participants as per the instructional letter (Appendix E). Prior to confirming participation in the study, the length of the scale was discussed with all participants, so as to minimize the loss of interest during its completion. It was emphasised that this was not a test and that there were no right or wrong answers. The data obtained were then analysed.

4.5.1.2.6 Analysis of data

Data were analyzed using a quantitative analysis approach. All statistical procedures and analysis were carried out using the SPSS version 11.6 computerized statistical program. The statistical analysis was completed under the advisement of a statistician (Ms. Cathy Connolly & Ms. Rebecca Shunmugam) at the Medical Research Council of South Africa in Durban in August 2006.

a) Mean scores:

This was calculated so that the degree of Familiarity, phonetic dissimilarity and low tone verbs could be measured across all raters. The words that achieved an average rating of 1.5 or less on all of the criteria, as indicated in previous studies (Hirsh et al. 1952; Madden, 1996) were to be selected for the next aim of the study. Mean scores are calculated by adding all the scores and dividing by the number of scores (Leedy & Ormrod, 2005). The mean is the most frequently used measure of central tendency (Mcmillan and Schumacher, 2001).

b) Kendall's co-efficient of concordance:

This method of analysis was used to assess inter-rater reliability. The rationale for the use of the Kendall's test was to determine the extent to which the raters agreed about what they rated (McMillan & Schumacher, 2001). The Kendall's Coefficient of concordance estimates agreement among multiple raters for ordinal responses as indicated in this study. Kendall's statistic is a measure of the association among appraisers' ratings. Kendall's statistic therefore can only be used when the data has three or more possible levels with natural ordering, such as strongly disagree, disagree, neutral, agree, and strongly agree. Therefore, this test of inter-rater reliability was suitable because the present study utilized three levels of natural ordering. The following table illustrates the values in terms of strength of the agreement when Kendall's W score is considered. Table 4.1 was used in the interpretation of the Kendall's W score in this study.

Table 4.1 Values representing strength of agreement for Kendall's W score.

Value of kappa	**Value of Kendall**	**Strength of agreement**
<0.20	-1.0 to -0.2	Poor
0.21-0.40	-0.6 to -0.2	Fail
0.41-0.60	-0.2 to 0.2	Moderate
0.61-0.80	0.2 to 0.6	Good
0.81-1.0	0.6 to 1.0	Very Good

The coefficient was calculated using the SPSS version 11.6 and a W score was calculated. A score between 0 to1 was regarded significant in terms of overall inter-rater reliability. This score assisted the researcher in terms of overall strength of the information received from the participants. It also confirmed that there was consistency in the measurement or rating of the words. After careful analysis using the above procedures, the words were considered for the next aim of the study.

4.5.2 Aim two: Assessment of the developed words

4.5.2.1 Objective 1: Assessing the homogeneity with respect to audibility of the fifty eight words selected in aim two

In order to achieve the above aim, the words analysed and selected in objective one and two had to be recorded on compact disc (CD). The following is a discussion about the process followed in the recording of the CD.

4.5.2.1.1 Recording the CD

a) Motivation for the use of recorded materials

The use of recorded materials is widely recommended in the literature and has recently been accepted by (ASHA, 1988) as a preferred method of presentation. The ASHA (1988) guidelines indicate that recorded materials maintain a level of standardization and consistent presentation of the materials. This choice was particularly relevant for this study due to the nature of the test materials and the kind of data that was required. Furthermore it allowed the researcher to control homogeneity with respect to audibility. This is best achieved with recorded materials (Lyregaard, 1997).

b) Equipment used for the recording

The recording was done in a large anechoic studio. The equipment for the recording and the methods of recording was according to the guidelines stipulated by (Lyregaard, 1997; ASHA, 1988; Nissan et al. 2005) for recorded materials. The equipment used for the recording is documented below and the description of the procedure follows.

- The U87A P48 type Neuman microphone was used for the recording. The AKG cover/windshield was used over the microphone to prevent distortion, especially when plosive sounds are produced.
- The mixer used was the Mackie - 32-8-2 8-Bus mixing console.
- Carrilon Audio systems computer hard drive
- Wave lab soft ware package.
- Nero Start Smart CD Writer.

c) The choice of speaker for the recording of the CD

The speaker selected for the recording of the CD was a Zulu First language University student, who resided in the Durban-Pietrmarzburg region. Therefore, the dialect used in the recording was matched to that of the material selected and the participants in this aim of the study. Lyregaard (1997) stated that as far as possible the speaker used for the recording should share the similar dialect to that of the participants. However, in this study a male speaker was utilized for the recording. There is literature to suggest that the measurement of homogeneity with respect to audibility is influenced by the gender of the speaker. However, Cambron, Wilson & Shanks (1991) have reported equivalent psychometric curves when both female and male speakers were used for the recording. Therefore, within the present study the selection of a male speaker was deemed adequate.

d) *Procedure for recording the test material*

- The microphone was positioned approximately 15cm from the speaker at 0 degree azimuth, as suggested by (Lyregaard, 1997). The microphone was connected to a sound mixer in the control room.
- Ambient noise levels in the anechoic chamber were approximately 5dBSPL which was measured by the recording technician using a Type 2 integrated sound level meter.
- The recordings made were normalized to 0dBHL levels. The recording of the words were preceded by a pure tone signal which is according to the recent ISO 8253-3 specification for recorded materials. The calibration signal was weighted, using a frequency-modulated tone at 1 KHz, which had a bandwidth of at least 1/3 octave (Nissen et al. 2005). The modulating signal was sinusoidal and had a repetition rate of 4-20Hz. The calibration tone lasted 60 seconds. The tone was followed by an instruction read by a male ZFLS.
- The Zulu words were recorded on six different tracks. Fifty-eight words were recorded on each of the six tracks. The fifty-eight words were recorded with a 5 second pause between each word, as recommended by (Lyregaard, 1997). Each word was preceded by a carrier phrase "Yithi" which means "say". Bess & Humes (2003) states that the use of the carrier phrase prepares the listener for the upcoming signal. The six tracks were randomizations of the same 58 words. Randomizations of the words were used to control for the learning effect. This also permitted a better measure of the relative range of intelligibility of the words. Six randomizations were considered adequate as suggested by

NAL laboratories and the more recent studies conducted in other languages. Randomizations of the words were done using the fishbowl technique. The Zulu Fist language speaker was advised to read the words in the natural tone that the words are spoken in accordance with the dialect used in the Durban, Pietermarizburg region of KZN.

- The recordings were transferred from the mixer desk to the Caririlon Audio system computer hard drive. The Wavelab soft ware package was used for editing of the words. The words were normalized to peak at 0dB and were adjusted once all recordings were done. The editing software allowed for the words to have the same RMS power as the 1000Hz calibration tone in an initial attempt to equate all the words. (Nissan et al. 2005). The normalization of the words was conducted in order to eliminate fluffs and errors that were made during the recording by the speaker. The recordings were then produced onto a CD using the Nero Start Smart CD writer. The completed recording thus had six randomizations of bisyllabic verb imperatives recorded by a first language speaker from KZN speaking the Durban, Pietermarizburg dialect of Zulu. These recordings were used in the assessment of the homogeneity of audibility of the words.

The following discussion is a description of the assessment of homogeneity of audibility using the recorded materials. This aspect of the data collection process occurred in two sessions i.e. Session 1 involved the screening of the participants for normal hearing and Session 2 involved the measurement of homogeneity of audibility. The description outlines the participant choices, sample method and sample selection criteria in session 1 of this part of the study. This discussion is concluded by a description of the pilot study, followed by detailed description of session 2.

4.5.2.1.2 Section 1: Screening of the participants for inclusion into aim two of the study.

4.5.2.1.2.1 Participants:

Thirty normal hearing Zulu First Language Speaking students from KZN were initially considered for this objective of the study. The mean age of the participants was 21.5 years. There were 22 males and 8 female participants. Thirty adults were considered adequate, as the minimum number used for the evaluation of homogeneity of audibility in other studies was reported to be between twenty and twenty five (Nissen et al. 2005). Further, the minimum number of participants in a quantitative study should be at least thirty according to (Leedy & Ormrod, 2005).

4.5.2.1.2.2 Sampling method

Purposive non- probability sampling was also used for this objective of the study. Zulu First Language Speakers attending University were targeted as the study population. Advertisements for participants included posters and an email advert on the University LAN. The advertisement included the specific criteria for participation in the study. Thirty-two participants responded to the original advertisements. However, once the sample selection criteria and the hearing screening process via case history, otoscopic examination, pure tone audiometry and immittance testing were completed only thirty participants passed the screening procedure. Thus, the sample considered for this part of the study was thirty. The two participants who failed the basic test battery were referred for further audiological testing and ENT management.

4.5.2.1.2.3 Sample selection criteria:

The following sample selection criteria were adopted for this objective of the study.

- The participants had to be between the age of 18 - 25 years, as hearing sensitivity is judged to be at its peak during this age period (Jerger, 1970).
- The participants of the group had to speak Zulu as their first language and had to have been permanent residents of KZN for more than 10 years. This criterion ensured that the participants would be familiar with the items selected for testing and that there would be no confounding factors related to the familiarity items in the tool.
- The participants could have been male or female, as gender specificity was not investigated.
- The participants were required to have had no previous exposure to industrial or recreational noise, no exposure to ototoxic drug consumption and must have reported no previous medical, neurological or acquired illnesses. Further there must be no report of a family history of hearing loss. The above factors could contribute to auditory disorders, which could have confounded the results. Bess & Humes (2003) describe the above factors as exogenous and endogenous factors, which could result in varying degrees of hearing loss. Thus participants had to have normal hearing. The above factors were screened for using the case history questionnaire and were further confirmed by the use of otoscopic examination, pure tone audiometry and immittance testing (Appendix G).
- The participants must not have had any exposure to hearing testing before their participation in this study (Robinson & Koenings, 1979). This criterion was necessary in order to control for any learned effects regarding any of the behavioral measures used.

4.5.2.1.2.4 Pilot study

A pilot study was conducted prior to the testing of the homogeneity of the words. The pilot study was firstly conducted to test the recorded CD and secondly to test the efficacy of the test protocol used for the assessment of homogeneity of audibility. The pilot study is therefore described in terms of piloting the CD and the pilot of the test procedures.

a) Pilot of the CD:

The recording of the CD involved several steps and once the CD was recorded and edited there was a need to pilot the outcome. The rationale for this was that this process was done for the first time, using technical support that is outside the field of Audiology. The 58 words were recorded 6 times using the same speaker. The original aim was to achieve a 0dB peaking for each of the words. This CD was then routed back through the GSI 61 audiometer. It was noted that the words recorded were over-peaking to a level of +3dB and there was no consistency with each list. The CD had to be edited further using the Wavelab editing software. A second CD was produced. This was evaluated and the level of distortion was too high, especially as the intensity of the words increased. A third revision revealed that the calibration tone peaked at +/-1dB and the words were peaking on average at +/-2dB. After consultation with the audio-visual experts (Z. Dlula, personal communication, 2005) it was decided that due the difference in calibration of the two systems, the words would be approximately 2dB different between the recording system and the audiometer used for testing. Further, according to (Nissen et al. 2005) the VU peaking of the words that are not spondees would be acceptable at 2dB. Thus, this level of peaking was accepted and the words recorded were accepted for the main study.

b) Pilot of the test procedures

A pilot study was completed with 5 participants. These participants were not part of the main study. The criteria for participation were similar to that of the main study i.e. all participants had to be between 18-25 years of age, speak Zulu as a first language, and reside in Kwa-Zulu Natal, present with normal hearing acuity with no previous adverse medical history. The five participants were screened for the above criteria using the case history questionnaire (Appendix G) and the basic audiological test battery was administered. All participants satisfied the selection criteria. The participants were then considered for the testing of homogeneity of the words using the recorded CD.

c) Results of the pilot study of the test procedures

All participants signed the consent form (Appendix H). There were no changes made to the form. The information in the form was clear to all of the participants. The case history questionnaire (Appendix G) was administered to each of the participants. All participants indicated that the questionnaire was adequate in terms of language, content and clarity. However, there were two editorial errors that were noticed by all participants. Otoscopic examination and immittance audiometry was conducted following the case history questionnaire. The procedure was preceded by a set of instructions. The participants were comfortable with the instructions and no recommendations were made. Air conduction testing was subsequently conducted on each of the participants. The participants were instructed in Zulu by a ZFLS. All instructions were clear and adequate for all participants. The researcher conducted the air-conduction test. The duration of the test was 15 minutes. No recommendations were made for this procedure.

The final procedure conducted was the assessment of the homogeneity of the words. This involved presenting each list of 58 words at –5dB, 0dB, 5dB, 10dB, 15,dB, 20dB to each of the participants The aim of the procedure was to determine the mean sensation level at which each of the words were correctly identified. This procedure lasted 45 minutes for each participant. The participants were instructed in Zulu by both the Zulu First language Speaker and via the recorded instructions on the CD. The participants reported that the instructions were appropriate and clear. However, recommendations were made with regard to the duration of the test. All participants felt that the duration of this aspect of the test was time consuming and strenuous to the participants. This was noted especially, as the duration between each word was 5 seconds. This seemed to have extended the duration of the list. Further, it was felt that rest periods needed to be built into the testing session. Apart from these recommendations there were no concerns regarding the actual list itself were made, except that at very low levels (-5dBHL) participants had difficulty hearing the first syllable in the word, which made identification difficult. All participants were unable to hear any of the words at -5dBHL. This seemed to influence their confidence in their performance, which could also affect reliability of the scores.

d) Modifications to the test procedures based on the pilot study:
The case history questionnaire was adjusted for the editorial errors. The duration between words was not changed. However, the suggestion of rest period was considered. All participants in the main study were to be given a 5-minute rest period after the first three lists were read. Rest periods are suggested in a similar study conducted by (Nissen et al. 2005). This was kept consistent with all participants. Further, after every 10 words the tester reinforced each participant through a nonverbal acknowledgement (nodding of the head or raising of the hand). This was kept consistent throughout the procedure. It was also noted from the participant's scores of the pilot study that all participants achieved a 0% score for the list at -5dBHL. Thus, for the main study the testing began at 0dB for all participants, in order to reduce the test time further. This also ensured better participation and reliability on the part of the participants. Apart from these changes the test procedure or process remained the same.

4.5.2.1.2.5 Data collection process for objective one of aim two

The researcher obtained informed consent (Appendix H) from all of the participants and ensured confidentiality of any results obtained in the testing process. Participants were also informed that should they wish to discontinue participation in the study at any point, they were free to do so. Figure 4.2 is a flow diagram to illustrate the data collection process. A detailed description regarding the equipment choices and testing procedures would follow.

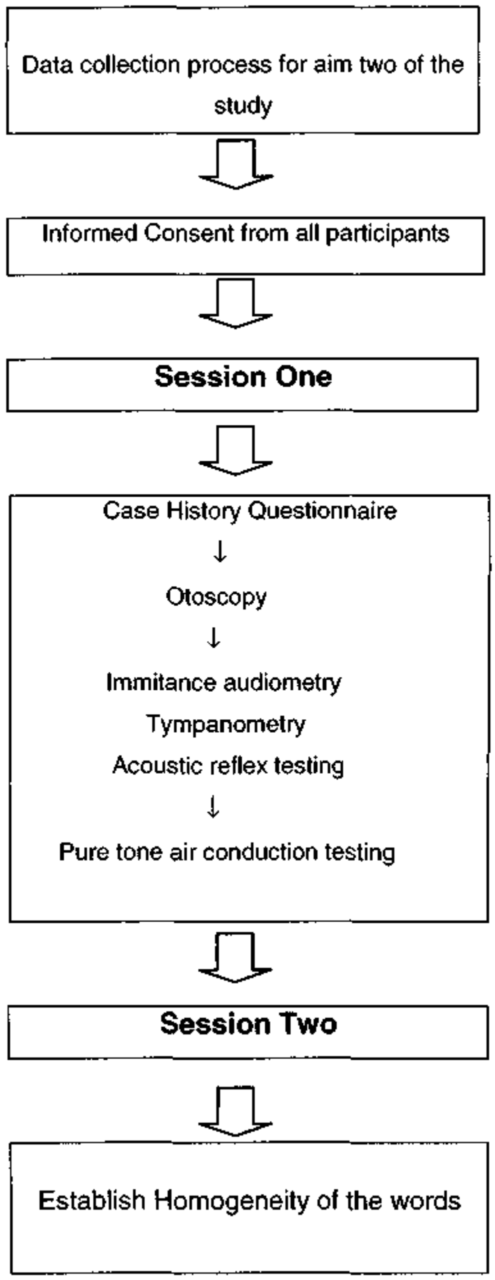

Figure 4.2: A flow diagram illustrating the data collection process for aim two.

The participants were screened for participation by the researcher using a developed case history questionnaire (Appendix G). The participants were further tested audiologically, whereby an otoscopic examination, immittance audiometry and pure tone air-conduction testing was done. Audiometric testing was conducted at the Discipline of Audiology at the University of Kwa-Zulu Natal, Westville Campus. The description of the test environment, the data collection instruments, motivations for the test procedures and the normative data for evaluating the results are detailed in (Appendix I). Session one therefore included administering the basic test battery to determine normal hearing acuity across all participants. Session two included evaluating the homogeneity of the Zulu words on the normal hearing participants identified in session one.

An isolated Industrial Acoustics Company (IAC) twin audiometric soundproof booth of double wall construction was used as the test environment for the pure tone testing and speech evaluation. These requirements were set by ANSI (1977) to meet the noise level requirements. All equipment used for the basic battery was calibrated in June 2005 and testing of all participants was conducted in October 2005 to December 2005.

Based on the results of the basic battery in session one the participants were selected or excluded from the study. Those participants who failed the initial testing were referred for further testing and appropriate management at the local clinic hospital or university clinic. The participants who presented with normal hearing were considered for session two i.e. testing the homogeneity of the words.

4.5.2.1.2.6 Session Two: Testing for Homogeneity of the words

The following is a description of the test procedure followed in establishing Homogeneity of the words.

- Sound level measurement: Sound level measurement was recorded using a portable Type 2 integrated (Cell 2) sound level meter. This was done in both audio-booths. This ensured that the noise levels were carefully controlled for.
- Seating arrangements of each participant: The participants were seated face to face with the researcher. The participants were seated in the test room and the researcher with the two Zulu first language scorers in the

control room. The Zulu first language speakers were third year Audiology students who were familiar with SRT testing and instructions for testing. The profile seating arrangement is recommended by Hodgeson (1980) and is usually considered if live voice testing was used. For the present study, recorded materials were used. Therefore, seating face to face was acceptable. Further, given the length of the test procedure the researcher was able to keep non-verbal contact with the participants.

- Instructions to the participants: Each participant was instructed in Zulu by a First language Zulu speaker. The Zulu first language speaker was trained by the researcher in terms of the instructions and procedure to be followed. The instructions orientated the participants to the nature of the task. The instructions specified the participant's mode of response and indicated that the test material was speech. Furthermore, the instructions indicated that the participants must only respond to the words. It was also stressed that the participants must respond to the faintest listening levels and guessing was encouraged.
- Response mode: Participants were asked to respond verbally to each word that was heard. This response mode is supported in the literature by Lyregaard (1997). This response method was also used, as the researcher required that the scoring of the responses be done by two first language Zulu speakers and the researcher.
- Scoring of responses: The researcher and two first language Zulu speakers scored each participant's response. The scoring of each participant was done independently. The researcher included this scoring method in order to improve the reliability of the scoring process and to ensure that the scores were accurate. The 58 words were captured onto a scoring form developed by the researcher (Appendix J) and each rater scored the participants response with a tick for accurate responses and a cross for inaccurate or no response.
- Method of determining homogeneity: The researcher randomly selected the test ear. The participants were instructed verbally by a first language Zulu speaker. The researcher presented recorded materials to each participant. Each participant was presented with the recording, which

began with the 1000Hz-calibration tone, followed by instructions that were presented in Zulu by the speaker on the CD recording. The instructions were routed through the GSI 61 audiometer using the same earphones. The intensity level of the instruction was at 30dBHL. At the onset of testing the attenuator dial was set at 0dBHL. At this level one recording of 58 words was presented to the participant. The number of correct and incorrect words was recorded by each scorer on a form developed by the researcher (Appendix J). The attenuator was raised in 5dB steps and a second recording was administered. One recording was then successively played at each 5dB increment until 100% identification was reached for all 58 words. The participants were given a 5minute rest period after three recordings were played. The rest period was incorporated in order to improve co-operation from all participants and to eliminate the fatigue variable. Further, participants were encouraged by the researcher through non-verbal reinforcements. All thirty participants were tested in the same manner.

4.5.2.1.2.7 Analysis of homogeneity of audibility

The analysis of this objective drew its conclusions from the use of logistic regression. Logistic regression was used since the data was binary (nominal) in nature. The words selected from objective two were dictated to the respondents who were asked to respond to the words. There were 3 raters used to assess the audibility of the words. Each word was recorded at different sound intensity levels viz. at 0, 5, 10, 15 and 20 decibels. Each rater recorded the responses at each of the levels of each word. An inter-rater reliability test was conducted across all three raters. The Kappa Test of agreement according to Agresti (1990) was used to assess the consistency of the raters. The Kappa test was chosen since the responses were binary and it was a suitable test of agreement between two or more raters. The kappa test of agreement indicated a good agreement amongst all raters at 0.05 level of agreement. Once the agreement was noted from the Kappa test, the scores of only one of the first language raters was considered for the logistic equation. The good inter-rater reliability across all three raters allowed the researcher to choose the scores of one of the first language raters.

Appendix K describes the motivation and procedure used regarding the logistic equations used, as stipulated by Agresti (1996). This was done using the computerized statistical analysis i.e. SPSS version 11.6 under the advisement of a statistician at the Medical Research Council of South Africa (Durban). The homogeneity of each word was determined. The average percentage correct identified by each participant for each word was calculated using the above equation. The psychometric curve for the most homogenous words was identified. The steepnees of the curve was calculated using a logistic regression plot .The raw scores for the 58 words were inserted into a logistic regression equation that was designed to calculate the percentage correct at each intensity level. Using the regression equation the calculations for the range of threshold (50%) and the slope of the curve was ascertained for each word. This model provided the researcher with a method of estimating at any given intensity, the performance of the words in terms of percentage. The most homogenous words were selected and the CD recording was edited (Appendix S). Appendix S includes a copy of the CD with track one indicating the twenty eight Zulu words. Twenty-eight words were then considered for acoustic analysis.

4.5.2.2 Objective 2: Acoustic analysis of the words

4.5.2.2.1 Motivation and description:

The words selected in aim 1 have been analyzed at the linguistic level. It is clear from this analysis and the theoretical discussion of the Zulu Language that the structure of the language i.e. morphological, phonological and lexical differs from that of English on many levels. In order to select and verify the words that meet criteria specific to the Zulu language the researcher introduced a second level of analysis i.e. the objective acoustic analysis of the words. Acoustical analysis has been used as a technique for SRT word selection in the Aboriginal languages (Plant, 1990). The introduction of this level of analysis was motivated for along similar lines to the present study.

There are commonalties in the linguistic structure of the Aboriginal language and Zulu. The Zulu language like Walpiri and Tiwi has different stress patterns to English. This characteristic is pertinent when dealing with the development of SRT words. Traditionally SRT words in English were spondees with equal stress on each syllable. Given that all languages do not adhere to this structure, requires a review of how speech material is evaluated for inclusion in an SRT list.

One such way would be the introduction of acoustic analysis via pitch contours, energy contours and time wave patterns. Plant (1990) demonstrated this as an adequate tool for the illustrations of the stress and tonal variations that existed in the Aboriginal languages. This level of analysis involved the use of specialized computerized equipment known as the Computerized Speech Laboratory. The procedure and instrumentation would be discussed in the ensuing discussion.

4.5.2.2.2 Instrumentation and choice of tests:

The Multispeech model 3700 was the most suitable instrument for the present study. It is a digital driven system. There are several soft ware packages that enable the system to execute various level of analysis such as pitch contours of the signal, determining of the fundamental frequency of the input and measuring the spectrographic waveform patterns of the speech signal. The system is designed to pick up an input signal and store the information for various levels of analysis. The Multispeech 3700 allows the researcher to display the data, measure and edit sections of the data that are relevant for study.

4.5.2.2.3 Sample:

The twenty-eight Zulu words identified as being most homogenous were included for this objective of the study. The recorded words were used for the analysis.

4.5.2.2.4 Procedure:

The words selected and analyzed in objective one of Aim two were recorded on a CD as described earlier. Thus, the input signal for the Multispeech 3700 analysis was via the CD recording. The Multispeech main program software was used. Four display window settings were created. Display A represented the digitized sound wave, display B was a wideband spectrographic analysis and C and D represented the pitch contour and energy contours respectively (see Appendix L for example of window settings). However, for the purposes on this study the pitch contour and energy contour settings were most relevant. Each of the 28 words recorded on the first track of the CD was analyzed acoustically. There was a separate pitch contour and energy contour for each word, which allowed for ease of analysis and comparison.

4.5.2.2.5 Analysis of Data

The acoustic analysis was conducted by the researcher and assisted by a lecturer in the field of acoustics, Mrs. Groenewald (University of Pretoria). All 28 words were carefully analyzed for the acoustic properties that were relevant for this study. The following parameters were used:

a) Energy contours
b) Pitch contours

The pitch contours and energy contours of each syllable within a word were analyzed via visual inspection. This entailed identifying the highest points for pitch and spectral energy for each syllable of the word, by placing the cursor on the highest point of the contour and reading the values. Thereafter, differences in the pitch and overall spectral energy for each syllable were determined using descriptive statistics. The data was represented via a table. The difference values for pitch and energy were calculated; as such values could be used to confirm the prosodic features of Zulu (E. Groenewald, personal communication, October 2006). The use of pitch was particularly important as the prosodic features in a language are usually indicated by the rise and falls in the pitch of the word (Kent & Read, 1992). Furthermore, the similarities in the pitch and energy content of the words could confirm the homogeneity of the words acoustically.

