Tone variation in Tswana-speaking individuals: The effect of voice disorders

by

Gail L. Jones

A dissertation submitted in fulfilment of the requirements for the degree

M. Communication Pathology

In the Department of Speech-Language Pathology and Audiology

UNIVERSITY OF PRETORIA

FACULTY OF HUMANITIES

SUPERVISORS:

Prof. A. van der Merwe
Mrs M. le Roux
Dr J. van der Linde

April 2016

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Professor Anita van der Merwe. Thank you for your invaluable guidance and patience throughout this process. Your attention to detail has set a very high standard throughout this dissertation. I am privileged to have had the opportunity to learn from you.

Mrs le Roux and Dr van der Linde, I am also sincerely grateful for your supervision of my research. Thank you for your input and guidance. Your continuous encouragement, especially towards the end, helped me to persevere, even when I thought I would never finish.

I wish to acknowledge the help provided by my statistician, Lynda Olinger, and my language editor, Dr Elsie Naude. Thank you both for your willingness to help and particularly your efficiency. Nothing was ever too much trouble.

Thank you also to all of the participants for giving up their time to participate in this research study.

I would like to offer special thanks to my colleagues from the adult speech therapy team, who have been routing for me from the beginning. I have appreciated your encouragement and willingness to assist me in any way possible.

To my parents, my biggest cheer-leaders, thank you for your ongoing support. You have *always* believed in me and for that I am so grateful.

Finally, a very special thank you to my husband Riccardo. You have helped me so much with my research that you deserve an honorary Master's degree. I could not have finished this research without your support, patience and understanding.

SUMMARY

Background: Bantu languages that are spoken in South Africa are tone languages which use syllabic or word-level tone variation to convey the meaning of a word. Producing the correct tone pattern within a word is crucial to convey the intended meaning. Pitch forms the basis of tone variation and may be affected by various factors such as changes to the physical attributes of the vocal folds, including length, tension, and mass. It is widely accepted that voice disorders cause deviant changes to the pitch, quality, and/or loudness of the voice. However, because of the fine control that is necessary to vary syllabic tone, it is possible that vocal control could be affected by various vocal pathologies, which may interfere with an individual's ability to make vocal pitch changes. This could potentially result in misperception of a word and have implications for speech intelligibility in tone language speakers. Speech-language therapists in South Africa should be aware of the impact that a voice disorder may have on tone variation when treating Bantu-speaking individuals, as this has implications for clinical practice. To date there has been no research conducted in this field and consequently no standardised tests or protocols have been developed to assess tone production and perception in any Bantu language speakers. This study focuses on Tswana, a South African Bantu language, and provides a starting point for research in the field of tone variation and how it is impacted by a voice disorder.

Aims: The purpose of this study was to develop and validate an experimental Tswana wordlist (containing minimal pair words which differ only according to tone pattern) for the assessment of tone production and tone perception. This study furthermore intended to determine whether the presence of a voice disorder in an L1 Tswana speaker influences the accuracy of tone perception by typical, normal hearing L1 Tswana-speaking individuals.

Method: The present study took place in two stages. In the first stage, a desk study was conducted where Tswana words were extracted from dictionaries. A picture and a sentence were also selected for each word in order to illustrate the meaning of the selected words. A series of three pilot studies, comprising questionnaires, were then conducted on this initial word list of 45 minimal pairs in order to determine whether the selected stimuli were familiar and appropriate. Twenty-one participants, who were representative of typical Tswana speakers, responded. Based on the results of these pilot studies, 29 pairs of words were excluded from the initial word list,

resulting in the experimental word list of 16 minimal pairs. The second stage involved data collection using the experimental word list with a control group and an experimental group. The control group comprised 9 typical L1 Tswana-speaking individuals without any voice or communication disorder and the experimental group comprised 5 L1 Tswana-speaking individuals with voice disorders. The participants from each group were required to produce words from one of four randomised lists generated from the experimental word list. A recording was made of each participant's production of the target words. These recordings were judged by a panel of 5 typical L1 Tswana-speaking judges, according to what word they perceived. Based on the results of the control group, the experimental word list was then revised to create a final word list. A between-group comparison was carried out, using the final word list, where the results of the experimental and control groups were compared.

Results: The typical L1 Tswana speakers and listeners did not achieve 100% accuracy in the tone production and tone perception task. The experimental word list did not elicit scores of 100%, although it was expected from the control group. These scores refer to the total number of words that were correctly perceived by the judges. The mean scores achieved by control participants ranged from 68% to 89%, while the control group as a whole obtained a mean score of 81%. Some words were found to have been consistently identified incorrectly by the judges, suggesting that they may have been unfamiliar to the participants or the judges. These words were therefore removed, resulting in the final 10-pair word list.

When recalculating the scores based on the final word list, the overall performance of the control group improved. The mean scores achieved by control participants ranged from 71% to 98%, while the control group as a whole attained a mean score of 88%. Four out of the nine control group participants achieved scores of 100% from at least one of the judges. It was observed, however, that three of the control group participants appeared to be 'outliers' with slightly lower mean scores than the rest of the group. It is possible that specific listener- and speaker-related issues may have affected their results.

Based on the final word list, the experimental group obtained an overall mean score of 78.6%, which is 9.4% lower than the mean score of the control group. Experimental participants P1, P2, P3, P4, and P5 obtained mean scores of 90%, 77%, 61%, 85%, and 80% respectively. Although the

results for the experimental group participants were lower compared to the results for the majority of the control group participants, some of the experimental participants obtained scores that were in keeping with those obtained by control participants. The experimental participant who obtained the lowest mean score of 61% presented with a severe primary organic voice disorder. None of the experimental participants were able to achieve individual scores of 100%. All of the words that were perceived as 'unintelligible' from the final word list were produced by the participants with a voice disorder. No statistical significance was found between the scores of the two groups, although an effect size analysis indicated that there is a 76.7% probability that a control participant would achieve a higher true score than a participant with a voice disorder.

