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Comparison of the South African Spondaic wordlist and the CID W-1 wordlist for measuring Speech Recognition Threshold

by

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With thanks to

My Lord and Saviour, the Good Shepherd, for life, and life in abundance.

My husband, Marc Hanekom, for your love, unending support and endless offers of tea.

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Brent Archer, for the initial inspiration earned over lunch.

Dedicated to the memory of my mormor

1927-2008

Speech is civilisation itself.

The word,

even the most contradictious word, preserves contact –

it is silence which isolates.

Thomas Mann, The Magic Mountain (1924)

I declare that the dissertation, which I hereby submit for the degree M. Communication Pathology (Audiology) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Please note that the South African Spondaic wordlist was originally developed in part at the University of the Witwatersrand, as an unpublished 4th year research report submitted in partial fulfilment of the requirements for the degree BA(Sp.&H.Th), Department of Speech Pathology and Audiology, School of Human and Community Development, Faculty of Humanities, University of the Witwatersrand.

The University of the Witwatersrand has granted permission for the work to be used in the current study. The researcher, Tanya Hanekom, was registered at the University of the Witwatersrand as Tanya Durrant (maiden name) in 2006.

Abstract

Title: Comparison of the South African Spondaic wordlist and the CID W-1 wordlist for measuring Speech Recognition Threshold
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Introduction. The Central Institute for the Deaf published Auditory Tests W-1 (CID W-1) spondaic wordlist was developed in the USA in 1947 and 1952. Certain American-English words contained in the wordlist are unfamiliar to many South Africans, even English first language (EFL) speakers, but particularly those who use English as a second language (ESL). Familiarity with spondaic words is one of the most important qualities of the test items used to determine Speech Recognition Threshold (SRT).
Objectives. The aim of this study was to compare the SRT results obtained with the English South African Spondaic (SAS) wordlist developed by Durrant (2006) and the English CID W-1 spondaic wordlist when measuring the SRT of adult ESL speakers in South Africa.
Method. Audiometric Pure Tone Average (PTA) and SRT measurements were obtained for 101 (197 ears) ESL participants with normal hearing or a minimal hearing loss <26 dBHL (mean age 33.3). PTA/SRT correlations were compared when using the SAS wordlist (groups one and two), as well as either the 'less familiar' CID W-1 (group one) or 'more familiar' CID W-1 (group two), in a mixed matched group design.
Results. A Pearson correlation analysis revealed a significant and positive correlation for all three wordlists. The Pearson correlation analysis revealed a strong PTA/SRT correlation when using the South African Spondaic (SAS) wordlist (right ear: 0.65; left ear 0.58) and the 'more familiar' words from the CID W-1 wordlist (right ear: 0.63; left ear: 0.56). The use of the 'less familiar' words from the CID W-1 wordlist revealed weak correlations (right ear: 0.30; left ear: 0.32). Paired sample T-tests indicated a statistically significantly stronger PTA/SRT correlation when the SAS wordlist was used, rather than either of the CID W-1 wordlists, at a 95% level of confidence.
Conclusions. The use of the SAS wordlist yields a stronger PTA/SRT correlation than the use of the CID W-1 wordlist, when performing SRT testing as part of the speech audiometry battery on South African ESL speakers with normal hearing, or minimal hearing loss <26 dBHL.
Key words: Speech Recognition Threshold (SRT), English second language (ESL), South Africa, South African Spondaic wordlist, CID W-1 wordlist, familiarity.

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List of abbreviations

CID W-1	Central Institute for the Deaf Auditory wordlist W-1
dB	Decibel
dB HL	Decibel (Hearing Level)
dB SL	Decibel (Sensation Level)
EFL	English first language speakers
ESL	English second language speakers
LoLT	Language of Learning and Teaching
MLV	Monitored Live Voice
PTA	Pure Tone Average
SAE	South African English
SRT	Speech Recognition Threshold
VU meter	Volume Unit meter

Chapter 1: Introduction and background

In this chapter, the rationale and contextual background will be presented, as well as the definition of terms and chapter layout.

1.1 Rationale

Speech audiometry is a vital element of the audiological test battery as it assesses the individual's ability to hear, understand or recognise speech, in its complexity of rhythm, frequency, rate, intensity and duration. Speech audiometry tests the ability of the auditory system beyond the level of the ear, as comprehension, knowledge, audition, and concentration are simultaneously assessed, thus providing a more realistic test of hearing function (Brandy, 2002).

The measurement of the speech recognition threshold (SRT) is a speech audiometry test that relies on the participant's recognition of familiar spondaic words from a closed set (American Speech-Language-Hearing Association, 1988). SRT is defined as the lowest intensity at which the spondaic words are correctly identified 50% of the time (Evans, 1997; Martin & Clark, 2003). A spondaic word consists of two long syllables (Evans, 1997). It is important to use spondees, or spondaic words, for determining SRT, as they are easier to identify, or recognise, than monosyllabic words (Evans, 1997). In conversational English, spondees are usually spoken as one long and one short syllable (Evans, 1997). During audiological testing however, it is necessary for the tester who presents the words to manipulate the stress to be equal across both syllables of the spondee (Martin & Clark, 2003).

There are three purposes for testing SRT. The first is to determine the participant's threshold level, that is, their hearing sensitivity for identifying speech. The second is to check the accuracy of the Pure Tone Average (PTA) results, by determining the correlation between PTA and SRT (American Speech-Language-Hearing Association, 1988), and the third is as a reference point for suprathreshold speech tests (Brandy, 2002). The most commonly used word list for assessing SRT is the Central Institute for the Deaf Auditory Word List W-1 (CID W-1) (Hirsh, Davis, Silverman, Reynolds, Eldert & Benson, 1952). The original spondaic words were developed by Hudgins, Hawkins, Karlin and Stevens (1947) at the Harvard Psycho-Acoustic Laboratories. Of the original 42 spondaic words, 36 are included in the Central Institute for the Deaf (CID) published Auditory Tests W-1 (CID W-1) (McArdle & Hnath-Chisolm, 2009, Hirsh et al., 1952).

The original CID W-1 words were developed at Harvard University, in 1947 and 1952. This is far removed in both space and time, from current day South Africa, where this study is established.

South Africa presents with a distinctly unique amalgamation of languages, dialects, cultures and linguistic communities (Tuomi, 1994, as cited in Swanepoel, 2006). There are 11 official languages and most of the population has a working knowledge of more than one language (Swanepoel, 2006). Although only 8% of the population uses English as their home language (Swanepoel, 2006), the majority of the population use English as one of their multiple languages, and English is considered the lingua franca, and is used extensively in government, business, commerce, education and tertiary education in South Africa (Minow, 2010). English is the language of learning and teaching (LoLT) of more than 90% of South African learners (Strauss, Van der Linde, Plekker & Strauss, 1999:10-11, as cited in De Wet, 2002).

The home language of the majority of audiology professionals in South Africa is either English or Afrikaans, and tertiary level training is frequently conducted in English or Afrikaans (Swanepoel, 2006). Roets (2005) found that 82 out of 84 surveyed audiologists in the South African clinic setting use English wordlists when conducting speech audiometry. This is in stark contrast to the demographics of South Africa, where the home language of the majority of the population is an African language (Uys & Hugo, 1997, as cited in Swanepoel, 2006). As a result, audiologists in South Africa face a predicament when the need arises to assess the speech recognition thresholds (SRT) of English second language (ESL) speakers, due to the implications of multilingualism on speech audiometry results (Von Hapsburg & Pena, 2002).

In South Africa, the CID W-1 wordlist (Hirsh et al., 1952), or variations thereof, is routinely used in speech audiometry as the test material for measuring SRT (Roets, 2005). The wordlist was originally developed and standardized on American English population groups, and many of the words, such as “inkwell”, “drawbridge” and “horseshoe”, are specific to American English, and is not standardised for people who do not have American English as their home language (Ramkissoon, Proctor, Lansing & Bilger, 2002). The wordlist is therefore unfamiliar to many South Africans, which may therefore lead to flawed results, particularly when testing multilingual speakers. Familiarity, as well as homogeneity and intelligibility of spondaic words is important (Ramkissoon, 2001; Sreedhar, Venkatesh, Nagaraja & Srinivasan, 2011). If spondaic words used in testing are familiar to the participant, it ensures that the auditory threshold is measured, rather than vocabulary or intelligence, thus resulting in good face validity (Ramkissoon, 2001; Ramkissoon et al., 2002; Sreedhar et al., 2011). In a multilingual, multicultural country such as South Africa (Dumakude, 2003; Swanepoel, 2006), this may seriously compromise the validity of the measurement, due to linguistically and culturally biased test items (Rudmin, 1987, as cited in Ramkissoon, 2001).

It is important that audiologists acknowledge the implications of multilingualism on speech audiometry results (Von Hapsburg & Pena, 2002), particularly in a context such as South Africa. The current SRT audiometry practices are in need of improvement. It is imperative that audiologists develop speech audiometry test materials that are familiar, sufficiently long (Ramkissoon, 2001) and relevant to the ESL population in the South African situation, provided that the speakers have a working knowledge of English. One of these alternative wordlists may be the South African Spondaic (SAS) wordlist which was developed by Durrant in 2006 (Durrant, 2006).

In 2006, Durrant assessed the subjective familiarity rating of the existing CID W-1 wordlist (Hirsh et al., 1952) among a group of English first language (EFL) and ESL speakers. A list of English spondaic words, which were determined as structurally balanced in terms of syllable structure, was developed by the researcher at the University of the Witwatersrand (Durrant, 2006). Permission was expressly granted by the University of the Witwatersrand to use this wordlist for the current study. A sample of 387 participants who broadly represented the South African population in terms of first language, additional spoken languages, age, gender, occupation and education levels, rated the spondaic words in terms of familiarity, through self-report, on a three point scale (Durrant, 2006). The highest rated words were therefore determined as the more familiar spondaic words among the South African population, as the SAS wordlist, which is listed below in Table 1 (Durrant, 2006).

Table 1. The South African Spondaic wordlist (SAS)

SOUTH AFRICAN SPONDAIC (SAS) WORDLIST (Durrant, 2006)*
LIST A
Cellphone
Bathroom
Sandwich
Building
Township
Dancing
Welcome
Housewife
Lightning
Toothbrush
Basket
Public
Workshop
Suitcase
Birthday
Sunlight
Homework
Sunshine

*Permission was expressly granted by the University of the Witwatersrand to use this wordlist for the current study.

Table 1 consists of the most familiar spondaic words as selected by a group of South Africans. The 18 words make up the new South African Spondaic (SAS) wordlist. The PTA/SRT correlation of the SAS wordlist is compared to the CID W-1 in the current study.

Typically, SRT is used as part of a crosscheck for the reliability of Pure Tone Average (PTA), and vice versa. PTA refers to the three-frequency average of pure-tone thresholds obtained at 500 Hz, 1000 Hz and 2000 Hz (Brandy, 2002). Clinically, literature specifies that PTA and SRT should be within 6 dB of one another to indicate good correlation and reliability from test results (Brandy, 2002). This may be referred to as the PTA/SRT relationship. Thus, PTA/SRT correlation, as opposed to PTA/SRT relationship, was used in order to compare the use of the SAS wordlist and the CID W-1 (Hirsh et al., 1952) original spondaic wordlist when measuring the SRTs of ESL speakers in South Africa.

This study aimed to answer the following question: Which list (CID W-1 or SAS wordlist) yields the most favourable PTA/SRT correlation when testing a group of South African English second language participants?

1.2 Definition of terms

Central Institute for the Deaf Auditory Word List W-1 (CID W-1)

A spondaic word list developed in 1952 by familiarity rating (Hirsh et al., 1952).

Decibel (dB)

A measurement unit for expressing intensity on a loudness scale; the difference between two sound pressure levels (Martin & Clark, 2003).

Decibel (Hearing Level) (dB HL)

The decibel level above an average intensity for normal hearing (0 dBHL) (Martin & Clark, 2003).

Decibel (Sensation Level) (dB SL)

The decibel level above the hearing threshold of an individual participant (Martin & Clark, 2003).

English first language (EFL) Speakers

Speakers of English who use English as their primary language of communication (Ramkissoon et al., 2002).

English second language speakers (ESL)

Speakers of English who do not use English as a first language, but rather have learnt English secondary to a home language, and who use any other language as their primary language, and have a speaking knowledge of English as one of their additional multiple languages, with various degrees of proficiency (Ramkissoon et al., 2002; Butler & Hakuta, 2008).

Monitored Live Voice (MLV)

The use of a speech signal in speech audiometry through a microphone. The loudness is monitored by the Volume Unit (VU) meter (Martin & Clark, 2003).

Pure Tone Average (PTA)

The average of pure-tone thresholds at three mid-frequencies of 500 Hz, 1000 Hz, 2000 Hz for each ear (Martin & Clark, 2003).

Pure Tone Average / Speech Recognition Threshold correlation (PTA/SRT correlation)

The statistical relationship of correlation observed between PTA and SRT obtained for each ear for each participant (Schiavetti & Metz, 2006).

Pure Tone Average / Speech Recognition Threshold relationship (PTA/SRT relationship)

Clinically, the PTA/SRT relationship refers to the literature specification that PTA and SRT should be within 6 dB of one another to indicate good correlation and reliability from test results (Brandy, 2002).

South African English (SAE)

A distinct form of English used in South Africa, which has been influenced historically and presently by surrounding languages such as Afrikaans and the African languages, as well as languages of trade (Wade, 1995).

Speech Recognition Threshold (SRT)

The lowest intensity at which the spondaic words are correctly identified 50% of the time (Martin & Clark, 2003).

Spondaic word ("spondee")

A word with two syllables manipulated to be presented with equal stress on each syllable (Martin & Clark, 2003).

Volume Unit (VU) meter

A meter on an audiometer which tracks the loudness of input into the microphone by a series of light diodes (Martin & Clark, 2003).

1.3 Chapter layout

Chapter 1 (Introduction and background): This chapter provides an introduction and rationale for the research study, as well as the statement of the problem. It includes a definition of terminology used in the study. This chapter ends with the research question.

Chapter 2 (Literature review): This chapter provides further overview regarding the history of speech audiometry, further theoretical background of speech audiometry, the development of existing wordlists, the context of the country of South Africa, and alternative solutions to the speech audiometry dilemma in South Africa.

Chapter 3 (Methodology): This chapter provides an explanation and background to the methodology used for the study. The main aim and sub-aims are stated according to the research question. The pilot study, sample population, selection criteria, research design, materials and apparatus, as well as data collection procedure and data analysis are described. Reliability and validity are also discussed.

Chapter 4 (Results and discussion): This chapter provides the results and discussion of the study. Statistical results and their significance and clinical implications are presented, together with a description, interpretation and discussion of each result, according to the aims and sub-aims of the study. Reliability of the results will also be addressed.

Chapter 5 (Conclusions, limitations and recommendations): This chapter provides conclusions with regard to the results obtained, as well as a presentation of the clinical value, and a critical evaluation with regard to limitations, and recommendations for future research possibilities.

Chapter 2: Literature review: theoretical background to spondaic words and wordlists

This chapter provides further overview regarding the history of speech audiometry, further theoretical background of speech audiometry, the development of existing wordlists, speech audiometry in the South African context and alternative solutions to the speech audiometry predicament in South Africa.

Spondaic (spondee) words are unique in the sense that they are made up of bi-syllabic words, typically English nouns, with equal stress placed on each syllable. Examples of typical spondaic words include ‘sunset’, ‘hotdog’ and ‘birthday’ (Gelfand, 2009). Spondaic words are structurally balanced words (consonant-vowel-consonant; consonant-vowel-consonant, CVC-CVC), which lend themselves to the production of equal stress across the two syllables, which is ensured by the presenter during audiological testing (Martin & Clark, 2003).

Spondaic words are so redundant that only minimal auditory cueing is necessary (Sreedhar et al., 2011), thus it is appropriate to use spondaic words to assess the SRT, rather than speech discrimination testing. Historically, Hudgins et al. (1947) determined that four criteria are essential for developing speech audiometry materials, namely familiarity, phonetic dissimilarity, representative sample of English speech sounds, and homogeneity of audibility. Ramkissoon (2001) determined that only familiarity and homogeneity are necessary criteria for threshold determination. All four criteria should be met for suprathreshold testing. Two of the criteria, namely, familiarity and homogeneity, are discussed in section 2.1 and 2.2 below.

2.1 Familiarity

Familiarity of spondaic words is "arguably one of the most important criterion to be considered in word list development" (Nissen, Harris, Jennings, Eggett & Buck, 2005, p. 391). Familiarity ensures that auditory threshold is measured, not knowledge of vocabulary (Ramkissoon, 2001). In terms of speech audiometry, familiarity means that the participant is frequently exposed to the word, socially using and hearing the word, as well as being aware that the word is part of the test items (Ramkissoon, 2001). Word familiarity is dependent on the individual but certain words are more familiar than others in a socio-linguistic group (Brandy, 2002). Aspects such as familiarity and emotional loading would be considered linguistic and psychological factors, therefore it is important that these factors are controlled (Brandy, 2002). According to Dillon and Ching (1995, as cited in Dietrich, 1999), the most important qualities of the items used in determining SRT are the participant's familiarity with the language and dialect in which the test is given, the educational level of the participant, familiarity with all the test words, and the presentation of the test words in a uniform manner.