4.6 PHASE 2: APPLICATION OF THE DEVELOPED ZULU SRT WORD LIST

4.6.1 Aim three: To assess the application of the Zulu SRT word list on a clinical normative population of KZN

4.6.1.1 Participants

Twenty-six Zulu First Language Speakers were considered for this phase of the study. The participants were University students who spoke Zulu as a First language, but were practically and functionally proficient in English. This was determined as all the students included had passed matric level of English.

4. 6.1.2 Sampling method

Purposive sampling was used. The motivation for the use of purposive sampling was similar to objective one in aim two of the study. Participants were recruited via advertisements as described in aim two of the study above.

4.6.1.3 Sample selection criteria

The selection criterion was as per objective one of Aim two of the study. The researcher also ensured that all participants were First language Zulu speakers of the Durban, Pietermarizburg region and were proficient in English.

4.6.1.4 Data collection process

All participants were screened for normal hearing bilaterally as per discussion in objective one of aim two of the study. This included a case history, immittance testing, pure tone testing. The details on the procedure followed are indicated in Appendix I.

4.6.1.5 Procedure for SRT testing using the Zulu words

Bilateral SRT were established on twenty six participants. There were established in all participants who presented with normal hearing based on the case history, immittance battery and pure tone testing. The procedure for eliciting the SRT is described below.

- Instructions to the participants: A Zulu First language speaker instructed each participant. ASHA (1988) stipulated that instructions for SRT must be done in the language of the client.
- Familiarization to test material: ASHA (1988) stated that this process is an essential step in the SRT procedure and should not be eliminated. The participants were familiarized with the test items by presenting the list in written format to the client as well as the recorded list was played to them at comfortable hearing levels (30dBHL). The participants were expected to repeat each of the words. This step was necessary to ensure that the participants knew the exact words in the test list and the participants could make adequate responses to each word on the list. Any of the words that the participants had difficulty understanding or repeating were eliminated from the list.
- Method for eliciting SRT: For the purposes of this study, the recorded presentation of the word list were used i.e. the words were recorded on a CD, which were routed through the GSI 61 audiometer. The motivation for the use of recorded materials has been made in earlier sections. The Chaiklin and Ventry (1964) descending method for eliciting SRT was used i.e. 5dB descents. It was found that this method produced similar findings as the ascending method. Further, Hirsh et al. (1952) found that the descending method almost exclusively was used during the development of speech materials and is widely used at present clinically. Two Zulu First Language speakers and the researcher scored the responses from the participants on a form developed by the researcher (see Appendix M).
- Response mode: The mode of response used was verbal repetitions.

- Recording of results: The speech threshold was recorded in dBHL. The test responses were verified between two Zulu First language speakers and the researcher before being recorded.
- Criteria used to determine SRT: The SRT was defined as the lowest level in dB HL, at which the subject was able to correctly identify 50% of the words presented (ASHA, 1988).

The three-frequency audiogram procedure was used to calculate the pure tone average in hearing threshold level (PTA HL). According to Carhart (1965) the simple averaging of the octave frequency 500Hz, 1000Hz and 2000Hz is adequate for estimating the sensitivity for speech. Thus, researchers have advocated the need to compare the PTA with the SRT. Each participant's PTA was correlated with his or her SRT values. Thereafter for the purposes of comparison, the participants were presented with the CID W-2 list via a CD recording. This word list was recoded on track two of the CD (Appendix S).

4.6.1.6 SRT using recorded English word list

The English CIDW-2 list was recorded on the CD by the same speaker who spoke English as a second language. The speaker was considered functionally and practically proficient in English. The second language English speaker was used for the recording, in order to control for any dialectal influences if a first language English speaker presented the words to the participants. An SRT was established using the recorded version of the word list. This was established on all 26 participants bilaterally. The motivation for establishing the SRT in English was to serve as comparison between PTA/SRT (Zulu) and PTA/SRT (English). The procedure followed was similar to that recommended by ASHA (1988). The familiarization process was the same as discussed above. An SRT value was recorded and the SRT values were used as part of the overall analysis.

4.6.1.7 Analysis of data

All data were analysed using the computerized SPSS version 11.6 method. In order for the researcher to establish the correlation between PTA and SRT (Zulu) values, the Parametric Pearson Product moment correlation co-efficient statistic was used as a quantitative procedure. This correlation is a parametric index, which serves a variety of functions, one of which is to determine the validity of measurement techniques and materials (Hinkle, 1982). In the present investigation the SRT values (Zulu) were correlated with the Pure Tone Averages for each of the participants, as it is widely accepted that these two measures serve as validity checks of each other (Konkle & Rintlemen, 1983). The pure tone values for the twenty-six participants across both the left and right ears were carefully examined and it was indicated that were no significant ear differences. This implied that there was no more than a 5dB difference between the ears for the pure tone average values. This allowed the researcher to group the data for left and right ears and thus increases the N value to 52. The critical values of the normal distribution were applied when interpreting data and testing for significance were done at the alpha level of p = 0, 01.

In addition, the researcher used a descriptive analysis approach to evaluate the difference in SRT score for the Zulu versus SRT in English in relation to the PTA, using percentage counts.

4.7 ETHICAL CONSIDERATIONS IN THE STUDY.

The present study is located within the field of social sciences research and has included Human participants in the study. Therefore Leedy & Ormrod (2005) advise that the ethical legal considerations in such study are critical. Within the description of the study the researcher paid careful attention to ethical issues which have been explained in the earlier sections. However, the following key elements regarding ethics were maintained.

- Informed consent: Leedy and Ormrod (2005) stated that any participation in a research project must be based on voluntary participation and on informed consent. For the present study informed consent was obtained from participants in Phase one of the study i.e. Tertiary educators, interpreters, linguists and the participants for hearing testing in Phase 2 of the study. In addition each participants received instructional letters informing them of their role in the study. Participants were also advised that their participation was voluntary and withdrawal from the study was not prohibited at any time.

- Protection from harm: Participants were advised that the study involved no risk and all procedures conducted especially in phase two of the study were non-invasive standard audiometic procedures. All instructions were carefully explained in their first language. Further, rest periods were built into objective three of the study and participants were explained the length of the procedure at the outset.
- Confidentiality and privacy: All participants were advised of their confidentiality. The names of participants have been omitted from all documentation and the participants for phase two of the study were coded. Participants who failed any of the screening procedues in phase two of the study were referred for further management and an appropriate clinical report was forwarded to the institution or practitioner concerned.
- Ethics committee: The research proposal of the present study was submitted to the then University of Durban-Westville ethics committee and full ethical clearance was obtained (Appendix A) before commencement of any aspect of the study.

4.8 RELIABILITY AND VALIDITY

Reliability and validity are two important considerations in any research project (Leedy & Ormrod, 2005). Reliability refers to the consistency with which measurements yield results (Leedy & Ormrod, 2005). Reliability checks within a study are usually varied. However or the purposes of this study, the following considerations were made in the study:

- All participants were provided with the same instructions regarding their role in the study.

- The data obtained in the study was considered reliable because the data was verified by several independent participant sources. Further, the rating scales used were standard across all raters in objective two of the study.
- The researcher used concordance and inter-rate-reliability tests i.e. Kendall's co-efficient of concordance and the Kappa test, to test the consistency of raters in both objective two and aim two respectively.
- All audiometric procedures used were standard universal procedures conducted by a registered Audiologist. Thus, all test scores obtained were considered reliable. All equipment used was calibrated according recommended standards. Further, with regard to scoring of the participants for objective one of Aim two of the study , the researcher utilized three raters. Two of the raters were First language speakers of Zulu. This further ensured that the responses were fairly accurate.
- A pilot study was conducted to increase reliability of the case history questionnaire, test the quality of the CD recording and to assess the overall reliability of the test procedures for objective three of phase one of the study. The procedure for the pilot study is indicated on p.80-81. This ensured efficiency and accuracy in the main study.

Validity refers to the accuracy of measurement tools (Leedy & Ormrod, 2005). In addition to measurement tools, validity according to Leedy &Ormrod must also be considered in terms the overall approach used in the study. The overall accuracy, meaningfulness and credibility of the research project are significant.

With regards to the present research project a two-phase methodological approach with several objectives within each phase was conducted. This allowed the researcher to verify data obtained in each of the objectives. Several quantitative methods of data collection and analysis procedures were used. This ensured the validity of data in the study.

The development of the word list for SRT was done according to both linguistic and audiological criteria. In addition, the researcher described the acoustic characteristic of the words. Most of the previous studies conducted internationally and locally focused on one of the above aspects. The above description would thus satisfy the principle of internal validity . Internal validity refers to the extent to which the design allows the researcher to draw accurate conclusions.

4.9 CONCLUSION

Chapter four described the methodological framework of the present study. The study is based on a two-phase methodological framework. However, several objectives make up each of the phases. The phases were designed such that each occurred consecutively. This design suited the present study in terms of the three aims of the study i.e. the development of the word list, the assessment of the word list and the application of the word list on a sample of normal hearing individuals. The measurement tools and analysis procedures are described. The following two chapters encompass the results and discussion of each of the phases. The following chapter would be written in terms of the aims and objectives of the study.

CHAPTER FIVE: RESULTS

5.1 INTRODUCTION

The chapter documents the results obtained in the study. The results are presented according to the aims and objectives of the study. In order to fulfill aim one, there were two objectives. Each of the objectives was sequentially realized. This process led to the construction or development of a Zulu word list which was assessed in aim two of the study. Herein, the measurement of the homogeneity with respect to audibility and the acoustic analysis of the list were completed. Finally, aim three measured the application of the Zulu word list on a sample of normal hearing adults from KZN.

5.2. Aim one :The development of the Zulu SRT words

5.2.1 Objective 1: To identify common bisyllabic Zulu words

A total word pool of five hundred and five common words was obtained from the four participants. Figure 5.1 below, illustrates the number of words identified per participant. The average number of words identified per participant was 126 words. The number of words identified ranged from 123 to 133. Participant four suggested the highest number of words i.e. 133. Participant two suggested the lowest number of words i.e. 123. Appendix N, illustrates the words suggested by each participant. Many of the words obtained by each of the four participants were repeated by more than one participant.

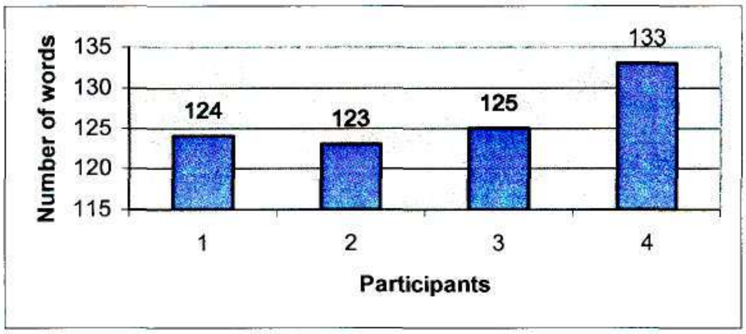

Figure 5.1 Number of words selected per participant

Thus, the above 505 words were categorized for inclusion and exclusion in terms of a 50% inclusion criterion. The 50% inclusion criterion implied that if a word was identified by two or more participants, the word was included into objective two of the study. Those words that were not identified by two or more participants were excluded. This process of inclusion and exclusion ensured that the words selected were the most common words selected amongst the participants for this study, as documented by (Madden, 1996). Figure 5.2 below illustrates that 131 words of the 505 words (26%) met the inclusion criterion. Seventy four percent of the words were excluded. In addition Appendix N illustrates the distribution of the 131 words according to the number of participants that suggested the words for objective one.

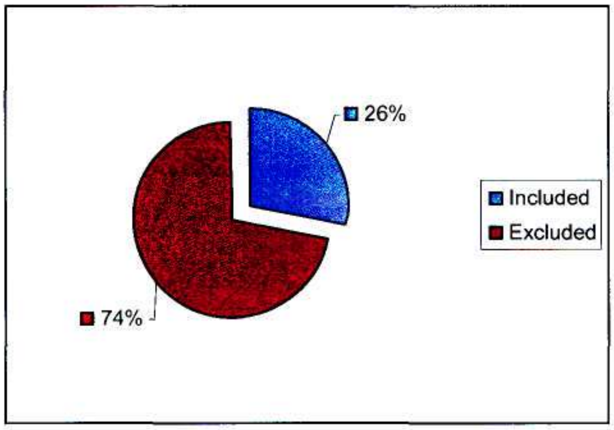

Figure 5.2 Percentage of words included and excluded from the list in objective one.

Appendix N indicates that there were 57/131 words that were suggested by two participants. Three of the participants suggested 52/131 words and

22/131 words were suggested by all four of the participants. However, all of the 131 words pre-selected were included in objective 2 of the study.

The 131 words identified above can be further categorized in terms of the characteristics of the words identified. Figure 5.3 illustrates the percentage of words according to the word classes.

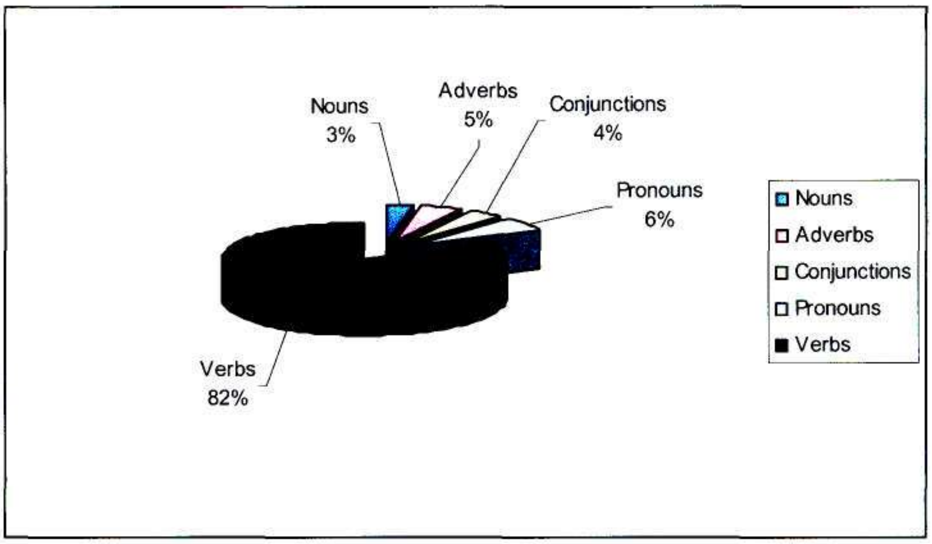

Figure 5.3: Pie chart illustrating the percentage of the words according to word classes

The majority (82%) of the words chosen were bisyllabic verbs with pronouns being (6%), adverbs (5%), conjunctions (4%), and nouns (3%) respectively. Examples of words within this distribution can be found in Table 5.1 below.

Table 5.1: Examples of bisyllabic words according to their different word classes

Bisyllabic Verbs	**Pronouns**	**Adverbs**	**Conjunctions**	**Nouns**
Bhala	zake	Lapha	Futhi	Nyama
Gxeka	zabo	Phansi		Nyanga
khanya		Phezu		
Geza		Muva		

These findings are in accordance with the linguistic structure of Zulu. The majority of bisyllabic words in Zulu are verbs rather than nouns (R. Bailey familiar. However, the final selection of the words also depended on the mean ranks for tone and phonetic dissimilarity.

Table 5.2 Means scores obtained for the criteria of familiarity.

Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev
Bhala	1.0000	.00000	hamba	1.0000	.00000	Ncama	1.2000	.44721	thenga	1.000	.00000
Bhaka	1.2000	.44721	Hleka	1.0000	.00000	Netha	1.0000	.00000	thanda	1.000	.00000
Bhema	1.0000	.00000	Hoya	2.4000	.89443	Ngena	1.0000	.00000	thola	1.000	.00000
Biza	1.0000	.00000	Hlala	1.0000	.00000	Nuka	1.0000	.00000	thula	1.000	.00000
Bona	1.0000	.00000	Hluba	1.0000	.00000	nyanga	1.4000	.54772	thela	1.000	.00000
Buza	1.0000	.00000	hlupha	1.0000	.00000	Ndiza	1.0000	.00000	thatha	1.000	.00000
Bheka	1.0000	.00000	Hola	1.0000	.00000	Pheka	1.0000	.00000	tslala	2.200	1.09545
Banga	1.0000	.00000	hlenga	1.0000	.00000	Phezu	1.8000	1.09545	vala	1.000	.00000
Bola	1.0000	.00000	Jika	1.0000	.00000	phupha	1.0000	.00000	vuka	1.000	.00000
Cacha	2.2000	1.09545	Jeza	1.4000	.89443	Phosa	1.0000	.00000	vuma	1.000	.00000
Cela	1.0000	.00000	Jula	1.0000	.00000	Phuza	1.0000	.00000	vula	1.000	.00000
Cwewa	1.4000	.89443	Jaha	1.4000	.89443	phapha	1.0000	.00000	veza	1.000	.00000
Cinga	1.0000	.00000	khanya	1.0000	.00000	Pheza	2.0000	1.00000	washa	1.000	.00000
Chela	1.0000	.00000	Kheta	1.5000	1.09545	Phuma	2.000	1.0000	wina	1.400	.89443
Dinga	1.0000	.00000	Khiye	1.8000	1.09545	Qala	1.0000	.00000	woza	1.000	.00000
Dlala	1.2000	.44721	Khola	2.2000	1.09545	Qeda	1.0000	.00000	xoxa	1.000	.00000
Dansa	1.000	.0000	Khaba	1.5000	1.09545	Qoba	1.0000	.00000	xola	1.000	.00000
Donsa	1.0000	.00000	Klekha	2.6000	.89443	Qonda	1.0000	.00000	yeka	1.000	.00000
Dula	1.2000	.44721	Khala	2.6000	.89443	Qina	1.0000	.00000	xosha	3.000	.00000
Duda	2.2000	1.09545	Khipa	1.000	.0000	Quela	2.0000	1.0000	yeba	1.000	.00000
Faka	1.0000	.00000	Lala	1.0000	.00000	Qaqa	2.0000	1.0000	wawa	2.200	1.0950
Funa	1.0000	.00000	Landa	1.0000	.00000	qhaqha	2.2000	1.0950	yifa	1.000	.00000
futhi	2.2000	1.09545	Letha	1.0000	.00000	Shaya	1.0000	.00000	yosa	1.200	.44721
Funda	1.0000	.00000	Lima	1.0000	.00000	shesha	1.0000	.00000	yonga	1.200	.44721
Finya	1.0000	.00000	Linda	1.0000	.00000	Siza	1.0000	.00000	yenza	1.000	.00000
fika	2.2000	1.09545	Loya	1.0000	.00000	Senga	1.0000	.00000	yona	1.000	.00000
Ganga	1.0000	.00000	Luma	1.2000	.44721	Sula	1.0000	.00000	zakhe	2.200	1.09545
Gcina	1.0000	.00000	Lunga	1.0000	.00000	Sefa	1.4000	.54772	zosha	2.200	1.09545
Geza	1.0000	.00000	Lapha	1.0000	.00000	Shiya	1.0000	.00000	Zabo	2.200	1.09545
Goba	1.0000	0.0000	Manje	2.6000	.89443	Sika	1.0000	.00000	minya	1.200	.44721
gqoka	1.000	0.0000	muva	2.6000	.89443	shada	1.000	.00000	nyama	2.200	1.09645
Gcaca	2.0000	1.00000	mina	2.0000	1.0000	Sina	1.0000	.00000	phansi	2.200	1.09645

Table 5.2 continued

Gxeka	**1.0000**	**.00000**	mila	**1.4000**	**.89443**	Susa	**1.0000**	**.00000**			

Table 5.3 below indicates the mean ranks obtained from the five linguists as it relates to tone of the words. A larger number of words obtained a score of greater than 1.5 in the table below compared to Table 5.2 above. The words obtaining a higher score indicated that these were high-low tone verbs. For the purposes of this study the low tone verbs are included. The low tone verbs obtained a mean rank of 1.5 or less.

Table 5.3 Means scores obtained for the Tone of words

Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev
Bhala	2.2000	1.09545	Hamba	2.600	.89443	**Ncama**	1.4000	.89443	**Thenga**	1.400	.89443
Bhaka	2.2000	1.09545	**Hleka**	1.000	.00000	**Netha**	1.0000	.00000	**Thanda**	1.400	.89443
Bhema	1.0000	1.09545	**Hoya**	1.000	.00000	Ngena	3.0000	.00000	**Thola**	1.400	.89443
Biza	3.0000	.00000	**Hlala**	1.000	.00000	Nuka	2.6000	.89443	Thula	3.000	.00000
Bona	2.6000	.89443	**Hluba**	1.400	.89443	nyanga	3.0000	.00000	**Thela**	.8000	.44721
Buza	2.2000	.00000	Hlupha	2.600	.89443	nyama	3.0000	.0000	**Thatha**	1.400	.89443
Bheka	1.0000	.00000	**Hola**	1.000	.00000	Ndiza	2.6000	.89443	Tslala	3.000	.00000
Banga	1.0000	.00000	**Hlenga**	1.000	.00000	phansi	2.6000	.08443	**Vala**	1.000	.00000
Bola	3.0000	.00000	Jika	3.000	.00000	**Pheka**	1.0000	.00000	Vuka	3.000	.00000
Cacha	2.6000	.89443	**Jeza**	1.000	.00000	Phezu	3.0000	.00000	Vuma	2.600	.89443
Cela	1.0000	.00000	Jula	2.600	.89443	**phupha**	1.0000	.00000	**Vula**	1.000	.89443
Cwewa	1.0000	.00000	**Jaha**	1.000	.00000	phuma	3.000	.00000	**Veza**	1.000	.00000
Cinga	1.0000	.00000	**Khanya**	1.000	.00000	**Phosa**	1.0000	.00000	**Washa**	1.000	.00000
Chela	1.0000	.00000	**Kheta**	1.000	.00000	Phuza	3.0000	.00000	**Wina**	1.000	.00000
Dinga	1.0000	.00000	Khiye	3.000	.00000	**phapha**	1.0000	.00000	Woza	3.000	.00000
Dlala	3.0000	.00000	**Khola**	1.000	.00000	Pheza	2.6000	.89443	Xoxa	3.000	.00000
Donsa	1.0000	.00000	**Khaba**	1.000	.00000	Qala	3.0000	.00000	**Xola**	1.000	.00000
Dansa	1.0000	.00000	**Khala**	1.400	.89443	Qeda	3.0000	.00000	Xosha	3.000	.00000
Duda	2.6000	.89443	**Khipa**	1.000	.00000	**Qoba**	1.0000	.00000	**Yeba**	1.000	.00000
Dula	2.6000	.89443	**Klekha**	1.000	.00000	**Qonda**	1.0000	.00000	Wawa	2.200	1.0950
Faka	1.0000	1.09545	**Lala**	2.600	.89443	Quela	3.0000	.00000	**Yeka**	1.000	.00000
Funa	3.0000	.00000	**Landa**	1.000	.00000	**qhaqha**	1.0000	.00000	**Yosa**	1.000	.00000
Funda	3.0000	.00000	**Letha**	1.400	.89443	Qaqa	2.0000	1.0000	**Yifa**	1.000	.00000
futhi	3.0000	.00000	**Lima**	1.000	.00000	Qina	2.6000	.89443	**Yanga**	1.000	.00000
Finya	1.4000	.89443	**Linda**	1.000	.00000	**Shaya**	1.0000	.00000	**Yenza**	1.000	.00000
fika	3.0000	.00000	**Loya**	1.000	.00000	**shesha**	1.0000	.00000	**Yona**	1.000	.00000
Ganga	1.0000	.00000	Luma	3.000	.00000	Siza	3.0000	.00000	Zakhe	2.200	1.09545
Gcina	2.6000	.89443	**Lunga**	1.500	1.09545	Senga	2.2000	1.09545	Zosha	**2.200**	1.09545
Geza	1.0000	.00000	**Lapha**	**3.000**	.00000	**Sula**	**3.0000**	**.00000**	**Zabo**	**2.200**	1.09545

Table 5.3 continued

Goba	1.0000	.00000	Manje	2.600	.89443	Sefa	1.0000	.00000			
Gcaca	1.0000	.00000	Mila	3.000	.00000	Shiya	3.0000	.00000			
			Mina	2.000	1.0000	Sika	3.0000	.00000			
Gqoka	1.0000	.00000	Muva	2.200	1.09545	Sina	3.0000	.00000			
Gxeka	1.0000	.00000	Minya	1.000	.00000						

Table 5.4 below illustrates the mean ranks for phonetic dissimilarity in the words. The table indicates that the majority of the words were phonetically dissimilar. However there were a small percentage of words that were highly similar in their phonetic structure. Phonetic dissimilarity was determined by *the focusing differences in consonant and vowel structures within each word.*

Table 5.4: Mean scores for phonetic dissimilarity

Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev	Word	Mean	Stdev
Bhala	1.0000	.00000	hamba	1.0000	.00000	ncama	1.0000	.00000	thenga	1.000	.00000
Bhaka	1.0000	.00000	hleka	1.0000	.00000	netha	1.0000	.00000	thanda	1.2000	.44721
bhema	1.5000	.89443	hoya	1.8000	1.09545	ngena	1.2000	.44721	thola	1.0000	.00000
Biza	1.0000	.00000	hlala	1.4000	.89443	nuka	1.0000	.00000	thula	1.0000	.00000
Bona	1.0000	.00000	hluba	1.0000	.00000	nyanga	1.0000	.00000	thela	1.2000	.44721
Buza	1.0000	.00000	hlupha	1.0000	.00000	nyama	2.0000	.00000	thatha	1.5000	1.34164
Bheka	1.0000	.00000	hola	1.0000	.00000	ndiza	1.0000	.00000	tslala	1.8000	1.09545
Banga	1.0000	.00000	hlenga	1.0000	.00000	pheka	1.2000	.44721	vala	1.000	.00000
Bola	1.0000	.00000	jika	1.0000	.00000	phezu	1.0000	.00000	vuka	1.0000	.00000
cela	2.6000	.00000	jula	1.8000	1.09545	phupha	2.6000	.89443	vula	1.000	.00000
Cacha	2.6000	.89443	jeza	1.0000	.00000	phuma	2.6000	0.0000	vuma	1.0000	.00000
cwewa	2.6000	.89443	jaha	1.0000	.00000	phosa	1.0000	.00000	veza	1.4000	.89443
Cinga	1.0000	.00000	khanya	1.0000	.00000	phapha	2.8000	.44721	Wawa	1.800	1.09545
Chela	1.0000	.00000	kheta	1.5000	1.09545	phuza	2.000	2.8000	Washa	1.000	.00000
Dinga	1.0000	.00000	khiye	1.0000	.00000	phansi	2.000	.00000	Wina	1.000	.00000
Dlala	1.2000	.44721	khola	1.8000	1.09545	pheza	1.0000	.00000	woza	1.0000	.00000
Donsa	1.0000	.00000	khaba	1.0000	.00000	qala	1.0000	.00000	xoxa	2.6000	.89443
Dansa	1.0000	.00000	khala	1.0000	.00000	qeda	1.0000	.00000	xola	1.0000	.00000
Duda	2.8000	.44721	khipa	1.0000	.00000	qoba	1.0000	.00000	xosha	1.0000	.00000
Dula	1.0000	.00000	klekha	3.0000	.00000	qonda	1.0000	.00000	yeba	1.0000	.00000
Faka	1.0000	.00000	lala	2.8000	.44721	quela	1.6000	1.34164	yeka	1.0000	.00000
Funa	1.0000	.00000	landa	1.0000	.00000	qhaqha	2.8000	.44721	yifa	1.0000	.00000
Funda	1.0000	.00000	letha	1.0000	.00000	qina	1.0000	.00000	yosa	1.0000	.00000

Table 5.4 continued

futhi	1.5000	.00000	**lima**	1.0000	.00000	**shaya**	1.0000	.00000	**yanga**	1.000 0	.00000
fika	3.0000	.00000	**linda**	1.0000	.00000	shesha	2.6000	.89443	**yenza**	1.000 0	.00000
Finya	1.0000	.00000	**loya**	1.0000	.00000	**siza**	1.4000	.89443	**yona**	1.000 0	.00000
Ganga	2.0000	1.00000	**luma**	1.0000	.00000	**senga**	1.0000	.00000	Zakhe	2.200	1.09545
Gcina	1.0000	.00000	**lunga**	1.0000	.00000	**sula**	1.0000	.00000	Zosha	2.200	1.09545
Geza	1.0000	.00000	**lapha**	1.0000	.00000	**sefa**	1.0000	.00000	Zabo	2.200	1.09545
Goba	1.0000	.00000	Manje	2.6000	.00000	**shiya**	1.0000	.00000			
Gcaca	2.6000	.89443	Mina	2.0000	1.0000	**sika**	1.0000	.00000			
Gqoka	1.0000	.00000	muva	2.0000	.00000	**sina**	1.0000	.00000			
Gxeka	1.0000	.00000	**mila**	1.0000	.00000	**shada**	1.0000	.00000			
qaqa	2.600	.89443	**minya**	1.0000	.00000	susa	2.6000	.89443			

Careful analysis of each of the mean ranks presented above resulted in the selection of the following 58 words to be included in aim two of the study. The 73 words that did not meet the criteria were excluded from the study. The 58 selected words included, satisfied the criteria for familiarity, tone and phonetic dissimilarity. These words are presented in Table 5.5 below.