Conclusions: The final Tswana minimal pair word list appears to be appropriate for the assessment of tone production and perception. Although not all of the typical speakers obtained full scores when using the final word list, the results indicated that the range of performance of typical speakers and listeners fell between 100% and 70%. It is possible that not all typical speakers can produce word-level tone variation in a way that makes identification possible in a single word context and therefore typical listeners may require the context of a sentence to add meaning to a word. However, lack of familiarity with certain words within the experimental and final word lists may have been a contributing factor that impacted accurate production and perception of tone. Although no significant difference was found between the results of the two groups, the results do suggest that a voice disorder could negatively impact tone variation. It is also possible that a more severe, primary organic voice disorder that affects the structure of the vocal folds will impact tone variation to a greater extent. A limitation of this study includes the small sample size, specifically regarding experimental participants. It is suggested that further research take place to continue to develop and validate this word list for various different L1 Tswana-speaking populations. It is also recommended that this study be repeated with a larger sample size of individuals who present with a voice disorder, grouping them according to the type and severity of voice disorder.

Keywords: minimal pair word; syllabic tone variation; tone; tone language; Tswana; voice disorder.

UNIVERSITY OF PRETORIA

FACULTY OF HUMANITIES

RESEARCH PROPOSAL & ETHICS COMMITTEE

DECLARATION

Full name :	Gail Lorna Jones
Student Number :	26018889
Degree/Qualification:	M. Communication Pathology (Speech-Language Pathology)
Title of dissertation:	Tone variation in Tswana-speaking individuals: The effect of voice disorders.

I declare that this dissertation is my own original work. Where secondary material is used, this has been carefully acknowledged and referenced in accordance with university requirements.

I understand what plagiarism is and am aware of university policy and implications in this regard.

_____ _____

SIGNATURE **DATE**

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

C-9: Word-specific scores indicating the number of times a word within the experimental word list was correctly perceived by all five judges

Appendix D: Apparatus for data collection

D-1: Tswana stimulus manual A

D-2: Instructions for word production task (English)

D-3: Instructions for word production task (Tswana)

D-4: Practise stimuli for word production task

Appendix E: Apparatus for data analysis

E-1: Listener score sheets (List A, List B, List C, List D)

E-2: Instructions for listening task (English)

E-3: Instructions for listening task (Tswana)

Appendix F: Data processing

F-1: Score sheet templates for marking (List A, List B, List C, List D)

F-2: Intra-rater reliability scores obtained by the judges for each control and experimental participant

F-3: Raw data for listening task conducted with control group participants, using experimental word list

F-4: Raw data for listening task conducted with control group participants, using final word list

F-5: Raw data for listening task conducted with experimental group participants, using final word list

Appendix G: Final Tswana Minimal Word Pair list

G-1: Final Tswana minimal pair word list for the assessment of tone production and tone perception

LIST OF TERMINOLOGY

Several key terms are used throughout this dissertation and require a detailed statement of meaning to facilitate interpretation within the content of this text. These terms need clarification because the scope of this dissertation is relevant to the fields of both speech-language pathology and linguistics. Some terms may be interpreted differently within a specific discipline and the expanded definitions aim to provide the context within which each term should be interpreted for the document in hand. There are also two descriptive definitions for muscles of the larynx, which are included as additional clarification for readers of non-medical disciplines.

The terms appear in alphabetical order.

List of terms

Cricothyroid muscle
Extrinsic muscles
Fundamental frequency of voice
Intonation
Intrinsic muscles
Lexical/syllabic/word-level tone variation
Minimal pair
Phonation
Prosodic features of speech
Speech intelligibility
Thyroarytenoid muscle
Tone language
Voice disorder
Voice intensity
Voice pitch
Voice quality

Definitions

Cricothyroid muscle: This is the largest of the intrinsic laryngeal muscles and is innervated by the superior laryngeal nerve (Sataloff, Heman-Ackah, Hawlshaw, 2007). This muscle is involved in regulating longitudinal tension by means of stretching and tensing the vocal folds, resulting in a sharpening of the edge of the vocal folds and a rise in voice pitch (Ferrand, 2012; Sataloff et al., 2007). Therefore it plays a prominent role in controlling the pitch of the voice. The broad, fan-shaped cricothyroid muscle attaches to the cricoid cartilage on the inferior aspect and to the thyroid cartilage on the superior aspect (Stemple, Glaze, & Klaben, 2010). As this muscle

contracts, it causes the thyroid cartilage to tilt downward towards the cricoid cartilage thereby increasing the distance between the thyroid and arytenoid cartilages, which subsequently stretches the vocal folds (Ferrand, 2012).

Extrinsic muscles: These muscles attach the larynx to various structures within the head and neck area (Ludlow, 2005). Their function is to adjust the overall vertical position of the larynx within the neck and to provide stability to the larynx so that the intrinsic laryngeal muscles may exert their forces (Jürgens, 2002). The extrinsic muscles of the larynx can be divided into two broad groups, namely the supra-hyoid muscles, above the hyoid bone, and the infra-hyoid muscles, below the hyoid bone (Sataloff et al., 2007). The supra-hyoid muscles serve to raise the level of the larynx in the neck by pulling the hyoid bone upward, while the infra-hyoid muscles pull the hyoid bone downward to lower the larynx. The infra-hyoid muscles include the thyrohyoid, sternothyroid, sternohyoid and the omohyoid. The supra-hyoid muscles include the stylohyoid, mylohyoid, anterior and posterior bellies of digastric, and the geniohyoid muscles (Sataloff et al., 2007).