According to Fry (1997, as cited in Dietrich, 1999), prediction of the most likely signal heard when listening to moderately degraded speech items is easier in one's first language, as one has a knowledge of acoustic and phonetic patterns, as well as an increased ability to discriminate between phonemes and predict words that are more likely (Braisby & Gellatly, 2012). Errors drew heavily from the participant's knowledge of the world, and more common words were exchanged for the unknown word, that is 'mouthwash' for 'whitewash', 'freeway' or 'fairway' for 'stairway' etc. (Dietrich, 1999). Participants tended to obtain SRT at a lower level (softer intensity) when tested in their first language, since they exhibited easier recognition of words from their first language (Dietrich, 1999; Brandy 2002). Familiarity lends to improved intelligibility of the words (Sreedhar et al., 2011), and increased familiarity results in improved performance, as the words are more readily recognised.

2.2 Homogeneity

Spondaic words should be homogenous in terms of structure, and in terms of audibility, to ensure valid test results (American Speech-Language-Hearing Association, 1988).

Homogenous structure requires each word to have two equally stressed syllables (Brandy, 2002). Both syllables of the spondaic words should peak at zero Volume Unit (VU), on the Volume Unit meter (VU meter), psychophysically, to allow for equal loudness presentation between the words, but this does not necessarily improve homogeneity of audibility (Schiavetti & Metz, 2006).

Historically, spondees are identified as having the highest homogeneity of audibility (Egan, 1948; Ramkissoon, 2001). Homogeneity of audibility requires each word in the wordlist to reach the speaker's ear at the same intensity as one another, and the ease with which the words are heard, resulting in similarity of thresholds (Brandy, 2002). Homogeneity of audibility allows for precise measurements to be made within a small range of intensity changes (Ramkissoon, 2001). Homogeneity of audibility can be improved by selecting certain words, or through the manipulation of the recording of the words. During audiological testing, it is necessary for the tester who presents the words to manipulate the stress to be equal across both syllables of the spondee (Martin & Clark, 2003).

Historically, familiarity and homogeneity are essential in the development of speech audiometry materials (Hudgins et al., 1947; Ramkissoon, 2001). Other aspects of the development of wordlists shall be discussed in section 2.3.

2.3 The development of wordlists for audiometric testing

Wordlists have historically been developed by determining the familiarity of words and the homogeneity of the words, which should be of equal difficulty.

The original spondaic words were developed by Hudgins et al. (1947) at the Harvard Psycho-Acoustic Laboratories (PAL). Following the development of the PAL wordlists, the words were evaluated for homogeneity of audibility, within ±2 dB for mean recognition thresholds (Gelfand, 2009). Six words were excluded from the original 42 spondaic words, and the remaining 36 were recorded and adjusted for homogeneity (McArdle & Hnath-Chisolm, 2009; Hirsh et al., 1952).

In the past, speech audiometry materials have been developed in different languages, such as Arabic (Alusi, Hinchcliffe, Ingham, Knight, & North, 1974; Ashoor & Prochazka, 1982); Brazilian Portuguese (Harris, Goffi, Pedalini, Gygi & Merrill, 2001); Korean (Harris, Kim & Eggett, 2003); Polish (Harris, Nielson, McPherson, Skarzynski & Eggett, 2004); Russian (Aleksandrovsky, McCullough, & Wilson, 1998); Mandarin (Nissen et al., 2005); Teluga (Sreedhar et al., 2011); Tswana (Khoza, Ramma, Mophosho & Moroka, 2008) and Zulu (Panday, 2009), among others as cited in Sreedhar et al. (2011), as well as digits (Ramkissoon et al., 2002).

The wordlists were typically generated informally and were non-standardised prior to testing (Nissen et al., 2005; Sreedhar et al., 2011; Khoza et al., 2008; Panday, 2009). The words were rated for familiarity (Nissen et al., 2005; Sreedhar et al., 2011) and inappropriate words were excluded from the wordlists. This procedure is similar to the procedure followed by Durrant (2006). Thereafter, the appropriate words were assessed by determining the correlation of the SRT obtained with the new wordlist with the PTA of the participants (Ramkissoon et al., 2002; Sreedhar et al., 2011; Khoza et al., 2008; Panday 2009), which is the aim in the current study.

The use of logistic regression to determine the regression slope and intercept of each of the spondaic words is valuable to ensure the words are homogenous and have a steep psychometric function slopes (Nissen et al., 2005). An analysis of homogeneity is further recommended for future research.

2.4 Recorded wordlists or monitored live voice

Either recorded materials, or monitored live voice may be used for speech audiometry. Monitored live voice is a generally accepted means of presenting speech signals during clinical audiological testing (Brandy, 2002), as it is flexible and quicker to administer (Roeser, Valente & Hosford-Dunn, 2000). However, the use of recorded materials is favourable, particularly in the light of research, as the presentation is standardised and homogeneity of audibility is much improved, as each item gets presented in the same manner and at the same intensity level (Gelfand, 2009), which naturally assists with the homogeneity of audibility. The American Speech-Language-Hearing Association (1988) recommends the use of recorded materials (Panday, 2006). Monitored live voice is typically used in South African audiology contexts (Ramkissoon & Khan, 2003). Little attention has been given to the quality of recorded materials for speech audiometry, resulting in broad variations in protocols and quality of recordings (Di Berardino, Tognola, Paglialonga, Alpini, Grandori, & Cesarani, 2010). Speech audiometry in the South African context will be discussed in the following section.

2.5 Speech audiometry within the South African context

South Africa presents with a distinctly unique amalgamation of languages, dialects, cultures and linguistic communities (Tuomi, 1994, as cited in Swanepoel, 2006). There are 11 official languages, which are listed below in Figure 1, and most of the population is multilingual, with a working knowledge of more than one language (Swanepoel, 2006).

Figure 1 depicts the distribution of first language use among South Africans (Statistics South Africa, 2012).

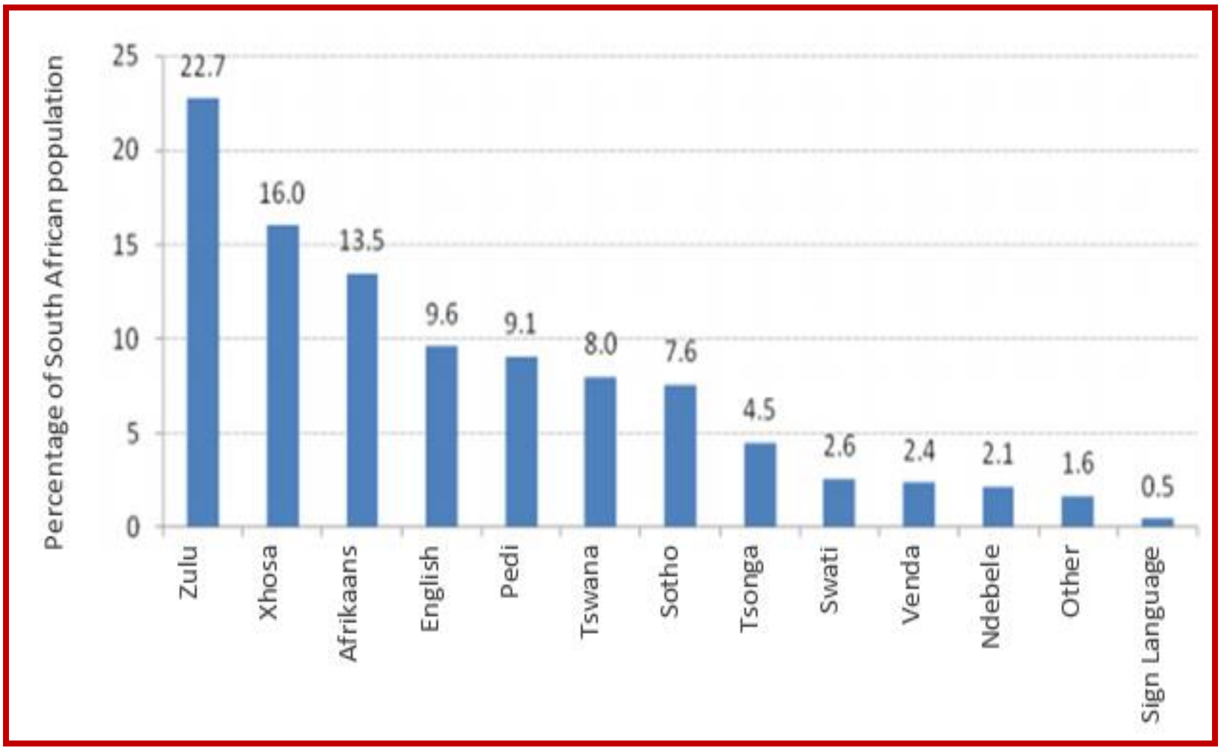


Figure 1. Distribution of the South African population by first language spoken (Statistics South Africa, 2012)

As shown in Figure 1, Zulu and Xhosa are the most widely spoken first languages among South Africans at 22.7% and 16% respectively. In comparison, only 9.6% of South Africans speak English as their first language in the home, making English the fourth most spoken first language.

With the resolution of apartheid, the 1996 constitution of South Africa prescribed a national language policy which structured 11 official languages, with the intent to restore the African languages to a position of use in mainstream society. Despite these changes, and although English is spoken by the minority as a first language, English is considered the lingua franca. Historically, English has been used extensively in public and private life, as well as education, law, government, news broadcasts, business, commerce, the army and parliamentary debate (Kamwangamalu, 1998; Verhoef, 1998; Wade, 1995; Alexander, 2000; Deumert, 2010; Minow, 2010).

Research has shown that South Africans are tending to choose to educate their children in English, rather than in their home language. Historically, English has been viewed by many African language speakers as the dominant and empowering language for industry (Mondstuk, 1996; Webb, 1992; Reagan, 1985, as cited in De Wet, 2002). If English is not spoken proficiently, many Africans in South Africa have experienced fear in the past that they will be unable to achieve success in the job market (Beukes, 1992, as cited in De Wet, 2002). Access to English may be considered the key to power in society in South Africa at present (Alexander, 2000). As a result, a cycle perpetuates where English remains the dominant language in South Africa society.

Although only 9, 6% of the population uses English as their home language (Statistics South Africa, 2012), the majority of the population use English as one of their multiple languages. Reportedly, between 32% and 69% of the population use English as one of their multiple languages. Due to various interpretations of the term, there are broad ranges in the statistical estimates (Market Research Africa 1994; Department of National Education, 1994:7, as cited in De Klerk, 1999; Minow, 2010).

The home language of the majority of audiology professionals in South Africa is either English or Afrikaans, and tertiary level training is frequently conducted in English or Afrikaans (Swanepoel, 2006). Roets (2005) found that 82 out of 84 surveyed audiologists in the South African clinic setting use English wordlists when conducting speech audiometry. This is in stark contrast to the demographics of South Africa, as seen in Figure 1, where the home language of the majority of the population is an African language (Uys & Hugo, 1997, as cited in Swanepoel, 2006). As a result, audiologists in South Africa face a predicament when the need arises to assess the SRTs of ESL speakers, due to the implications of multilingualism on speech audiometry results (Von Hapsburg & Pena, 2002).

The majority of audiologists registered in South Africa are white English-speaking, or Afrikaans-speaking individuals. The minority of audiology professionals in South Africa are African (Penn, Frankel, Watermeyer & Muller, 2009). The non-African professionals are unlikely to speak an African language (Khoza et al., 2008). This indicates a significant mismatch between the overall population in South Africa who speak an African language as their first language, (approximately 77% of the population) (Statistics South Africa, 2012), and the number of audiologists who are likely to speak an African language as one of their multiple languages.

2.6 Alternative solutions to speech audiometry in South Africa

In light of the context of South Africa as discussed above, the following section will describe existing and potential alternatives for speech audiometry material for use in South Africa.

2.6.1 Digit pairs

The use of digit-pair stimuli as an alternative has been determined as an appropriate solution to the problem, but it is a short term solution. Ramkissoon et al. (2002) aimed to develop a valid test of SRT for ESL speakers, by using pairs of digits to measure SRT. The digits were paired in order to form two-syllable words, with equal stress, that is spondees. Digit-pairs can be used cross-culturally, thus eliminating the cultural bias threat to validity. Even those with a minimal competence in speaking English are able to recognise the numbers from one to ten, and thus this improves validity (Ramkissoon, 2001). The use of digit-pairs resulted in SRT measurements that are more accurate than the use of CID W-1 words, when testing ESL participants (Ramkissoon, 2001). Continued research in the use of digits for SRT testing is still indicated.

2.6.2 Wordlists in African languages

Regarding the development of wordlists in other African languages, several wordlists have been developed in South Africa, but the wordlists are generally not formally standardised. Khoza et al. (2008) determined that PTA/SRT correlation was optimal when testing a group of first-language Tswana speakers using a Tswana SRT wordlist, as opposed to the English CID W-1 wordlist or digits. One of the recognised shortfalls of the study is that the participants were all tertiary students, who were proficient in English, and enrolled at a university where the language of instruction is in English (Khoza et al., 2008). Additionally the words were presented via monitored live voice by a Tswana speaking individual. The use of wordlists in the home language of the patient, for example Tswana, requires the presenter/audiologist to be proficient in that language (Khoza et al., 2008) to allow for natural and proficient production of the words, without erroneous accent and stress. Although, this would be ideal practice, at present, there are minimal recorded wordlists in the African languages. According to Scott (1998, as cited in Ramkissoon, 2001) clinicians should be proficient in the language of the test to ensure accuracy in administration and scoring.

The African languages spoken in South Africa differ substantially from English in terms of morphology and syntax (Donaldson, 1991, as cited in Khoza et al., 2008). In particular, many African languages are multisyllabic tonal languages. That is, production of words in that language by a second language speaker may result in significant errors of production (Khoza et al., 2008). In addition, the use of the Zulu wordlists for determining SRT is flawed, as the words used are not spondaic. The words are monosyllabic, instead of bisyllabic, which compromises their audibility and redundancy (Ramkissoon & Khan, 2003).

This mismatch between audiologists who speak an African language and the population in South Africa means that the use of African wordlists is not a practical solution at this time in South Africa. On the contrary, all audiologists are likely to use English as one of their multiple languages (Swanepoel, 2006), and the majority (up to 69%) of the population speak English as one of their multiple languages, particularly in urban areas (Market Research Africa, 1994; Department of National Education, 1994:7, as cited in De Klerk, 1999). Thus the use of an English wordlist that is familiar to all South Africans who use English as one of their multiple languages may be a good solution.

2.6.3 The development of the SAS wordlist

In 2006, Durrant developed a list of structurally balanced (consonant-vowel-consonant; consonant-vowel-consonant, CVC-CVC) South African English spondaic words, which were rated in terms of familiarity, through self-report, on a three point scale, by a broad sample of

387 South African participants. Simultaneously, the familiarity of the existing CID W-1 wordlist (Hirsh et al., 1952) was also determined. The top rated words in terms of familiarity were combined into a list known as the South African Spondaic wordlist (Durrant, 2006). This list requires further testing, which is the purpose of the current study.

2.7 Summary

In this chapter, overview was provided regarding the history of speech audiometry, theoretical background of speech audiometry, the development of existing wordlists, the context of the country of South Africa and alternative solutions to the speech audiometry dilemma in South Africa.

The next chapter will focus on the methodology used to answer the research question, which is: Which list (CID W-1 or SAS wordlist) yields the most favourable PTA/SRT correlation when testing a group of South African English second language (ESL) participants?

Chapter 3: Methodology

This chapter will describe the research design, sample population, participation criteria, procedures for data collection, equipment used, and data analysis methods.

3.1 Research aims

With cognisance of the research problem described in Chapter 1 and Chapter 2, and with the research question in mind, the following research aims were formulated for this study:

3.1.1 Main aim

The main aim of the investigation was to compare the SAS wordlist and the CID W-1 wordlist for measuring SRT when testing a group of South African ESL participants.

3.1.2 Sub-aims

The following sub-aims were formulated:

- To determine the PTA/SRT correlation when using the SAS wordlist
- To determine the PTA/SRT correlation when using the CID W-1 wordlist
- To compare the results obtained with the SAS wordlist and the CID W-1 wordlist

3.2 Hypotheses

3.2.1 Null hypothesis

There is no statistically significant difference between the results obtained for PTA/SRT correlation with the use of the SAS wordlist or the CID W-1 wordlist, at a .05 level of statistical significance.

3.2.2 Alternative hypothesis

There is a statistically significant difference between the results obtained for PTA/SRT correlation with the use of the SAS wordlist and the CID W-1 wordlist, at a .05 level of statistical significance.