Table 5.5 Selected words for objective three of the study.

banga	hlala	loya	veza
bheka	hleka	lunga	vula
bhema	hlenga	minya	vuma
chela	hluba	pheka	washa
cinga	hola	phonsa	wina
dansa	jaha	qoba	xola
dinga	jeza	sefa	yanga
donsa	khaba	shada	yeba
faka	khanya	shaya	yeka
finya	kheta	thanda	yenza
geza	khipa	thatha	yifa
goba	landa	thela	yona
gonda	letha	thenga	yosa
gqoka	lima	thola	
gxeka	linda	vala	

In addition to the above result, the researcher measured the reliability of the ratings across all five linguists. The measurement tool used was the Kendall's W or coefficient of concordance. Kendall's W, or coefficient of concordance, was developed as a measure of association, with the N blocks representing Number of independent judges or raters, each one assigning ranks to the same set of K applicants (Kendall & Babington-Smith, 1939). Kendall's W measures the extent to which the number of judges agrees on their rankings of the K applicants. The Kendall's statistic was considered as it is a measure of the association among the raters. Furthermore, the data for the present study obtained was ordinal in nature, as there were three levels with natural ordering e.g. very familiar, not so familiar and unfamiliar. Table 5.6 below indicates the classification system used for the grading of the Kendall's W score. The results obtained for the co-coefficients of concordance for each criterion is presented.

Table 5.6 Classification of Kendall's W Score

Value of kappa	**Value of Kendall**	**Strength of agreement**
<0.20	-1.0 to -0.2	Poor
0.21-0.40	-0.6 to -0.2	Fail
0.41-0.60	-0.2 to 0.2	Moderate
0.61-0.80	0.2 to 0.6	Good
0.81-1.0	0.6 to 1.0	Very Good

5.2.2.1 Familiarity

The test statistic below indicates that a W score 0.823 was obtained. This implies that a very good agreement existed among all five raters for the criteria of familiarity. The agreement is noted at 0.05 level of confidence (Assyp.Sig= 0.000<0.05). Therefore, the null hypothesis is rejected with 95 % confidence level. This suggests that there was little difference among the raters with regard to the rating of the words for familiarity. Therefore, we can accept the contention that words rated as highly familiar were reliable and could be included in objective three of the study.

H0: co-efficient of concordance = 0

H1: co-efficient of concordance # 0

Test Statistics

N	5
Kendall's W[a]	.823
Chi-Square	481.488
df	117
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

5.2.2.2 Tone

The test statistic below shows N = 5. This implies that there were 5 raters. The coefficient of concordance is 0.431 which implies that there was a moderate agreement among the 5 raters for the criteria of tone, which is significant at the 5% level of significance (asymp. sig. = 0.000 < 0.05). Therefore, the null hypothesis is rejected with 95% confidence. These results suggest that there were no significant differences in the rating of the tone of the words, even though the agreement was moderate as compared to very good agreement in the familiarity aspect. The researcher could therefore accept the contention that the words rated as low tone words were reliable and valid for inclusion in objective three of the study.

H0: co-efficient of concordance = 0

H1: co-efficient of concordance # 0

Test Statistics

N	5
Kendall's W[a]	.431
Chi-Square	252.067
df	117
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

5.2.2.3 Phonetic dissimilarity

The test statistic below shows N = 5. This implies that there were 5 raters. The coefficient of concordance is 0.665 which implies that there is a good agreement among the 5 raters. This is significant at the 0.05 level of significance (asymp. sig. = 0.000 < 0.05) Therefore, the null hypothesis is rejected at 95% confidence level.

H0: co-efficient of concordance = 0

H1: co-efficient of concordance # 0

Test Statistics

N	5
Kendall's W[a]	.665
Chi-Square	388.906
df	117
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

In summary, objective two indicated mean ranks for the three criteria i.e. familiarity, phonetic dissimilarity and low tone. In addition the level of agreement among the raters for each criterion is presented above. There was agreement among the raters for all three criteria, with very good agreement for familiarity, good agreement for phonetic dissimilarity and moderate agreement for tone. The 58 words selected as a result of the analysis of objective two were considered for aim two, objective one i.e. the measurement of homogeneity

5.3 Aim two: Assessment of the developed word list and acoustic analysis of the words

5.3.1 Objective 1: Measurement of homogeneity with respect to audibility

This step of the analysis draws its conclusions from a logistic regression. This was used since the data was binary in nature. The words selected from the analysis of objective 2 in aim one were presented to the participant via the recorded CD. Participants were asked to respond. A correct response was recorded as a yes (1) and an incorrect response as a no (0). A sample size of 58 words was admitted to this objective.

These 58 words are listed in Table 5.5 above. There were 3 raters used to assess the audibility of the words. Each word was recorded at different sound intensity levels i.e. at 0dB 5dB, 10dB, 15dB and 20dB (see section 4.5.2.1.7, p.86). Each rater indicated a 1 (yes) if the word was repeated *perfectly* back to them by the participant and recording a 0 (no) otherwise. The Kappa Test of agreement was done to assess the consistency of the raters. The Kappa test was chosen since the responses were binary (nominal) and since the categories (yes/no) were not ordinal in nature. The results of the test of agreement can be found in (Appendix O).

The above test showed nothing less than good agreement among the raters. In light of the good agreement among all of the raters, it was decided that data from only one of the raters would be used. The first rater's data was selected.

This rater is one of the first language Zulu speakers who rated the words. The data was considered for logistic analysis.

The results of the logistic regression would hold true for the other raters, since they agreed so closely with each other's rating. Thus, analysis was carried out at 0.05 level of significance on each of the words. Fifty eight logistic equations and graphs were drawn up for this section (Appendix P).

5.3.1.1 The analysis of homogeneity of audibility using regression analysis.

In order to understand the background to the use of regression analysis and for the details on the development of the regression equation the reader to is referred to Appendix K. There were 30 respondents who listened to each of the 58 words at the 5 presentation levels mentioned earlier. Therefore, for the word, /banga/ there was 150 observations. Thus, there were 150 observations for each of the words. Each of these 58 words was then subjected to the logistic regression. The estimates of the regression model are indicated in Table 5.7 below. All slopes and intercepts were significant at the 0.05 level of significance. The calculations of the threshold intensity and slope are also given below. These values are calculated from the equations in Appendix K. Table 5.8 indicates the slope obtained at 50%, the slope at 20 to 80% and the estimated threshold according to the mathematical model for each of the words.

Table 5.7 Estimates of the regression model

Word	α	β	Word	α	β
banga	**-2.393**	**0.227**	linda	-2.267	0.24
Bheka	-1.351	0.179	**loya**	**-3.017**	**0.237**
Bhema	**-1.586**	**0.173**	lunga	-3.856	0.262
Chela	-3.014	0.307	**minya**	**-3.662**	**0.237**
cinga	**-2.91**	**0.258**	pheka	-1.897	0.162
dansa	-1.974	0.222	**phonsa**	**-2.001**	**0.175**
dinga	**-2.7**	**0.133**	qoba	-1.105	0.203
donsa	-2.165	0.234	**sefa**	**-1.817**	**0.077**
faka	**-0.283**	**0.257**	shada	-1.978	0.304
finya	-3.268	0.175	**shaya**	**-0.433**	**0.186**
geza	**-1.85**	**0.228**	thanda	-1.729	0.156
goba	-1.827	0.168	**thatha**	**-2.689**	**0.242**
gonda	**-2.578**	**0.617**	thela	-2.877	0.271
gqoka	0.104	0.167	**thenga**	**-2.871**	**0.353**
gxeka	**-1.121**	**0.3**	thola	-2.313	0.439
hlala	0.921	0.214	**vala**	**-1.199**	**0.216**
hleka	**-1.205**	**0.19**	veza	-3.942	0.273
hlenga	-2.347	0.226	**vula**	**-2.794**	**0.207**
hluba	**-2.587**	**0.193**	vuma	-2.527	0.195
hola	-2.524	0.178	**washa**	**-1.109**	**0.383**
jaha	**-2.197**	**0.22**	wina	-3.401	0.26
jeza	-2.94	0.322	**xola**	**-2.262**	**0.321**
khaba	**-2.013**	**0.288**	yanga	-1.908	0.261
khanya	-1.385	0.229	**yeba**	**-2.566**	**0.261**
kheta	**-2.227**	**0.26**	yeka	-2.061	0.316
khipa	-2.581	0.254	**yenza**	**-2.222**	**0.214**
landa	**-1.377**	**0.178**	yifa	-2.024	0.154
letha	-2.334	0.206	**yona**	**-2.94**	**0.322**
lima	**-2.288**	**0.158**	yosa	-3.489	0.2

Table 5.8 Summary of the slope at 50%; slope at 20 to 80% and the estimated threshold.

Word	Slope a 50% (0.5*0.5*b)*100	Slope at 20 or 80%: (0.2*0.8*b)*100	(-)a/b = threshold	Word	Slope a 50% (0.5*0.5*b)*100	Slope at 20 or 80%: (0.2*0.8*b)*100	(-)a/b = threshold
banga	5.675	**3.632**	10.542	linda	6.000	**3.840**	9.446
Bheka	4.475	**2.864**	7.547	**loya**	5.925	**3.792**	12.730
Bhema	4.325	**2.768**	9.168	lunga	6.550	**4.192**	14.718
Chela	7.675	**4.912**	9.818	**minya**	5.925	**3.792**	15.451
cinga	6.450	**4.128**	11.279	pheka	4.050	**2.592**	11.710
dansa	5.550	**3.552**	8.892	**phonsa**	4.375	**2.800**	11.434
dinga	3.325	**2.128**	20.301	qoba	5.075	**3.248**	5.443
donsa	5.850	**3.744**	9.252	**sefa**	1.925	**1.232**	23.597
faka	6.425	**4.112**	1.101	shada	7.600	**4.864**	6.507
finya	4.375	**2.800**	18.674	**shaya**	4.650	**2.976**	2.328
geza	5.700	**3.648**	8.114	thanda	3.900	**2.496**	11.083
goba	4.200	**2.688**	10.875	**thatha**	6.050	**3.872**	11.112
gonda	15.425	**9.872**	4.178	thela	6.775	**4.336**	10.616
gqoka	4.175	**2.672**	-0.623	**thenga**	8.825	**5.648**	8.133
gxeka	7.500	**4.800**	3.737	thola	10.975	**7.024**	5.269
hlala	5.350	**3.424**	-4.304	**vala**	5.400	**3.456**	5.551
hleka	4.750	**3.040**	6.342	veza	6.825	**4.368**	14.440
hlenga	5.650	**3.616**	10.385	**vula**	5.175	**3.312**	13.498
hluba	4.825	**3.088**	13.404	vuma	4.875	**3.120**	12.959
hola	4.450	**2.848**	14.180	**washa**	9.575	**6.128**	2.896
jaha	5.500	**3.520**	9.986	wina	6.500	**4.160**	13.081
jeza	8.050	**5.152**	9.130	**xola**	8.025	**5.136**	7.047
khaba	7.200	**4.608**	6.990	yanga	6.525	**4.176**	7.310
khanya	5.725	**3.664**	6.048	**yeba**	6.525	**4.176**	9.831
kheta	6.500	**4.160**	8.565	yeka	7.900	**5.056**	6.522
khipa	6.350	**4.064**	10.161	**yenza**	5.350	**3.424**	10.383
landa	4.450	**2.848**	7.736	yifa	3.850	**2.464**	13.143
letha	5.150	**3.296**	11.330	**yona**	8.050	**5.152**	9.130
lima	3.950	**2.528**	14.481	yosa	5.000	**3.200**	17.445

SUMMARY STATISTICS	Slope a 50%	Slope at 20 or 80%:	Threshold Intensity
Mean	5.986	3.831	9.657
Standard deviation	2.037	1.304	4.850
Maximum	15.425	9.872	23.597
Minimum	1.925	1.232	-4.304
Range	13.500	8.640	27.901

The above table provides data to indicate that on average the estimated threshold intensity at which all the words were heard was 9.66 dBHL. On average the 50% correct perception occurred at about 9.66dBHL. The slope at 50% was an important statistic to calculate, since it represents the steepest slope on the logistic curve. This indicates that the rate of change is greatest at this point. For a unit change in x (intensity level) we see the largest increase in the probability of audibility (p(x) = 1). The measurement of homogeneity of the word list is dependent on those chosen to have a steep threshold slope.

The mean slope at 50% was found to be 5.986%/dB. The standard deviation was noted to be 2.037. Therefore, the words that were above the mean slope were considered for aim three of the study. These words had the steepest slope and satisfied the criterion of homogeneity of audibility. Twenty eight words were therefore considered fairly homogenous on the basis of the above analysis. The performance intensity curve for all 58 words is indicated in (Appendix P). These graphs included additional intensity levels. Using the logistic model estimates, any intensity level could be picked and the percentage correct could be predicted using equation (2) (see Appendix K). Furthermore, the performance intensity curves for the words selected as most homogenous are presented below in Figure 5.4. Figure 5.5 illustrates the performance intensity curves for the words not selected. The mean slope of the words selected as indicated in Figure 5.4 below was 5.9865%/dB. This figure also clearly indicates that the words selected had the steepest slope compared to the words not selected in Figure 5.5. Figure 5.5 indicates that the slope at 50% for each of the words was more gradual. The gradual slope indicates that for these words to be identified correctly the words had to be presented at higher intensity levels compared to the words identified as being most homogenous.

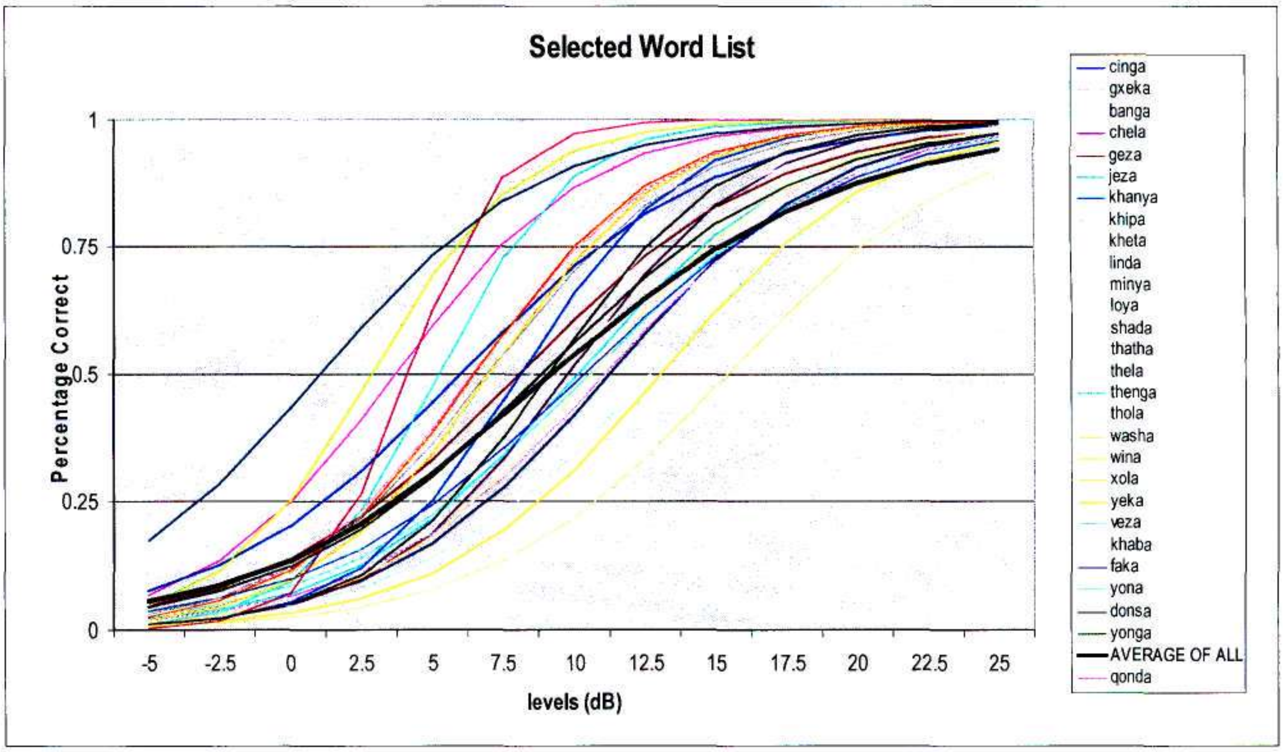

Figure 5.4 Performance intensity curves for Zulu words selected

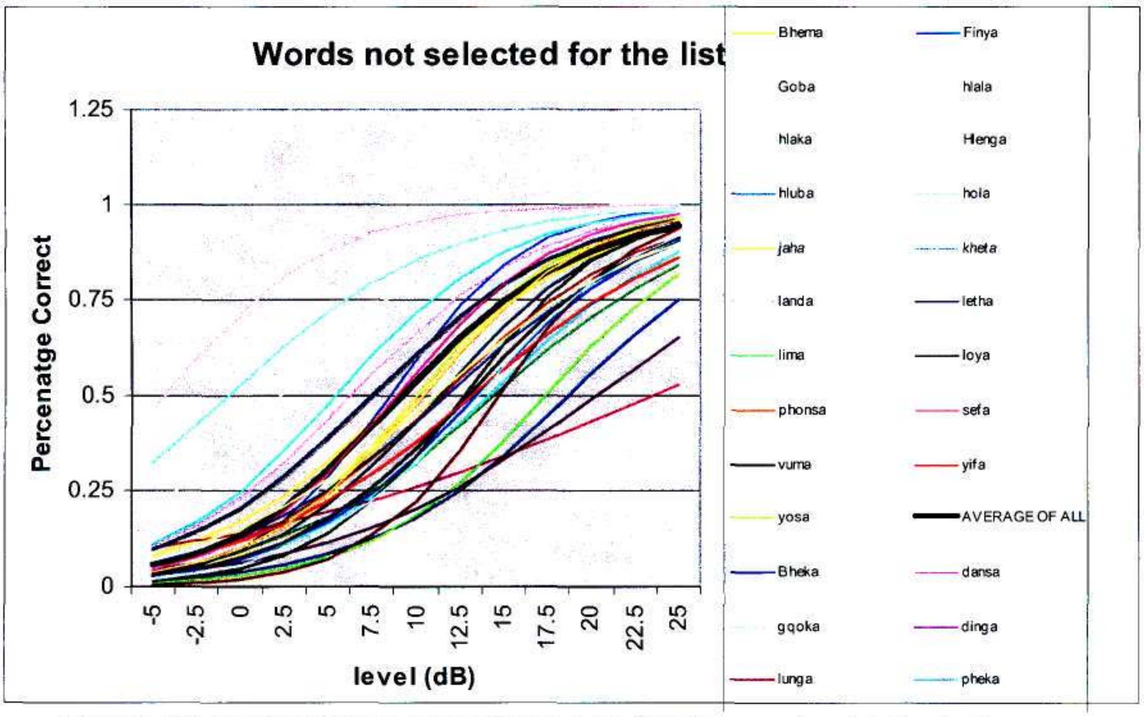

Figure 5.5 Performance intensity curves for the word not selected

5.3.2 Objective 2: Acoustic analysis of the words

The twenty eight words selected in objective one above was analyzed acoustically (see Appendix L for an example of one of the words). The pitch contour levels and energy levels have been measured for each word. Table 5.10 indicates the results obtained for each of the twenty eight words. The results indicate the pitch value for syllable one and two for the twenty eight selected words. In addition the energy values for each syllable are also indicated in the table. The majority of the words (89%) indicate a relatively lower pitch value in the first syllable compared to the second syllable. The pitch values in Table 5.10 also indicate a difference between syllable one and two. The magnitude of the difference value confirms the change in pitch between syllable one and two. The majority of the words (89%) show a similar pattern regarding pitch, which may confirm prosodic patterns of Zulu. A mere 11% (3/28) did not indicate this pattern. This finding could have been influenced by the speaker placing artificial stress on the first syllable, similar to a spondee word. This limitation was expected as the speaker was a student of Audiology and the common use of spondee words in clinical practice may have influenced this production. The energy values of the vowels in each syllable also indicated a difference between syllable I and 2. Generally, a higher energy value was noted in the second syllable of the words with exception of 7 of the words. The difference in the energy values obtained may also be due to the prosodic features of Zulu, whereby in isolation low tone verbs may indicate lengthening of the penultimate syllable and therefore prominence is noted in the second syllable.

Table 5.9 Pitch and energy values: Syllable 1 and 2

No	**Word**	**Pitch value Syllable 1**	**Pitch value Syllable 2**	**Difference in Pitch between syllables**	**Energy value Syllable 1**	**Energy value Syllable 2**	**Difference in energy values between syllables**
1	Banga	107	113	**6**	67.83	73.9	**10.1**
2	Gxeka	107	144	**37**	69.75	73.0	**3.5**
3	cinga	176	125	**51**	73.91	67.4	**6.5**
4	khanya	81	106	**25**	68.05	67.01	**0.9**
5	thela	106	135	**29**	60.3	68.8	**8.5**
6	khaba	108	132	**24**	69.12	75.4	**6.2**
7	kheta	104	125	**21**	55.1	60.9	**5.8**
8	jeza	79	152	**73**	69	69.18	**0.2**
9	donsa	139	93	**46**	69.9	69.31	**0.6**
10	khipa	85	121	**36**	66.38	72	**5.6**
11	chela	82	130	**48**	60.25	74.06	**13.6**
12	xola	109	131	**22**	66.64	60.3	**1.3**
13	yonga	88	104	**16**	70,28	69.26	**1.0**
14	yona	88	104	**16**	66.26	67.6	**1.3**
15	linda	87	98	**11**	65.91	66.08	**0.8**
16	veza	91	97	**6**	68.63	75.3	**6.7**
17	loya	106	127	**21**	72.06	63.6	**8.5**
18	thenga	151	141	**10**	60.2	46.1	**14.2**
19	wina	108	136	**27**	52.3	61.2	**8.9**
20	faka	81	106	**25**	68.63	75.8	**72**
21	washa	87	98	**11**	66.65	67.6	**0.9**
22	yeka	82	130	**48**	66.38	72	**5.6**
23	minya	105	151	**46**	49.2	56.9	**7.7**
24	thola	96	130	**34**	66.64	70.81	**4.2**
25	shada	85	121	**36**	70.26	74.81	**4.6**
26	thata	85	127	**42**	68.63	74.81	**6.2**
27	qonda	107	139	**32**	69.75	72.81	**3.1**
28	geza	109	146	**37**	66.71	69.1	**7.4**

In summary, Phase one of the study focused on the identification of common words, selection of the Zulu words and the assessment of the word list. This phase was divided into two aims with several objectives. Objective one was to identify common bisyllabic words in Zulu. One hundred and thirty one bisyllabic words were suggested by four participants. These words were analyzed through a 50% inclusion and exclusion criteria. Objective two focused on the rating of the words according to the SRT criteria for Zulu i.e. familiarity, phonetic dissimilarity and tone. This was achieved using linguistic experts. The mean ranks were documented in Table 5.2, 5.3, 5.4. In addition the reliability across the raters was measured and the agreement was generally good according to the Kendall's W score. The analysis of the mean ranks resulted in 58 words being selected for aim two of the study. These words were assessed for homogeneity of audibility. A mathematical equation was generated using the regression model discussed in Appendix K. Detailed tables and graphs indicate the measurement of the homogeneity of audibility and 28 words were finally selected. The acoustic analysis of the twenty eight words was described in Table 5.9. The majority of the words (89%) were identified to have similar pitch patterns i.e. low pitch in the fist syllable and higher pitch in the second syllable. Clearly there is a difference between the two syllables. The energy contours also indicate difference between the two syllables.