Fundamental frequency of voice: The human voice is a complex tone which is made up of many frequencies. The fundamental frequency of voice (F0) refers to the lowest frequency, which determines the listener's perception of the speaker's voice pitch (Raphael, Borden & Harris, 2011). The fundamental frequency refers specifically to the rate of vibration or the number of vibratory cycles per second of the vocal folds during phonation. The fundamental frequency is measured in Hertz (Raphael et al., 2011).

Intonation refers to the use of fundamental frequency variation as a means of conveying information at levels higher than words alone, that is, at a phrase- or utterance-level, or even within discourse as a whole (Raphael et al., 2011; Vaissière, 2006; Wells, 2006). The intonation patterns of speech are mostly determined by pitch variations (Cruttenden, 1997; Ferrand, 2012). Intonation is important at a supra-segmental level of speech to contrast utterances, for example to distinguish questions, which typically have a rising pitch contour, from statements, which have a falling pitch contour (Behrman, 2013).

Intrinsic muscles: The intrinsic laryngeal muscles work synergistically to regulate all aspects of laryngeal function in a highly complex and coordinated manner (Ferrand, 2012). Their primary role includes adduction, abduction and tension of the vocal folds (Sataloff et al., 2007). There are five intrinsic muscles, all confined to the larynx and attached to various cartilages within the larynx (Ludlow, 2005). These muscles work together to alter the cartilage framework of the larynx, thereby adjusting the length, tension, and position of the vocal folds (Stemple, et al., 2010). The intrinsic muscles include the cricothyroid, thyroarytenoid, lateral cricoarytenoid, interarytenoid and posterior cricoarytenoid muscles (Colton, Casper, & Leonard, 2011).

Lexical/syllabic/word-level tone variation: This refers to "contrastive variations in pitch, present at the syllable or word level, which are involved in distinguishing the lexical meaning of words" (Gandour, 1998, p118). Since tone languages differ with regard to the amount and pattern of lexical tones, there are different patterns of tone variation across languages (Moen, 2007). Many Asian tone languages have a large repertoire of tone inventories, such as Mandarin Chinese which has four lexical tones including high, low, rising, and falling (Moen, 2007). Tswana, a South African Bantu language, is a two-level tone language with pitch contours that have only high and low distinctions (Zerbian & Barnard, 2008).

Minimal pair (as it relates to language): A minimal pair refers to a pair of words that have different meanings but have exactly the same phonemes in the same order except for a single difference in sounds (Yavaş, 2011). With reference to a tone language, a minimal pair refers to a pair of phonologically identical words that differ only with regard to tone pattern. It is the syllabic or word-level tone variation which changes the meaning of each word within the pair.

Phonation is the physiological act of producing voice. For phonation to take place there needs to be an exhaled air stream from the lungs that drives the vocal folds into vibration. The exhaled air stream is converted into sound (voice) by means of vocal fold oscillation (Aronson & Bless, 2009).

Prosodic features of speech: This refers to certain suprasegmental features or characteristics of speech, which derive from variations in stress, intonation, and speech rate (Fletcher, 2013; Raphael et al., 2011). Prosody, therefore, concerns the *manner* of speech, which provides the

acoustic realisations of certain communicative functions, such as differentiating questions from statements or conveying attitudes and emotions (Peppé, 2009).

Speech intelligibility refers to how accurately a speaker's intended message, which is transmitted acoustically, can be received and recovered by the listener (Kent & Kim, 2011). The clarity of the speech utterance that is produced by the speaker will determine to a large extent whether the listener perceives the message correctly. Intelligibility, or how understandable an individual's speech is to another person, is an indicator of oral communication competence. There are various components to speech that, if negatively affected, can impact intelligibility, including articulation, vocal quality, resonance, loudness, and prosody (Hodge & Whitehill, 2013).

Thyroartytenoid muscle: This muscle is innervated by the recurrent laryngeal nerve and forms the body of the vocal folds (Stemple, et al., 2010). It is involved in rapid shortening of the vocal folds and in making fine adjustments in tension along the edge of the vocal folds (Ferrand, 2012). The thyroartytenoid muscle is therefore involved in pitch variation of the voice. It consists of two sections, namely the *medial thyrovocalis* muscle fibres, which extend from the vocal processes of the arytenoid cartilage to the thyroid cartilage, and the *lateral thyromuscularis* fibres, which extend from muscular processes of the arytenoid cartilage to the thyroid cartilage (Ferrand, 2012).

Tone language: A tone language is a language in which tone serves a lexical and/or grammatical function (Clements & Railland, 2008). The term *tone* refers to the distinctive pitch level of a syllable (Crystal, 2008). Tone languages make use of pitch contours as a minimally contrastive feature to distinguish between the meanings of words (Berhman, 2013). Tone languages therefore rely on tone variation at syllable level to change the core meaning of a particular word (Nguyen, et al., 2009; Van der Pas et al., 2000; Yip, 2002). In non-tone languages, pitch is used at a phrase or sentence level to signal intonation changes (Moen, 2007).