3.3 Research design and approach

The experimental design was mixed in nature. That is, the design contained both between-participants and within-participants designs. A mixed group design studies one independent variable with a within-participants design, and another independent variable with a between-participants design (Schiavetti & Metz, 2006).

A within-participants design exposes all participants to the same test condition. In this instance, every participant was exposed to the same test material, that is, the SAS wordlist. The within-participant design allowed for test-retest reliability within the same patient, thereby eliminating certain extraneous conditions, such as language level and education level (Schiavetti & Metz, 2006).

A between-participants design exposed the participants to two conditions, that is, the ‘more familiar’ and ‘less familiar’ CID W-1 wordlists. Participants were randomly assigned to one of two groups: group one or group two. This design allowed for comparisons to be made between the groups. The design also ensured that factors that could jeopardise internal validity were controlled as the groups were matched in every variable, except for the test condition (Schiavetti & Metz, 2006).

The research approach was quantitative and correlational in nature (Schiavetti & Metz, 2006). Quantitative research allows for measurable quantities to be determined, with a change in variable or circumstance (Schiavetti & Metz, 2006). Correlational research aims to study the relationship between two variables (that is, PTA and SRT), to determine the degree of change on the first variable depending on the test conditions of the second variable. Correlational research is typically depicted on scattergrams (Schiavetti & Metz, 2006).

3.4 Ethical considerations

The ethical implications of the study needed to be considered, as the study involved the participation of humans (Schiavetti & Metz, 2006). The research proposal was approved by the Postgraduate Research and Ethics Committee of the Faculty of Humanities of the University of Pretoria (Appendix A) prior to beginning the study. The following ethical considerations were addressed in the planning of this study.

Informed consent was obtained from every participant. This ensured that the participants were aware and accepted the known risks and implications in the study (Bulman & Osborn, 2002, as cited in Avula, 2013). Participants were issued with a written information sheet about the nature, purpose and risks of the study, which was also verbally explained, and a consent form was signed (Appendix B & Appendix C). Only participants who gave their informed written consent were included in the study. Participants were made aware that their participation was voluntary; that they could withdraw from the study at any time; and that confidentiality and anonymity were ensured. The comfort, security and freedom of the participants were valued at all times (Schiavetti & Metz, 2006). The participants' right to privacy was honoured through the use of numbering and the use of initials, as well as conducting the testing in a private room to ensure anonymity. Confidentiality was ensured by using only the initials of the participants, and using a numbering system (Schiavetti & Metz, 2006). Participants were informed that the results of the study would be made available to other researchers and society, while maintaining confidentiality of participants, and that the data and results would be archived for 15 years at the University of Pretoria (Mouton, 2001; Babbie & Mouton, 2001).

The researcher has a responsibility to report the information obtained from the research (Schiavetti & Metz, 2006). Following completion, the results will be made known to the audiological community in a complete form through oral presentations and printed articles. All publications that contributed to the content of the research paper were acknowledged and referenced appropriately, to avoid plagiarism (Babbie & Mouton, 2001).

3.5 Sample population

In this section, the criteria for participant selection are discussed, as well as the justification of each parameter. Adult ESL participants (n=101, 197 ears) who were employed at the participating hospital were invited to participate in the study. The participant sample had a broad range of age, ethnicity, first language use, education and occupation, which will be described in more detail.

In this study, purposive non-probability sampling was used. Sampling allows one to obtain information about a population based on a sample of that population (Avula, 2013). Purposive non-probability sampling is not a probabilistic sample, and therefore is not representative of the population as a whole (Schreuder, Gregoire & Weyer, 2001). The participants were all drawn from the participating hospital, using convenience sampling. Purposive sampling is a selection method determined by the researcher according to the purpose of the study. In this study, a predefined group of ESL adults was determined and sampled accordingly using convenience sampling (Tansey, 2007). Advertisements for participants included the use of posters, word of mouth and announcements distributed within the hospital. Ideally, a sample that is representative of the various first languages spoken in South Africa would be obtained, with the exception of English. The limitations of convenience sampling might have resulted in bias or unknown trends. However, due to the broad representation obtained in the sample, this is unlikely (Schreuder et al., 2001).

3.5.1 Criteria for the selection of participants

The criteria for the selection of participants are outlined below:

- Age

Inclusion criteria stipulated that participants had to be older than 18 years of age, in order for informed consent to be obtained without parental consent (Gill, 2004, as cited in Coyne, 2010). Further ethical considerations were discussed in section 3.4. There was not an upper age limit, as the sample was of adults, and factors such as hearing thresholds and auditory processing related to age were not considered to be significant, as discussed in section 3.5.4.

- Language

Participants had to be ESL speakers, with a speaking knowledge of English. As the wordlists are primarily targeted for use with speakers who use English as one of their multiple languages, but not as their first language, the participants had to be ESL speakers. ESL speakers may be considered to use a second language, with various degrees of proficiency, to communicate with other speakers in a given society. Depending on one's definition of bilingualism, this may be considered as a degree of bilingualism (Butler & Hakuta, 2008).

- Hearing thresholds

All participants had to have hearing thresholds within normal limits, or a minimal hearing loss. Those participants who had audiometric thresholds lower than 26 dBHL from 250 Hz to

8000 Hz were considered to have hearing within normal limits, or a minimal hearing loss. The classification of degree of hearing loss was obtained from Silman and Silverman's (1991) classification system (Northern & Downs, 2002, as cited in Schlauch & Nelson, 2009). Participants were excluded from the study if audiometric thresholds were identified at levels higher than 26 dBHL at any frequency. Exclusion was ear-specific if hearing loss was present in one ear only. The criterion of hearing thresholds within normal limits was necessary at this stage to eliminate extraneous variables such as degree, type and configuration of hearing loss (Schiavetti & Metz, 2006). The participants with hearing loss were referred for further diagnostic testing. Participants were not excluded from the study based on tympanogram results, unless the middle ear status contributed to a hearing loss (PTA>26 dBHL). Further audiological and/or appropriate medical management was made available to the excluded participants.

- Employment

ESL speakers who were employed at the participating hospital were invited to participate in the study. This was primarily for the purpose of convenience sampling. The sample revealed a broad range of age, language and education, although this might have limitations as the generalisation may be compromised (Schiavetti & Metz, 2006).

3.5.2 Material and apparatus used for the selection of participants

- Case history interview

The researcher interviewed each participant based on the questions as indicated in Appendix F. Pen and paper were used to record verbal responses. Questions included age, gender, language use, language exposure, subjective language proficiency, audiological concerns, education and occupation. The information obtained was recorded on a table that may be seen in Appendix F.

- Heine mini 3000 otoscope

Otoscopic examinations were conducted using a handheld Heine mini 3000 otoscope.

- Maico M134 tympanometer

Immittance audiometry was conducted using a Maico MI34 immittance machine, which was calibrated on 6 April 2011.

- Interacoustics diagnostic audiometer

Audiometric pure-tone audiometry was conducted using an Interacoustics diagnostic audiometer (AD229b, calibrated on 6 April 2011), using TDH-39 headphones, in a single sound-treated audiology booth in a quiet office (American Speech-Language-Hearing Association, 2005).

3.5.3 Procedure for the selection of participants

The management of the participating hospital was contacted, and provided with the research proposal to inform management about the intended purpose of the study, as well as the implications on the staff's wellbeing and time demands. The management granted permission to conduct the study (Appendix E). ESL speakers who were employed at the participating hospital were invited to participate in the study. Advertisements for participants included the use of posters, word of mouth and announcements. Participants were scheduled in 15 minute interval appointments with the researcher.

The steps taken in the preliminary testing are outlined below. Case history interviews, otoscopic examinations, immittance testing and pure-tone air-conduction testing were conducted. Only participants who had given their informed consent were selected for this section of the study (n=104).

3.5.3.1 Procedure for case history interview

Participants were seated across a desk from the researcher, and underwent a brief verbal interview, the contents of which were noted under material and apparatus.

3.5.3.2Procedure for otoscopic examinations

Otoscopic examinations were carried out on each participant, which involves a visual inspection of the outer ear. Light was directed into the external auditory canal using a handheld otoscope, to ensure there was no excess cerumen in the external ear canal, and to ensure that the tympanic membranes were visible (Martin & Clark, 2003). The tympanic membrane had to have a pearl-grey appearance, and had to be translucent if it was in a normal and healthy condition. The tympanic membrane had to be in a neutral position, with a distinct cone of light, handle, short process of the malleus and umbo visible (Martin & Clark, 2003). Participants were not excluded from the study if there was a pathology noted, unless the pathology caused a hearing loss, but they were later referred for further medical treatment.

3.5.3.3Procedure for immittance testing

Tympanometry procedures were carried out on each participant. A low frequency probe tone of 226 Hz was used, while the pressure change initiated by the tympanometer measured the displacement of the tympanic membrane from the resting position, thereby measuring compliance and the pressure level at the highest compliance (Martin & Clark, 2003). The tympanogram type by classification was noted. Participants were not excluded from the study based on tympanogram results, unless the middle ear status contributed to a mild or greater hearing loss (PTA>26 dBHL). It should be noted that a test battery approach was used (Roeser et al., 2000).

The tympanogram classifications were based on Jerger's categorizations (1970, as cited in Martin & Clark, 2003): Type A tympanograms indicate middle ear pressure to be within normal limits at or near 0 daPa (±50 daPa) and compliance within 0.3 to 1.7 ml (Margolis & Hunter, 2000, as cited in Martin & Clark, 2003). Type As and Ad tympanograms indicate normal middle ear pressure, as above, with compliance levels that fall below (Type As) or above (Type Ad) the norms stated above (Margolis & Hunter, 2000, as cited in Martin & Clark, 2003). Type B tympanograms indicate no maximum compliance level through the range of pressure, and likely indicate fluid within the middle ear system (Margolis & Hunter, 2000, as cited in Martin & Clark, 2003). A Type B tympanogram with normal ear canal volume suggests otitis media or the presence of fluid in the middle ear system. A Type B tympanogram with increased ear canal volume suggests a perforation or grommet in situ in the tympanic membrane Type C tympanograms occur when the maximum compliance of the tympanic membrane occurs at a negative pressure of -100 daPa or greater, or positive pressure of +100 daPa or greater (Margolis & Hunter, 2000, as cited in Martin & Clark, 2003). Further audiological and/or appropriate medical management was made available to the excluded participants, where indicated.

3.5.3.4 Procedure for pure-tone air-conduction audiometry

Pure-tone testing was conducted to measure hearing thresholds from 250 to 8000 Hz. Pure-tone thresholds was measured by presenting tones at each octave point frequency (250, 500, 1000, 2000, 4000, 8000 Hz) (Martin & Clark, 2003), using the modified Hughson-Westlake procedure (Harrell, 2002). Initial presentation began at 40 dBHL, and decreased in 10 dB steps after the participant responded to the tone by pushing a response button. Ascending steps were in 5 dB increments. When the participant responded to 50 percent of the presentations at a given intensity, then that intensity level was considered to be the pure-tone threshold for that frequency (Martin & Clark, 2003).

Those participants who had audiometric thresholds that were lower than 26 dB from 250 Hz to 8000 Hz were considered to have hearing within normal limits, or a minimal hearing loss. The classification of degree of hearing loss was obtained from Silman and Silverman's (1991) classification system.

Participants with hearing thresholds outside of normal limits were excluded from the study. Exclusion was ear-specific due to the presence of hearing loss. Further audiological and/or appropriate medical management was made available to the excluded participants, where indicated.

Pure-tone average (PTA) per ear was calculated from the sum of hearing thresholds at 500 Hz, 1000 Hz, and 2000 Hz, divided by three, and rounded off to within one decimal place for each ear (Martin & Clark, 2003).

3.5.4 Description of the sample

Following pure-tone testing, 101 participants (197 ears – 100 right ears, 97 left ears) were considered suitable for the study. The age range was 19 to 63 years. The mean age of the participants was 33.3 years. Participants included 27 males and 74 females. There was a broad range of highest education level achieved (grade 9 to master's degree) and occupation (plumbers, waitresses, security, reception, nurses and management).

Table 2 below depicts the distribution of the participant sample across the age groups, according to gender.

Table 2. Distribution of participants by age and gender

	Age (years)						
Gender	18-19	20-29	30-39	40-49	50-59	60-69	Grand Total
Male		9	10	5	3		27
Female	1	17	20	20	12	4	74
Grand Total	1	26	30	25	15	4	101

As shown in Table 2, the participant sample included a broad range of age groups. More females participated in the study than males. The sampling took place in a hospital, which is predominantly staffed by females (Pillay, 2009). The largest age group in the sample was the 30 to 39 year old age group.

A large portion (42%) of the sample consisted of participants over the age of 40. Although all participants had hearing levels within normal limits (< 26 dBHL), considerations in terms of age related changes in auditory processing must be taken into account. Studies have shown an age-related difference in temporal processing skills (gap detection and interaural time differences) in older individuals (Pichora-Fuller & Souza, 2003). However, there is no evidence of a relationship between temporal resolution and performance in speech perception tasks. Although they are presented at low intensities, spondaic words are highly redundant and highly predictable, which excludes the factors of temporal cues on speech recognition tasks (Sreedhar et al., 2011). Therefore, the contribution of age may be considered negligible in terms of determining SRT. Figure 2 provides a depiction of the first language use among the participants in the study.

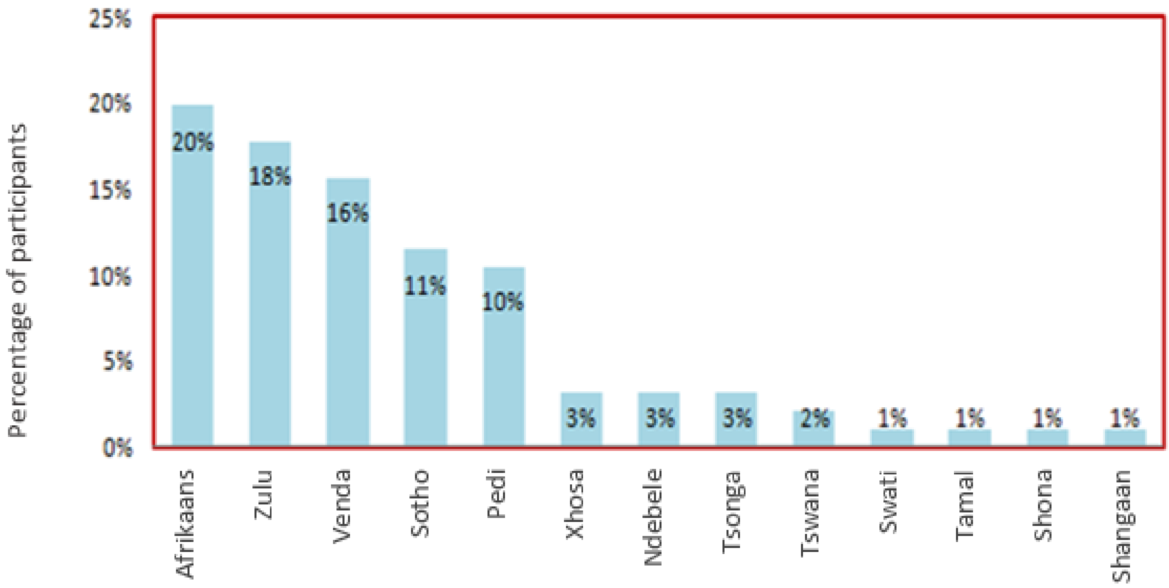


Figure 2. Distribution of first language groups in the sample

As shown in Figure 2, the first language distribution of the sample was comparable to the language distribution of the country, indicating a sample that is representative of the various first languages spoken in South Africa. First language use included Afrikaans, Zulu, Venda, Sotho, Pedi, Xhosa, Ndebele, Tsonga, Tswana, Swati (10 of the 11 official South African languages, with the exception of English, which was not sampled) (Statistics South Africa, 2012). First language speakers of Xhosa were under-sampled due to the geographical location of the sampling (see Figure 1 in the introduction and Figure 2 above).

The distribution of educational levels among the participants is depicted in Figure 3.