5.4 Aim three: Application of the SRT words to normative clinical population

The outcome of the analysis in phase one of the study indicated that twenty-eight words satisfied the criteria described in the study for the development and assessment of a suitable SRT word list in Zulu. The aim of phase two of the study however, was to determine the application of the 28 words selected in Phase one. The 28 words were utilized as a clinical tool to obtain an SRT in Zulu.

This was established by obtaining the SRT in 26 normal hearing Zulu First Language speaking participants. In order to complete this clinical task, the 26 participants underwent a standard hearing evaluation. The details of the hearing evaluation procedure were documented in the methodology chapter. Further, in order to assess or evaluate the application of the words, the 26 participants were also evaluated for SRT using the Standard English CIDW-2 word list. The outcome of the hearing assessment and the scores obtained for SRT in English and Zulu allowed the researcher to assess the relationship between the SRT (Zulu) to that of the gold standard viz. pure tone averages, as well as to assess the relationship of the SRT (English) to the gold standard viz pure tone averages.

The following section highlights the results obtained for phase two of the results. This section is presented in terms of the objectives for phase two. The objectives for phase two were:

5.4.1 The evaluation of the relationship between the pure tone averages and the scores obtained for SRT in Zulu for normal hearing ZFLS.
5.4.2 The evaluation of the relationship between the pure tone averages (PTA) and the scores obtained for SRT in English for normal Hearing ZFLS.
5.4.2 A comparison of the relationship between the PTA and SRT (Zulu) scores versus the relationship between the PTA and SRT (English) scores in ZFLS.

The results of this phase of the study are presented according to the overall aim and objectives. Twenty-six participants were included in this phase of the study. The twenty-six participants presented with normal hearing thresholds bilaterally. The results obtained for the twenty-six participants were in terms of the pure tone thresholds and the speech reception threshold scores for the Zulu word list and the English word list. For the purposes of this study the pure tone averages (average of the pure tone values for 500Hz, 1000Hz, and 2000Hz) were used in the analysis process.

5.4.1. The evaluation of the relationship between pure tone averages and the SRT scores when the Zulu word list was used for ZFLS.

Appendix Q indicates the PTA and SRT scores using the Zulu word list for both the right and left ears for the 26 participants. There were minimal ear differences noted for all 26 participants viz. less than 5dB difference. Therefore, the scores for both ears were grouped and the N value for the number of normal hearing ears tested and analyzed was raised to fifty-two.

Table 5.10 indicates that mean for the PTA scores were 2.7552 with a standard deviation of 4.37494. The mean for the SRT sores in Zulu was 5.4808 with a standard deviation of 3.86787. The difference in the mean scores between the PTA and SRT was 2.7328.

Table 5.10 Mean values and Standard deviations for the PTA and SRT (Zulu) scores for the fifty-two ears evaluated.

	Mean	Standard Deviation	N
PTA	2.7552	4.37494	52
SRT (Zulu)	5.4808	3.86787	52

Furthermore, the relationship between the PTA and the Zulu SRT scores were analyzed using the Pearson r product moment correlation co-efficient. Table 5.11 below indicates the results of the Pearson r analysis. The Pearson r statistic as indicated is 0.769. Therefore, there is a fairly strong positive correlation between the PTA scores and the SRT scores for the Zulu word list. Further this correlation is significant at the 0.01 alpha level.

Table 5.11 Analysis of the Pearson r correlation co-efficient for PTA and SRT (Zulu).

Correlations

		PTA	SRT_Z
PTA	Pearson Correlation	1	.769**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	976.144	663.970
	Covariance	19.140	13.019
	N	52	52
SRT_Z	Pearson Correlation	.769**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	663.970	762.981
	Covariance	13.019	14.960
	N	52	52

**. Correlation is significant at the 0.01 level

5.4.2 The evaluation of the relationship between the PTA and the SRT (English) list.

Appendix R documents the SRT score when the English word list was administered to the 26 participants. Appendix R includes the results for both the left and right ears. There were no significant ear differences noted i.e. less than 5dB across all participants. Therefore, the SRT scores for 52 ears were analyzed in relation to the 52 PTA scores obtained.

Table 5.12 Mean values and Standard deviations for the PTA and SRT (English) scores for the fifty-two ears evaluated.

	Mean	**Standard Deviation**	**N**
PTA	2.7552	4.37494	52
SRT (English)	10.000	4.74858	52

The mean score for the PTA was 2.7552 with a standard deviation of 4.37494 as indicated in Table 5.11 and Table 5.12. However, the mean for the SRT when the English words were used was 10.00 dB with a standard deviation of 4.74858. The difference between the mean of the PTA and the mean of SRT (English) scores was 7.2448. Further analysis of the relationship between the

PTA and SRT English scores were done using the Pearson r moment correlation co-efficient. The results of the Pearson statistic analysis is tabulated below in Table 5.13. The Pearson statistic for the PTA and SRT (English) was 0.629. This indicates that there was a correlation between the two scores at an alpha level of 0.01. However, the strength of the correlation for the PTA and SRT (English) 0.63 was weaker than the strength of the correlation obtained between PTA and SRT (Zulu scores) viz. 0.76.

Table 5.13 Analysis of the Pearson r correlation co-efficient for PTA and SRT (English)

Correlations

		PTA	SRT_E
PTA	Pearson Correlation	1	.629**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	976.144	666.050
	Covariance	19.140	13.060
	N	52	52
SRT_E	Pearson Correlation	.629**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	666.050	1150.000
	Covariance	13.060	22.549
	N	52	52

**. Correlation is significant at the 0.01 level

5.4.3 The comparison of the relationship between the PTA and SRT for Zulu and the relationship between PTA and SRT (English)

In addition to the above analysis the relationship between the PTA and SRT (Zulu) and SRT (English score was analyzed using descriptive statistics. Traditionally and clinically the SRT is compared to the pure tone average using the Carhart (1965) correlation data. The present study utilized the correlation figures as a guideline to describe qualitatively the relationship outlined above.
Table 5.14 describes the percentage of participants who obtained a PTA versus SRT score in terms of the broad classification described by Carhart (1965). The table documents percentages for both the SRT (Zulu) and for the SRT (English). From Table 5.14 below, it is clear that there is a higher percentage

(94%) in terms of the +/- 5dB level for the Zulu SRT and PTA relationship when compared to the SRT (English) and PTA. Moreover, 42% of the participants obtained +/-10dB difference for SRT (English) and PTA compared to a mere 5.7% when the SRT (Zulu words were used.

Table 5.14 Qualitative analysis of the PTA and SRT correlation

Classification	**PTA Vs SRT (Zulu)**	**PTA Vs SRT (English)**
+/- 5dB	94.2%	58%
+/-10dB	5.7%	42%
> 10dB	0%	0%

In addition to the above correlation, inferences can be drawn. While both lists i.e. Zulu and English indicated a high positive correlation with that of the PTA for the fifty two ears evaluated, the strength of the correlation is different. The strength of the correlation for Zulu words was 0.76 which is greater than the strength of 0.629 for the English words. This difference however, is more clearly exemplified when the results are viewed qualitatively. A higher percentage of participants showed a closer relationship between the SRT (Zulu) and PTA than SRT (English) and PTA.

In summary the phase two results indicate that there was a high positive correlation at a 0.01 level for both the SRT (Zulu and SRT (English) compared to the PTA. However, closer examination of the Pearson r statistic indicates that the strength of the correlation for the Zulu SRT and PTA is stronger statistically than the SRT (English) and PTA. The higher number of participants obtaining a +/-5dB difference in the scores confirms the strength of the relationship. The forthcoming chapter would include a discussion of the above findings.

CHAPTER SIX: DISCUSSION

6.1 INTRODUCTION

The preceding chapter documented the results obtained in the study according to the aims described in the methodology section. The following chapter aims to provide the discussion of the results, with reference to the literature on the development of speech reception threshold materials. This chapter is presented according to the aims and objectives of the study.

6.2 Aim one: To develop a Zulu SRT word list

This aim was achieved through two objectives i.e.

- the identification of commonly used bisyllabic words in Zulu;
- the selection of Zulu words that were familiar, phonetically dissimilar and low tone verbs

In order to achieve the aim of developing a suitable word list for SRT in Zulu, the researcher had to consider both linguistic variables and audiological principles inherent in the development of SRT materials. This implies that the process of developing a word list for SRT in any language requires insight into the linguistic structure of the language (Knight, 1997). The criteria stipulated for an SRT word list should depend on what is linguistically permissible. Furthermore, the historical criteria suggested for the SRT word list in English could not be applied generically to all languages, due to the structural variability that exists in languages. This premise is widely supported by previous research conducted in languages other than English, as indicated by Nissan et al. (2005).

Thus, for the present study, an adaptation of the original SRT criteria was required, as the linguistic structure of Zulu showed that firstly, stress patterns in Zulu do not have a specific role linguistically. Stress is not used to differentiate the words or syllables (Cope, 1982). The fact that stress in Zulu may occur only on one syllable of the word suggests that there would be difficulty selecting words that have equal stress. Thus, the prospect of finding spondee words (equally stressed words) in Zulu within the present study was not likely.

Secondly, the syllable structure of the Zulu language indicates that most noun classes are trisyllabic as compared to nouns in English, which are bisyllabic. It was therefore deemed necessary within the present study to maintain the criteria of bisyllabic words and to adapt the criteria of the word class selected viz. verbs instead of nouns, as this was possible in terms of the language. Bisyllabic nouns in Zulu are few, due to most noun classes having a prefix formative. This results in the syllable structure becoming trisyllabic. The dominance of bisyllabic verbs over bisyllabic nouns was clearly demonstrated in the pre-selection of the words in objective one of this study, where the majority of the words selected were verbs (82%) as indicated in Figure 5.3 in chapter five p. 99. This dominance of bisyllabic verbs in Zulu is prevalent in most Nguni languages (Jacobson & Trail, 1986).

Locally, studies conducted in the Nguni languages with regards to SRT and other speech audiometry materials generally have used bisyllabic verbs as the choice of word class. These studies include (Madden, 1996; Balkisson, 2001; Chetty, 1990). While the Madden (1996) and Balkison (2001) studies focused on speech discrimination, the arguments for the choice of verbal commands is relevant. The relevance of the argument is based on the fact that Xhosa and Zulu are both Nguni languages and thus share very close linguistic structures. Both these studies argued for the use of bisyllabic verbs for speech discrimination testing in Xhosa on the basis of the availability of the verbs as a word class.

Chetty (1990), however, compared bisyllabic verbal commands and trisyllabic nouns for SRT testing, using the same argument of availability in the language. The diversity of the word choices made in some of the local and international studies with regards to SRT and speech audiometry materials is reflected in Table 6.1. This diversity of word class and syllable structure supports the claim made by Nissan et al. (2005) that the criteria for word selection for speech audiomtery word list should suit the linguistic structure of the language. These arguments were supported in the present study, as indicated in objective one of the study. Four participants were easily able to generate a total word pool of 505 bisyllabic words, with the majority of the words (82%) being verbs (see Figure 5.3 in chapter 5 p. 99)

Table 6.1 Diversity of word class and syllable structure in studies conducted locally and internationally.

Researcher/s	**Language**	**Word-class & Syllable structure used for the word list**
Liden (1954)	Swedish	Bisyllabic nouns (SRT)
Kapur (1971)	Hindi	Bisyllabic nouns (SRT)
Myunga (1974)	Lingala (Central African Language)	Bisyllabic words (SRT)
Ashoor &Proshazka (1985)	Arabic	Bisyllabic nouns (SDT)
Plant (1990)	Walpiri and Tiwi	Bisyllabic nouns (SRT and SDT).
Cardenas& Marreco, 1993	Castillian, Spanish	Trisyllabic and Polysyllabic words nouns (SRT)
Chetty (1990)	Zulu	Trisyllabic nouns and Bisyllabic verbs commands (SRT)
Madden (1996)	Xhosa	Bisyllabic verbs (SDT
Balkisson (2001)	Zulu	Bisyllabic verbs (SDT, children)
Nissan et al. (2005)	Mandarin	Trisyllabic nouns
Present study (Panday, 2006)	Zulu	Bisyllabic low tone verbs

The five-hundred and five bisyllabic words generated at this stage of the study appeared adequate, even though many of the words were repeated across the four participants. This was in accordance with the Madden (1996) study that generated 720 familiar words using similar methods of word pool generation, as indicated in the present study. The large word pool at the preliminary phase of the study prevents the final word list from being limited in number. The overall number of words selected has been documented as an important consideration for researchers and clinicians. This follows the argument that SRT scores improve significantly if there are a limited number of SRT words (fewer than 36) in the final word list (Punch & Howard, 1985). The underlying reason for the improvement is related to the possible learning effect as would be the case if there are too few words. Therefore, to prevent the learning effect, the present study supports the above contention of generating a large pool of words.

Thus, the number of words considered in the identification stage i.e. objective one of the study, was pertinent to the overall development of the test material for the assessment of SRT. In order to attain objective one of the study, however, the most common of the 505 words were required. An analysis of these words indicated that 26% (131) of the 505 words (see Figure 5.2 in chapter 5 p. 98) were included for objective two of the study. The 131 words identified met the inclusion criteria of being the most common bisyllabic words in Zulu for the KZN (Durban-Pietermarizburg dialect). While objective one was fulfilled, the common words selected were further considered for treatments in objective two and aim two of the study before a final word list was developed and assessed.

Seventy four percent of the words were excluded from the study due to the fact that two or more participants did not suggest them. This indicated that these words were not common across all four participants. In terms of the participant's selection criteria for this objective of the study, the four participants had knowledge of the Zulu language for the KZN (Durban-Pietermarizburg) dialect. Therefore, it was necessary that only words that were suggested by two or more participants would be considered, as this would ensure reliability of the choices made at a preliminary level.

Nonetheless, it could be argued that the exclusion of 74% of the words could possibly be related to the methodological choice made within the study i.e. only common words were selected. The literature however is not explicit about standard methods used. Knight (1997) suggests that words must be selected after careful analysis of written texts, articles and national radio and television newscasts. Furthermore, studies such as Hirsh et al. (1952) used dictionaries and word resources such as the 1000 most common words spoken in a language. The use of dictionaries and word resources has been known to historically generate large word pools that are representative of the most common words in a language. This method could be considered a good starting point for word selection. However, this method of selection is appropriate for languages where there are well-developed dictionaries and word list resources e.g. The English Thorndike's list of word frequency, used in the (Hirsh, 1952) study. The South African Zulu language literature has not yet come to consensus in so far as the most common words spoken in Zulu are concerned (R. Bailey, personal communication, September, 2006). In fact, this has also been reported in the Madden (1996) study of Xhosa word resources. Therefore, the paucity of such resources in the African languages has resulted in the researcher considering the present methods of word selection, by utilizing tertiary educators and Zulu language interpreters. This appears to have been a suitable alternative to the historical methods used and suggested by (Jacobson &Trail, 1986).

The use of speakers of the language to identify common words as indicated in the present study implies that the words generated may have more relevance in present times. Generating a word pool from the speakers of a language at the time would naturally result in the words being more familiar than if words were selected out of a dictionary that might have been developed many years prior to the study. This also supports the notion that vocabulary does indeed possess a "shelf life" and that all living languages change over time (Fromkin & Rodmin, 1993).

Furthermore, the concept of languages being dynamic and ever-changing has significance in the present study. A closer analysis of the common words selected indicate that a small percentage of the words (3.8 %) or (5/131) were words borrowed from English e.g. "wina". Thus, indicating that all words considered common may not be completely indigenous to the language. There is a different argument on borrowed words in the literature. Jacobson and Trail, (1986) argue that this percentage of words are usually small and should be excluded from the list. Balkisson (2001) also excluded borrowed words from the final list.

However, the present study considered the inclusion of borrowed words. The inclusion of the borrowing merely enhances the relevance of the list in terms being common, to the diverse Zulu-speaking clinical population. The support for the inclusion of borrowing in a language is limited to what linguists and language rights activists state i.e. that languages have developed over the years through "liberal borrowings from neighboring languages" (Alexander, 2006, p. 3). Zulu should be no different, especially when one considers the present state of globalization and acculturation within the South African context.

Therefore, the present researcher argues that while an indigenous word list for Zulu is relevant, the content of the words list must be highly familiar to the population for which it is meant for. This argument also illustrates that researchers could possibly run the risk of excluding highly familiar and common words should their methodological design follow rigid and traditional methods of relying on dictionaries and standard dialects. These standard dialects are often spoken on newscasts for television and radio, which would exclude words that may be borrowed from another language.

The results obtained in objective one of the study, therefore, indicate that careful consideration of the linguistic structure of that language is certainly relevant in word list development. In addition, this study demonstrated that in the development phase of a word list, the researcher has to develop astute methods of generating the word list. While adhering to linguistic and audiological principles for word choices, reliability and validity in the data are ensured. Therefore, within the present study the 131 words selected were considered as a preliminary selection. Thereafter, careful rating of the words by expert linguists on the criteria of familiarity, phonetic dissimilarity and tone of the words was conducted and this related to objective two of the study.

For objective two of the study the 131 words were rated by five linguists on the linguistic criteria of familiarity, phonetic dissimilarity and low tone verbs. Mean scores were obtained for each word across the five raters on each criteria stipulated. In rating the 131 words, words with a rating score of 1.5 or less for each criterion was selected to be included into aim two of the study.

Table 5.2 in Chapter 5 documents the means scores for the 131 words for the criterion of familiarity. It would appear that 106/131 (81%) of the words were rated with a score of 1.5 or less on the Likert rating scale across all five raters. Eighty four percent of the words in the pre-liminary list were regarded as very familiar and a mere 19% were indicated as being unfamiliar. This high percentage of words (81%) that were rated as very familiar confirms that these words identified by participants in objective 1 are common to the KZN Zulu speaking population. This result also reinforces the contention that words considered most common in everyday environment can be considered to be the most familiar words in that environment (Wilson & Margolis, 1983).

The criterion of familiarity was historically included as an important criterion for the development of materials for SRT. Familiarity, unlike other standard criteria suggested, is often permissible in most languages irrespective of their linguistic structure. Therefore, within the present study, familiarity was maintained as a criterion as familiar bisyllabic verbs do occur in Zulu. This was clearly demonstrated from the responses in both objective one and two of the present study. The confidence in the responses of the raters was further indicated by the scores obtained for the Kendall's coefficient of concordance as indicated in the results section of the study. For familiarity of the words, there was a very good agreement amongst the raters as indicated by the Kendall's W score of 0.823, which implied that that a very good agreement existed among all raters. The agreement was noted at an alpha level of 0.05 level of confidence, therefore this meant that statistically, all raters agreed with each other at a high level of confidence. The agreement among the linguistic experts also adds validity for the selection of the words for the next aim of the study.

With regard to familiarity of words in other studies, it would appear that researchers have relied on various methods for the selection of familiar words. Traditionally Hirsh et al. (1952) utilized a judging system whereby English words were rated on a Likert scale. A recent study conducted on Mandarin speakers selected familiar words on the basis of dictionaries that existed in their language. In addition the use of judges was only considered for screening the word list for culturally insensitive words which were deemed unfamiliar. However, in the present study taking into account the paucity of dictionaries that indicates the most frequently occurring bisyllabic verbs in Zulu, having all the 131 words rated for familiarity by linguistic experts was a suitable alternative. This method has been used in two previous South African studies that developed a Xhosa speech discrimination word list and a Zulu speech discrimination word list respectively.

While the mean ratings for the familiarity of the words indicated that the majority of the words were highly familiar, the selection of the words for aim two of the study was also dependent on the tone and phonetic dissimilarity of the words. Low tone verbs were introduced as an adapted criterion for SRT words in Zulu. This criterion was introduced after careful analysis of the linguistics of Zulu. As discussed earlier, Zulu has one main stress in most words, which prevents the language from having spondee words. However, after consultation with a linguist of Zulu it would appear that low tone verbs allows for the lengthening of the penultimate syllable, thus allowing for the final syllable to gain prominence. Tone is a complex phenomenon in Zulu and even linguists and users of the language have grave difficulty identifying tonal patterns (R. Bailey, personal communication, February, 2004). The complexity of the tone of Zulu is also expressed by Buell (2004). There are "scant sources for lexical tone in Zulu" (Buell, 2004, p.1).

This could possibly explain the results obtained within the present study with regards to the rating of the tone of the words. The moderate level of agreement among the linguists, i.e. the Kendall's w score of 0.431 is indicative that even linguistic experts differ with regard to low tone and high tone verbs. However, the agreement is still considered reliable at 95%

confidence level, indicating that the linguists had a moderate strength of agreement, but the level of agreement was not as strong as compared to the concept of familiarity. These results merely confirm the complexity of languages and also illustrate that developing a word list with adapted criteria requires extensive resources and expertise.

Nevertheless, the data obtained for the concept of tone was considered and the mean scores for the words indicated that 55% of the words were low tone verbs, thus, eliminating 45 % of the words. The 55% of the words indicated as low tone words were verified against a list of Zulu verbs with tone markers compiled by Buell (2004). However, 100% of the low tone verbs identified by the linguists in the present study were indicated as low tone verbs on the Buell (2004) list.

The use of low tone verbs was particularly relevant for the recording process and the subsequent delivery of the words to the participants via the audiometer. Low tone verbs, as discussed earlier allows for the lengthening of the penultimate syllable when the speaker produces the word in isolation. Thus, facilitating an almost equivalent peaking on the VU meter for each syllable. The inclusion of low tone verbs would therefore become an important criterion in terms of satisfying the audiological principle for SRT testing. The criteria for the selection of words within the present study, however, indicate that the words had to familiar, low tone verbs that were also phonetically dissimilar.

Historically, phonetic dissimilarity was included as a criterion for SRT materials in order to ensure that the test material varies in consonant and vowel combinations according to the language being used (Silman & Silverman, 1991). The variation in the phoneme structure, therefore, suggests that during the task of SRT testing, the words are identified on the basis of understanding the content of the word and not merely on discriminating the word. This implies that words following each other in a list should not be minimal pairs e.g.: /Hleka/, /Pheka/. Hence, words that were similar phonetically were traditionally excluded from word lists. The criterion of phonetic dissimilarity, like most of the other criteria, was stipulated as being suitable for the linguistic and phonetic structure of English. Traditionally, variability in the phoneme structure was easily achieved because of the number of consonants and vowel choices in the English language.

While the importance of phonetic dissimilarity is acknowledged, the choice of low tone verbs modifies the criterion for the present study. The concept of phonetic dissimilarity appears simple to achieve in the Zulu language, but the adoption of the criterion based on how it was originally conceptualized required adaptation in view of the choice of low tone verbs and the simple vowel system in Zulu.

The modification or adaptation was based on the scrutiny of the vowel system in Zulu. The Zulu language has a simple five-vowel system. A simple vowel system implies that the variability of the phonemes within and among the words may be limited. In the present study the inclusion of low tone verbs further limits the phonemes and structural variability of the words. This is so, since the majority of the low tone verbs in Zulu end in the same vowel /a/. e.g. Bhala, Bhema, Gqoka. Hence, the second syllable of most verbs in the list could potentially be very similar in phoneme structure. This suggests that words in the final list for Zulu would possibly have variability of consonants and vowels in the first syllable, but variability would be limited in the second syllable as illustrated in the example above.

However, Zulu has a much more complicated consonant system than English. In addition to the known sound system like fricatives, stops and plosives, Zulu has the prominent click sounds. The inclusion of the click sounds in the phoneme distribution of the words contributes to consonant variability in the words. Thus, within the present study, because of the importance of low tone verbs, the researcher concentrated on the variability of the consonant structure and to lesser extent on the variability of the vowel system. This standpoint was supported by the linguistic choices made within the study. However, to a large extent words that were included in the final word list demonstrated phonetic dissimilarity in accordance with the constraints of low tone verbs. Words such as /gcaca; ncama/ were eliminated and rated as very similar in phonetic structure by the linguists.

Thus, the above approach to phonetic dissimilarity was clearly supported by the linguistic experts rating the words in the study. This support was indicated by the overall results obtained from the linguist's rating of the 131 words for the criteria of phonetic dissimilarity.

The majority of the words, i.e. 102/131 were rated as phonetically dissimilar. Twenty seven percent of the words were indicated as phonetically similar. While the criterion of phonetic dissimilarity was possibly influenced or restricted by the choice of low tone verbs, there was certainly a good agreement among the raters. The good agreement was noted by the Kendall's co-efficient score of 0.665. The good agreement was significant at an alpha level of 0, 05 level, indicating that there was a significant agreement among the raters about the phonetic dissimilarity of the words existed.

Phonetic dissimilarity in previous studies does not appear prominently as a criterion when compared to familiarity and homogeneity of audibility. However, Nissen, et al. (2005) report that Mandarin words were selected from the frequency usage dictionary and words that had a similar pronunciation, but those with a different meaning were eliminated. An examination of studies conducted in other languages indicates that researchers report vaguely on the issue of phonetic dissimilarity, but studies such as (Ashoor & Prochazka, 1985; Plant, 1990) often refer to the range of phoneme representation.