Voice disorder: This refers to an "abnormal voice that tends to call attention to itself, does not meet the social or occupational needs of an individual, or is not appropriate for an individual's gender, age or particular situation" (Aronson & Bless, 2009, p3). A voice disorder is the result of a flaw in the structure and/or function of the vocal tract during the processes of respiration,

phonation, or resonance (Boone & McFarlane, 2000). Generally a voice disorder is characterised by abnormal pitch, quality, or loudness or a combination of these three parameters (Aronson & Bless, 2009). An individual with a voice disorder may also lack the appropriate flexibility to be able to vary the pitch, loudness, or quality of the voice during contextual speech to convey more subtle or emotional aspects (Aronson & Bless, 2009).

Voice intensity is the acoustic correlate to the perceived loudness of the voice. It refers to the power of a sound pressure wave, which is determined by its amplitude (Berhman, 2013). The greater the amplitude of a sound wave, the more power it will have and therefore the louder that sound will be perceived. Intensity is measured in decibels, with a symbol dB (Raphael, et al., 2011).

Voice pitch refers to the subjective perception of the fundamental frequency of voice. The more stretched and tense the vocal folds, the more rapidly they vibrate. A faster vibration creates a higher frequency and therefore the perception of a higher pitch. The inverse of this also applies: the slower the vibration of the vocal folds, the lower the perceived pitch (Ferrand, 2012).

Voice quality is a perceptual and subjective attribute which describes the sound of the voice over and above its pitch and loudness (Berhman, 2013). It refers to the perceived 'timbre' of a voice and is often incorrectly treated as analogous to pitch and loudness (Kreiman, Vanlancker-Sidtis & Gerratt, 2005). It is in fact a multi-dimensional feature that does not possess a unique acoustic determinant (Kreiman et al., 2005). Voice quality is traditionally defined as "that attribute of auditory sensation in terms of which a listener can judge that two sounds similarly presented and having the same loudness and pitch, are dissimilar" (ANSI, 1960, p. 45). Voice quality is therefore what makes two voices of the same pitch and loudness different from one another. The mode of vibration of the vocal folds contributes to voice quality (Berhman, 2013). Several descriptors may be used to describe voice quality, such as hoarse, breathy, rough, or strained, amongst others (Timmermans, De Bodt, Wuyts, Boudewijns, Clement, & Peeters, 2002).

CHAPTER 1: LITERATURE REVIEW, PROBLEM STATEMENT, AND RATIONALE

1. Introduction

The human voice serves a variety of functions, including vegetative use to signal biological states such as pain or to convey emotions by laughing or crying. Most prominently however, voice is used for linguistic purposes during phonation to convey a message (Boone & McFarlane, 2000). Voice therefore plays a primary role in communication. There are, however, many physical, emotional and/or environmental conditions which will result in a voice disorder.

A voice disorder is present when the pitch, quality, or loudness of the voice differs from that found in individuals with a similar age, gender, and cultural background (Stemple, et al., 2010). These atypical attributes, can affect not only an individual's communication abilities but also their psychological and emotional wellbeing (Krischke, Weigelt, Hoppe, Köllner, Klotz, & Eysholdt, 2004). Regardless of a person's profession, age or gender, a voice disorder can affect quality of life and the extent of this often depends on both the severity of the voice disorder and the individual's specific voicing needs (Murry, Medrado, Hogikyan, & Aviv, 2003). It is assumed then that an individual whose job is highly reliant on frequent voice use, will experience a greater effect on quality of life than someone who does not rely largely on their voice for work purposes.

Voice disorders are generally quite common across various groups of individuals although it has been found that they occur more frequently in certain occupational groups, such as within the teaching profession (Villanueva-Reyes, 2009). Although no published data exists regarding the prevalence of voice disorders in South Africa, a study in the United States found that as many as 28 000 000 workers experience some form of voice problems (Villanueva-Reyes, 2009). There is also a high prevalence of voice disorders among the elderly population (aged 65 years and older) due to age-related structural changes within the larynx (Gregory, Chandran, Lurie, & Sataloff, 2011).

The prevalence of voice disorders and its effect on quality of life is well established, but more recent research has also provided evidence that voice disorders may have an effect on speech

intelligibility (Nguyen, Kenny, Tran, & Livesey, 2009). In most languages a voice disorder will not necessarily impact intelligibility of the message directly. In languages such as tone languages, however, some aspects of voice, for example voice pitch, are used phonologically to differentiate meaning. In tone languages, a voice disorder may impact the ability of an individual to manipulate tone and therefore to convey an intelligible message. In South Africa, and various other African countries, Bantu languages are predominantly spoken (Statistics South Africa, 2012). The Southern African Bantu languages are tone languages (Cole, 1992; Cole & Moncho-Warren, 2011) which rely on skilful manipulation of the vocal folds to correctly produce syllable-level tone variation. A voice disorder may therefore have a negative impact on the ability to use syllabic tone variation for lexical changes at word level.

Bantu languages are unique in that they share various linguistic features, which are not present in Germanic languages such as English or Afrikaans (Van der Merwe & Le Roux, 2014). These *idiosyncratic characteristics* within the Bantu languages suggest the presence of Bantu language-specific symptoms that occur in the presence of speech, language and hearing disorders (Van der Merwe & Le Roux, 2014). A speech and/or voice disorder may, therefore, present with different symptoms in Bantu-speaking individuals than in individuals who speak Germanic languages. Lexical tone variation forms one of these idiosyncratic characteristics which, if absent or distorted, may affect speech intelligibility. The present study focuses on the demands of word-level syllabic tone variation on the movement of the vocal folds and the possible impact of a voice disorder on vocal fold movement.

This chapter highlights the role of tone variation in Tswana, a South African Bantu language, and examines how tone manipulation distinguishes meaning between phonologically similar words. The physiological basis of tone variation, as well as the underlying mechanisms that contribute to tone variation, are discussed. Various types of voice disorders are also described in terms of their effect on the structure and function of the larynx.