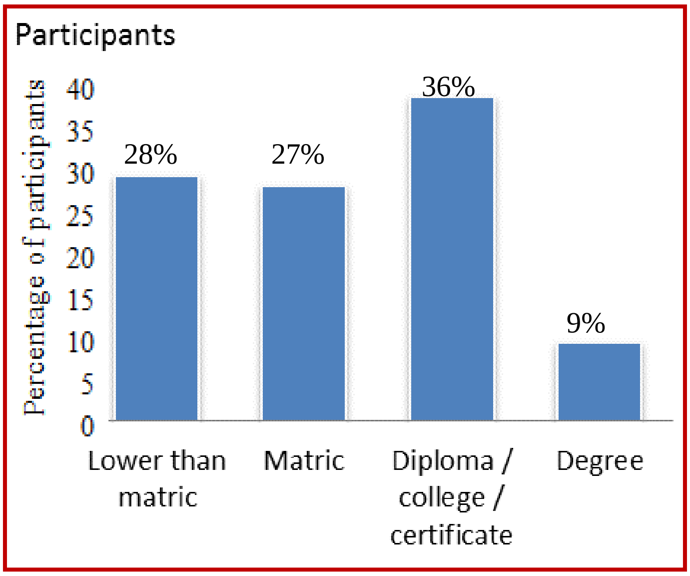


Figure 3. Distribution of educational levels within the participant sample

As shown in Figure 3, a broad range of educational levels was represented in the participant sample. The term ‘matric’ or ‘matriculation’ is a South African term which refers to the final year of secondary or high school qualification (the twelfth year of formal schooling), and the qualification obtained for completing high school (Kaabwe, 2003). 28% of the sample did not complete their secondary schooling. 55% of the sample had no additional schooling other than high school. Educational level has implications with regard to word familiarity, due to exposure, language use and vocabulary (Song & Fox, 2008), and is therefore a factor to be taken into account when considering the vocabulary content of unfamiliar wordlists. The sampled population may be considered to be a fair representation of the current education levels in South Africa.

3.6 Material and apparatus used for data collection

The material and apparatus used to collect the data is discussed in this section. The first phase of the study involved recording of the wordlists. The second phase of the study involved the evaluation of the participants’ performance with each of the wordlists.

3.6.1 Development of the material

The speech audiometry material used in this study is listed below in Table 3. The development of the material is discussed in this section.

Table 3. Available spondaic wordlists in terms of familiarity

South African Spondaic (SAS) wordlist (Durrant, 2006)*	'Less familiar' CID W-1 wordlist (Hirsh et al., 1952, Durrant, 2006)	'More familiar' CID W-1 wordlist (Hirsh et al., 1952, Durrant, 2006)
LIST A	**LIST B**	**LIST C**
Cellphone	Greyhound	Schoolboy
Bathroom	Inkwell	Sunset
Sandwich	Whitewash	Grandson
Building	Mousetrap	Toothbrush
Township	Duckpond	Playground
Dancing	Sidewalk	Cowboy
Welcome	Horseshoe	Northwest
Housewife	Baseball	Hotdog
Lightning	Stairway	Mushroom
Toothbrush	Iceberg	Hardware
Basket	Railroad	Workshop
Public	Oatmeal	Eardrum
Workshop	Drawbridge	Headlight
Suitcase	Hothouse	Birthday
Birthday	Daybreak	Pancake
Sunlight	Airplane	Armchair
Homework	Padlock	
Sunshine	Nutmeg	

*Permission was expressly granted by the University of the Witwatersrand to use this wordlist for the current study.

As shown in Table 3, Durrant developed list A, the SAS wordlist, which is a list of structurally balanced (consonant-vowel-consonant; consonant-vowel-consonant, CVC-CVC) South African English spondaic words, which were rated in terms of familiarity, through self-report, on a three point scale, by a broad sample of 387 South African participants (Durrant, 2006). Simultaneously, the familiarity of the existing CID W-1 wordlist (Hirsh et al., 1952) was also determined. The top rated words in terms of familiarity were combined into a list known as the South African Spondaic (SAS) wordlist (see Table 1), (Durrant, 2006). The original CID W-1 words were grouped into list B (least familiar) and list C (more familiar), according to the same rating scale. The CID W-1 words were split into two lists (lists B and C) for the sake of comparison. Clinically, this may have implications if the ‘less familiar’ words were excluded from the CID W-1, and the ‘more familiar’ words were used instead. The exclusion of certain unfamiliar words from an existing wordlist may be an alternative solution to the problem. However, the exclusion of certain words would reduce the set size of a list, and contradict the normative data of the wordlists as a whole, and is therefore not recommended (Ramkissoon & Khan, 2003).

Some of the words included in the SAS wordlist, as shown in Table 3, namely ‘building’, ‘public’, ‘lightning’, ‘basket’ and ‘dancing’ may be questionable as spondaic words, depending on the definition used. Although the words are structurally balanced (consonant-vowel-consonant; consonant-vowel-consonant, CVC-CVC), which lends itself to equal stress across the two syllables, these words may be considered to be ‘trochees’, which have two syllables with unequal stress, according to Gelfand (2009). However, in conversational English, spondees are usually spoken as one long and one short syllable (Evans, 1997). During audiological testing however, it is necessary for the tester who presents the words to manipulate the stress to be equal across both syllables of the spondee (Martin & Clark, 2003). Therefore the above words may be included, provided the audiologist applies appropriate stress when presenting the words using monitored live voice (Martin & Clark, 2003). This aspect was considered in the recording of the wordlists. The stress was also modified using Praat (Boersma & Weenink, 2009), which is described in the following section.

3.6.2 Material and apparatus used for the recording of wordlists

The recording of the wordlists for the purpose of the current study will now be described. An Olympus WS-100 digital voice recorder, a single sound-treated audiology booth, an Interacoustics diagnostic audiometer (AD229b, last calibrated 6 April 2011), TDH-39 headphones, a scientific software program, Praat (Boersma & Weenink, 2009), and a recordable compact disc (CD) were used for the recording of the wordlists. The apparatus will be described in this section:

- Interacoustics diagnostic audiometer

The wordlists (lists A, B and C, as seen in Table 3) were presented through the microphone of an Interacoustics diagnostic audiometer (AD229b, last calibrated 6 April 2011), which is connected to speakers in free-field in a sound-treated audiology booth.

- Sound treated audiology booth

A single sound treated audiology booth (2 metres square) was used to eliminate background noise. The words were recorded in the booth with a digital voice recorder.

- Digital voice recorder

A portable digital voice recorder (Olympus WS100, serial number 200107495) was used. The digital voice recorder was placed one meter away from the sound source speaker, and the spoken words were recorded as various tracks on the digital voice recorder.

- Praat

Praat is a scientific computer software program developed by Paul Boersma and David Weenink (2013). Praat (the Afrikaans and Dutch word for ‘talk’) was initially developed in Amsterdam in 1995, at the University of Amsterdam. Praat is an open-source software and can be downloaded free of charge (Boersma & Weenink, 2013).

Praat allows for the acoustic analysis, synthesising and manipulation of speech sounds in recorded phonetics. Therefore the pitch contour, as well as the duration and amplitude of each syllable could be manipulated to result in a list of homogenous wordlist recordings.

Praat has been cited in more than 800 research articles since 2002, including linguistics, acoustics and communication disorders journals (Boersma & Weenink, 2013).

- Compact disc (CD)

The digital wordlists were burned onto a recordable compact disc, to allow for playback via a CD player attached to an audiometer.

3.6.3 Material and apparatus used for the assessment of SRT

Speech audiometry was conducted using an Interacoustics diagnostic audiometer (AD229b, calibrated on 6 April 2011), using TDH-39 headphones, in a single sound-treated audiology booth in a quiet office, with a compact disc player connected via an audio cable to allow for presentation of the recorded wordlists.

Prior to the collection of data, a pilot study was conducted.

3.7 Pilot study

A pilot study is recommended to allow for assessing the feasibility, determining resources required, allowing errors to be corrected prior to beginning the study. This tends to result in improved reliability and internal validity (Van Teijlingen & Hundley, 2001).

The following aims were established for the pilot study:

- To determine the efficacy of the verbal history wording and recording of data;
- To determine if the instructions given to the participants were easily understood;
- To determine the efficiency of the test process and the recording of data;
- To determine the time period required for each participant for the test procedure to be completed.

Eleven participants were tested as part of the pilot study. Two of the participants presented with hearing loss in one ear only. Exclusion was ear specific, so the total subject count was 11 participants (20 ears). Participant selection was obtained in the same manner as for the final study. Testing took place during regular work hours. Testing was conducted in the same room and using the same recorded words and equipment as the final study. The participants were not informed that they were part of the pilot study only. The data collected of these participants was not used in the final study. After selection of the participants, preliminary case histories, otoscopic examinations and immittance testing were conducted in the office which contains the sound proof booth. The results of the pilot study were as follows:

The participants demonstrated sufficient use of English to answer the case history questions and the participants all demonstrated full understanding of the verbal interview questions. Therefore the wording of the verbal history questions was appropriate. The recording of the participants' responses was easily noted, demonstrating that the recording table developed for the study was easy to use (Appendix F). No changes were made to the questions or the recording thereof.

Similarly, the participants demonstrated full understanding of the instructions given for the test procedure. The instructions did not need to be repeated for any of the participants.

Next, the efficiency of the test process and the ease of the recording of data were determined. Pure-tone testing was conducted in the sound proof booth. Thereafter, the participants were instructed for SRT testing and familiarised with the recorded wordlists in a randomised order, as recommended by Gelfand (2009). Following familiarisation, SRT was determined per ear using two different wordlists for each participant. The test procedure was found to be stream-lined and did not require any changes. The results were effectively and easily recorded on the data form (Appendix F).

There was a mismatch in the results for PTA and SRT, which was later identified as the result of poor recording quality, but unfortunately this trend was not identified at the stage of the pilot study, due to the small sample size. Further adaptations and considerations for the difference in results will be discussed in the results and discussion section.

Finally, the time period required for each participant for the test procedure to be completed was determined. Table 4 indicates the time demands per participant during the pilot study:

Table 4. Time breakdown per participant for pilot study

Test procedure	Time taken per participant
Case history	2 minutes
Otoscopic examination	1 minute
Tympanometry	2 minutes
Pure-tone testing	4 minutes
SRT familiarisation	2 minutes
SRT threshold (both ears)	4 minutes

As shown in Table 4 above, the time requirement totalled 15 minutes per participant in the pilot study. The participants were therefore booked at 15 minute intervals in the final study. This allowed for planning of time demands in the final study.

With the knowledge gained from the pilot study, the data collection for the final study was conducted as follows:

3.8 Procedure for the collection of data

The following procedures were carried out for the collection of data.

3.8.1 Procedure for the recording of wordlists

A South African, English-first-language female audiologist spoke the wordlists (lists A, B and C, as seen in Table 3), with equal stress on each syllable, into the microphone of the audiometer. The spondaic words were recorded without a carrier phrase onto a digital voice recorder, in a single sound-treated audiology booth. The use of a carrier phrase is indicated for suprathreshold testing, but the literature indicates mixed findings with regard to the benefit of using a carrier phrase for threshold testing, as it may be considered time consuming and distracting (Gelfand, 2009).

The recorded words were analysed in terms of frequency spread, duration and intensity of each syllable within each word, with the software program Praat (Boersma & Weenink, 2009). The words were normalised to peak at zero decibels (0 dB) and were adjusted to allow for similar frequency spread, duration and intensity of each syllable within and between each spondaic word, to allow for maximum homogeneity in terms of audibility. The words were burned onto a recordable compact disc.

Three wordlists were recorded. List A contains the South African Spondaic (SAS) words (Durrant, 2006), list B contains those original CID W-1 (Hirsh et al., 1952) words that were rated as ‘less’ familiar by Durrant (2006), and list C contains those original CID W-1 (Hirsh et al., 1952) words that were rated as ‘more’ familiar by Durrant (2006). Each wordlist was recorded twice, in different orders, to allow for familiarisation with one list, and threshold determination with the second list. Familiarisation with the spondaic words is recommended prior to actual threshold testing. Familiarisation allows the participant to know the test vocabulary and recognise the test words to allow for accurate interpretation of the words at soft intensities (Gelfand, 2009). The importance of familiarisation is a well-established concept (Gelfand, 2009). If a participant is not familiarised with the words prior to testing, it may result in SRTs that are 4 dB to 5 dB poorer than their actual thresholds (Gelfand, 2009).

3.8.2 Procedure for the assessment of SRT

Only participants who met the specified selection criteria were selected for this portion of the study (n=101). The recorded words were presented through a compact disc (CD) unit attached to the diagnostic audiometer, with both syllables of the spondaic words peaking at zero Volume Unit (VU), on the VU meter, to allow for equal loudness presentation between the words (Gelfand, 2009). The participants were given the following instructions:

> “The aim of this test is to measure the softest level at which you can recognise and repeat some words. The words will have two syllables, and all the words will first be said at a comfortable loudness level. Those same words will then be repeated, but this time will be made softer and softer. Keep repeating the words, even when they are

very soft, but try not to guess. Are there any questions?" (Martin & Clark, 2003, p.115).

Each of the wordlists was initially presented at 75 dBHL in one ear, in order to familiarise the participant with the spondaic words prior to testing (Brandy, 2002). The presentation level was at a comfortable suprathreshold intensity, which allowed for adequate loudness levels for familiarisation, without presenting the sound at loudness which may be uncomfortably loud (Martin & Clark, 2003). No masking was applied as this procedure was conducted simply to familiarise the participants with the wordlists.

All participants were therefore familiarised with list A (SAS wordlist). Thereafter, the participants were randomly delegated to group one or group two. The test participants in group one were similarly familiarised with List B (the less familiar CID W-1 words), and the participants in group two were familiarised with list C (the more familiar CID W-1 words).

Following familiarisation, SRT was determined in each ear using the second recordings of lists A, B or C, which has the same content as the first lists, but in a different presentation order, to exclude variables such as order effect. SRT was determined by beginning with the presentation of a single word at 40 dBHL, and decreasing in 10 dB steps, presenting one word at each intensity level. When one word was repeated incorrectly, the tester stopped descending and presented three more words at that level. The intensity level was then increased or decreased in 5 dB steps to determine the softest intensity at which 50% of the words were repeated correctly, as first described by Carhart (1946, as cited in Brandy, 2002). The order of presentation of the wordlists was randomized in order to minimize the effects of sequencing (Schiavetti & Metz, 2006). The use of 5 dB steps was favoured over the use of 1 dB or 2 dB steps in the interest of clinical timeliness and brevity. However, for research purposes, 1 dB or 2 dB steps would have been more precise (Brandy, 2002). This is discussed further under recommendations for future research.

3.9 Procedure for the capturing of data

All the raw data was captured on a spreadsheet, to allow for systematic management, interpretation and statistical analysis of the data. A summary and a sample of the captured raw data can be viewed in Appendix G.

3.10 Procedure for the processing and analysis of data

The statistical techniques used included one-way Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), paired sample T-tests and a Pearson correlation analysis. Intergroup reliability was also determined using paired T-tests (Howell, 2009).

A raw data summary (Appendix G) was analysed using the statistical analysis package SAS JMP version 10.0 (Gerber, 2012, personal consultation).

3.10.1 The determination of correlation

A correlation matrix was calculated to measure the strength and direction of the relationship between two variables, namely PTA and SRT for lists A, B and C. List A was also split for the two groups (groups one and two). A Pearson correlation analysis was conducted (Howell, 2009). To determine if the correlation was statistically significant, a statistical test was conducted to determine the probability value (p-value) (Howell, 2009).

Table 5 was extrapolated from Schiavetti and Metz (2006), to show the strength of correlational relationship.

Table 5. Interpretive guide for correlation coefficients (Schiavetti & Metz, 2006)

Coefficient	Direction	Strength
+1.00	Positive	Maximum
+0.50 to +1.00	Positive	Moderate to strong
+0.50	Positive	Moderate
0.00 to +0.50	Positive	Weak to moderate
0.00	Nil	Nil
0.00 to -0.50	Negative	Weak to moderate
-0.50	Negative	Moderate
-0.50 to -1.00	Negative	Moderate to strong
-1.00	Negative	Maximum

As shown in Table 5, a correlation relationship may be considered positive if the correlation occurs in the same direction. The strength of the correlation relationship is determined according to the correlation coefficient.

3.10.2 The comparison of the difference in mean scores for PTA and SRT

The differences between the mean scores for PTA and SRT were compared for lists A, B and C using the paired sample T-test (the PTA and SRT values were paired).

Lists A and B were compared, using the difference between PTA and SRT for the total number of ears using the paired sample T-test (lists A and B were paired).

Lists A and B were compared, using the total difference between PTA and SRT for the total number of ears using the paired sample T-test (lists A and B were paired).

Lists A and C were compared, using the difference between PTA and SRT for the total number of ears using the paired sample T-test (lists A and C were paired).

Finally, lists A and C were compared, using the total difference between PTA and SRT for the total number of ears using the paired sample T-test (lists A and C were paired) (Howell, 2009).

3.10.3 The description of differences in mean scores for PTA and SRT according to various factors

The mean difference between PTA and SRT was then analysed according to various factors such as the subjective rating of English language proficiency, age, education and occupation.

3.10.4 The description of errors

The description of errors was evaluated qualitatively and descriptively.

3.10.5 The description of inter-ear reliability per wordlist

The differences between the mean scores for the right and left ears were compared for lists A, B and C using the paired sample T-test (the left and right values were paired) to determine the inter-ear reliability, to ensure that there was good test-retest reliability within participants (Howell, 2009).

3.10.6 The description of intergroup reliability

The ANOVA, MANOVA and paired T-tests (Howell, 2009) were conducted to determine intergroup reliability for groups one and two, to ensure there was no bias between the groups. This could only be conducted using list A, due to the design of the study.