Further, in studies where phonetic dissimilarity is reported on, there is little discussion on the procedure followed methodologically to ensure dissimilarity. One such study is (Schneider, 1992), which indicated that the 12 Spanish words considered for testing were phonetically dissimilar in terms of vowel sequences. In the Plant (1990) study reference to the varying phoneme structure is made. The author also details the differences between the phoneme structures of Walpiri compared to English, illustrating issues of words list development in that language, but there is no reference to whether

In order to achieve aim 2 of the study the words selected in aim one of the study were measured for homogeneity with respect to audibility. Homogeneity with respect to audibility has been described as one of the most important criterion when creating SRT test materials (Nissen et al. 2005). The concept of homogeneity of audibility is defined as the ease with which words are understood when spoken at a constant level (Silman & Silverman, 1991). Homogeneity with respect to audibility of the words was one of the four original criteria stipulated by Hudgins et al (1947). The concept of homogeneity has received immense attention historically. Researchers repeatedly demonstrated over the years that homogenous words result in accurate and precise threshold measurements (Hudgins et al. 1947; Bowling & Elpern, 1961; Curry & Cox, 1966; Beatie et al. 1975; Young et al. 1982; Ramkisson, 2002; Nissen et al. 2005).

In order to achieve homogeneity of audibility, a performance intensity curve is used to illustrate how words are heard at different intensity levels. The critical element of the performance intensity curve is the steepness or slope of the curve. Years of research in speech audiometry have focussed on improving the steepness of the psychometric curve of the English words, thus contributing to a homogenous set of words. However, an examination of some of these studies indicates variability and discrepancies in the results obtained regarding the homogeneity of audibility of the English words.

Variability in the results regarding homogeneity of words can be influenced by factors such as type of stimuli used, linguistic or structural limitations of the language, methodological approaches chosen and procedural variables. Some of these factors were operative in the present study and are discussed below.

Within the present study, 58 bisyllabic low tone Zulu verbs were assessed for homogeneity with respect to audibility on 30 normal hearing adults between 18 to 25 years of age and were Zulu first language speakers from Kwa -Zulu Natal. The 58 words were analysed using the logistic regression equation as discussed in the methodology chapter. Psychometric curves were generated for each of the 58 words (Appendix P). From Figure 5.4 in the results section, p. 111, it would appear that there was variability in the curves generated. The slope of the psychometric functions for the bisyllabic Zulu words for the range 20% to 80% was 1.232 %/dB to 9.872%/dB (Mean=3.81%/dB). However, the slope at 50% was steeper i.e. 1.925%/dB to 15.425%/dB (Mean= 5.9865/dB).

While variability was noted in the slopes of the 58 words, the aim was to select those words that were most homogenous. The words that had the steepest psychometric slope for the Zulu language were accepted. Statistically, words that had a greater than 5.986% /dB slope, were considered as being the most homogenous words. Essentially, all words above the mean slope at 50% were considered to have the steepest slope. This resulted in 28 words being selected for the aim three of the study which related to the application of the selected words to a normative clinical population.

Closer inspection of the psychometric curves for the 28 words selected (see Figure 5.4 in the results section) indicate that the majority of the curves appear similar in shape with a distinct s- shaped curve. In contrast, however, the remaining 30 words were very different in shape (see Figure 5.5 in the results section p. 112). These words indicated a more gradual slope than the words considered as most homogenous. Furthermore, the gradual slope indicate that for these words to be identified correctly the words had to be presented at higher intensity levels compared to the words identified as being most homogenous.

The results obtained in the present study, however, when compared to that of other languages indicate both similarities and differences. Table 6.2 provides a summary of the data obtained across different studies regarding the homogeneity of the word lists. The table indicates the language of the study, the type of stimuli used, measurement scales used and the mean slopes obtained.

Table 6.2 indicates clearly that there are differences in the performance of the words across languages. The mean slope at 50% for the studies that utilized trisyllables compared to the bisyllables appear to be steeper e.g. 9.9%/dB in the Nissen et al. (2005) study compared to the 6%/dB in the present study. The steepness of the curve however is directly influenced by the type of stimuli used (Kruger & Kruger, 1997). The question that arises concerns the number syllables and the steepness of the slope. The answer lies in the understanding that words with many syllables are easier to identify under auditory stress. This is so, since trisyllabic or polysyllabic words are more redundant than bisyllabic or monosyllabic words. The abundance of information present within the speech signals of trisyllables or polysyllables allows for the words to be heard at softer levels, contributing to a steeper slope (Stach, 1998).

Furthermore, while the concept of redundancy is not highlighted as a criterion in the development of SRT measurements, Stach (1998) warns that the more redundant the stimuli is, the more immune the signal is to detecting a hearing loss. Therefore, the present researcher maintains the argument for the use of bisyllabic Zulu words, as they are more sensitive in determining an SRT clinically, even though the performance curve was not as steep compared to studies that utilized trisyllables.

Moreover, the aim of homogeneity of audibility should be specific to the language concerned and the linguistic structure of that language. Hence, the aim of homogeneity with respect to audibility for the Zulu bisyllabic words was realized in the present study. An accurate replica of scores would certainly not be possible, as the languages used are different and the methodologies followed also differed.

Another explanation for the more gradual slopes obtained in this study compared to the earlier studies conducted in English could be related to the differences in the linguistic structure of the languages. The use of spondees with equal stress explains the ease of identification at low intensity levels. Brandy (2002) confirms this by stating that the performance intensity function for spondaic words is very steep. The average level for 100% correct to be obtained would usually occur at 27.5dBSPL (7.5dBHL). This is supported by earlier statements made by Egan (1948) that spondees have the highest homogeneity of audibility in comparison to other stimuli. The historical support regarding steepness of the curves in English has often influenced subsequent researchers, who confirmed the homogeneity with respect to audibility in their studies by drawing comparisons that are very closely related to the spondee words.

It must be understood that for languages like Zulu, which do not have spondees, it is reasonable to expect that the criterion for the steepness of the slope should be altered or modified. It would seem logical to suggest that if the stimuli are vastly different in terms of stress pattern and structure, the reference data used to evaluate steepness should be different. There is a strong possibility that the normal hearing ZFLS in the present study may have had difficulty identifying the bisyllabic words in Zulu due to the lack of prominence on the first syllable, but required the intensity of the signal to be slightly higher for 100% identification. This could, therefore, serve as a possible explanation for the mean threshold intensity for 100% correct identification in the present study being 9 dBHL.

In addition, the morphological structure of the bisyllabic verbs usually has a /-a/ bound to the verb root (Rycroft & Ncgobo in Chetty, 1990). The presence of the /-a/ sound in the second syllable together with the prominent high tone may account for the poor recognition of the first syllable. Thus, under auditory stress, recognition of the first syllable may have been difficult to hear, because of the lack of the similar acoustic and morphological cues in the first syllable compared to the second syllable (Chetty, 1990).

Furthermore, scrutiny of the performance intensity curves for the Zulu words indicates that the words that had the click sound in the first syllable e.g. /qonda/ and /gxeka/ had the steepest slopes at 50% i.e. 15.425%/dB and 7.5 %/dB respectively. These click sounds carry a higher spectral energy content acoustically and thus, could account for these words performing better at the lower intensity levels. However, the words such as /finya; dinga; lima/ appeared to have had more gradual slopes at 50%. These words may be regarded softer sounding phonemes due to the fricatives and lower intensity vowel sound /i/ being used. The variation in the energy content acoustically of the consonants and vowels of Zulu therefore may have implications for the steepness of the slope. Chetty (1990) briefly alludes to the influence of the acoustic properties of vowels and consonants on the steepness of the curve. Within the present study it would appear that the acoustic properties of the vowel and phoneme combinations could have contributed to the slope patterns observed. Apart from (Chetty, 1990), previous researchers have not referred to the influence of the energy content on the steepness of the slope. However, the present researcher holds the opinion that for a language like Zulu the argument is relevant and is worthy of noting. This point introduces a new lens through which homogeneity with respect to audibility is viewed in languages where spondees are not available. Further, informal comments from participants that they often heard the second syllable at the lower intensities, but had difficulty with hearing the first syllable confirms the possible influence of tone and on the steepness of the slope.

Apart from the possible lower acoustic energy of the first syllable, however, the actual recording of the materials could have also affected the performance of the listeners. Nissen et al. (2005) explains the importance of high quality digital recording in the development of materials for SRT. While every attempt in the present study was made to adhere to this recommendation, the recording of the words in terms of VU meter peaking were +/-2dB across the words. Manual adjustments had to made to the VU settings between the calibration tone and the words itself. This limitation has been extensively discussed in the methodology section of the study. Furthermore, the six randomizations were individually recorded due to a lack of software to randomdomize one recording. These recording limitations could have possibly affected the performance of the listeners with regard to the words.

Nevertheless, within the resource constraints and time limitation of this study all data obtained were verified at several levels of analysis and still remain reliable. Perhaps an implication of this would be to re-record the most homogenous words after introducing a correction factor. This has been done historically and more recently by Nissen et al. (2005). Simply, the variability of words is reduced and the steepness of the curves is improved. This could possibly also account for the reason why the slopes obtained in Nissen et al. (2005) study, reflects data that were similar to that of the original English studies.

Table 6.2 Description of the mean slope values across studies.

Researcher/s	**Language**	**Type of stimuli and number of words evaluated**	**Scale of measurement**	**Mean Slope @ 50%**
Present study	Zulu	Bisyllabic Verbs (28)	dBHL	5.98%/dB (6%/dB)
Hudgins et al. (1947)	English	Bisyllabic spondees (36)	dB	7.2%/dB
Young et al. (1982)	English	Bisyllabic (15)spondees	dBSPL	10%/dB
Cardenas & Marrero (1994)	Spanish	Trisylables and four syllables (24)	dB	8%/dB
Chritensen (1995), as cited in Nissen et al. (2005)	Spanish	Trisyllables (12	dB	11.1%/dB
Greer (1997), as cited in Nissen et al. (2005)	Itallian	Trisyllabic	dB	7.3%
Nissen et al. (2005)	Mandarin	Trisyllabic (24)	dB	9.9%/dB

From a methodological perspective, homogeneity of audibility has been assessed using different mathematical, statistical and procedural methods.

Young et al. (1982) has raised the historical discrepancies noted in the English word lists regarding homogeneity of audibility. These researchers articulated concerns regarding the definition of homogeneity. Earlier studies (Bowling & Elpern, 1961; Curry & Cox, 1966; Beattie et al. 1975) reported on the intensity level at which words were first identified correctly and made no provisions in their analysis if the word was missed in subsequent presentations (Young et al. 1982). In addition, the rate at which words were intelligible was not specified in the earlier studies. The present study considered these earlier limitations and utilized a more stringent mathematical model to calculate accurately the threshold of intensity and the slope of the psychometric function, taking into account the performance of participants across all lists. In addition the rate at which words became intelligible is easily calculated using this model. The model has also been also described in the Nissen et al. (2005) study.

However, the present study followed a 5dB change in the intensity levels. All of the studies discussed above including the Nissen et al. (2005) study used a 2dB intensity change. The motivation for the use of the 5dB intensity change was done to be consistent with how SRT is usually measured clinically. The difference in intensity change however, could account for the more gradual slope in the present study. This is so, since the performance intensity curve with 2dB levels would have more reference points for calculating percentage correct responses. The outcome of these curves would certainly improve the overall slope and shape of the curve. Perhaps, as an implication for future research would be that studies should consider changing or decreasing the increments between the different intensity levels, thus ensuring that many more levels are assessed.

Another issue to be considered is the learning effect. Young et al. (1982) presented concerns regarding the learning effect that could unfold if the same words are presented with several randomizations at the many reference levels discussed above. While the use of randomization is considered to eliminate the learning effect, one could also argue that with 13 presentations to a participant of the same words, there is strong possibility that the participants learn the words and their performance would therefore appear better. This could also account for the excellent performance noted in the Nissen et al. (2005) study. On account of the above, careful considerations must be made regarding the choice of intensity changes and the number of randomizations selected. While the possibility of improving the curves exists, and is an implication for future research, the variable of the learning effect remains important.

In summary, it is clear that selecting homogenous words in any language presents a challenge. Several factors can influence and affect the outcome i.e. linguistic, methodological and procedural variables, as discussed above. These challenges reinforce the need for adaptation of the original criteria for SRT at many levels when materials are developed. The reference data for evaluating homogeneity of audibility in English simply cannot be applied stringently to that of Zulu. It may be concluded, therefore, that the concept of homogeneity of audibility is achievable in any language, but the criteria for assessing homogeneity must suit that language. The arguments presented above also strongly reiterate the point that ,in developing a word list for SRT, the researcher must be cognizant of the complex interplay between linguistic variables and audiological principles. At times there may be a need for a trade-off between these variables in order for the test to be meaningful to the population it serves. The present researcher acknowledges the differences and variability that exist, but is satisfied that the aim of homogeneity of audibility for the 28 Zulu words was realized, notwithstanding the limitations discussed.

Furthermore, the present study described the selected words acoustically via an acoustic analysis system. The information obtained for the pitch contours is relevant to the present study. The majority of the words (25/28) analyzed indicated a similar pitch contour i.e. there was a difference in the pitch between the first and second syllable. Syllable one was consistently lower in frequency than syllable two. These findings follow the prosodic pattern of the Zulu words selected i.e. low high tone verbs. Similarly the energy contours of the vowel sound in each word indicated differences between the two syllables.

- A comparison of the scores of Zulu SRT and PTA to that of the scores of English SRT and PTA.

The primary significance of SRT testing in the initial audiological test battery has been to serve as a validity check against the gold standard i.e. pure tones (ASHA, 1988). This clinical purpose has stemmed from the close relationship that exists between the pure tone average and the SRT measurement. However, the validity of these comparisons could be severely compromised if the test tool used to assess SRT is not linguistically matched to that of the listener. With the above clinical significance and the fact that SRT materials did not exist in Zulu the present study was born.

Aim one and two provided the discussion towards the development of the word and assessment of the list. Critical to the above discussion was the adapted criteria used to develop the word list and the challenges that unfolded during the process. The present study also investigated the application of the developed test on a sample of normal hearing adults. A review of many of the other studies which developed word lists have omitted this objective in the studies conducted. Many of the studies conducted in languages other than English focused on assessing the tool via homogeneity with respect to audibility. Words that satisfied this criterion were accepted for clinical use. The inclusion of an assessment of the application of the test on a clinical population represents strength in this study as it allows the researcher to evaluate the tool and its performance. In fact Nissen et al. (2005) highlighted this aspect as a recommendation for future research.

This aim therefore focused on establishing the PTA and SRT in Zulu and English on a group on normal hearing First language Zulu speaking university students who spoke English as a second language. Essentially these individuals were considered proficient in English because of their exposure to University level of study and in an English medium environment. Further, according to Grosjean (1989), individuals who have developed sufficient communicative competencies for everyday life would satisfy candidacy for such a study. Thus, the university students satisfied this criterion and for the task expected they appeared to be a reliable sample to consider.

Table 5.10 and Table 5.11 in the results section indicate a fairly strong and high correlation between the SRT (Zulu) and PTA which was significant statistically at 95 % confidence levels, using the Pearson r correlation. The Table 5.10 and Table 5.11 also indicate a high positive correlation with 95 % confidence for the same sample of students. However, inspection of the strength of the correlation r = 0.77 indicate that there was greater strength in the correlation co-efficient for the Zulu words than for the English words (r = 0.63)

The above results can be explained from several viewpoints. The most plausible explanation would be based on the concept of familiarity and on how words are perceived when the stimuli are closer to threshold. Theoretical explanations for this exist in the literature on how words are perceived and these have been raised in chapter one. The Zulu words used for SRT testing were considered the most common words in Zulu for speakers of KZN. Thus, it would be reasonable to assume that the frequency of occurrence of these words would be greater than the CIDW-2 English words to the Zulu speaker. Chermack & Musiek (1997) confirms this by stating that words having a high frequency of occurrence would be more easily recognized than words that have a low frequency of occurrence. This implies that even though the CID words were considered familiar words of English, the familiarity and frequency of occurrence of these words for South African First or second language English speaker is questionable.

This contention is based on research evidence whereby even the familiarity of words in the different English speaking populations produce results that are poor (Bench, 1997). Bench (1997) adds that the content of the English material in one country may be different from that of the Standard English, thus suggesting that the performance on the English word list may not only be due to the words being a different language for the Zulu speakers, but that some of the English words in terms of vocabulary and everyday use of these words is unfamiliar. Therefore, the findings in this study supports the theoretical claims about language being ever-changing and the need for the lists to be relevant to the linguistic group it serves.

Furthermore, the outcome of the present study lends support to the theoretical claim that listeners rely on higher order information such as prosody, semantics, lexical and the pragmatic knowledge of the language in order to recognize words. The findings in this study also support the premise that word recognition and processing is not merely as a result of detecting acoustic signals, but should be seen as a combination of detecting the acoustic signals and relying on the context of the language for processing. Therefore, the unfamiliar words in English to the First language Zulu speaker are more difficult to hear under when the stimuli are closer to threshold. This contention has been widely supported by earlier researchers such as (Howes, 1952; Owens, 1961).

The statistical evidence discussed above was reinforced by the descriptive statistics outlined in the results section. This clearly revealed that the percentage of participants who achieved a +/- 5dB relationship with PTA was greater with the Zulu list than with the English list (refer to Table 5.14 in the results section). Thus, while there was a high positive correlation at 0.01 level of confidence, the relationship between the SRT and PTA for Zulu appears stronger than English. The results also suggest that the developed tool indicate trends that make for important clinical applications. It also implies that the tool may be effective in assessing the SRT in Zulu.

The strength of the correlation (r = 0.76) obtained for the Zulu words were similar to that of the correlation obtained in other studies. The Pearson r has been historically used for the assessment of correlation between SRT and PTA (Hirsh, et al. 1952; Young et al. 1982; Wilson & Margolis, 1983; Chetty, 1990). A high positive correlation of 0.76 in the present study compared to the studies described later demonstrates the possible effectiveness of the SRT words in Zulu. A point of worthy of note is that the possible reason for the slightly stronger correlation for the Young et al. (1982) and Chetty (1990) studies is that both these studies utilized spondee nouns and trisyllabic nouns respectively. However, in the present study bisyllabic verbs were used. The use of nouns compared to the verbs may have influenced the redundancy in the words and therefore improved the SRT score. Nevertheless, a strong relationship is evident and the SRT in Zulu correlates well with the PTA scores.

Table 6.3 Pearson r correlation figures in other studies.

Researcher	Language	Type of Stimuli	Pearson r correlation
Present study	Zulu	Bisyllabic verbs	0.76
Young et al. (1982)	English	Spondees	0.80
Chetty (1990)	Zulu	Trisyllables	0.77

However, it is necessary to state that while the Zulu speakers performed slightly better on the Zulu words than on the English words, a firm conclusion cannot be drawn unless the sample included a control group of First language English speakers who spoke Zulu as a second language. This, therefore, has implications for future research. However, while this argument is a relevant criticism of the study, it is also important to note that presently in South Africa and KZN it would be difficult to draw a sample of individuals who speak English as first language and Zulu as a second language.

In the present study the participants tested in the application phase of the study were considered First Language Speakers of Zulu, but were also functionally competent in English. Therefore, the slightly better performance for SRT on the Zulu list confirms the claim that even though the students were fairly proficient in the English language, some of the words may have been difficult to understand under trying listening condition. Perhaps a purely monolingual sample would have been able to demonstrate the value of the test better. However, within the South African context characterized by the intermingling of various languages (Balkisson, 2001) purely monolingual speakers of Zulu are often not available. This is the case because many speakers of Zulu are in fact multi-lingual speakers because of their exposure to many African languages. Therefore, the results of the study have implications for use for both the monolingual speakers of Zulu and First language speakers of Zulu.

The clinical applications of the present study are significant. Perhaps one of the most important undertakings for future research would be to obtain SRT results on a group of individuals with varying degrees of hearing loss and compare these to the PTA. Such a project would provide data that is more relevant and richer to the clinical environment.

Therefore, the findings in this study have far-reaching implications, both clinically and in terms of future research in the field. The Constitution of the Republic of South Africa (Act 200 of 1993), as amended by Act 109 of 1996, clearly confirms that the importance of the eleven languages of the country and the linguistic rights of individuals. In this context, the present study could be seen as a step towards the development of speech audiometry materials that are suitable, relevant and scientifically designed to cater for the audiological needs of ZFLS in KZN.

In terms of the diagnostic significance, it is clear that the measurement of SRT is fundamental to the initial audiological process. However, the value of the test is lost when the materials used are not appropriate to the linguistic background of the client. In fact, the danger of over and under-diagnosis is very possible. Thus, research of this nature provides the necessary steps towards improving the service delivery of Zulu first language client in KZN.

However, while the process towards the development of a suitable SRT words list was achieved in this study, the data obtained is limited to the adult normative population. Hence, there is a need for future research in terms of standardization and validation of the tool on a larger clinical population.

The value and the need for the present study are important in the current context of KZN. However, a possible criticism of this kind of research could be whether the developed word list for the Zulu Fist language speakers would truly represent the language. A critique of this nature is based on a different premise to which this study was based, but it is worth reflecting on. The present study focused much attention on the socio-linguistic aspects that contribute to the development of a word list and in so doing it reflected on the richness of the language of Zulu. However, limitations of word lists itself may not identify the complexities and vast number of facets in the language (Balkisson, 2001) e.g. the importance of context, issues relating to language and culture and dialect. Therefore, while word lists may be able to represent the formal structure of a language, the richness of language as it relates to everyday lives, thought and culture may be lost.

Thus, while the present study addresses many of the key theoretical elements towards the development of an appropriate word list for ZFLS in KZN, there is the alternative viewpoint by researchers such as Borg, Wilson & Samuelson, (1998). These researchers support the idea that traditional test procedures such as SRT may not be completely suitable for the evaluation of an individual's hearing for speech, as each individual belongs to an 'optimal environment" and should therefore be assessed accordingly. This perspective is known as the ecological perspective in audiology, whereby Borg et al. (1998) proposes that in order to truly assess the individuals hearing for speech, a realistic listening environment must be used with realistic listening conditions. Thus, the argument for using an alternative paradigm for the evaluation hearing for speech is proposed.

Within the South African context, with the limited resources and the vast array of health and social difficulties, alternative techniques as proposed above may not be cost effective. Therefore, focusing resources on the development of an SRT words list to suit the audiological needs of the population is still relevant and attainable as indicated in the present study. The development and assessment of such materials should however aim to represent the language, culture and lives of the individuals it is meant for.

6. 5 CONCLUSION

Chapter six provided the reader with the discussion of the findings in this study in terms of the aims and objectives of the study. The results obtained were discussed with reference to the literature and the general theoretical trends. More importantly, a discussion of the findings in relation to other studies was made. Some comparisons and similarities were indicated. From the discussion above it is apparent that the aims of the study have been realized. However, the researcher draws the reader to certain limitations and challenges that have unfolded in the study. Reference to future clinical and research implications is also advanced. Chapter 6 is followed by the conclusion chapter that outlines the overall conclusion of this study and lists the research and clinical implications.

CHAPTER SEVEN: CONCLUSION AND IMPLICATIONS OF THE STUDY

7.1 CONCLUSION

South Africa celebrates its twelfth year of democracy and one of the most important aspects of the South African constitution is the equality status for all eleven official languages. Zulu is one the official languages spoken by the majority of the KZN population. In keeping with the government's vision of equal status of languages and the importance of appropriate service delivery, the present study focused on developing a SRT word list for the Zulu First Language Speaker of KZN. In order to develop this word list, the researcher engaged in a process whereby both the audiological and linguistic principles inherent in speech reception testing were adhered to. A two phase methodological process was followed, whereby three aims were achieved.

The aims and objectives of the study were as follows:

- Aim one focused on the development of the Zulu word list for ZFLS in KZN.
- Aim two focused on the assessment of the developed word via the measurement of homogeneity with respect to audibility and the description of the acoustic analysis of the words,
- Aim three evaluated the application of the Zulu SRT words on 26 normal hearing ZFLS.

This study therefore, concluded that for aim one, 131 words were identified as common bisyllabic words for adult Zulu First language Speakers. Using a modified identification schedule these words were identified by two Zulu First Language interpreters and two tertiary educators from KZN. Descriptive statistics was used to analyse the data and the majority of the words (82%) were identified as bisyllabic verbs. These findings were reported to be in accordance with the structure of the Zulu language (Jacobson & Trail, 1986). Objective two of the study concluded that 58/131 words that were identified in objective one satisfied the criterion of familiarity, phonetic dissimilarity and low tone verbs. These words were rated on three point Likert scale by five linguistic experts. The Kendall's co-efficient of concordance was found to be very good for familiarity, moderate for tone and good for phonetic dissimilarity. These were obtained at 95% level of confidence. Therefore, the results obtained from the raters were found to be reliable and valid. Aim one of the study therefore, concluded that 58 words were identified as being common bisyllabic low tone verbs that satisfied the criterion of familiarity and phonetic dissimilarity.

However, in addition to the above criteria, the words had to satisfy the criterion of homogeneity with respect to audibility. Aim two of the study, therefore, focused on the measurement of homogeneity of audibility of the 58 words. All 58 words were recorded on a CD by a Zulu First Language Speaker from KZN. The recording process followed careful guidelines, as specified in the literature on word list development. A pilot study was conducted to verify the quality of the CD before the testing process began. Thirty normal hearing adults with a mean age of (21.5 years) were selected for this aim of the study. The 58 words were presented via six randomizations to the participants and the responses were recorded by two Zulu First Language Speakers and the researcher. The Kappa test of agreement confirmed reliability of scoring among the raters. Therefore, the scores of only one of the First language raters were considered. This aim of the study drew its conclusions from the logistic regression analysis. Performance intensity curves for each of the 58 words were identified. The mean slope at 50% for the 28 words was identified to be 5.985/dB. Some variability was noted in the slope at 50%. This was confirmed in the literature and accounted for methodologically in the study.

In addition to assessing the tool audiologically, acoustic analysis of the 28 words was also described. The pitch and energy contours confirm the prosodic patterns of the verbs in Zulu. The majority of the words followed a similar pitch contour pattern i.e. low pitch in the first syllable and high pitch in the second syllable. Furthermore, the energy contours across the words indicated both similarities and differences.