2. Syllabic tone variation in Bantu languages in South Africa

South Africa has 11 official languages, nine of which are Bantu languages (Statistics South Africa, 2012; Van der Pas, Wissing, & Zonneveld, 2000). Bantu languages form a major part of the Niger-

Congo family of languages spoken across central and southern Africa. Bantu languages may be typologically characterised by the fact that they share certain linguistic and phonological characteristics, in terms of their syllable structure, morphology, syntax, and tone structure (Nurse & Philippson, 2003). The Bantu languages in South Africa, which are spoken by 78% of South Africa's population (Statistics South Africa, 2012), can be divided into four language groups, namely Nguni, Sotho, Tsonga, and Venda (Herbert & Bailey, 2002; Zeller, 2004; Zerbian & Barnard, 2008). The Sotho group can further be subdivided into Northern Sotho, Southern Sotho and Tswana (Cole, 1992; Van der Merwe & Le Roux, 2014). The present study will focus on Tswana, which is widely spoken across Botswana, Namibia, and South Africa. There are more than four million Tswana speakers across these countries (Coetzee & Pretorius, 2010). In South Africa specifically, 8.2% of the population are first language Tswana-speaking (Statistics South Africa, 2012) and this language group predominantly resides in the North-West Province of South Africa (Van der Merwe & Le Roux, 2014; Van der Pas et al., 2000).

2.1. Role of tone variation in Bantu languages

Approximately two thirds of all languages worldwide are tone languages (Haviland, Prins, McBride, & Walrath, 2014) and approximately 80% of African languages, are tone languages (Clements & Railland, 2008). Bantu languages are classified as tone languages which use word-level variations in fundamental frequency (pitch) to convey lexical meaning (Cole, 1992). The term *tone* refers to the distinctive pitch level of a syllable (Crystal, 2008). *Tone* languages therefore rely on tone variation at syllable level to change the core meaning of a particular word (Nguyen, et al., 2009; Van der Pas et al., 2000; Yip, 2002). In Tswana, and in other Bantu languages, tone plays a role in distinguishing meaning between two phonologically similar words in a minimal pair. For example, the Tswana word *dikhukhu* can either mean 'umbrellas' or 'dung beetles' depending on the pattern of tone variation. The tone variation pattern may consist of a specific sequence of tone heights (high or low tone). In Tswana, tone is present across all vowels and syllabic consonants. Syllables may consist of a single vowel (V), a single consonant (C) which is then called a syllabic consonant, specifically /l/, /m/, /n/ and /r/, or a combination of both C and V, that is, a CV structure (Cole, 1955; Snyman, 1989).

Tswana is a two-level tone language distinguishing only between high and low tones (Zerbian & Barnard, 2008). For a Tswana word with a CVCV syllable structure, there may be four potential patterns of tone variation, namely: high-high (HH); high-low (HL); low-low (LL); or low-high (LH). For example, the CVCV word '*kaba'* can be produced with a combination of high-low tone (kábà) which means *'plug or cork'* or a combination of low-low tone (kàbà) which means *'shoulder'.* This example illustrates how a relatively small change in tone, such as high tone instead of low tone, can change the meaning of a given word (Yip, 2002).

In the example above, it is important that a combination of laryngeal muscle contractions and relaxations across each syllable within each word are correctly sequenced to achieve the correct tone pattern. If anything interferes with this pattern of tone variation and therefore the pronunciation of the word, it might change the meaning of the word or render it meaningless, such as *kábá* (high-high), which has no meaning. A tone language speaker has to form strong associations between the pitch variations within a word and its meaning in order to understand, as well as to produce the word (Yip, 2002).

While the tonal inventory in Tswana is not as rich as in some Asiatic tone languages (which can contain up to five tones), the two tones, high or low, combine to create 'tone sequences' which signal different meanings (Brunelle, 2009). This sequence of high and low tones within a word needs to be clearly distinguished from one another to convey the appropriate meaning. Although tone within a word may be described as high, "high" is a relative term in that it does not describe an absolute value but rather high pitch in relation to surrounding pitch (Zerbian & Barnard, 2008).

It is obvious that one of the prominent features that distinguishes Bantu languages from Germanic languages is that Bantu languages are tone languages, while Germanic languages do not use syllabic tone variation to convey meaning. The term *tone* should not be confused with the term *intonation*, which is reserved for the use of pitch variation at a sentence level to indicate the intended function of an utterance, for example whether the statement was intended as a question or as a statement. The term *intonation* refers to "the distinctive use of patterns of pitch, or melody" across a sentence (Crystal, 2008). Rhythm and stress also contribute to changes in

intonation of speech (Hirst & Di Cristo, 1998). Both Bantu and Germanic languages use *intonation* across a sentence as part of supra-segmental features, but only Bantu languages make use of *syllabic tone* variation (Zerbian & Barnard 2008).

2.2. Orthographic representation of tone

Tone orthography refers to the orthographic representation of tonal distinctions using various accent markers (Stegen, 2005). African linguists have traditionally used specific accent marks above the vowel to indicate tone (Yip, 2002). That is, an acute accent for high tone (á), a grave accent for low tone (à) and an absence of any accent marker indicates mid tone (a). Although a tone language may be represented orthographically, tone languages are not written with tone marks as there is evidence that tone orthography actually hinders fluent reading and writing (Stegen, 2005).