To determine the intergroup reliability, if there were statistically significant differences between the mean SRT of groups one and two, for the right and left ears, one-way Analysis of Variance (ANOVA), that is, only one independent variable (SRT) per group was considered, and Multivariate Analysis of Variance (MANOVA) (both PTA and SRT) were considered (Howell, 2009). The measurements were used to ensure that there was no bias between groups one and two, for the right and left ears. The ANOVA and MANOVA could only be applied to list A due to the study design.

Intergroup reliability was also determined using paired T-tests to compare the differences between the mean scores for PTA and SRT for groups one and two using the paired sample T-test (the PTA and SRT values were paired) when using list A (Howell, 2009).

The results of the analysis will now be presented.

Chapter 4: Results and discussion

In this chapter, the results and discussion will be presented according to the aims of the study.

4.1 The results and discussion for PTA/SRT correlation

Typically, SRT is used as part of a crosscheck for the reliability of Pure Tone Average (PTA), and vice versa. PTA refers to the three-frequency average of pure-tone thresholds obtained at 500 Hz, 1000 Hz and 2000 Hz (Brandy, 2002). PTA and SRT should be within 6 dB of one another to indicate good correlation and reliability from test results (Brandy, 2002). In order to determine which of the wordlists (lists A, B or C) yielded the most favourable PTA/SRT correlation, when testing a group of the South African ESL participants, the PTA/SRT correlation was determined in the following scenarios:

4.1.1 Results and discussion for PTA/SRT correlation when using list A

A correlation matrix was calculated to measure the strength and direction of the relationship between two variables, namely PTA and SRT for list A. List A was also split for the two groups (groups one and two). The relationship between two variables can be illustrated graphically on a scattergram (Schiavetti & Metz, 2006). The strength and direction of the relationship between PTA and SRT was determined for list A, as reflected in Figures 4 and 5 (below) for groups one and two respectively. The scattergrams represent PTA for the right and left ears and SRT (list A) for the right and left ears. The correlation strengths are described below.

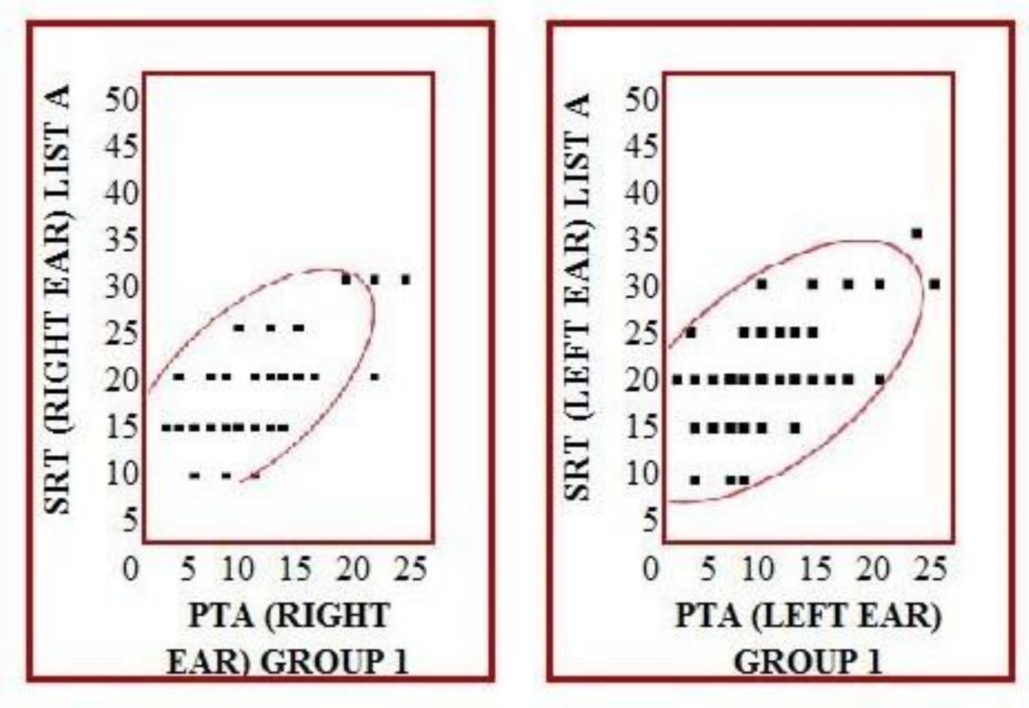


Figure 4. PTA/SRT correlation for list A in group one (N=54R; 51L)

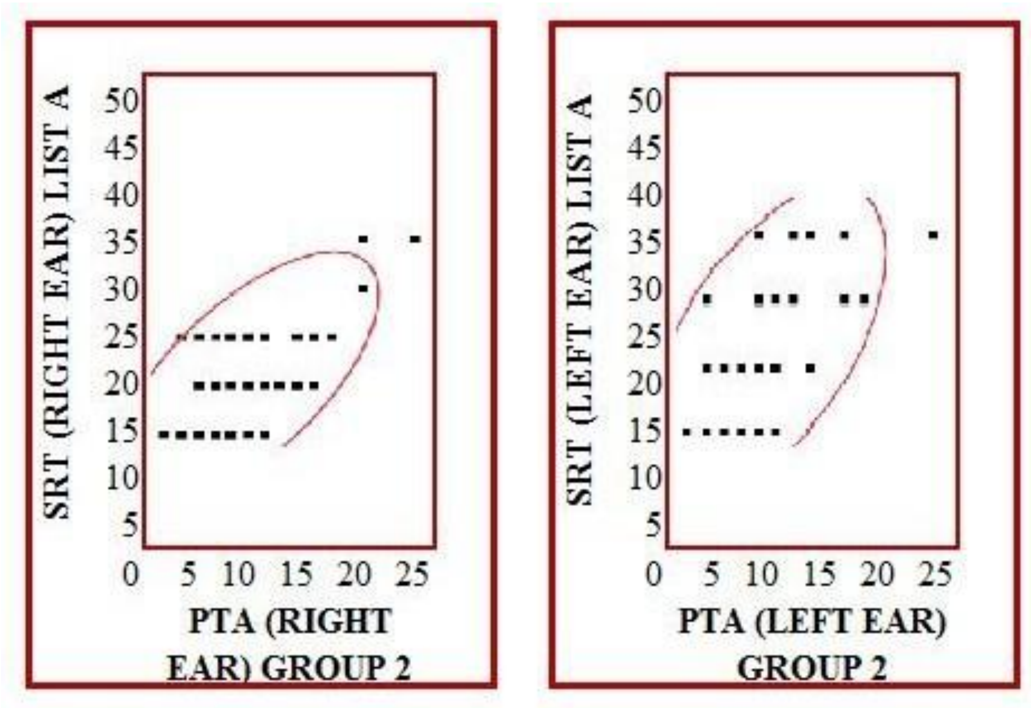


Figure 5. PTA/SRT correlation for list A in group two (N = 46R; 46L)

As may be seen in Figures 4 and 5 above, the scattergrams are densely clustered, with a similar pattern for groups 1 and 2, for both the right and left ears (Schiavetti & Metz, 2006), suggestive of good inter-group reliability. The scattergram is clustered between 15 dB and 35 dB thresholds for SRT, with a corresponding range of 0 dB to 25 dB for PTA. A Pearson correlation analysis revealed a significant and positive, moderate to strong correlation relationship for list A. That is, as the variable of SRT tends to increase according to the increase of the variable of PTA, the relationship may be considered positive in all instances (Howell, 2009; Schiavetti & Metz, 2006).

Where "1" denotes a perfect positive correlation, and "0" denotes no correlation (Howell, 2009), when compared to PTA for the right ear, list A (right ear) revealed a moderate to strong correlation of 0.63 ($N = 54$, $p<0.0001$) for group one, and 0.67 ($N = 46$, $p<0.0001$) for group two. When compared to PTA for the left ear, list A (left ear) revealed a moderate to strong correlation of 0.58 ($N = 51$, $p<0.0001$) for group one, and 0.57 ($N = 46$, $p<0.0001$) for group two. When the results for groups one and two were combined, list A (right ear) revealed a moderate to strong correlation of 0.65 ($N = 100$, $p<0.0001$) (Schiavetti & Metz, 2006). When the results for groups one and two were combined, list A (left ear) revealed a moderate to strong correlation of 0.58 ($N = 97$, $p<0.0001$) (Schiavetti & Metz, 2006).

The relationship is considered moderate to strong (0.65 and 0.58 for the right and left ears respectively) with the use of list A due to the high value of the correlation, as well as the density with which the plots of the scattergram are clustered (Schiavetti & Metz, 2006).

It is interesting to note that the correlation for the right ear is stronger than the correlation for the left ear, despite the randomisation of test order. This may be related to right ear processing dominance for speech which may require further investigation in future studies (Bellis, 2003).

For all conditions, the correlations between PTA and SRT were statistically significant for list A, at a 95% level of confidence since the p-value is smaller than 0.05 (Schiavetti & Metz, 2006). In addition, there were no significant differences between groups one and two for list

A, indicating a homogenous sample, no bias between groups and no advantage for either group, at a 95% level of confidence (Schiavetti & Metz, 2006).

In conclusion, the results indicate that the use of list A results in a SRT that has a good correlation to PTA, and this may be considered statistically significant. This result is as expected, as list A is considered to consist of the most familiar SAS words, according to Durrant (2006).

The results obtained with the use of list B are presented and discussed in the next section.

4.1.2 Results and discussion for PTA/SRT correlation when using list B

A correlation matrix was calculated to measure the strength and direction of the relationship between two variables, namely PTA and SRT for list B. Figure 6 depicts a visual representation of the correlation strength.

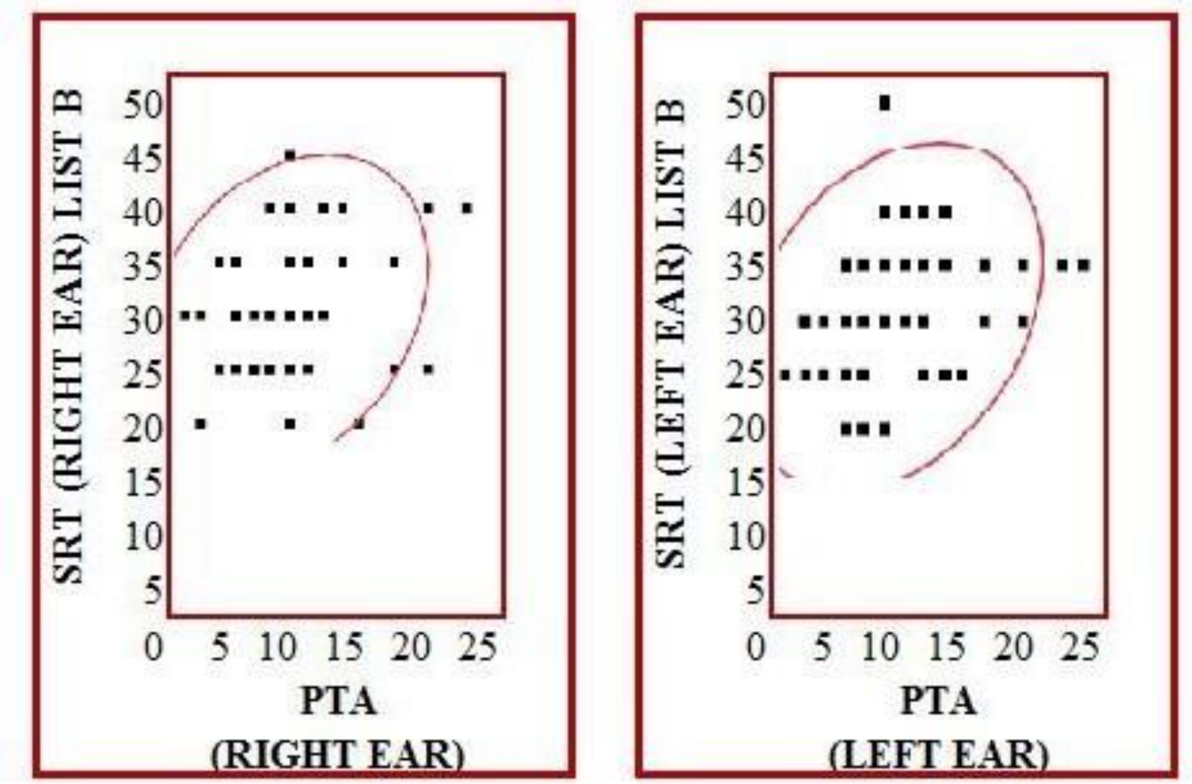


Figure 6. PTA/SRT correlation for list B in group one (N = 54R; 51L)

As may be seen in Figure 6 above, the scattergrams are less densely clustered, with a similar pattern for the right and left ears (Schiavetti & Metz, 2006). The scattergram is clustered between 20 dB and 50 dB thresholds for SRT, with a corresponding range of 0 dB to 25 dB for PTA, indicating much higher SRT responses when list B was used, despite the matched groups. A Pearson correlation analysis revealed a positive, moderate to weak correlation relationship for list B, for both the right and left ears (Howell, 2009, Schiavetti & Metz, 2006). Where "1" denotes a perfect positive correlation, and "0" denotes no correlation, when compared to PTA for the right ear, list B (right ear) revealed a moderate to weak correlation of 0.30 (N = 54, p = 0.0266). When compared to PTA for the left ear, list B (left ear) revealed a moderate to weak correlation of 0.32 (N = 51, p = 0.0226). As the variable of SRT for list B tends to increase according to the increase of the variable of PTA, the relationship may be considered positive (Schiavetti & Metz, 2006). However, the strength of the relationship is considered moderate to weak (0.30 and 0.32 for the right and left ears respectively, with p = 0.0266 in both instances) with the use of list B due to the low value of the correlation (Schiavetti & Metz, 2006). This is indicative of a poor correlation with PTA when list B is used.

The correlations between PTA and SRT were statistically significant for list B, at a 95% level of confidence since the p-value is smaller than 0.05 (Schiavetti & Metz, 2006). This result is as expected, due to the unfamiliar linguistic content and vocabulary of the words contained in list B. Many ESL South Africans have never been exposed to many of the words contained in list B and they are considered the most unfamiliar words, according to Durrant (2006).

The results of list C are presented and discussed in the next section.

4.1.3 Results and discussion for PTA/SRT correlation when using list C

A correlation matrix was calculated to measure the strength and direction of the relationship between two variables, namely PTA and SRT for list C. Figure 7 depicts a visual representation of the correlation strength.

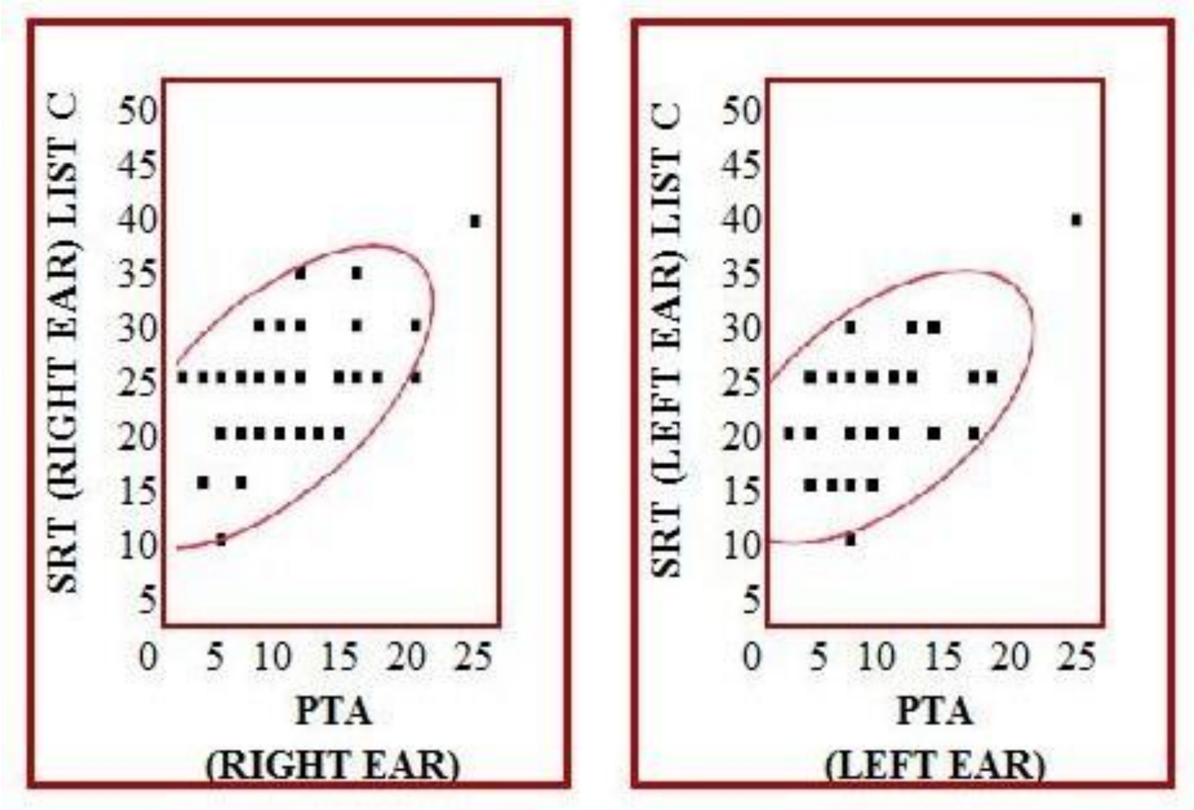


Figure 7. PTA/SRT correlation for list C in group two (N = 46R; 46L)

As may be seen in Figure 7 above, the scattergrams are densely clustered, with a similar pattern for the right and left ears (Schiavetti & Metz, 2006). The scattergram is clustered between 10 dB and 40 dB thresholds for SRT, with a corresponding range of 0 dB to 25 dB for PTA. A Pearson correlation analysis was conducted, and revealed a significant and positive, moderate to strong correlation relationship for list C, for both the right and the left ear (Schiavetti & Metz, 2006; Howell, 2009). Where “1” denotes a perfect positive correlation, and “0” denotes no correlation, when compared to PTA for the right ear, list C (right ear) revealed a moderate to strong correlation of 0.63 (N = 46, p <0.0001). When compared to PTA for the left ear, list C (left ear) revealed a moderate to strong correlation of 0.56 (N = 46, p<0.0001).