Finally, aim three of the study established that for the 26 normal hearing ZFLS of KZN, there was a strong relationship (r =0.76) between the SRT and PTA for when the Zulu words lists were used and measured at 99% confidence level. However, there was also a relationship between the SRT and PTA for the sample when the English CIDW-2 was used, but the strength of the correlation was greater for the former. The Pearson r correlation result in this study compared favorably with that of other studies in the literature

Therefore, the aim of developing and assessing a suitable word list for ZFLS in KZN was achieved. Moreover, the application of the test tool to a normative sample was indicated in the present study. The present study had several clinical and research implications which would be highlighted below.

7.2 RESEARCH IMPLICATIONS

The present study addressed a gap in the literature with regards to SRT word list development for Zulu. Therefore, several future research implications have been identified and they are;

- To assess the application of the Zulu word list on a varied clinical population with hearing disorders or losses.
- To standardize the present SRT word list on a much larger sample of normal hearing ZFLS.
- To compare the SRT/PTA using the developed list between monolingual speakers of Zulu and bilingual speakers.
- The results in the study indicate that bisyllabic low tone verbs indicate a strong relationship with the PTA. However, the slope of the psychometric curve was not as steep. Therefore, it would be necessary to evaluate the trisyllabic words within a similar study design.
- To compare the SRT/PTA of the six different dialects in the case of KZN using the developed list, in order to measure dialectical differences.
- This study also motivates the need for the development of speech materials in the other official African languages.

7.3 CLINICAL IMPLICATIONS

- The findings in this study support the need for test material to be appropriate to the language of the client. Therefore, the CID W-2 list should not be used for assessment of SRT for ZFLS.
- The present SRT test can be used clinically, but with caution as the test has not been standardized. However, the present test is applicable to both the monolingual and ZFLS and to the ZFLS who is also functionally proficient in English from KZN (Durban, Pietermarizburg region).
- The use of the present test should be administered via the recorded medium and not via monitored live voice testing.
- The results of the test indicate that the common bisyllabic verbs, which are low tone verbs indicate a strong correlation with the PTA and therefore, is a suitable option for SRT in Zulu

7.4 LIMITATIONS OF THE STUDY

The limitations of the study have been raised in the discussion chapter. However the following limitations are also acknowledged:

- The limited software regarding the recording of the CD could have compromised the quality of the recording. This implies that VU peaking and variability in peaking of some of the words could have been avoided if software was suited to the type of recording required.
- The list is only valid to the adult population as the familiarity of the materials was focused on adults. The use of this list on paediatric population would be invalid.
- The sample was University students and this could have limitations in terms of applicability to the wider population, however the vocabulary has been verified to be fairly common words in the list.

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APPENDIX A

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21 SEPTEMBER 2006

MS. S PANDAY (10539)
SPEECH AND HEARING THERAPY

Dear Ms. Panday

ETHICAL CLEARANCE APPROVAL NUMBER: HSS/02232A

I wish to confirm that ethical clearance has been granted for the following project:

"The development of a Zulu SRT word list for first language Zulu speakers in KZN"

Yours faithfully

MS. PHUMELELE XIMBA
RESEARCH OFFICE

PS: THIS APPROVAL IS CONFIRMED ON THE BASIS OF YOUR APPLICATION AND THE UNDERSTANDING THAT YOUR PROJECT HAS NOT CHANGED IN ANY WAY

cc. Faculty Officer (Post-Graduate Studies)
cc. Supervisor

APPENDIX B

Letter to the Head of Department of the Zulu department of a Tertiary institution.

DISCIPLINE OF SPEECH LANGUAGE PATHOLOGY AND AUDIOLOGY

10/04/04

To : ----------------------

I am a student registered for the Masters degree in Audiology at the University of Durban-Westville. As part of my degree requirements I am conducting a research project. Mr CD Govender, Prof Kathard and Dr. M. Pillay are supervising my study.

The study is aimed at developing Zulu word lists for adult Zulu First Language speakers in Kwa- Zulu Natal. The word list would contribute to improving the Speech Reception Test battery used for ZFLS in KZN. This test is part of the initial hearing battery for testing adult Zulu First Language Speakers. Currently there is a paucity of developed word lists for this population group. It is envisaged that the development of such a word list would contribute significantly to appropriate and relevant service delivery for adult ZFLS.

In order to achieve the aims of the study I humbly request permission for the participation of First Language Zulu speaking educators in your Department to participate in the First phase of the study. Their task would involve selecting commonly spoken bisyllabic Zulu words in KZN

All responses would be treated with confidentiality and anonymity of the Department and participants will be ensured at all times. Information obtained would not be used in any other way except for the purposes of the study.

I thank you for your assistance and will provide you with a copy of the findings of the study.

Yours sincerely

Ms S Panday	Mr. CD Govender	Prof. H Kathard	Dr. M Pillay
Student	Supervisor	Supervisor	Supervisor

APPENDIX C

<u>Instructional letter to the Tertiary Educators Re: Identification of common bisyllabic Zulu words for Adults</u>

Dear ------------------------

Thank you for participating in this study. Kindly make a list of the most common words spoken by adult Zulu First Language Speakers in Kwa-Zulu Natal. The words must be bisyllabic in nature. Please make a list of about 100 words.

The purpose of this list is to identify the common bisyllabic Zulu words used by ZFLS used in everyday speech .These words would be selected for the development of a hearing test suitable for adult ZFLS. Currently no such tool exists which creates difficulty in assessing this population group appropriately.

- Please think carefully about the words you select and the words must be fairly common in terms of use by the adult First language speakers of the province.
- There are no right and wrong answers. Your choice of words will aid in developing speech material suitable for use in hearing evaluations.

Thank you kindly for your participation.

Yours sincerely

Seema Panday

APPENDIX D

<u>Identification Schedule</u>: Adapted from Balkisson (2001)

Please list the most commonly used bi-syllabic Zulu words used by Zulu First Language Speakers in KZN. Each individual must fill a minimum of 100 words

Number	Commonly used Bi -syllabic Zulu words
1.	
2	
3	
4	
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13	
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100	

APPENDIX E

Instructional letter to the Linguists re: Selection of final word list according to criteria.

Dear Sir/Madam

Thank you for participating in the study. My study involves identifying a list of bisyllabic Zulu verb imperatives words that are familiar for adult Zulu First Language speaking (ZFLS) individuals from KZN.

These words need to be:

- Familiar,
- Phonetically dissimilar,
- Low tone verb imperatives

A preliminary list has been developed. I require 80 words that you feel meet the above mentioned criteria. These words must be rated or given a score of 1 or 2 or 3. The rating scale would be explained on each rating scale.

- Please select the words that achieve these criteria and rank the remaining words in order of preference for inclusion in the list.
- There are no right and wrong answers. Your choice of words will aid in developing speech material suitable for use in hearing evaluations.

Thank you for your assistance in the study

Yours sincerely

Ms S Panday
Masters Student

APPENDIX F

RATING SCALES

Rating Scale 1. Familiarity

Please rate the following words independently using the key below in terms of First Language Zulu spoken in KZN. The purpose of the scale is to obtain Familiar bi-syllabic Zulu verb imperatives that can be selected for a hearing test suitable for First Language Zulu speakers in KZN.

Your task is to decide how familiar the following bi-syllabic verbs are to you. Think carefully about how often they are used by First Language speakers. The words must be given a number1, 2, or 3.

1) **Means most familiar (It is very common and used very often)**
2) **Means fairly familiar (It is common, used often, but not as often as words rated as (1))**
3) **Means very unfamiliar (It is not common, hardly ever used)**

WORDS	1	2	3
1 bhala			
2. bhaka			
3. bhema			
4. biza			
5. bona			
6. buza			
7. bheka			
8. banga			
9. bola			
10 cacha			
11. cela			
12. cwewa			
13. cinga			
14. chela			
15. dinga			
16. dlala			
17. donsa			
18. dansa			
19. duda			
20. dula			
21. f aka			
22. futhi			
23. fika			
24. funa			
25. funda			

26. finya			
27. ganga			
28. gcina			
29. geza			
30. goba			
31. gcaca			
32. gqoka			
33. gxeka			
34. hamba			
35. hleka			
36 .hoya			
37 hlala			
38. hluba			
39. hlupha			
40. hola			
41. hlenga			
43. jika			
42 jeza			
43 jula			
44. jaha			
45 khanya			
46 kheta			
47 khiye			
48 khola			
49 khaba			
50 khala			
51 khipa			
52 klekha			
53 khanya			
54 lala			
55 landa			
56 letha			
57 lima			
58 linda			
59 loya			
60 luma			
61 lunga			
62 lapha			
63 manje			
64 mina			
65 mila			
66 muva			
67 minya			
68 ncama			
69 netha			

70 nyama			
71 ngena			
72 nuka			
73 nyanga			
74 ndiza			
75 phanzi			
76 pheka			
77 phuma			
78 phezu			
79 phupha			
80 phosa			
81 phuza			
82 phapha			
83 pheza			
84 qala			
85 qeda			
86 qoba			
87 qonda			
88 quela			
89 qhaqha			
90 qaqa			
91 qina			
92 shaya			
93 shesha			
94 siza			
95 senga			
96 sula			
97 sefa			
98 shiya			
99 sika			
100 sina			
101 shada			
102 susa			
103 thenga			
104 thanda			
105 thola			
106 thula			
107 thela			
108 thatha			
109 thsala			
110 vala			
111 vuka			
112 vuma			
113 vula			
114 veza			

115 washa			
116 wina			
117 woza			
118 wawa			
119 xoxa			
120 xola			
121 xosha			
122 yeba			
123 yeka			
124 yifa			
125 yosa			
126 yanga			
127 yenza			
128 yona			
129 zakhe			
130 zosha			
131 zabo			

Rating Scale 2 Low/high tone

Please rate the following words independently using the key below in terms of First Language Zulu spoken in KZN. The purpose of the scale is to obtain verb imperatives that are homogenous in terms of tone ie: low /high tone verbs so that the verbs can be selected for a hearing test suitable for First Language Zulu speakers in KZN.

Your task is to decide whether each verb is a definite low/high tone verb or a fairly low / high tone or definitely not a low/high tone verb. Think carefully about the tone of each of the verbs. Each verb must be given a number 1, 2, 3.

1) **Means definitely Low/high Tone**
2) **Means fairly Low /High Tone**
3) **Means definitely not Low/High tone**

WORDS	1	2	3
1 bhala			
2. bhaka			
3. bhema			
4. biza			
5. bona			
6. buza			
7. bheka			
8. banga			
9. bola			
10 cacha			
11. cela			
12. cwewa			
13. cinga			
14. chela			
15. dinga			
16. dlala			
17. donsa			
18. dansa			
19. duda			
20. dula			
21.faka			
22. futhi			
23. fika			
24. funa			
25. funda			
26.finya			
27. ganga			
28. gcina			
29. geza			
31. gcaca			

32. gqoka			
33. gxeka			
34. hamba			
35. hleka			
36.hoya			
37 hlala			
38.hluba			
39.hlupha			
40. hola			
41. hlenga			
43. jika			
42 jeza			
43 jula			
44. jaha			
45 khanya			
46 kheta			
47 khiye			
48 khola			
49 khaba			
50 khala			
51 khipa			
52 klekha			
53 khanya			
54 lala			
55 landa			
56 letha			
57 lima			
58 linda			
59 loya			
60 luma			
61 lunga			
62 lapha			
63 manje			
64 mina			
65 mila			
66 muva			
67 minya			
68 ncama			
69 netha			
70 nyama			
71 ngena			
72 nuka			
73 nyanga			
74 ndiza			
75 phanzi			

76 pheka			
77 phuma			
78 phezu			
79 phupha			
80 phosa			
81 phuza			
82 phapha			
83 pheza			
84 qala			
85 qeda			
86 qoba			
87 qonda			
88 quela			
89 qhaqha			
90 qaqa			
91 qina			
92 shaya			
93 shesha			
94 siza			
95 senga			
96 sula			
97 sefa			
98 shiya			
99 sika			
100 sina			
101 shada			
102 susa			
103 thenga			
104 thanda			
105 thola			
106 thula			
107 thela			
108 thatha			
109 thsala			
110 vala			
111 vuka			
112 vuma			
113 vula			
114 veza			
115 washa			
116 wina			
117 woza			
118 wawa			
119 xoxa			
120 xola			

121 xosha			
122 yeba			
123 yeka			
124 yifa			
125 yosa			
126 yanga			
127 yenza			
128 yona			
129 zakhe			
130 zosha			
131 zabo			

Rating Scale 3 Phonetic Dissimilarity

Please rate the following words independently using the key below in terms of First Language Zulu spoken in KZN. The purpose of the scale is to obtain verbs that are phonetically dissimilar so that the verbs can be selected for a hearing test suitable for First Language Zulu speakers in KZN.

Your task is to decide how phonetically dissimilar each of verbs is. Think carefully about the phonetic composition of each of the verbs. Each verb must be given a number 1, 2, and 3.
1)Means most phonetically dissimilar
2)Means fairly phonetically dissimilar
3)Means very phonetically similar

WORDS	1	2	3
1 bhala			
2. bhaka			
3. bhema			
4. biza			
5. bona			
6. buza			
7. bheka			
8. banga			
9. bola			
10 cacha			
11. cela			
12. cwewa			
13. cinga			
14. chela			
15. dinga			
16. dlala			
17. donsa			
18. dansa			
19. duda			
20. dula			
21.faka			
22. futhi			
23. fika			
24. funa			
25. funda			
26.finya			
27. ganga			
28.gcina			
29.geza			
31. gcaca			

32. gqoka			
33. gxeka			
34. hamba			
35. hleka			
36.hoya			
37 hlala			
38.hluba			
39.hlupha			
40. hola			
41. hlenga			
43. jika			
42 jeza			
43 jula			
44. jaha			
45 khanya			
46 kheta			
47 khiye			
48 khola			
49 khaba			
50 khala			
51 khipa			
52 klekha			
53 khanya			
54 lala			
55 landa			
56 letha			
57 lima			
58 linda			
59 loya			
60 luma			
61 lunga			
62 lapha			
63 manje			
64 mina			
65 mila			
66 muva			
67 minya			
68 ncama			
69 netha			
70 nyama			
71 ngena			
72 nuka			
73 nyanga			
74 ndiza			
75 phanzi			

76 pheka			
77 phuma			
78 phezu			
79 phupha			
80 phosa			
81 phuza			
82 phapha			
83 pheza			
84 qala			
85 qeda			
86 qoba			
87 qonda			
88 quela			
89 qhaqha			
90 qaqa			
91 qina			
92 shaya			
93 shesha			
94 siza			
95 senga			
96 sula			
97 sefa			
98 shiya			
99 sika			
100sina			
101 shada			
102 susa			
103 thenga			
104 thanda			
105 thola			
106 thula			
107 thela			
108 thatha			
109 thsala			
110 vala			
111 vuka			
112 vuma			
113 vula			
114 veza			
115 washa			
116 wina			
117 woza			
118 wawa			
119 xoxa			
120 xola			

121 xosha			
122 yeba			
123 yeka			
124 yifa			
125 yosa			
126 yanga			
127 yenza			
128 yona			
129 zakhe			
130 zosha			
131 zabo			

APPENDIX G

CASE HISTORY QUESTIONNAIRE

Dear Participant

Thank you for indicating an interest in the following study. This study is aimed at developing a word list for first language Zulu speakers in Kwa-Zulu Natal. For the purposes of this study the hearing of Zulu speakers would to be tested. In order to qualify for the participation in this study, you need to complete this pre – test questionnaire.

- Kindly indicate with a cross [X] if you are willing to participate in such a project or not.
- The researcher would like to inform you that strict care will be employed when conducting any tests in order to protect your physical, emotional and social well-being. All information including test results will be treated with strict confidence by the researchers.
- Your consent to participate in this project will be greatly appreciated.

☐ I am willing to participate in this project.

☐ I am not willing to participate in this project because:

If you are willing to participate in this project please complete the following questionnaire carefully.

INSTRUCTIONS

1. Participants are required to mark the appropriate answer to each question with an X, and give further details if necessary.
2. There are three sections, (A, B & C) to this questionnaire, please answer all the questions contained in each section.

SECTION A
BIOGRAPHICAL DATA

1. SUBJECT NUMBER: ______________________________

2. DATE OF BIRTH: ________________________________

3. AGE: ____

4. SEX: ____

5. FIRST LANGUAGE ________________________________

SECTION B
GENERAL MEDICAL AND NEUROLOGICAL HISTORY

1. Do you or have you suffered from any medical problems? For example Rubella, CMV, Herpes. (Place a X where appropriate)

Yes ☐ No ☐

If yes, state the nature and duration of the condition.

____

____

____

2. Do you or have you suffered from any neurological problems, for example brain tumors?

Yes ☐ No ☐

If yes, state the nature and duration of the condition.

____

____

____

3. Are you or have you previously received treatment for any of the above?

Yes ☐ No ☐

If yes, state the nature and duration of the treatment.

____

____

____

4. If you are taking or have taken any form of medication, please state:

a. The name of the drugs taken ____________________

b. Dosage taken: 5mg 5ml OR 10mg 10ml OR > 10mg > 10ml

c. Frequency of consumption: 1 2 3 4 >4 times a day

d. Duration of treatment: <1 2 >3 months

5. Have you been hospitalised or received treatment for a prolonged period for any medical, surgical or neurological problems?

Yes ☐ No ☐

If yes, please describe.

____

____

____

6. Do you suffer from headaches?

Yes ☐ No ☐

If yes, answer the following:

a. Type: Migraine Tension Other ________________

b. Onset: Morning Midday Afternoon Night

c. Duration: < 1 hour > 1 hour

d. Frequency: 1 2 3 per day OR continual

e. Severity: Mild Moderate Severe Very Severe

7. Do you or have you previously suffered from any dizzy spells?

Yes ☐ No ☐

If yes, answer the following:

a. Onset: Morning Midday Afternoon Night

b. Duration: < 1 min > 1 min

c. Nature: When experiencing dizziness, do you tend to fall to the
Right Left Forward Backward

d. Do you feel that objects around you tend to spin?

Yes ☐ No ☐

e. Do you feel that you are spinning around?

Yes ☐ No ☐

f. Frequency: 1 2 3 per day OR continuously

g. Severity: Mild Moderate Severe Very Severe

SECTION C
AUDIOLOGICAL HISTORY

1. Do you experience difficulty in hearing?

Yes ☐ No ☐

If yes, describe your difficulties:

____
____
____
____
____

2. Have you experienced any pain in your ears?

Yes ☐ No ☐

If yes, what diagnosis was given upon visiting a doctor?

____
____
____

3. Do you have any discharge from your ears?

Yes ☐ No ☐

4. Did you suffer from any other nose, ear or throat problems?

Yes ☐ No ☐

If yes, describe your problem:

____

____

____

5. Do you experience difficulty listening in background noise?

Yes ☐ No ☐

If yes, describe your problem:

____

____

6. Do you hear any unusual sounds or noises in your ears?

Yes ☐ No ☐

If yes, answer the following:

a. Ear: Left Right Both

b. Nature: High pitched Low pitched Ringing Pulsating Roaring

c. Onset: Morning Midday Afternoon Night

d. Frequency: Intermittent Continuous

e. Severity: Soft Loud Very Loud

f. Does this worry you?

Yes ☐ No ☐

7. Do you live in a noisy environment?

Yes ☐ No ☐

If yes, state the source and type of noise that you are exposed to.

Does this noise annoy or disturb you?

Yes ☐ No ☐

Please describe.

8. Do you participate in any hobbies or sports that involve exposure to very loud sounds?

Yes ☐ No ☐

If yes, please describe.

9. Have you experienced head or ear injury at any time?

Yes ☐ No ☐

If yes, please describe.

10. Are you particularly sensitive to loud noises; do they annoy, irritate or cause you any discomfort?

Yes ☐ No ☐

If yes, please elaborate.

11. Do you have difficulty listening to male or female voices?

Male ☐ Female ☐

Please describe.

____

____

____

SECTION D
FAMILY HISTORY

1. Does anyone in your family have a hearing problem?

Yes ☐ No ☐

Please describe.

____

____

____

SECTION E
OCCUPATIONAL HISTORY

1. Please describe your current and previous working environments?

____

____

____

____

2. How long have you worked in each environment?

____

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____

3. Please state any exposure to excessive noise in each environment.

____

____

____

I wish to inform you that the data you have supplied will be screened and selected individuals will be required to undergo a complete audiological evaluation. As you have already indicated your willingness to participate in such a program, we will be contacting you at the given address/telephone number.

THANK YOU FOR YOUR TIME AND WILLINGNESS TO PARTICIPATE IN OUR RESEARCH PROCESS.

Ms S. Panday
Researcher(Masters Student)

APPENDIX H

CONSENT LETTER

Dear ______________________

Thank you for indicating an interest in this study. The study is aimed at developing a word list for First Language Zulu speakers in KwaZulu-Natal. The study would be conducted by Ms. Seema Panday (Masters student and registered audiologist) in the Department of Audiology, University of KwaZulu-Natal. Please be informed that all results obtained in this study would be strictly confidential and anonymity of participants would be ensured at all times. The information obtained would not be used in any way except for the purposes of the study. In no way without your consent would I distribute the information to third parties. You are free to remove yourself from study at any time of the project.

Should you wish to participate in the study, you would undergo a free hearing test. All participants are required to fill out a preliminary questionnaire to qualify for the participation in the study. The participants who meet the selection criteria will undergo the following procedures which are usually used to evaluate hearing:

a) Otoscopic examination, which is to ensure that you do not have any wax build up or that you do not have a hole on the ear drum.
b) Immitance audiometry, is done to ensure that your middle ear is free of infection.
c) Pure tone testing is done to determine the softest level at which you can hear sound.
d) Speech testing is done to determine how well you hear the Zulu words presented to you. The entire procedure will not last longer than one hour. If a further hearing test or management is required, the necessary referrals would be made timeously.

Please complete the consent form below to allow you to participate in the study.

Sincerely,

--------------------	------------------------
Ms. Seema Panday	Mr. CD Govender
Student	Supervisor

I, ________________________ consent to participating in the research project conducted by Seema Panday, Masters student in the Department of Speech Pathology and Audiology at the University of KwaZulu-Natal. I understand that a hearing evaluation would be conducted on me at the University of KwaZulu-Natal, Audiology clinic.

____

Participants Signature

____

Date

APPENDIX I

Test Battery, equipment, motivations for the use of such equipment and procedures used for the audiological tests conducted.

1.The pre test case history questionnaire was used.

Purpose of the procedure: This questionnaire was aimed at establishing the subject's audiological, medical and neurological history. Thus it served as a method of eliminating individuals who have had previous ear pathology due to any medical, surgical, neurological, occupational or social reasons. The case history questionnaire has become the single most important test within the test battery (Gelfand, 1997)). Furthermore, a questionnaire is a practical way of obtaining information from the target population (Ventry & Schiavetti, 1986). An adapted case history questionnaire was used.

Procedure: Each subject completed a case history questionnaire. All case history questionnaires were carefully analyzed. Those participants with no previous history of ear pathologies due to the above mentioned reasons were allowed to participate in the remaining data collection process. Thus participants who failed to meet the criteria of no previous history of ear pathologies were referred for further evaluations in one of the following facilities i.e.: private audiologists or university clinic or provincial hospitals.

2. Otoscopic examination: The Keeler Fibre Optic wall mounted otoscope was used to conduct the otoscopic examinations.

Purpose of the evaluation: Otoscopic examinations were conducted to determine the presence of cerumen, to observe the tympanic membrane and ear canal for abnormalities and to determine the size and shape of the ear canal in preparation for impedance testing (Hodgeson, 1980)

Procedure: The researcher chose a speculum that fitted comfortably in the ear canal. The following were observed: the pinnae, outer ear canal and the tympanic membrane. The subjects were allowed to continue with the test procedures if there was an absence of an occlusion of the ear canal by excess cerumen or foreign bodies and if the tympanic membrane was healthy reflecting a visible light reflex (Hodgson, 1980).

3. Immittance testing: Tympanometry: A clinical middle ear analyzer, the Grason-Stradler GSI33, equipped with a probe tip was used to administer the impedance test battery. The meter was calibrated according to ISO -389 and ANSI S3.39 - 1989 specifications and was technically calibrated in February2004.The immittance meter was used to elicit a tympanogram and ipsi-lateral acoustic reflexes bilaterally.

Purpose of the Evaluation: Tympanometry was conducted to determine the mechanical status and function of the middle ear. (Hodgeson, 1980)
Procedure: Tympanomety was conducted on each of the subjects. An acoustic seal was obtained using an appropriate sized probe tip. The integrity of the middle ear system was then determined by recording a tympanogram over a pressure range of +200mmH20 and - 200mmH20 using a probe tip. Physical volume measures and static compliance measures were obtained from the tympanogram, which were in accordance with the procedure outlined by Jerger (1970, as cited in Katz, 2002). A Type A tympanogram indicated normal middle ear function and occurred when the following three criteria were met according to the GSI 33 normative data

a) The static compliance of the middle ear system is 0.2ml to 1.8ml
b) The peak middle ear pressure is between -100daPa to +50 daPa
c) The physical volume is between 0.2ml to 2,0ml

Immitance testing: Ipsi-lateral acoustic reflexes: This was conducted using the same immitance meter that was used for tympanometry.
Purpose of the evaluation: Ipsi-lateral acoustic reflexes were conducted to assess the lowest stimulus level needed to elicit a reflex response of the stapedius muscle. Absent or elevated reflexes were considered indicative of ear pathology.

Procedure: The air pressure was set at maximum compliance. Threshold finding was started estimation was done using the ascending method in 5dB steps. The stating level was 75dBHL. A response was considered normal if it was between 70-100dBHL for ipsi-lateral reflexes (Hall and Mueller, 1997)

4. Pure Tone Air conduction testing: A twin channel clinical audiometer, the Grayson-Stradler GSI10 was used for pure tone (air conduction). This audiometer was equipped with a pair of TDH-49p telephonic adjustment earphones with MX41cushion. This type of earphone is recommended by Martin, 1997 as suitable for speech audiometry research and testing assist has more "built in dampening and a flatter frequency response to higher frequencies. The equipment was technically calibrated to meet Standards set by ANSI 3.6-1989 standards in February 2004.