Orthographic representation is present in some Tswana dictionaries but not in others. The way in which tone is indicated also varies amongst different dictionaries. The *Setswana-English-Setswana Dictionary* by Matumo (1993) does not employ any accent markers to differentiate tone pattern. In this dictionary phonetically identical words that have different meanings due to tone variation appear twice as separate entries, each indicating a different meaning. This is in contrast to the *Setswana and English Illustrated Dictionary* by Cole and Moncho-Warren (2011) in which tonal distinctions are made by use of the letters H (high tone) and L (low tone) after each and every word in the dictionary. For example*, mafatlha* (LLL), meaning lungs/chest, indicates that low tone falls on all three syllables within the word, while *mafatlha* (LHL), meaning twins, contains low tone on the first and last syllable and high tone on the second syllable. The *Setswana-English-Afrikaans Dictionary* by Snyman, Shole and Le Roux (1990), however, uses the acute accent marker (´) as described above, to indicate high tone, while vowels and syllabic consonants with low tone are left unmarked.

3. The physiological basis of voice pitch and tone variation

Variation in pitch and tone can be explained with reference to the physiology of the larynx in terms of vocal fold vibration and laryngeal movements.

3.1. Normal vocal fold movement and vibration

Phonation requires the coordination of expired air flowing from the lungs with vocal fold adduction (Raphael, et al, 2011). The intrinsic laryngeal muscles are responsible for adducting (closing) and abducting (opening) the vocal folds. Adducted vocal folds seal the airway, preventing any movement of air into or out of the lungs, while abducted vocal folds create an open glottis to allow inspiration and expiration to take place (Behrman, 2013). Voiceless sounds, such as /p/, /t/, and /k/, are those sounds which are produced with abducted vocal folds, which allow a free flow of air from the lungs to create noises in the oral cavity during articulation (Raphael et al., 2011). In order for a speaker to produce voiced sounds, the vocal folds need to adduct and vibrate.

In addition to the opening and closing motion of the vocal folds, there may also be a lengthening and shortening movement of the vocal folds, which creates the basis of pitch variation (Boone & McFarlane, 2000). This is described in more detail in the section regarding voice pitch variation. However, over and above the abduction/adduction and the lengthening/shortening movements of the vocal folds, there is the more complex movement of vocal fold vibration. Various theories have been proposed to explain normal vocal fold vibration, including the *Myoelastic-Aerodynamic Theory of Voice Production* (Van den Berg, 1958), the *Body-Cover Model* (Hirano, 1974), and the *Model for Vocal Fold Vibratory Motion* by Childers, Hicks, Moore and Alsaka (1986).

The *Myoelastic-Aerodynamic Theory of Voice Production* emphasises the interdependent relationship of the Bernoulli Effect and specific physical properties of the vocal folds, in particular their tension, mass, and elasticity (Berhman, 2013). This theory describes one cycle of vocal fold vibration in terms of muscle forces, elastic recoil forces, and aerodynamic forces (Ferrand, 2012). The vibratory cycle is initiated when muscle forces apply medial compression to adduct the vocal folds, while elastic recoil force is generated as the vocal folds are displaced from their adducted position (Ferrand, 2012). During phonation, there is increased sub-glottal air pressure from the lungs which overcomes the resistance of the vocal folds and displaces the adducted vocal folds, thus setting them into motion (Berhman, 2013). Once separated, the vocal folds close again

quickly due to forces of elasticity. The Bernoulli Effect or Bernoulli's Principle describes the aerodynamic principle in which negative pressure (caused by increased velocity of air travelling through the glottis) exerts a suction effect that also assists in adducting the vocal folds again for the next vibratory cycle (Ferrand, 2012).

The *Body-Cover model* (Hirano, 1974) describes vocal fold vibration based on the structure of the vocal folds. It is suggested that the vocal folds comprise two different tissue layers, namely the body layer and the cover layer, each having its own mechanical properties. Muscle fibres and collagen fibres of the vocal ligament make up the body layer. The cover layer acts as a flexible sheath, which is loosely connected to the body layer, and consists of pliable, non-contractile tissue, including epithelium and layers of the lamina propria. During vocal fold vibration, the body layer is involved primarily in lateral movement (as seen during the opening and closing motion of the vocal folds). The cover layer, however, can be seen to have both a lateral and a vertical motion. The vertical motion can be observed as a surface wave that propagates in an upward direction from the bottom of the vocal fold (Hirano, 1974).

A change in the frequency of vocal fold vibration can also be explained by the *Body-Cover model* (Hirano, 1974). The stiffness of the vocal folds is based on the contribution of the thyroarytenoid and cricothyroid muscles. It is proposed that the more lax the body layer is, the greater the amplitude displacement in the body layer and the lower the frequency of the vibrations. When there is limited contraction of the thyroarytenoid and cricothyroid muscles, both the cover and the body layer are fairly lax and this will result in phonation that is low in pitch and low in intensity (Story & Titze, 1995). Conversely, contraction of the thyroarytenoid muscle increases the body stiffness, thereby lowering the amplitude of the body layer and resulting in higher pitches (Story & Titze, 1995).

Childers et al. (1986) used an electroglottogram to study the high-speed movement of the vocal folds. Based on the findings of this study, a *Model for Vocal Fold Vibratory Motion* was proposed, in which the opening and closing movement of the folds is described as occurring in a zip-like manner. The development of this model was based on observations of a normal male voice in modal register and summarises the movement of the membranous anterior third of the vocal

folds. The zip-like movement takes place in the following manner: When the glottis is fully open, the contact area of the vocal folds starts to increase with contact initiating anteriorly and progressing posteriorly until maximum vocal fold contact has been achieved. In addition to the anterior to posterior movement, the vocal folds also approximate inferiorly to superiorly (that is, the lower/inferior margins of the vocal folds come into contact before the upper/superior margins). The lower margin leads the upper margin in both the *opening and closing* stages of vibration. When maximum vocal fold contact is achieved, the reverse action occurs in the opening stage, with the lower margins of the vocal folds beginning to separate posteriorly to anteriorly in a zip-like manner. The cycle then repeats (Childers et al., 1986).