The relationship is considered moderate to strong (0.63 and 0.56 for the right and left ears respectively) with the use of list C due to the high value of the correlation, as well as the density with which the plots of the scattergram are clustered (Schiavetti & Metz, 2006).

Similarly to list A, it is interesting to note that the correlation for the right ear is stronger than the correlation for the left ear, despite the randomisation of test order. This may be related to right ear processing dominance for speech which may require further investigation in future studies (Bellis, 2003).

The correlations between PTA and SRT were statistically significant for list C, at a 95% level of confidence since the p-value is smaller than 0.05 (Schiavetti & Metz, 2006). The correlation value is high when list C is used. This result is as expected, as list C is considered to be the more familiar words of the original CID W-1 wordlist, according to Durrant (2006).

The results of the comparison of correlations obtained for lists A, B and C are presented and discussed in the next section.

4.1.4 Results and discussion for the comparison of the PTA/SRT correlations for lists A, B and C

The values for the PTA/SRT correlations were tabulated for lists A, B and C for the whole group, as seen in Table 6 below.

Table 6. Summary of PTA/SRT correlation per list

	Right ear		Left ear	
List administered	Correlation	Description	Correlation	Description
List A	0.65	Moderate to strong	0.58	Moderate to strong
List B	0.30	Moderate to weak	0.32	Moderate to weak
List C	0.63	Moderate to strong	0.56	Moderate to strong

As can be seen in Table 6, when determining the SRT correlation to the PTA, for both the right and left ears, the use of list A revealed a moderate to strong positive correlation, the use of list B revealed a moderate to weak positive correlation, and the use of list C revealed a moderate to strong positive correlation (Schiavetti & Metz, 2006).

The correlation obtained for list A (0.65; 0.58) and list C (0.63; 0.56) are comparable to the correlation obtained by Khoza et al. (2008) when using the CID W-1 wordlist (0.61), a Tswana wordlist (0.62) and a digit wordlist (0.60), in their sample of university ESL students, as well as the correlation obtained by Ramkissoon et al. (2002) for the CID W-1 wordlist (0.63) for ESL speakers. However, the correlation obtained by Ramkissoon et al. for the digit wordlist was slightly stronger (0.71). This is evident of improved performance for digit testing, for Ramkissoon's study (2002).

The correlation for each of the lists differs significantly from 0 at a 95% level of confidence since the p-value is smaller than 0.05 (Schiavetti & Metz, 2006). However lists A and C revealed a higher absolute correlation than list B, indicating a stronger correlation for lists A and C.

These results indicate that lists A and C yield a similarly stronger PTA/SRT correlation than the use of list B when measuring SRT of the participants. This is as expected, based on the familiar ratings of the wordlists (Durrant, 2006).

The results of the comparison of the difference in mean scores obtained for lists A, B and C are presented and discussed in the next section.

4.2 Results and discussion for the comparison of the difference in mean scores for PTA and SRT for lists A, B and C

The differences between the mean scores for PTA and SRT were compared for lists A, B and C using the paired sample T-test (the PTA and SRT values were paired).

The mean differences between PTA and SRT for list A (11.66 and 11.96) and list C (14.84 and 12.80) were significantly lower than that for list B (22.13 and 20.90), for the right and left ear respectively, indicating stronger PTA/SRT compliance for lists A and C. The analysis showed a significant difference for all three lists - greater than the ideal of 6 dB (Brandy, 2002). This discrepancy exists due to a suboptimal quality of the recording, due to the nature of the recording equipment used. Audibility of the wordlists was compromised somewhat, and this was only noted following the analysis of raw data. However, it should be noted that this discrepancy occurs equally across all the wordlists (lists A, B and C), as the wordlists were all recorded in the same manner, and under the same conditions, with acceptable inter-ear and intergroup reliability.

Lists A and B were compared, using the difference between PTA and SRT for both ears using the paired sample T-test (lists A and B were paired). The analysis showed a difference between PTA and SRT correlation of 11.08 for the right ear, and of 9.51 for the left ear, both of which are statistically significant (with a t-value of <.0001), which indicates that lists A and B differ significantly at a 99% level of confidence, yielding a stronger PTA/SRT correlation when list A is used.

Lists A and B were compared, using the total difference between PTA and SRT for combined sets of ears using the paired sample T-test (lists A and B were paired). The analysis showed a difference between PTA and SRT correlation of 20.58 for the combined ears, which is statistically significant (with a t-value of <.0001), which indicates that lists A and B differ significantly at a 99% level of confidence, yielding a stronger PTA/SRT correlation when list A is used.

The use of the paired sample T-test indicates a large difference in mean scores between lists A and B, which differ significantly at a 99% level of confidence, yielding a significantly stronger PTA/SRT correlation when list A is used. List B contains the less familiar words within the CID W-1 original spondaic wordlist, and those words may be deemed unreliable when testing SRT in the ESL sample, due to the poor correlation obtained.

Lists A and C were compared, using the difference between PTA and SRT for both ears using the paired sample T-test (lists A and C were paired). The analysis showed a mean difference between PTA and SRT of 2.67 for the right ear, which is statistically significant (with a t-value of 0.0015), and only 0.45 for the left ear, which is not statistically significant (with a t-value of 0.5612), yielding a statistically stronger PTA/SRT difference for the right ear only.

Finally, lists A and C were compared, using the total difference between PTA and SRT for combined sets of ears using the paired sample T-test (lists A and C were paired). The analysis showed a mean difference between PTA and SRT of 3.12 for the combined ears, which is statistically significant (with a t-value of 0.0232). The use of lists A and C revealed similar correlations, with a small difference in mean scores, yielding similar results. However, the use of the paired sample T-test indicates that lists A and C differ significantly at a 95% level of confidence, yielding a statistically significantly stronger PTA/SRT correlation when list A is used.

The null hypothesis is that there is no statistically significant difference in PTA/SRT correlation, when lists A, B or C is used, at a .05 level of statistical significance. Therefore the null hypothesis is disproved as there is a statistically significant difference in PTA/SRT correlation.

The alternative hypothesis is that list A yields a statistically significantly stronger PTA/SRT correlation than the use of lists B or C, at a .05 level of statistical significance. The alternative hypothesis is proven correct.

The results of the influence of various factors on the mean difference in PTA and SRT scores for lists A, B and C are presented and discussed in the next section.

4.3 The results and discussion of the difference in mean scores for PTA and SRT for lists A, B and C according to various factors

Certain factors may be considered to influence the test results, such as age, education, occupation and subjective language proficiency. Figure 8 depicts the mean difference between PTA and SRT according to the factors of subjective rating of English language proficiency, age, education and occupation

As can be noted from Figure 8, the use of list A (groups one and two) and the use of list C results in a much smaller mean difference between PTA and SRT for all participants. The use of list B results in a much larger mean difference between PTA and SRT for all participants.

The use of list B resulted in great variation in the difference between PTA and SRT. Those participants who rated their own use of English as ‘excellent’ tended to yield a smaller (17.04 dB) mean difference in PTA and SRT. Those who considered their English language use to be ‘poor’ tended to yield a larger (25.03 dB) mean difference in PTA and SRT. Participants who have a ‘matriculation’ level of education tended to yield a larger (25.21 dB) mean difference in PTA and SRT. The use of list B results in a higher degree of variation in the mean difference between PTA and SRT, with a minimum difference of 8.11 dB and a maximum difference of 13.76 dB, with a range of 5.65 dB, depending on factors such as education and subjective language proficiency.

In contrast, those who were tested with lists A and C resulted in less variation in test results with regard to various factors. Those who rated their own English as ‘excellent’ tended to yield a smaller (8.11 dB and 9.8 dB for groups 1 and 2 respectively) mean difference in PTA and SRT with the use of list A.

Those who considered their English language use to be ‘poor’ tended to perform similarly with lists A and C, yielding 13.76 dB, 12.95 dB and 14.45 dB mean difference in PTA and SRT for lists A (group one), A (group two) and C respectively. This indicates minimal variation in the range of performance (1.5 dB range), even with participants who consider their own English proficiency to be poor. Furthermore, there is minimal variation in performance with the use of list A and/or list C (range of 7.77 dB) with regard to factors such as age, subjective language proficiency, education or occupation. For example, a cleaner who has a grade 9 level of education and who considers his own English proficiency to be ‘poor’

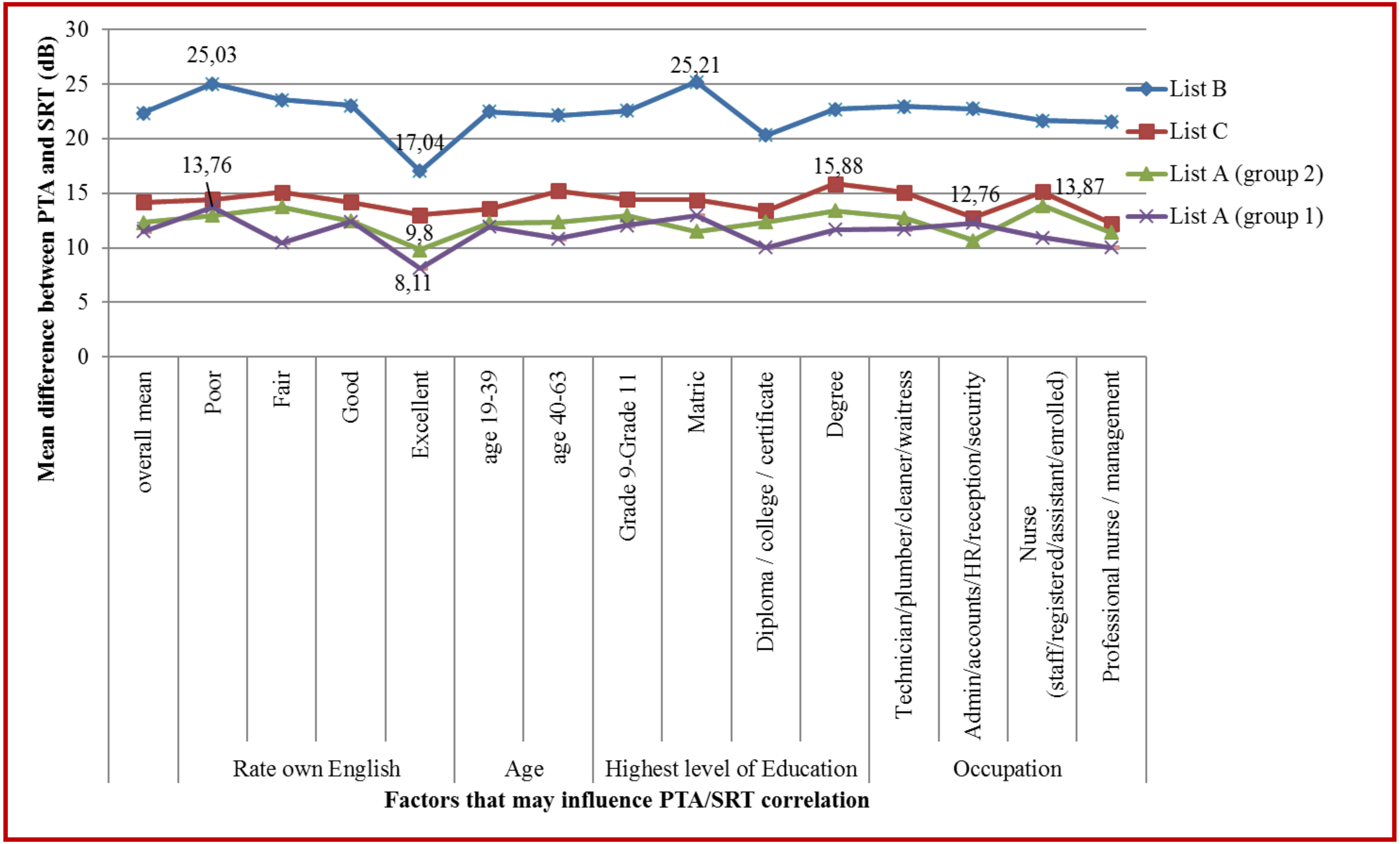


Figure 8. The mean difference (y-axis) between PTA/SRT in relation to various factors (x-axis) that may influence the correlation

can obtain a similar test score to a professional nurse who considers her own English proficiency to be good.

In the following section, the errors made during testing are reported and described:

4.4 The results and discussion of the description of errors

Certain errors were noted when participants were exposed to unfamiliar words for SRT testing, even at suprathreshold intensities, and at soft intensities. Table 7 tabulates the errors.

Table 7. Examples of errors made upon word repetition with unfamiliar wordlists

List	target word expected	error word produced by participant	description of the phonetic error – first syllable	description of the phonetic error – second syllable	Is the word valid or nonsensical?
A	building	everything	no pattern	vowel and final phoneme correct	valid
	building	all day	no pattern	first phoneme correct	valid
	toothbrush	dishwash	no pattern	final phoneme correct	nonsensical
	suitcase	sweetcakes	initial and final phonemes correct	initial and final phonemes correct	valid
	sunlight	sunrise	correct	vowel correct	valid
	sunshine	sunrise	correct	vowel correct	valid

List	target word expected	error word produced by participant	description of the phonetic error – first syllable	description of the phonetic error – second syllable	Is the word valid or nonsensical?
B	inkwell	involve	first vowel and consonant correct	mid-phoneme correct	valid
	whitewash	mouthwash	no pattern	correct	valid
	whitewash	nightwatch	vowel and final phoneme correct	initial phoneme and vowel correct	valid
	mousetrap	mousetrack	correct	initial cluster and vowel correct	nonsensical
	horseshoe	horsecream	correct	no pattern	nonsensical
	baseball	facebook	vowel and final phoneme correct	first phoneme correct	valid
	stairway	stay away	initial cluster correct	correct	valid
	stairway	stay there	initial cluster correct	no pattern	valid
	railroad	main road	vowel correct	correct	valid
	oatmeal	hotel	vowel correct	final phoneme correct	valid
	oatmeal	ordeal	no pattern	vowel and final phoneme correct	valid
	drawbridge	‘corporage’	vowel correct	vowel and final phoneme correct	nonsensical word
	hothouse	whitehouse	final phoneme correct	correct	valid word
	hothouse	hotel	initial and final consonants correct	no pattern	valid word
	airplane	anything	final vowel correct	no pattern	valid word

List	target word expected	error word produced by participant	description of the phonetic error – first syllable	description of the phonetic error – second syllable	Is the word valid or nonsensical?
C	playground	powerpoint	initial phoneme correct	no pattern	valid word
	cowboy	powerball	vowel correct	initial phoneme correct	valid word
	cowboy	tallboy	no pattern	correct	nonsensical word
	headlight	headlice	correct	initial phoneme and vowel correct	valid word

Table 7 represents some of the errors that were made in response to the task of repeating unfamiliar words. The table shows that the majority of errors occurred with list B, which is the list of the least familiar words. The nature of the errors, even when simply repeating a word at suprathreshold intensities, is evident of a stark lack of familiarity and exposure to the words (Postma, 2000).

Listeners tend to use sounds and syllables from their first language to make predictions of words that are more likely (Braisby & Gellatly, 2012). Errors draw heavily from the participant's knowledge of the world, and more common words tend to be exchanged for the unknown word (Dietrich, 1999). Dietrich (1999) reported similar errors, such as 'mouthwash' for 'whitewash', 'freeway' or 'fairway' for 'stairway'.