Purpose of the evaluation: Pure tone audiometry determines an individuals hearing sensitivity across the 250Hz to 8kHz frequency range. This procedure provides a detailed account of each ear's performance across the frequency and intensity range Hodgeson (1980).

Procedure:

Tester: The pure tone testing was not done by the researcher but by another trained audiologist. This ensured that the researcher was blind to the pure tone averages of each subject. This controlled for tester bias in the research.

Instructions: The subjects were instructed to press the response button each time a tone was heard. They were also informed that the tone would get softer and that they should respond even if the sound was very soft. The instructions were given to each client in Zulu and English.

Earphone placement: Obstacles were removed e.g. spectacles. The headband of the earphones was tightened to fit each subject's head comfortably and to ensure that the earphone is appropriately placed on the head of the subject.

Threshold estimation: The plateau method of down 10db and up 5dB as described by Carhart & Jerger (1959),as cited in Katz (2002). Testing began at

30-40dBHL. The tester descended in 10dB steps until the subject responded and increased in 5dB steps until a response was obtained. The tester used three consecutive responses were a 50% level was obtained and a threshold was thus established.

Materials used for recording data: A pure tone and speech audiogram developed by the Department of Speech Therapy and Audiology, University of Kwa-Zulu Natal was used to record manually the pure tone results.

Criteria for interpretation of results: The ANSI scale was used to calculate hearing acuity. All results that were within the 0-25dBHL were considered normal. (Hodgeson, 1980; Gelfand, 1997).

APPENDIX J Randomized Zulu words

khanya		donsa		goba		qonda		khaba		chela	
hleka		shada		thatha		banga		landa		shaya	
chela		goba		hleka		minya		washa		washa	
jaha		hlala		bhema		gxeka		yona		vula	
yeba		jaha		donsa		vuma		veza		geza	
loya		letha		faka		thenga		finya		vala	
vala		yeka		washa		yosa		sefa		pheka	
yona		yanga		wina		yanga		linda		xola	
yeka		bheka		finya		washa		jeza		banga	
qonda		dansa		yosa		vala		yeka		lima	
khipa		veza		vala		loya		hola		veza	
minya		minya		bheka		landa		yifa		gqoka	
finya		sefa		phonsa		xola		hluba		linda	
donsa		geza		hola		chela		gxeka		dansa	
yenza		khetha		geza		geza		thenga		bheka	
shaya		pheka		hluba		gqoka		vula		wina	
thatha		khanya		khipa		sefa		donsa		qonda	
cinga		thela		hlala		jaha		geza		khaba	
hluba		lunga		thanda		linda		wina		jaha	
dansa		vala		khanya		thanda		pheka		khanya	
hlenga		finya		dinga		vula		kheta		lunga	
vuma		qonda		vuma		thatha		hlala		minya	
sefa		thenga		xola		hlenga		loya		yanga	
phonsa		phonsa		loya		bheka		chela		yona	
yanga		faka		gqoka		hlala		shaya		landa	
geza		landa		yenza		letha		shada		qoba	
shada		yosa		banga		veza		yanga		yeka	
wina		dinga		lunga		yifa		bhema		hlala	
yosa		wina		shaya		yona		goba		thela	
letha		linda		gxeka		kheta		dansa		kheta	
gxeka		thata		pheka		phonsa		vala		goba	

qoba		washa		shada		shaya		yosa		jeza	
xola		khaba		chela		shada		bheka		donsa	
hola		banga		qoba		khipa		cinga		vuma	
gqoka		thanda		yeka		khanya		hlenga		faka	
faka		khipa		yona		thela		gqoka		yeba	
hlala		gxeka		hlenga		yeka		hleka		shada	
landa		lima		yeba		faka		thola		dinga	
jeza		hola		Vula		thola		qonda		thenga	
pheka		hlenga		thela		pheka		vuma		cinga	
thenga		qoba		Vala		qoba		thanda		loya	
dinga		hluba		Sefa		wina		minya		yosa	

APPENDIX K

Motivation for logistic regression

Logistic Regression:

Some basic background on the logistic model:

Since the binomial distribution is used, we might expect that there will be a relationship between logistic regression and chi-square analysis. It turns out that the 2x2 contingency analyses with chi-square is really just a special case of logistic regression. With chi-square contingency analysis, the independent variable is dichotomous and the dependent variable is dichotomous. Logistic analysis does not restrict the independent variable to be dichotomous.

Generally when one uses binary data the linear regression is not an appropriate model at all, in fact the data usually takes on an S-shaped curve. Our statistical effort to transform the S-shaped curve to a linear one requires us to employ the logistic distribution.

Figure: 1. S-shaped linear approximation to logistic regression curve.

For a binary response Y and a quantitative explanatory variable X, we allow p(x) to show the probability of a success when X takes on any of its values – example in our data let X represent the sound intensity levels and Y denote the success or failure (audible or not respectively.) Then when x = 10. Mathematically we write,

$$p(x) = \text{Prob}(y|x).$$

Read, the probability of y given x.

We also define the odds of success as:

$$odds = \frac{p(x)}{1-p(x)}$$

The log of the odds is known as the logit.

The simple logistic model is of the form, (for only for one explanatory variable, x):

$$\text{logit}[p(x)] = \log\left(\frac{\text{p(x)}}{1-\text{p(x)}}\right) = \alpha + \beta x \qquad (1)$$

This transformation, namely, the logit (log of the odds), yields is a *linear* function of the explanatory variables x. Estimation of the parameters of interest in the logistic regression is done similarly to linear regression once the transformation has been applied. That is, we will have estimates for α and β which represent the intercept and slope respectively (These are generally calculated by some software package). Solving for p(x) in equation (1) above gives,

$$p(x) = \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}} \quad . \qquad (2)$$

Therefore, p is the proportion correct at any given intensity level. By inserting the intercept and slope into equation (2) we can predict the percentage correct at any given intensity level.

Any line drawn tangent to the curve in figure 1, has a slope equal to β*p(x)*[1 - p(x)]. The steepest slope occurs at p(x) = 0.5. The x value at this slope is usually called the threshold, (intensity required for 50% intelligibility). A simple equation to calculate threshold is given by

$$x = \frac{\log(p/1-p)-\alpha}{\beta}. \qquad (3)$$

At p = 0.5,

$$x = \frac{-\alpha}{\beta}. \qquad (4)$$

Example of Calculation:

Estimates of α and β are got from software package being used (here SPSS). Let us consider the word Geza at sound intensity level x = 5.

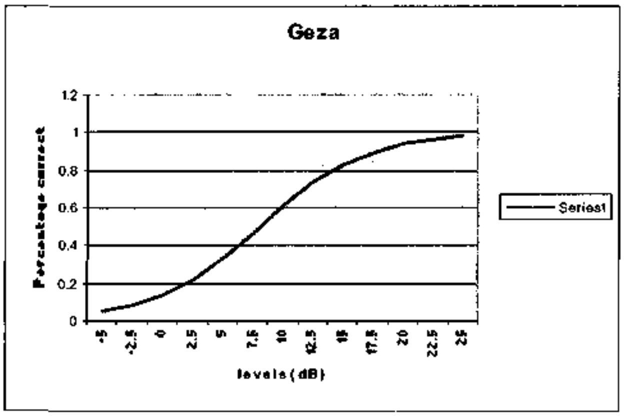
GEZA

α	β
-1.85	**0.228**

Thus the logistic model is of the form

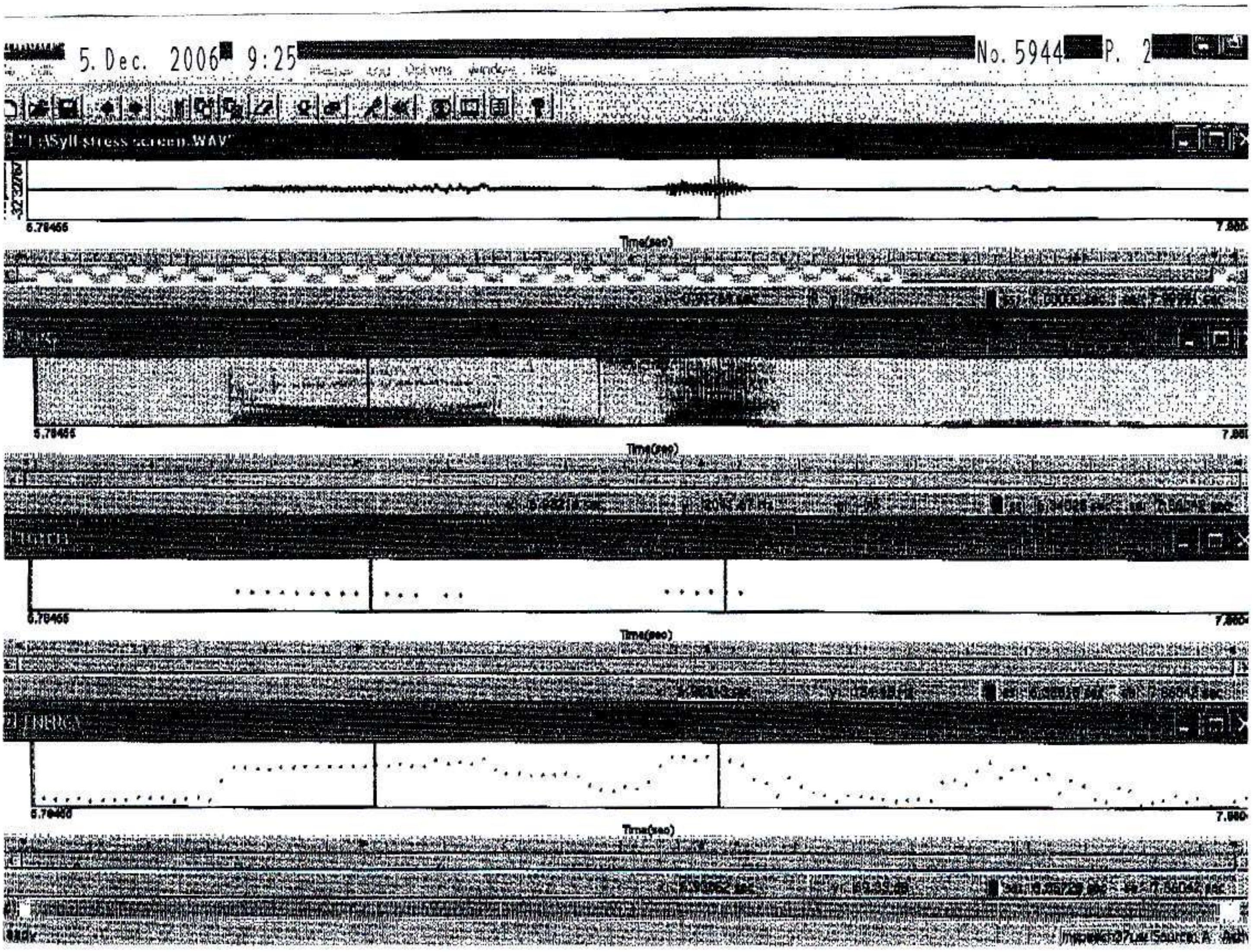
$$\text{logit}[\ p(x)] = \log\left(\frac{\text{p(x)}}{1-\text{p(x)}}\right) = \alpha + \beta x$$
$$= -1.85 \ + \ 0.228\ x$$

And p(5) is



Calculations for the other words continue in a similar way.

APPENDIX L



APPENDIX M

ZULU SRT WORD LIST

Banga

Gxeka

Cinga

Faka

Thela

Linda

Khaba

kheta

Thatha

Donsa

Washa

Chela

Xola

Yonga

Yona

Veza

Wina

Khanya

Shada

Geza

Khipa

Thola

Jeza

Qonda

Thenga

Loya

Minya

Yeka

	PTA	*SRT*
Right Ear		
Left Ear		

APPENDIX N

A description of the words obtained per participant for objective one of aim one of the study

Words suggested any of the two participants	Words suggested by any of the three participants	Words suggested by any of the four participants
1.Bhala	Bona	Bhaka
2.Bhema	Banga	Biza
3.Buza	Bheka	Bola
4.cela	Cwewa	Cacha
5.chela	Dinga	Cinga
6.dansa	Dlala	Donsa
7.duda	Faka	Gcina
8.dula	Futhi	Geza
9. fika	Ganga	Hamba
10.funa	Goba	Khipa
11.funda	Gxeka	Landa
12.finya	Hleka	Netha
13.gcaca	Hoya	Ndiza
14.gqoka	Hlala	Pheka
15.hola	Hluba	Phuma
16.jika	Hlupha	Shaya
17jula	Hlenga	Siza
18jaha	Jeza	Shada
19khiye	Khanya	Thatha
20.khala	Kheta	Vala
21.klekha	Khola	Woza
22letha	Khaba	Yifa
23.lima	Lala	
24.loya	Linda	
25.lapha	Luma	
26.minya	Lunga	
27.ngena	Manje	
28.nuka	Mina	
29.nyanga	Mila	
30phansi	Muva	
31phezu	Ncama	
32.phuza	Nyama	
33qeda	Phupha	
34.qonda	Phosa	
35.qina	Phapha	
36.senga	Pheza	
37.sula	Qala	
38.sefa	Qoba	
39.shiya	Quela	
40.Sika	Qhaqha	
41.sina	Qaqa	
42.susa	Shesha	
43.Thola	Thenga	
44.Thula	Thanda	
45.thela	Vuka	
46.tshala	Vula	
47.veza	Vuma	
48.wawa	Washa	
49.xoxa	Wina	
50.xola	Xosha	
51.Yeka	Yeba	
52.Yanga	Yosa	
53.yenza		
54.yona		
55.zakhe		
56.zosha		
57.Zabo		

APPENDIX O

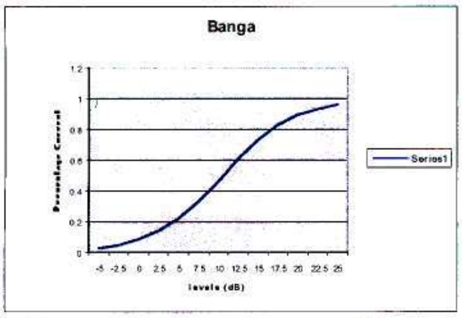
	rater1 versus rater2		rater1 versus rater 3		rater2 versus rater 3	
word	kappa	strength	kappa	strength	kappa	strength
banga	0.973	Very Good	0.894	Very Good	0.894	Very Good
bheka	0.945	Very Good	0.904	Very Good	0.877	Very Good
bhema	0.946	Very Good	0.839	Very Good	0.839	Very Good
chela	0.933	Very Good	0.84	Very Good	0.825	Very Good
cinga	0.893	Very Good	0.866	Very Good	0.866	Very Good
dansa	0.92	Very Good	0.933	Very Good	0.906	Very Good
dinga	0.892	Very Good	0.747	Good	0.718	Good
donsa	0.973	Very Good	0.88	Very Good	0.853	Very Good
faka	829	Very Good	0.792	Good	0.75	Good
finya	0.868	Very Good	0.854	Very Good	0.868	Very Good
geza	0.959	Very Good	0.959	Very Good	0.919	Very Good
goba	0.907	Very Good	0.828	Very Good	0.84	Very Good
gonda	0.966	Very Good	0.901	Very Good	0.901	Very Good
gqoka	0.781	Good	0.684	Good	0.702	Good
gxeka	0.88	Very Good	0.799	Good	0.882	Very Good
hlala	0.919	Very Good	0.824	Very Good	0.835	Very Good
hleka	0.889	Very Good	0.902	Very Good	0.848	Very Good
hlenga	0.907	Very Good	0.8	Very Good	0.813	Very Good
hluba	0.848	Very Good	0.836	Very Good	0.796	Good
hola	0.859	Very Good	0.717	Good	0.721	Good
jaha	0.987	Very Good	0.853	Very Good	0.867	Very Good
jeza	0.919	Very Good	0.852	Very Good	0.825	Very Good
khaba	0.901	Very Good	0.929	Very Good	0.887	Very Good
khanya	0.943	Very Good	0.971	Very Good	0.943	Very Good
kheta	0.959	Very Good	0.839	Very Good	0.852	Very Good
khipa	0.92	Very Good	0.854	Very Good	0.827	Very Good
landa	0.932	Very Good	0.878	Very Good	0.838	Very Good
letha	0.946	Very Good	0.906	Very Good	0.88	Very Good
lima	0.854	Very Good	0.704	Good	0.758	Good
linda	0.933	Very Good	0.853	Very Good	0.893	Very Good
loya	0.917	Very Good	0.836	Very Good	0.837	Very Good
lunga	0.925	Very Good	0.81	Very Good	0.767	Good
minya	0.921	Very Good	0.904	Very Good	0.887	Very Good
pheka	0.933	Very Good	0.866	Very Good	0.906	Very Good
phonsa	0.852	Very Good	0.773	Good	0.813	Very Good
qoba	0.897	Very Good	0.813	Very Good	0.857	Very Good
sefa	0.866	Very Good	0.85	Very Good	0.817	Very Good
shada	0.927	Very Good	0.871	Very Good	0.942	Very Good
shaya	0.932	Very Good	0.882	Very Good	0.85	Very Good
thanda	0.96	Very Good	0.92	Very Good	0.88	Very Good
thatha	0.973	Very Good	0.854	Very Good	0.827	Very Good
thela	0.933	Very Good	0.853	Very Good	0.813	Very Good
thenga	0.946	Very Good	0.878	Very Good	0.851	Very Good
thola	0.954	Very Good	0.85	Very Good	0.836	Very Good
vala	0.927	Very Good	0.942	Very Good	0.899	Very Good
veza	0.882	Very Good	0.894	Very Good	0.808	Very Good
vula	0.943	Very Good	0.835	Very Good	0.834	Very Good

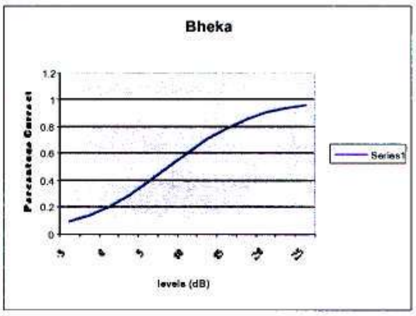
vuma	0.917	Very Good	**0.837**	**Very Good**	0.783	Good
washa	0.888	Very Good	**0.941**	**Very Good**	0.904	Very Good
wina	0.844	Very Good	**0.807**	**Very Good**	0.847	Very Good
xola	0.916	Very Good	**0.875**	**Very Good**	0.848	Very Good
yanga	0.903	Very Good	**0.809**	**Very Good**	0.795	Good
yeba	0.947	Very Good	**0.96**	**Very Good**	0.907	Very Good
yeka	0.957	Very Good	**0.871**	**Very Good**	0.886	Very Good
yenza	0.933	Very Good	**0.907**	**Very Good**	0.92	Very Good
yifa	0.876	Very Good	**0.872**	**Very Good**	0.796	Good
yona	0.946	Very Good	**0.919**	**Very Good**	0.919	Very Good
yosa	0.864	Very Good	**0.799**	**Good**	0.736	Good

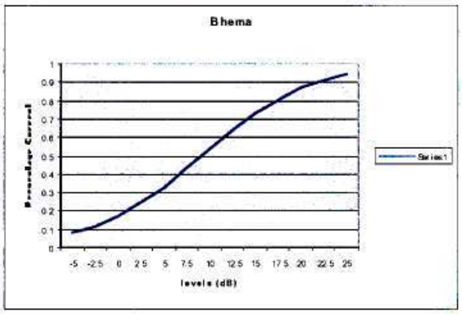
rater1	**Z**
rater2	**R**
rater3	**S**
kappa	**statistic describing concordance**
strength	**the strength of the agreement**

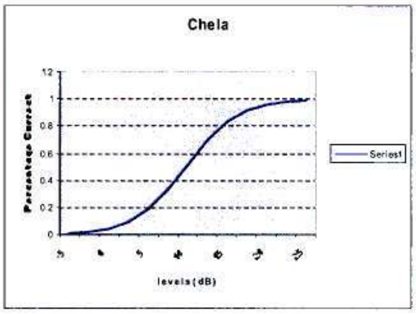
APPENDIX P

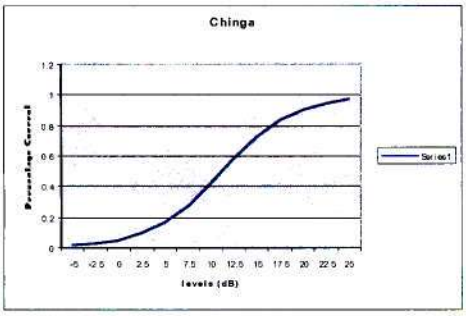
Performance intensity curves for each of the 58 words

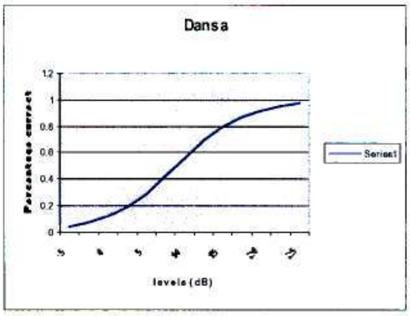


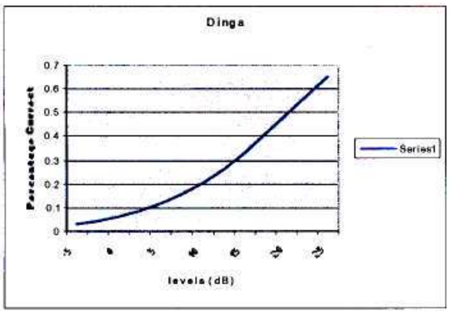


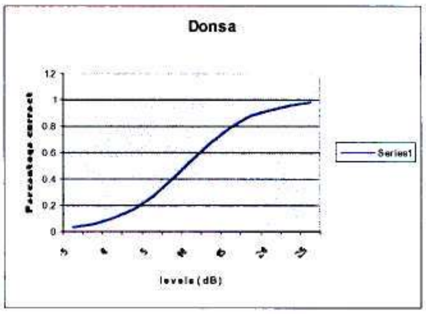


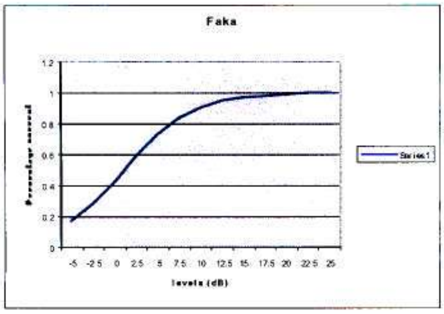


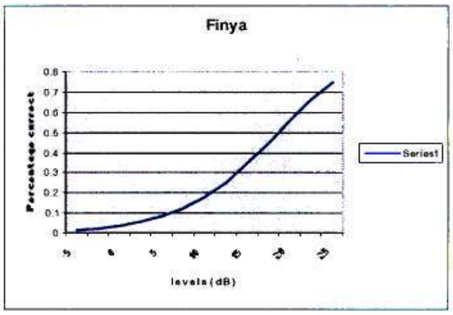









Faka
Percentage correct
levels (dB)
Series1
0
0.2
0.4
0.6
0.8
1
1.2
-5 -2.5 0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25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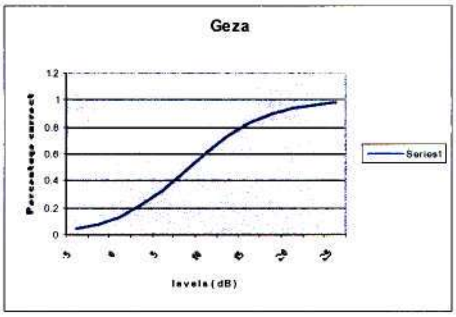
0.6
0.7
0.8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0.4
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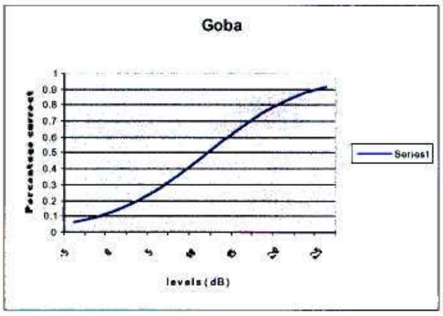
0.8
1
1.2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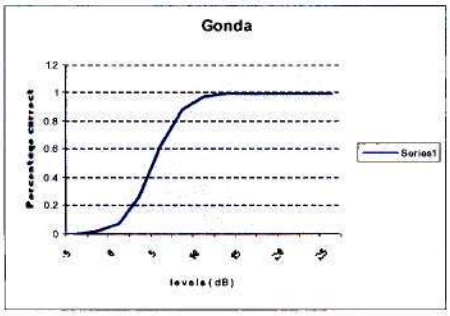
0.8
0.9
1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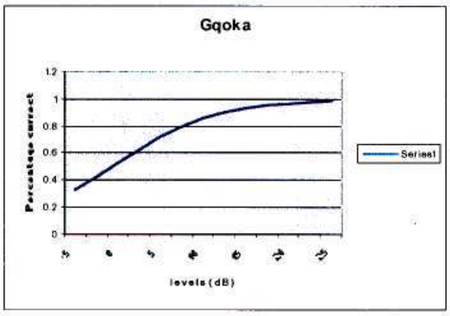
0.8
1
1.2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0.8
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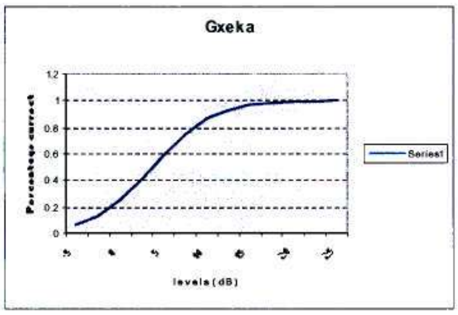
1.2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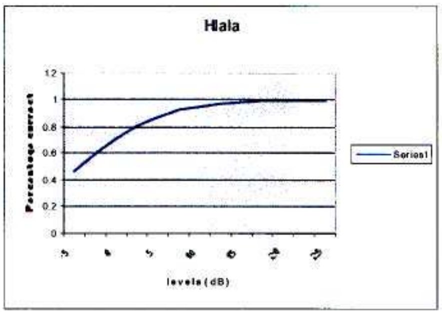
0.2
0.4
0.6
0.8
1
1.2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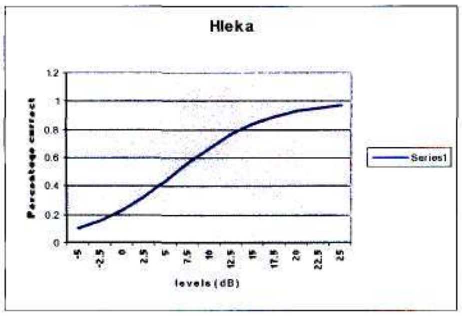
0.4
0.6
0.8
1
1.2