3.2. The parameters of voice

A listener can typically perceive the following audible characteristics of the speaker's voice: the loudness of the voice, the quality of the voice, and the pitch of the voice. These are referred to as the parameters of voice. Each of these parameters is the result of changes in the vocal folds themselves, the muscles that innervate the vocal folds, and/or the air stream.

Loudness is the subjective psychological sensation or auditory perception that is associated with the acoustic dimension of vocal intensity (Adler, Hirsch, & Mordaunt, 2012). As the intensity of the voice increases it will be subjectively judged as louder by the listener (Raphael et al., 2011). An increase in loudness of the voice is brought about by a combination of rate of airflow through the vocal folds, increased sub-glottal pressure, and increased tension at the glottis (Boone & McFarlane, 2000).

Voice *quality* is a perceptual and subjective attribute which describes the sound of the voice over and above its pitch and loudness (Berhman, 2013). There are various factors that influence voice quality, but the organic condition or characteristics of the vocal folds are most prominent, as they affect the way in which the vocal folds vibrate. Any kind of organic pathology, such as irregularities along the edges of the vocal folds, serves to change the quality of the voice. For example, irritated or swollen vocal folds will result in aperiodic (irregular) vocal fold vibration and subsequent hoarse voice quality (Raphael et al., 2011). Voice quality may also be influenced by how closely the vocal folds are approximated during vibration. Reduced amounts of vocal fold

adduction will result in a more breathy voice quality, while significant amounts of vocal fold adduction may result in a more strained voice quality (Behrman, 2013).

The third parameter refers to the *pitch* of the voice. This is addressed in greater detail in the section to follow.

3.3. Voice pitch variation

Pitch, which forms the basis of tone variation, (Yu & Lam, 2014) is affected by various factors. Firstly, there are the physical attributes of the vocal folds, that is, the length, tension, and mass that are intrinsic to determining the fundamental frequency of the voice. Secondly, there are physiological changes that take place within the larynx during pitch variation that have an effect on the fundamental frequency of the voice. These changes in length, tension, and mass of the vocal folds during pitch variation are inter-related so that, a change in length, for example, will affect the mass and tension of the vocal folds. A more detailed description is provided in the following sections. Other contributing factors to vocal pitch variation include the involvement of the intrinsic and extrinsic laryngeal muscles in changing the position of the vocal folds and the position of the larynx itself. The influence of subglottal pressure during pitch variation will also be considered in the relevant section to follow.

3.3.1. Physical attributes of the vocal folds

An individual's gender and age affect the physical attributes of the vocal folds (the length and mass) which in turn determine the fundamental frequency of the voice. In general, males have slightly lower-pitched voices than females, with a typical fundamental frequency of 125Hz for men and 225Hz for women (Adler, et al., 2012; Boone & McFarlane, 2000). The difference is attributed to the fact that men have slightly longer and thicker vocal folds than women (approximately 17-20mm for men and 12-17mm for women).

A person's age also plays a role in fundamental frequency. For both young boys and girls, the fundamental frequency of the voice falls within a range of about 220-250Hz until puberty (Ferrand, 2012), thereafter it lowers gradually as the vocal folds lengthen and thicken with age. In the elderly population, females undergo a decrease in the fundamental frequency of the voice, which may be attributed to postmenopausal factors such as fluid retention in the tissues and

changes in contours of the vocal folds (Ferrand, 2012). Elderly men on the other hand experience a slight increase in the fundamental frequency of the voice with advancing age due to the effects of vocal fold atrophy, which thereby reduces the elasticity of the vocal folds (Pontes, Brasolotto, & Behlau, 2005).

3.3.2. Physiological changes that affect vocal fold length, tension and mass

The fundamental frequency (F_0) of the voice, or the perceived vocal pitch, is primarily determined by the mass, length, and tension of the vocal folds (Colton, et al., 2011). These three physical attributes interact during pitch variation to either increase or decrease the fundamental frequency.

Vocal folds that are longer and have a greater mass will produce a lower pitched voice. The fundamental frequency of the longer and thicker vocal folds will be lower, as measured in hertz (Boone & McFarlane, 2000). A change in pitch is effected by increasing the length of the vocal folds and thereby reducing their relative mass per square unit (Boone & McFarlane, 2000). This lengthening action will also increase their longitudinal tension and affect their elasticity, which limits the vibratory wave to the thinnest portion of the vocal fold. As a result the frequency of vibration of the vocal folds will increase and the voice will be perceived as being higher in pitch (Raphael et al., 2011; Stemple, et al., 2010; Yip, 2002).

Lowering of the fundamental frequency of the voice would conversely require shortening and relaxing of the vocal folds. A vocal fold that has been shortened and is therefore thicker will vibrate at a slower rate (producing a low pitch) than a longer and resultantly thinner, tense vocal fold (Behrman, 2013). This shortening and thickening of the vocal folds increases the mass of the vibrating medial edge, which in turn plays a role in reducing the fundamental frequency and perceived pitch of the voice (Behrman, 2013; Stemple, et al., 2010).

3.3.3. Contribution of the intrinsic laryngeal muscles

The intrinsic laryngeal muscles that interconnect the laryngeal cartilages, are involved in bringing about changes in the movement of the vocal folds (Colton, et al., 2011). The two intrinsic laryngeal muscles involved in pitch variation are the cricothyroid muscles and the thyroarytenoid muscles. These are sets of paired muscles.