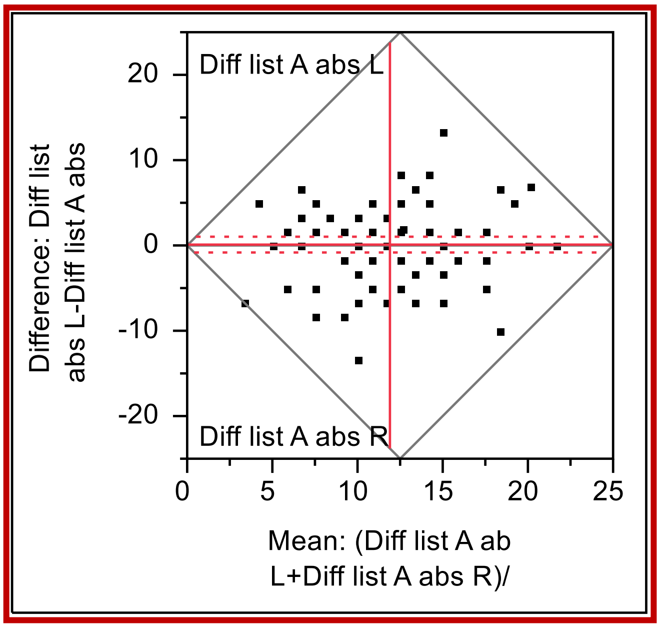
As the vowel pronunciation in English is reduced in ESL speakers, many vowels may be confused (such as in the instance of 'stair-way' error 'stay-away'. In addition, South African English does not product the final /r/ as in stair.

The majority of the words produced in error were valid words, some specific to the South African lexicon (such as 'powerball', which is the name of a lottery game). The errors were typically with either the first or second syllable of the word. At least one of the phonemes was recognisable in the errors (Postma, 2000). The pattern of errors was equally spread between the initial and final syllables of the words, with marginally more errors made in the final syllables (Postma, 2000).

In the following section, the inter-ear reliability obtained for each wordlist will be reported and discussed:

4.5 The results and discussion of the description of inter-ear reliability per wordlist

The differences between the mean scores for the right and left ears were compared for lists A, B and C using paired sample T-tests. That is, the left ear and right ear values were paired for list A, which may be seen in Figure 9 below.



KEY TO FIGURE 9

Diff list A abs L – difference in the left ear responses for list A

Diff list A abs R – difference in the right ear responses for list A

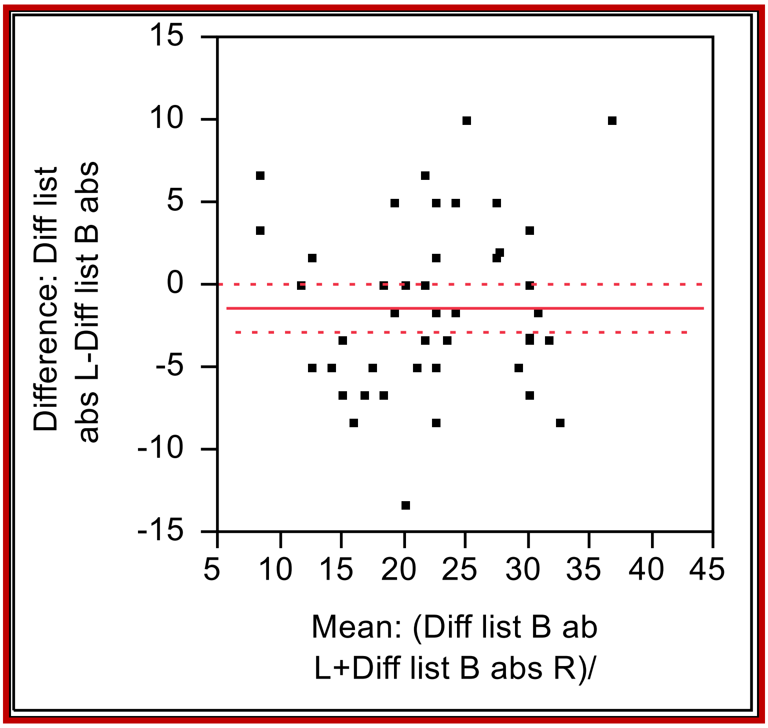
Mean: (Diff list A abs L + Diff list A abs R)/2 – the difference in the right ear and left ear responses for list A, added together and divided by two to obtain a mean.

Difference: Diff list A abs L – Diff list A abs R – the difference in the right and left ear responses for list A.

Figure 9. Paired sample T-test: Matched pairs list B – Left versus Right

The inter-ear reliability is an indication of the difference in performance of the right ear and left ear of each participant with each wordlist used. As may be seen in Figure 10, there is no significant difference between the mean information obtained for the right and left ears [$t(95) = 0.21$; $p < 0.8322$]. This indicates that list A yields excellent inter-ear reliability, with minimal differences between the values obtained for the right and left ears. Therefore, the use of list A may be considered to result in good within-participant reliability, thereby eliminating certain extraneous conditions, such as language level and education level (Schiavetti & Metz, 2006).

Paired sample T-tests were also used to pair the left ear and right ear values for list B, which may be seen in Figure 10 below.



KEY TO FIGURE 10

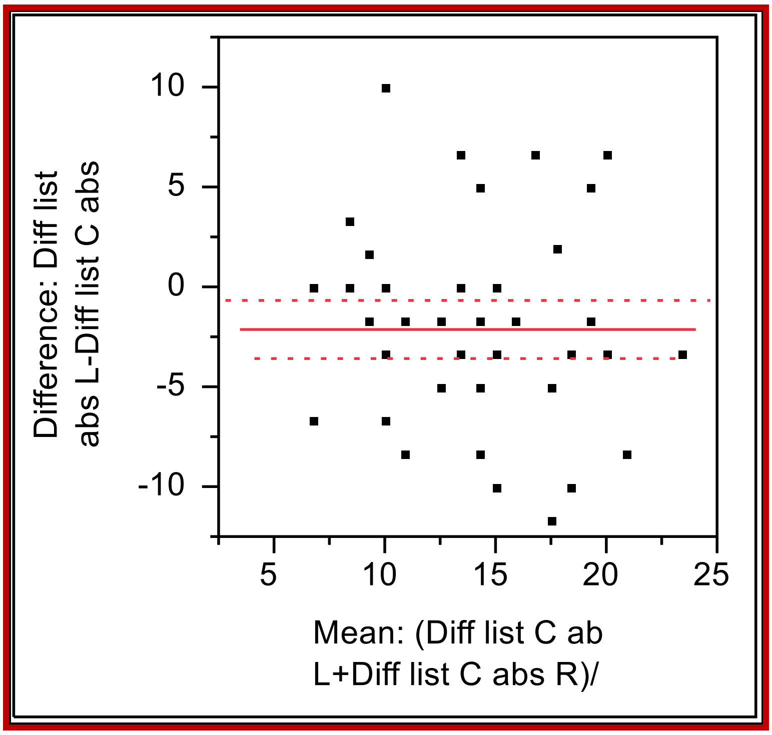
Mean: (Diff list B abs L + Diff list B abs R)/2 – the difference in the right ear and left ear responses for list B, added together and divided by two to obtain a mean.

Difference: Diff list B abs L – Diff list B abs R – the difference in the right and left ear responses for list B.

Figure 10. Paired sample T-test: Matched pairs list B – Left versus Right

The inter-ear reliability is an indication of the difference in performance of the right ear and left ear of each participant with each wordlist used. As may be seen in Figure 11, the analysis showed a significant difference between the mean information obtained for the right and left ears for list B [$t(50) = -2.01$; $p < 0.0496$]. This indicates that list B yields poor inter-ear reliability, with significant differences between the values obtained for the right and left ears. Therefore, the use of list B may be considered to result in a less favourable within-participant reliability than for list A. Extraneous conditions such as language level and education level may therefore have more of an influence on the test results when list B is used (Schiavetti & Metz, 2006). This is consistent with the implications of education level on word familiarity, due to exposure, language use and vocabulary (Song & Fox, 2008), and these factors should be taken into account when considering the vocabulary content of unfamiliar wordlists such as list B. It should be noted that list B was tested on the same group of participants as list A.

Paired sample T-tests were also used to pair the left ear and right ear values for list C, which may be seen in Figure 11 below.



KEY TO FIGURE 11

Mean: (Diff list C abs L + Diff list C abs R)/2 – the difference in the right ear and left ear responses for list C, added together and divided by two to obtain a mean.

Difference: Diff list C abs L – Diff list C abs R – the difference in the right and left ear responses for list C.

Figure 11. Paired sample T-test: Matched pairs list C – Left versus Right

The inter-ear reliability is an indication of the difference in performance of the right ear and left ear of each participant with each wordlist used. As may be seen in Figure 11, the analysis showed a significant difference between the mean information obtained for the right and left ears for list C [$t(44) = -2.96$; $p < 0.0050$]. Similarly, this indicates that list C yields poor inter-ear reliability, with significant differences between the values obtained for the right and left ears. Therefore, the use of list C may be considered to result in a less favourable within-participant reliability than for list A. Extraneous conditions such as language level and education level may therefore have more of an influence on the test results when list C is used (Schiavetti & Metz, 2006). Similarly, this is consistent with the implications of education level on word familiarity, due to exposure, language use and vocabulary (Song & Fox, 2008), and these factors should be taken into account when considering the vocabulary content of unfamiliar wordlists such as list B. It should be noted that list B was tested on the same group of participants as list A.

The use of lists B and C resulted in poor inter-ear reliability, with a larger mean inter-ear difference. It should be recalled that lists B and C were tested on the same participants as list A (groups one and two), which removes extraneous factors which could influence the test results. The use of list A may be considered to result in improved within-participant reliability than the use of lists B or C.

This may be due to the less familiar vocabulary contained in lists B and C, which can compromise validity and reliability due to linguistically biased content (Ramkissoon, 2001; Ramkissoon et al., 2002; Sreedhar et al., 2011).

In the following section intergroup reliability is discussed:

4.6 The description of intergroup reliability

The ANOVA, MANOVA and paired T-tests (Howell, 2009) were conducted to determine intergroup equivalence for groups one and two, to ensure there was no bias between the groups. This could only be conducted using list A, due to the design of the study.

When considering the results of the ANOVA, to determine the statistical significant differences between groups one and two, the F-test was used at a 95% level of confidence. If the calculated p-value is greater than 0.05, it may be considered as not significantly different (Schiavetti & Metz, 2006). There were no significant differences between the groups [$F(1, 99) \approx 2.01$, $p = 0.1596$ for the right ear; $F(1, 96) \approx 1.19$, $p = 0.2786$ for the left ear], indicating a homogenous sample, no bias between groups and no advantage for either group, at a 95% level of confidence (Schiavetti & Metz, 2006).

When considering the results of the MANOVA, the SRT mean and PTA mean were similar between the two groups, with no statistical difference between the groups. To determine the statistically significant differences between groups one and two, the F-test was used at a 95% level of confidence. If the calculated p-value is greater than 0.05, it may be considered as not significantly different. There were no significant differences between the groups [F (2, 97) ≈ 1.33, p =0.2683 for the right ear; F (2, 94) ≈ 0.64, p = 0.5293 for the left ear], indicating a homogenous sample, no bias between groups and no advantage for either group, at a 95% level of confidence.

When considering the results of the paired T-tests, the differences between the mean scores for PTA and SRT were compared for list A, comparing groups one and two using the paired sample T-test (the PTA and SRT values were paired). The analysis showed that the mean differences between PTA and SRT for list A for group one (11.17 and 11.61) and group two (12.24 and 12.36), for the right and left ear respectively, were similar, indicating good intergroup equivalence. This is to be expected, as the groups were matched. It does indicate that the sample is homogenous in terms of performance, despite the variations in age, gender, first language use, education and language proficiency.

4.7 Summary

All the correlations for PTA/SRT were considered significant. The correlations for lists A and C were stronger than the correlation for list B, indicating a higher correlation for lists A and C.

The mean differences between PTA and SRT were significant for all lists; however the differences for lists A and C were lower than the difference between PTA and SRT for list B. This indicates a stronger compliance for lists A and C. Note that the mean is still above 6 dB for all three lists.

The PTA/SRT correlations for lists A and B differ significantly at a 99% level of confidence, yielding a stronger PTA/SRT correlation when list A is used. Lists A and C differ significantly at a 95% level of confidence, yielding a stronger PTA/SRT correlation when list A is used.

The use of lists A and C results in a much smaller mean difference between PTA and SRT, compared to the use of list B, which resulted in much larger mean differences and more variation between PTA and SRT, according to various factors, such as age, subjective language proficiency, education or occupation.

The errors that were made on repetition of words were significant. More errors were made with list B. The number and nature of errors indicate a stark unfamiliarity with many of the words contained in list B particularly.

The inter-ear differences between the right and left ears were significant for lists B and C, but the use of list A resulted in improved inter-ear reliability. The use of list A may be considered to result in improved within-participant reliability than the use of lists B or C.

There were no significant intergroup differences. This indicates that the sample was homogenous in terms of performance, despite the variations in age, gender, first language use, education and language proficiency.

Therefore the null hypothesis - that no statistically significant difference between the results obtained for PTA/SRT correlation with the use of the SAS wordlist or the CID W-1 wordlist, at a .05 level of statistical significance – was found to be disproved as there is a statistically significant difference in PTA/SRT correlation.

The alternative hypothesis – that a statistically significant difference was found between the results obtained for PTA/SRT correlation with the use of the SAS wordlist and the CID W-1 wordlist, at a 0.05 level of statistical significance – is proven correct.

This chapter presented the results obtained and the discussion thereof. The conclusions and limitations of the study will be presented in the following chapter:

Chapter 5: Conclusions, limitations and recommendations

In this chapter, the conclusions, limitations and recommendations are presented subsequent to the results as described in Chapter 4.

5.1 Conclusions

The spondaic words, which have been determined as the more familiar words to the South African population who use English as one of their multiple languages, were compiled to form a spondaic wordlist specific to South Africa (Durrant, 2006), the SAS wordlist. The main aim of this study was to compare the PTA/SRT correlation when using the SAS wordlist and the CID W-1, for measuring SRT in a group of South African English second language participants.

The null hypothesis is rejected in favour of the alternative hypothesis. The alternative hypothesis is as follows: The use of the SAS wordlist does yield a statistically significantly stronger PTA/SRT correlation than the use of the CID W-1 when measuring SRT in the South African population with normal hearing or a minimal hearing loss <26 dBHL, who use English as a second language.

The use of the SAS wordlist may be employed tentatively when performing SRT testing as part of the speech audiometry battery on a South African ESL speaker with normal hearing, or minimal hearing loss <26 dBHL, within the understanding that the wordlist has not been standardized at a national level.

Considering that the home language of the majority of audiology professionals in South Africa is either English or Afrikaans (Swanepoel, 2006), whereas most South Africans speak an African language as their home language (Uys & Hugo, 1997, as cited in Swanepoel, 2006), the use of an English wordlist, which is familiar to the South African population who use English as a second language indicates a potential solution to the predicament faced when testing the speech recognition thresholds (SRT) of English second language (ESL) speakers, due to the implications of multilingualism on speech audiometry results (Von Hapsburg & Pena, 2002).

Although this is not an ideal solution to the predicament that audiologists face when conducting speech audiometry in South Africa, in light of limited resources and the complex linguistic context of the country at present, this may be considered a reasonable solution which will yield more reliable results than using the lists which are currently used.

5.2 Limitations of the study

The limitations of the study include the exclusive use of participants with normal hearing or minimal hearing loss <26 dBHL, as participants with different degrees of hearing loss were not included in the study.

The participants were sampled from the province of Gauteng only, and the results of the study may not be applicable to other provinces within South Africa.

The use of 5 dB increments was employed for the purpose of SRT determination. The use of 5 dB increments was preferred over the use of 1 dB or 2 dB increments, as this is more clinically relevant. The use of 1 to 2 dB increments may result in more accurate PTA/SRT correlations due to more specific SRT measurements, although it is not necessarily clinically relevant.

The quality of recording was unfortunately substandard, resulting in mean differences between PTA and SRT that are disproportionate for each of the wordlists, but the mean differences were equal for each list, and this was accounted for in the statistical analysis. According to Di Berardino et al. (2010), the sensitivity of the VU meter should be adjusted according to the speech material levels prior to testing, in order to compensate for any differences. This was not identified prior to data collection.

Lastly, the length of the SAS wordlist may be considered to be a limitation, due to the relatively short length of the SAS wordlist (19 words) in comparison to the recommended length of the CID W-1 (36 words) (Hirsh et al., 1952).

5.3 Recommendations for further research

Future studies should include participants with hearing loss of various types, degrees and configurations, to allow for clinically relevant application of the results to include the population with hearing loss. In addition, this allows for interpretation of results to include factors such as type, degree and configuration of hearing loss (Martin & Clark, 2003).