Hleka
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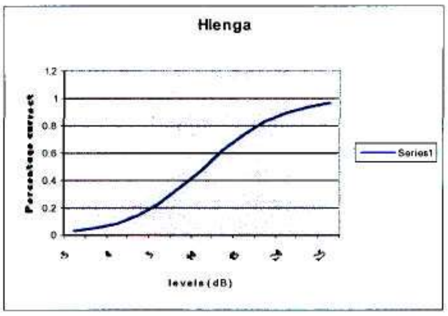
Series1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levels (dB)
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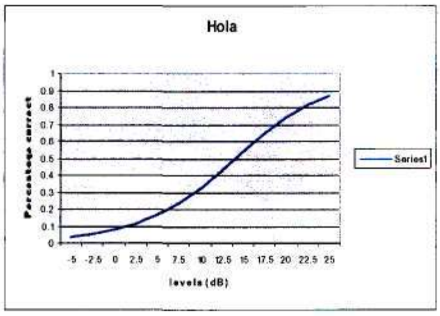
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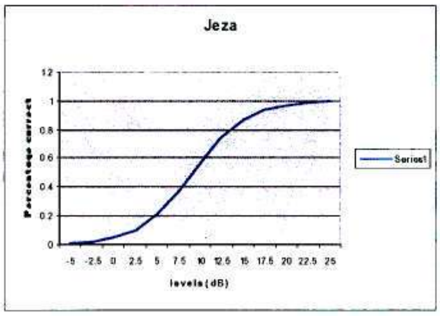
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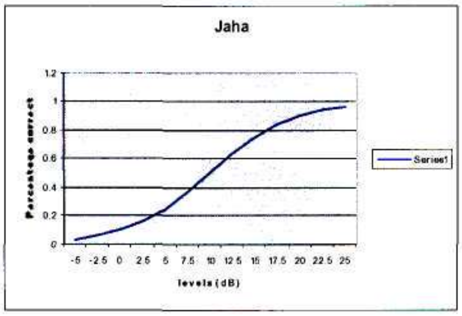
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levels (dB)
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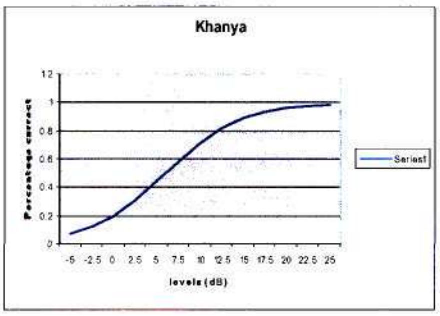
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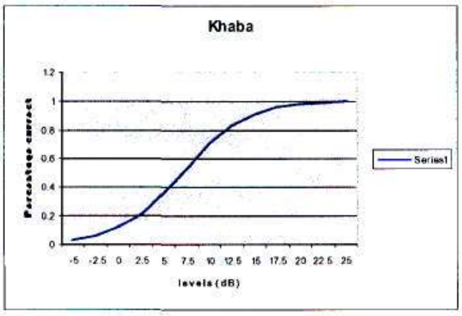
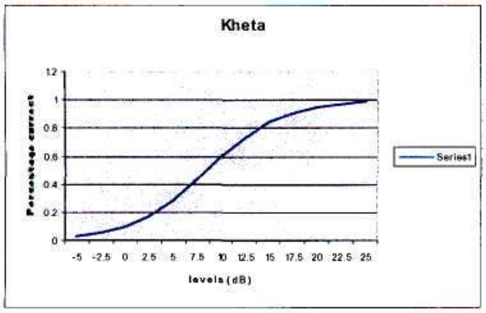
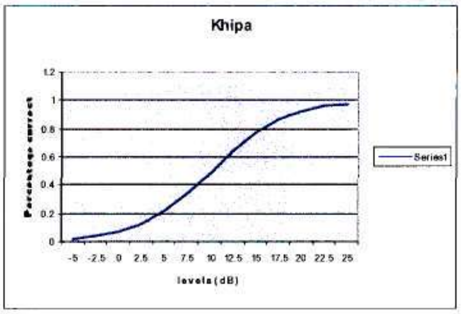
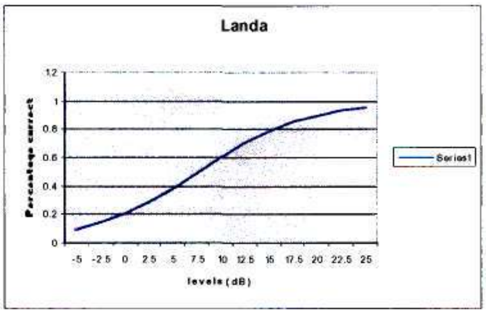
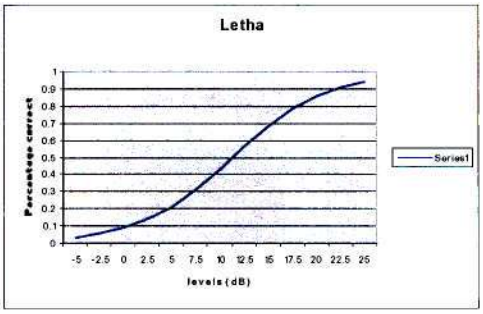
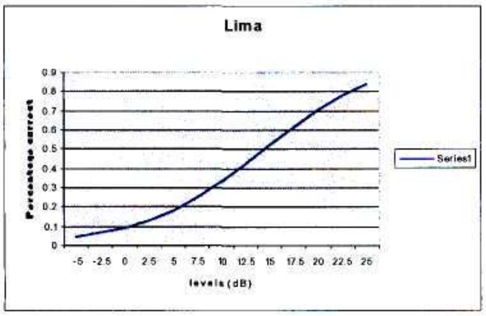

Khaba
Percentage correct
levels (dB)
Series1

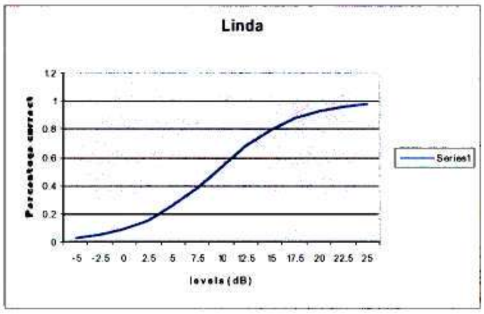

Kheta
Percentage correct
levels (dB)
Series1

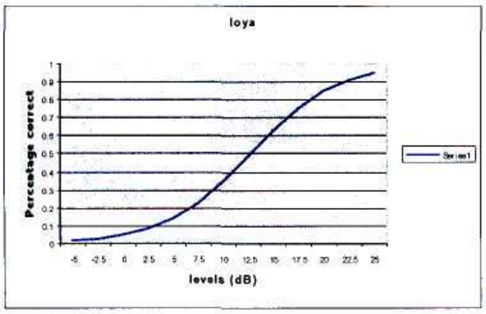

Khipa
Percentage correct
levels (dB)
Series1

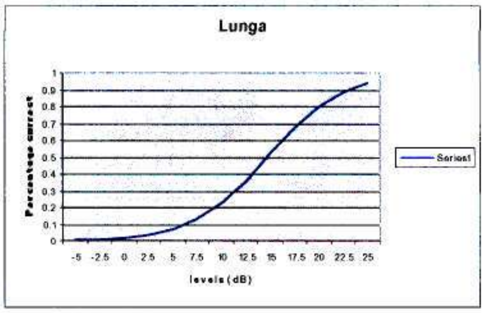

Landa
Percentage correct
levels (dB)
Series1

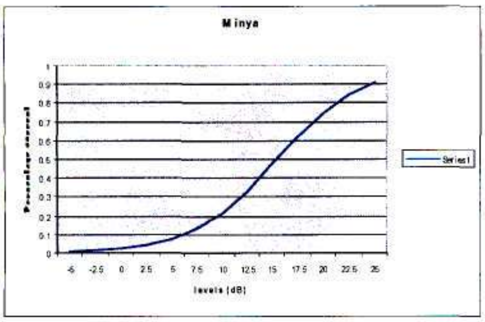

Letha
Percentage correct
levels (dB)
Series1

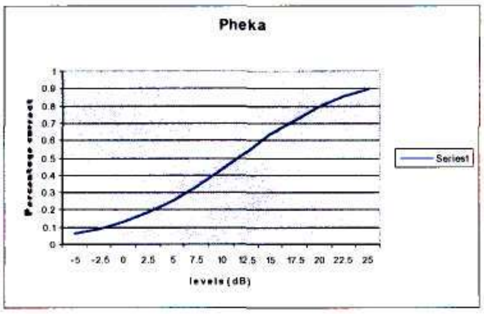

Lima
Percentage correct
levels (dB)
Series1

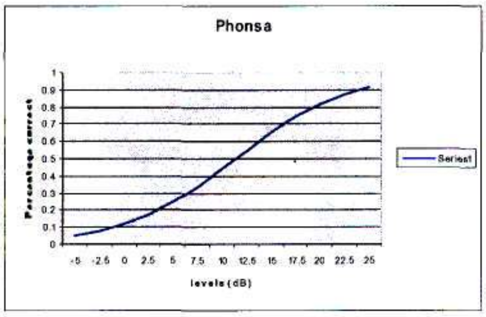

Linda
Percentage correct
levels (dB)
Series1

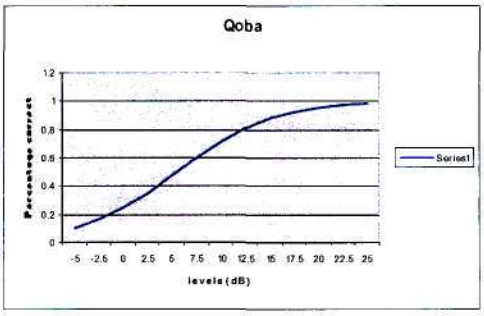

loya
Percentage correct
levels (dB)
Series1

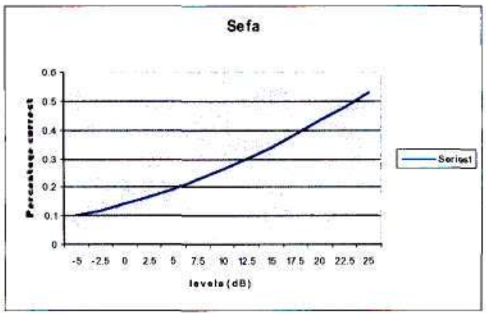

Lunga
Percentage correct
levels (dB)
Series1

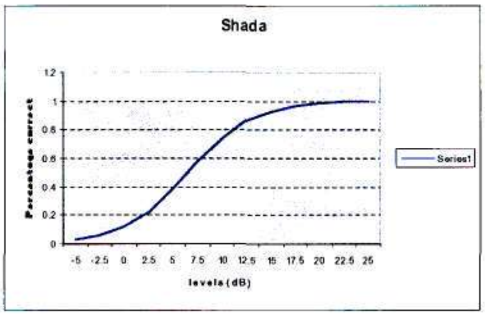

Minya
Percentage correct
levels (dB)
Series1

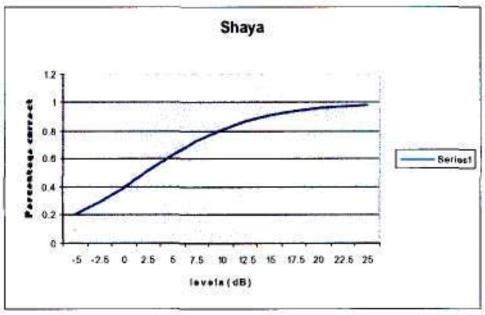

Pheka
Percentage correct
levels (dB)
Series1


Phonsa
Percentage correct
levels (dB)
Series1


Qoba
Percentage correct
levels (dB)
Series1


Sefa
Percentage correct
levels (dB)
Series1


Shada
Percentage correct
levels (dB)
Series1


Shaya
Percentage correct
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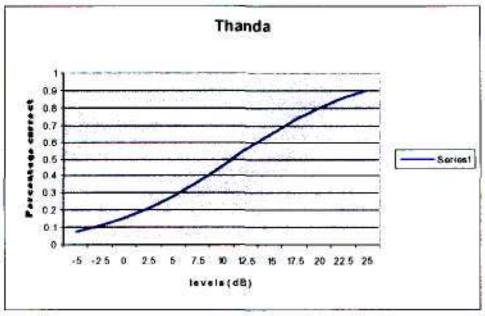
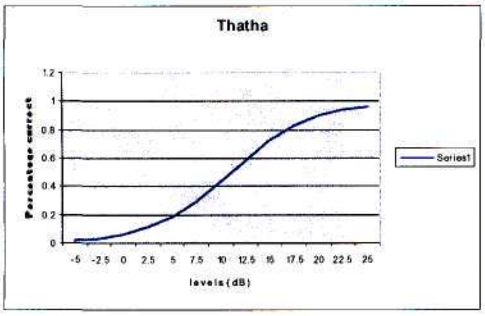
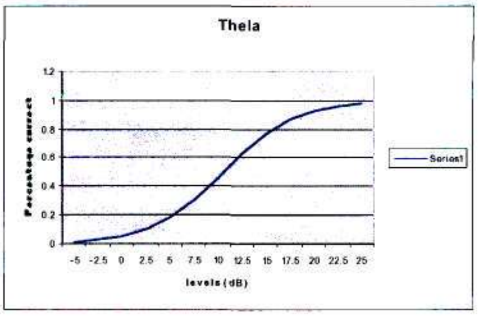
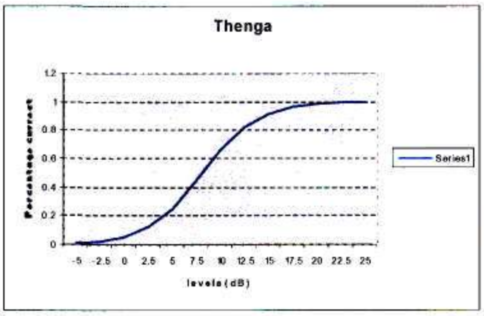
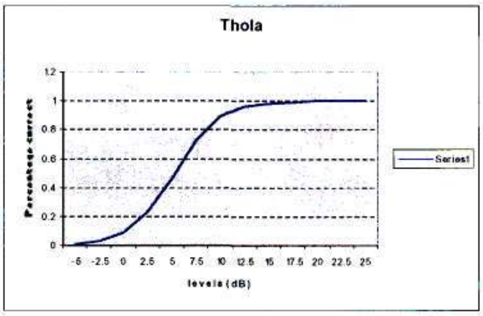
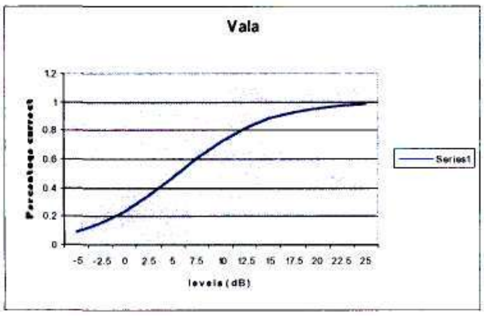

Thanda
Percentage correct
levels (dB)
Series1

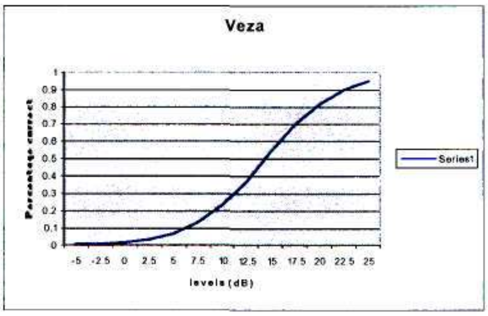

Thatha
Percentage correct
levels (dB)
Series1

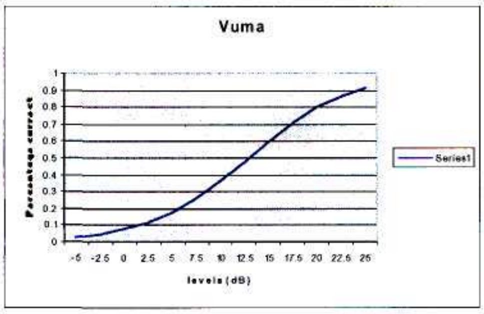

Thela
Percentage correct
levels (dB)
Series1

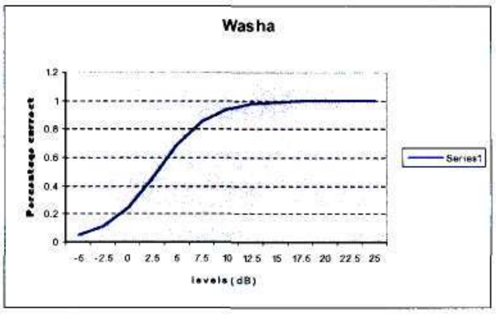

Thenga
Percentage correct
levels (dB)
Series1

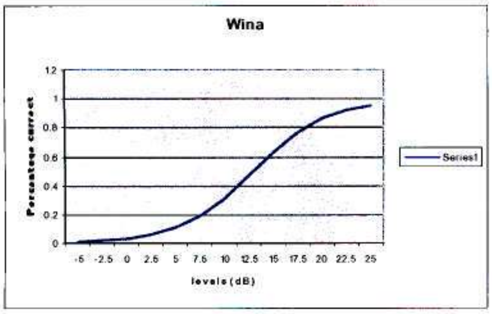
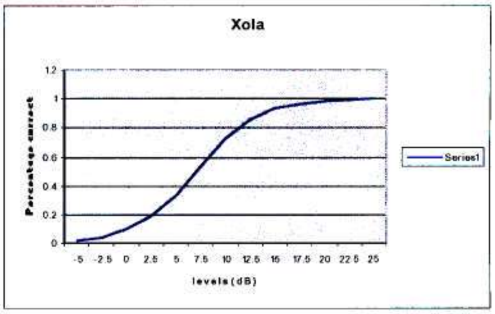
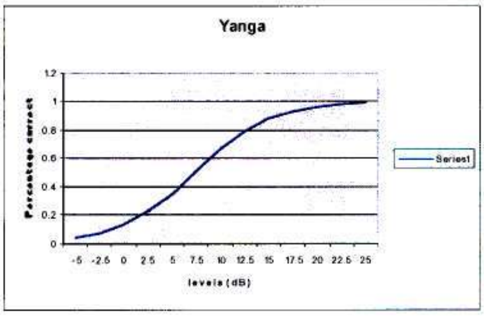
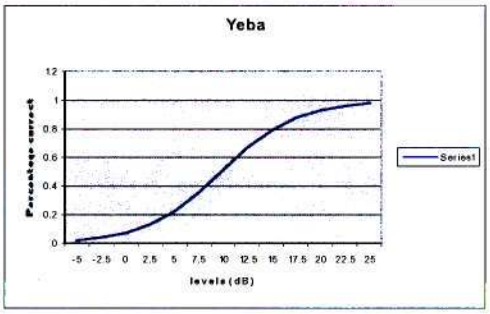

Thola
Percentage correct
levels (dB)
Series1


Vala
Percentage correct
levels (dB)
Series1


Veza
Percentage correct
levels (dB)
Series1


Vuma
Percentage correct
levels (dB)
Series1


Washa
Percentage correct
levels (dB)
Series1


Wina
Percentage correct
levels (dB)
Series1

Xola
Percentage correct
levels (dB)
Series1

Yanga
Percentage correct
levels (dB)
Series1

Yeba
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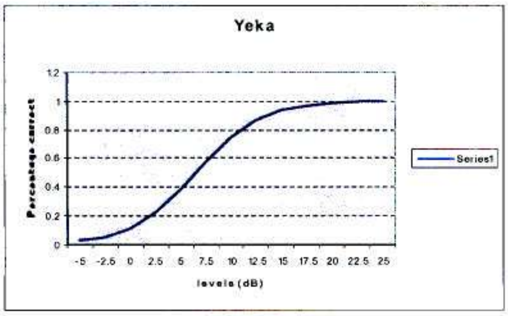
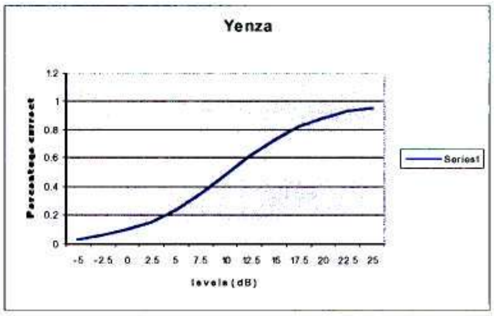
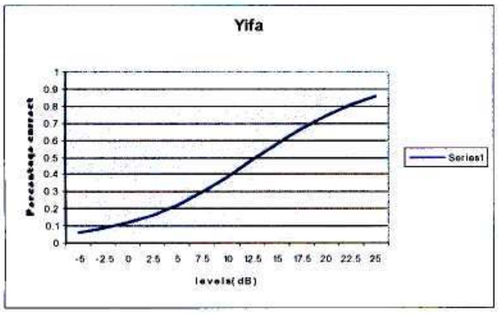
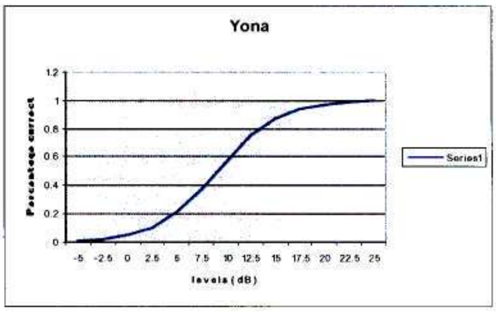
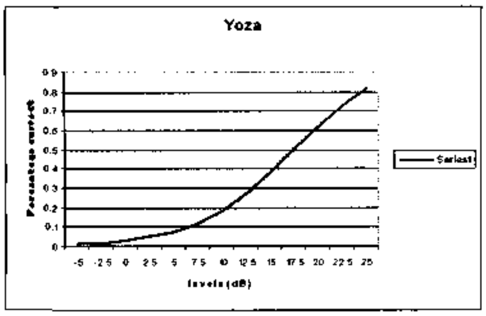
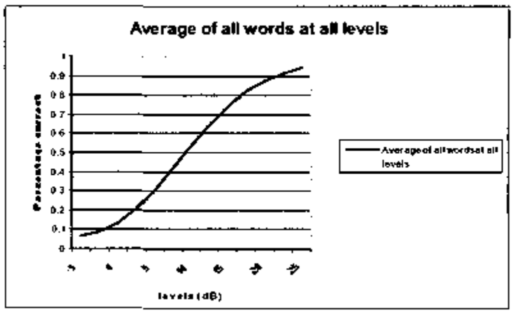
levels (dB)
Series1

Yeka
Percentage correct
levels (dB)
Series1

Yenza
Percentage correct
levels (dB)
Series1

Yifa
Percentage correct
levels(dB)
Series1

Yona
Percentage correct
levels (dB)
Series1


Yoza
Percentage correct
levels (dB)
Series1


Average of all words at all levels
Percentage correct
levels (dB)
Average of all words at all levels

APPENDIX Q

Pure tone Average scores and SRT (Zulu) for both left and right ears.

N	PTA(right)	PTA(left)	SRT(right)	SRT(left)
1	.00	.00	5.00	5.00
2	5.00	.00	5.00	5.00
3	13.30.	8.30	15.00	10.00
4	.00	.00	0.00	5.00
5	6.67	6.67	10.00	5.00
6	.00	.00	5.00	.00
7	.00	.00	5.00	.00
8	.00	-5.00	5.00	.00
9	.00	.00	5.00	5.00
10	.00	-5.00	5.00	5.00
11	15.00	.00	15.00	5.00
12	.00	10.00	.00	10.00
13	5.00	5.00	10.00	10.00
14	6.67	3.33	10.00	10.00
15	.00	.00	5.00	.00
16	.00	.00	.00	.00
17	5.00	6.67	10.00	10.00
18	.00	.00	5.00	5.00
19	.00	.00	.00	.00
20	.00	.00	.00	5.00
21	.00	.00	5.00	5.00
22	3.33	.00	10.00	5.00
23	5.00	5.00	5.00	5.00
24	3.33	5.00	5.00	5.00
25	13.33.	11.67	10.00	10.00
26	5.00	5.00	5.00	5.00

APPENDIX R

SRT (English) for the right and left ears

N	SRT (right)	SRT(Left)
1	10.00	5.00
2	10.00	10.00
3	20.00	20.00
4	5.00	10.00
5	15.00	10.00
6	10.00	5.00
7	10.00	5.00
8	10.00	.00
9	5.00	10.00
10	10.00	10.00
11	20.00	10.00
12	5.00	10.00
13	10.00	10.00
14	15.00	15.00
15	20.00	.00
16	5.00	15.00
17	15.00	5.00
18	5.00	10.00
19	15.00	10.00
20	10.00	5.00
21	5.00	5.00
22	10.00	10.00
23	10.00	10.00
24	5.00	15.00
25	15.00	15.00
26	10.00	10.00