Further studies should include participants from different regions of South Africa. The SAS wordlist should be tested on a national basis, as current participants resided in one province only, namely Gauteng. Due to the broad differences in population and language use across South Africa, this would be valuable information (Statistics South Africa, 2012). This would allow for more accurate generalisation of the results for use within South Africa

Future studies may use 1 dB or 2 dB steps for the purposes of determining SRT, as this allows for more precise information and correlation to be gleaned (Brandy, 2002).

In future testing, an improved quality of recording would be strongly recommended, and should an improved quality of recording be utilized, an equally proportioned improvement in PTA/SRT correlation would be expected for each of the wordlists. Additionally, the sensitivity of the VU meter would be adjusted, and specified accordingly (Di Berardino et al., 2010).

Furthermore, the evaluation of each of the spondaic words in the SAS wordlist should be conducted in terms of homogeneity of audibility, using a performance-intensity, or articulation gain curve, which gives information about the precision with which threshold can be obtained (Brandy, 2002).

The SRT obtained using the SAS wordlist should be compared with the SRT obtained when using a digit wordlist when testing ESL speakers in South Africa (Ramkissoon et al., 2002).

5.4 Summary

In this chapter, conclusions were made about the use of the SAS wordlist. The limitations were discussed and suggestions made for further research.

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Appendix A – Ethical clearance form

UNIVERSITEIT VAN PRETORIA
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Faculty of Humanities
Research Ethics Committee

12 July 2011

Dear Dr Soer

Project:	**Comparison of the South African Spondaic Wordlist and the CIDW-1 Wordlist for measuring Speech Recognition Threshold**
Researcher:	**TH Durrant**
Supervisor:	**Dr M Soer**
Department:	**Communication Pathology**
Reference number:	**29360979**

Thank you for your response to the Committee's correspondence of 26 November 2010.

I have pleasure in informing you that the Research Ethics Committee formally **approved** the above study at an *ad hoc* meeting held on 11 July 2011. Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should your actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

The Committee requests you to convey this approval to the researcher.

We wish you success with the project.

Sincerely

Prof. John Sharp
Chair: Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: john.sharp@up.ac.za

Appendix B - Participation information letter

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Department of Communication Pathology

2 March 2011

Dear participant,

Request to participate in research

I am currently completing a thesis for a Masters degree in audiology through the Department of Communication Pathology, at the University of Pretoria. I would appreciate if you would consider participating in the research. Before agreeing to participate in the study, it is important for you to know about the purpose of the study, the procedures and your rights with respect to the research.

The title of the thesis is "Comparison of the clinical use of the South African Spondaic Wordlist and the CIDW-1 Wordlist for measuring Speech Recognition Threshold".

The purpose of the study is to compare a newly developed South African Spondaic Wordlist to the CIDW-1 list, which has been used in speech audiometry for several years. Spondaic words (spondees) are specific types of words that are used to measure the softest level at which a person can recognize familiar words, which is known as the Speech Recognition Threshold (SRT). The CIDW-1 wordlist was developed in the 1940's in America and England, and some of the words are therefore not familiar to many South African speakers of English, particularly those who use English as a second language. Test results may therefore be unreliable. The aim of this research is therefore to compare the accuracy of the two wordlists when measuring the SRT of South Africans who use English as one of their multiple languages.

Your participation in this research is entirely voluntary and you have the right to withdraw at any point in time without any prejudice or penalties. If you choose to withdraw from the research, then any data linked to your participation will be destroyed. All personal information obtained during the course of the study will be held in strict confidence, and will not identify you as a participant in the study. There is no personal gain in participation, but society may benefit from the development of a more appropriate wordlist for audiological testing. The research data obtained will be stored in the University of Pretoria's Department of Communication Pathology in a hard copy format.

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UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Department of Communication Pathology

I would like to invite you to participate in this research. Should you choose to participate in the research, you will need to sign a form stating that you understand the above information. Your outer ear will be examined using an otoscope which allows light to shine into the ear canal. Your middle ear pressure and compliance will be measured using tympanometry, which will involve a sensation of pressure in your outer ear canal. Thereafter, your hearing sensitivity will be screened using different tones which will require you to indicate when you hear the tones. If your hearing falls out of the range of normal hearing acuity, your data will not be withdrawn from the study, but further referrals may be recommended for further medical or audiological management. The softest level at which you can recognize speech will then be measured using two wordlists in each ear. You will be required to repeat words back to the clinician, even when they may be difficult to hear.

The entire process should not take more twenty minutes of your time. None of the above procedures should cause you any discomfort or pain. If, during the test procedure, a hearing loss is identified, you will receive suitable audiological intervention, recommendations and counseling services through the Sandton Hearing & Balance clinic at the hospital.

Should you be interested in further information regarding the study or the results, or seek clarity on any aspect of the research, I would be willing to share my findings with you. I may be contacted on 084 243 2740 or (011) 463 4639.

Thank you for taking the time to read this information sheet.
Yours sincerely,

Mrs. T Hanekom	Dr M Soer & Dr L Pottas
Researcher	Supervisors

Acting head: Department of Communication Pathology, University of Pretoria

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Appendix C - Informed consent form

I, the undersigned, hereby confirm that I have been informed by the researcher, Tanya Hanekom of the nature of the study. I have also received, read and understood the above information given to me regarding the study (Participant Information), or it was explained to me verbally. I understand that the research will add approximately five minutes to the hearing screening test time, and that the total test time should not exceed twenty minutes. I confirm that I am aware of the testing procedures, and that I will be required to respond to auditory beeps, and repeat audible words. I understand that testing is not harmful, and will not cause any harm to me.

I am aware that the results of the study will be treated in a confidential manner and that my personal details will not be released to any third party. I understand that I may at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and declare myself prepared to participate in the study, of my own free will.

PARTICIPANT

____

Signature

RESEARCHER / CLINICIAN

____

Signature

SIGNED AT SANDTON ON _____________ 2011

Appendix D – Permission from the hospital

SANDTON MEDI-CLINIC
Private hospital

18 April 2011

To whom it may concern:

Permission for hearing screening – Sandton Medi-Clinic

I, Monique Lenz, as the Nursing Manager (title) of Sandton Medi-Clinic, hereby grant permission for Tanya Hanekom (audiologist) to conduct hearing screening of the hospital staff, as well as permission for the additional test procedure to be included in the hearing screening protocol.

This permission is preliminarily granted on condition that ethical clearance is granted by the Research Ethics Committee of the University of Pretoria.

SIGNATURE

M.D. Lenz
NAME (PRINTED)

Appendix E – Case history interview questions

Patient initials / number

First language

Second language

Age of first exposure to English

Highest level of education

Occupation

Own rating of English

Male / female

Age

Subjective hearing concerns?

INITIALS	EAR	PTA	SRT (SA)	LIST	SRT (CID-W1)	LIST	TYMP (A/B/C)	1ST LG	2ND LG	AGE OF FIRST EXPOSURE TO ENG	EDUCATION	JOB	RATE OWN ENG	M/F	AGE
	Right														
	Left														
	Right														
	Left														
	Right														
	Left														
	Right														
	Left														
	Right														
	Left														

Appendix F – Proof of submitting an article to a journal

Tanya Hanekom <hanekomtanya@gmail.com>

[SAJCD] Submission Acknowledgement

Michelle Pascoe <editor@sajcd.org.za> Wed, Feb 27, 2013 at 4:39 PM
To: Mrs Tanya Heather Hanekom <hanekomtanya@gmail.com>

Mrs Tanya Heather Hanekom:

Thank you for submitting the manuscript, "COMPARISON OF THE SOUTH AFRICAN SPONDAIC WORDLIST AND THE CIDW-1 WORDLIST FOR MEASURING SPEECH RECOGNITION
THRESHOLD" to South African Journal of Communication Disorders. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL:
http://www.sajcd.org.za/index.php/SAJCD/author/submission/230
Username: tanyahanekom

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Michelle Pascoe
South African Journal of Communication Disorders
South African Journal of Communication Disorders
www.sajcd.org.za

Appendix G – Raw data summary and raw data capturing

	Right	Left	Right	Left	Right	Left	Right	Left
	PTA	PTA	SRT	SRT	SRT	SRT	SRT	SRT
Participant			List A	List A	List B	List B	List C	List C
1	excluded due to hearing loss							
2	5	10	20	20			20	20
3	3.3	8.3	15	20	35	35		
4	13.3	18.3	20	25			20	25
5	6.6	8.3	15	20	25	20		
6	25	25	35	30			40	40
7	6.6	6.6	15	20	25	25		
8	16.6	16.6	25	30			25	25
9	0	5	15	20	20	35		
10	3.3	6.6	20	20			20	20
11	5	6.6	15	15	25	20		
12	3.3	3.3	20	25			20	15
13	10	13.3	25	30	35	35		
14	8.3	6.6	15	15			25	30
15	6.6	5	15	15	30	25		
16	15	18.3	20	25			30	25
17	21.6		30		40			
18	excluded due to hearing loss							
19	18.3	23.3	30	35	35	35		
20	6.6	8.3	25	25			30	20
21	8.3	8.3	20	25	40	50		
22	8.3		20				20	
23	13.3		20		35			
24	5	6.6	20	15			15	10
	Right	Left	Right	Left	Right	Left	Right	Left

	PTA	PTA	SRT	SRT	SRT	SRT	SRT	SRT
Participant			List A	List A	List B	List B	List C	List C
25	1.6	3.3	10	15	25	25		
26	5	8.3	20	25			15	25
27	5	8.3	20	25	25	20		
28	10	8.3	20	20			35	25
29	8.3	6.6	20	10	35	25		
30	6.6	10	20	15			25	20
31	8.3	11.6	20	20	20	25		
32	3.3	5	15	15			10	15
33	3.3	1.6	20	20	30	30		
34	10	8.3	25	30			25	20
35	25	25	30	30	40	35		
36	5	6.6	15	20			20	20
37	6.6	11.6	15	15	30	30		
38	10	10	15	20			30	25
39	11.6	8.3	20	30	40	40		
40	5	8.3	15	20			20	15
41	8.3	1.6	15	10	30	25		
42	10	8.3	25	25			25	20
43	8.3	6.6	20	15	25	20		
44	1.6	13.3	15	20			15	20
45	8.3	8.3	20	20	20	20		
46	excluded due to hearing loss							
47	13.3	16.6	25	20	40	35		
48	8.3	10	25	20			25	25
49	21.6		20		25			
50	11.6	10	20	20			20	20
51	5	5	20	20	25	20		
	Right	Left	Right	Left	Right	Left	Right	Left

	PTA	PTA	SRT	SRT	SRT	SRT	SRT	SRT
Participant			List A	List A	List B	List B	List C	List C
52	20	16.6	35	25			30	20
53	-1.6	1.6	15	15	30	30		
54	15	11.6	25	30			35	30
55	0	5	20	20	30	35		
56	5	5	25	20			25	15
57	1.6	5	15	20	35	35		
58	10	10	15	20		20	20	20
59	0	0	20	20	20	25		
60	13.3	10	20	20			25	20
61	10	10	25	25	35	40		
62	3.3	6.6	15	20			25	25
63	10	15	20	20	25	25		
64	6.6	3.3	25	20			20	15
65	1.6	3.3	15	15	25	25		
66	8.3	11.6	25	30			30	30
67	3.3	16.6	15	30	30	30		
68	5	3.3	15	20			25	20
69	5	5	10	10	25	20		
70	20	10	30	25			25	25
71	3.3	16.6	20	20	30	35		
72	1.6	8.3	15	15			15	20
73	10	10	25	25	30	30		
74	6.6	8.3	15	25			20	20
75	10	11.6	15	20	35	35		
76	8.3	13.3	20	30			20	30
77	13.3	20	20	20	35	35		
78	6.6	8.3	15	20			20	20
	Right	Left	Right	Left	Right	Left	Right	Left

	PTA	PTA	SRT	SRT	SRT	SRT	SRT	SRT
Participant			List A	List A	List B	List B	List C	List C
79	8.3	6.6	20	20	30	30		
80	1.6	6.6	15	15			15	20
81	5	5	15	20	30	25		
82	6.6	5	15	15			20	25
83	11.6	10	15	20	30	35		
84	15	6.6	25	15			25	15
85	6.6	13.3	25	25	40	40		
86	1.6	11.6	25	25			25	25
87	5	5	15	15	25	25		
88	13.3	16.6	25	25			25	25
89	3.3	5	20	20	35	35		
90	8.3	8.3	10	15	25	30		
91	0	3.3	15	15			25	25
92	3.3	3.3	15	20	25	30		
93	6.6	5	15	15	25	30		
94		11.6		25				25
95	10	11.6	25	25	30	30		
96	8.3	8.3	20	20	30	30		
97	6.6	8.3	15	20			20	20
98	18.3	20	30	30	25	30		
99	3.3	1.3	20	25	30	30		
100	3.3	1.3	15	15			20	20
101	8.3	11.6	15	20	45	40		
102	3.3	6.6	20	25	35	35		
103	3.3	3.3	25	25			20	25

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1–2		NAME	EAR	PTA	SRT (SA)	LIST	SRT (CID W1)	LIST	TYMP (A/B/C)	SRT (SA) % words correct 75dB	CIDW-1 % words correct 75dB	1ST LG	2ND LG	Eng 3- or 3+	EDUCATION	JOB	RATE OWN ENG	M / F	AGE
3	1	NK	Right	30	25	A1	55	B	A	76	8	3	1	1	0	3	1	1	6
4			Left	40	30	A1	65	B	A										
5	2	PN	Right	5	20	A1	20	C	A	89	87	1	0	0	3	2	2	1	3
6			Left	10	20	A1	20	C	A										
7	3	LL	Right	3.3	15	A	35	B1	A	66	10	4	1	1	0	3	2	1	4
8			Left	8.3	20	A	35	B1	A										
9	4	NP	Right	13	20	A	20	C1	A	89	75	5	1	1	0	1	1	1	6
10			Left	18	25	A	25	C1	A										
11	5	SM	Right	6.6	15	A1	25	B	A	89	47	2	1	1	0	3	1	1	4
12			Left	8.3	20	A1	20	B	A										
13	6	RO	Right	25	35	A1	40	C	A	100	93	2	1	1	1	3	2	1	6
14			Left	25	30	A1	40	C	A										
15	7	BM	Right	6.6	15	A	25	B1	A	76	27	4	1	1	0	1	1	1	4
16			Left	6.6	20	A	25	B1	A										
17	8	JS	Right	17	25	A	25	C1	C1	100	87	2	1	0	2	3	2	1	6
18			Left	17	30	A	25	C1	C2										
19	9	MD	Right	0	15	A1	20	B	A	88	33	2	1	1	3	2	2	1	3
20			Left	5	20	A1	35	B	A										
21	10	MM	Right	3.3	20	A1	20	C	A	66	70	4	1	1	3	3	2	1	3
22			Left	6.6	20	A1	20	C	A										
23	11	LB	Right	5	15	A	25	B1	A	94	77	2	1	1	2	3	2	1	2
24			Left	6.6	15	A	20	B1	A										
25	12	BM	Right	3.3	20	A	20	C1	A	77	60	6	1	1	2	3	1	1	2
26			Left	3.3	25	A	15	C1	A										
27	13	GM	Right	10	25	A1	35	B	A	73	52	3	1	1	0	3	2	1	4
28			Left	13	30	A1	35	B	A										
29	14	EK	Right	8.3	15	A1	25	C	C1	94	77	2	1	1	1	3	3	1	2
30			Left	6.6	15	A1	30	C	A										
31	15	EL	Right	6.6	15	A	30	B1	A	96	70	2	1	1	3	3	2	1	3
32			Left	5	15	A	25	B1	A										
33	16	AB	Right	15	20	A	30	C1	A	73	56	7	1	1	2	2	3	1	2
34			Left	18	25	A	25	C1	A										
35	17	FJ	Right	22	30	A1	40	B	A	90	44	5	1	1	1	3	2	1	5
36			Left	27	35	A1	40	B	A										
37	18	AN	Right	30	35	A1	45	C	C1	100	100	2	1	0	0	3	3	1	5

LANGUAGE	
NONE	0
ENG	1
AFRIK	2
ZULU	3
PEDI	4
TSWANA	5
XHOSA	6
TSONGA	7
SOTHO	8
NDEBELE	9
VENDA	10
SISWATI	11
TAMAL	12
DUTCH	13
SHANGAAN	14
SHONA	15

JOB	
CSSD / store / technician / stock control / cleaner / plumbers / w	1
Admin / accounts / HR / reception / security	2
Nurse (staff/registered/assistant/enrolled)	3
Management / professional nurse	4

AGE LEARNT EN	
ENG 3-	0
ENG 3+	1

GENDER	
MALE	0
FEMALE	1

AGE	
20	2
30	3
40	4
50	5
60	6
70	7

RATE OWN ENGLISH
POOR
FAIR
GOOD
EXCELLENT

LEVEL OF EDUCATION
NOT MATRIC
MATRIC
DIPLOMA/COLLEGE/CERTIFICA
DEGREE