With contraction of the *cricothyroid* muscles, the distance between the cricoid and thyroid cartilages is reduced and this results in a simultaneous lengthening of the membranous vocal folds (Colton, et al., 2011; Stemple, et al., 2010). As described above, the lengthening of the vocal folds is associated with an overall increase in vocal pitch. The cricothyroid muscles therefore play a prominent role in changing the fundamental frequency of the voice. Should the superior laryngeal nerve be damaged, the action of the cricothyroid muscles would be impaired, which would result in difficultly achieving pitch shifts during phonation (Boone & McFarlane, 2000).

The *thyroarytenoid* muscles form the actual 'body' or 'bulk' of the muscular portion of the vocal folds (Stemple, et al., 2010). The inner or medial portion of each thyroarytenoid muscle is known as the 'vocalis' and the more lateral fibres are referred to as the 'thyromuscularis' (Boone & McFarlane, 2000). The mass of the vocal folds is altered by contraction of the thyroarytenoid muscle. When there is contraction, the length of the vocal folds decreases, which thickens the vocal folds, thereby increasing the mass of the vocalis. Shorter vocal folds with an increased mass are associated with decreased fundamental frequency (Behrman, 2013; Colton, et al., 2011).

3.3.4. Contribution of the extrinsic laryngeal muscles

Although the intrinsic laryngeal muscles are primarily responsible for pitch variation of the voice, there is also some contribution from the extrinsic laryngeal muscles. Unlike the intrinsic laryngeal muscles, which are located within the larynx, these muscles extend from the laryngeal cartilages to an attachment external to the larynx. The action of the extrinsic laryngeal muscles is an additional physiological mechanism involved in pitch variation, changing the vertical positioning of the larynx by either elevating or lowering its position in the neck (Berhman, 2013; Boone & McFarlane, 2000).

Contraction of the suprahyoid muscles elevates the position of the larynx slightly, which results in rotation of the cricoid cartilage thereby increasing vocal fold tension. Increased vocal fold tension is known to increase the fundamental frequency of the voice, as described earlier. This action can be seen more prominently during the production of high pitched phonation. A critical component of the fundamental frequency control mechanism is laryngeal elevation (Boone & McFarlane, 2000).

The infrahyoid muscles (also known as strap muscles), in particular the sternohyoid muscle, contribute to lowering of the larynx which then reduces vocal fold tension and thus lowers the pitch of the voice (Honda, Hirai, Masaki, & Shimada, 1999; Raphael, et al., 2011).

3.3.5. Other factors that contribute to changes in pitch

The amount of subglottal air pressure can also influence the pitch of the voice (Boone & McFarlane, 2000; Plant & Younger, 2000). In a study by Plant and Younger (2000), it was found that at low intensities, the pitch of the voice was independent of subglottic air pressure. At higher intensities, however, both pitch and intensity increase as subglottic air pressure is raised. When speaking at much louder levels, individuals with an untrained voice, for example non-professional singers, usually experience increases in pitch as part of increased loudness (Boone & McFarlane, 2000).

4. Acoustic and perceptual correlates of voice pitch

Each parameter of voice, namely voice pitch, loudness, and quality, is linked to various acoustic attributes of the sound wave, however, and has correlated perceptual characteristics. Voice pitch is a perceptual parameter of voice which refers to the subjective and psychological auditory sensation of sound wave frequency (Raphael, et al., 2011). The subjective unit of pitch is the 'mel' (Siegel, 1965). In the 'mel-scale', 1000 mels is arbitrarily assigned to equal the pitch of a 1000Hz tone (Raphael, et al., 2011). Fundamental frequency (F_0) on the other hand is an acoustic measurement, measured in Hertz (Hz), that refers to the rate at which the vocal folds vibrate (Ferrand, 2012; Raphael et al., 2011). In other words, fundamental frequency is determined by how many vibratory opening and closing cycles the vocal folds perform in one second (Boone & McFarlane, 2000). This process occurs hundreds of times per second, depending on the individual's gender and age. A high frequency sound will be perceived to be high in pitch and a low frequency sound will be perceived to be low-pitched. This relationship between frequency and pitch is not linear, however; an increase in 10Hz, for example, is not necessarily equal to an increase of 10 mels (Raphael, et al., 2011). In the current study the focus will be on the perceptual attribute of pitch, as perceived by the listener. A variation in voice pitch is the basis of tone variation.

5. The demands of syllabic tone variation on vocal fold movement

As described earlier, tone variation requires a change in vocal pitch. This is a very precise process that requires manipulation of the laryngeal muscles in order to achieve the appropriate length and tension of the vocal folds. The vocal folds therefore act as articulators during tone variation by skilfully controlling this sequence of laryngeal muscle contraction and relaxation (Zhang, 2008).

Over and above the abduction and adduction of the vocal folds during production of voiceless and voiced sounds, tone variation during syllable production adds another level of control to the vocal folds (Van der Merwe & Le Roux, 2014). Due to the high amount of laryngeal control and precision that is needed, a voice disorder, which affects the laryngeal function, could potentially also interfere with tone variation.

6. An overview of types of voice disorders

There are various types of voice disorders and these may be classified in different ways. Authors differ slightly in their classification. For the purposes of this study, voice disorders will be classified into three general categories, namely primary organic voice disorders, hyper-functional voice disorders, and psychogenic voice disorders. These different types of voice disorders are described below and an explanation is provided regarding how these voice disorders may interfere with normal vocal fold movement.

6.1. Primary organic voice disorders

A primary organic voice disorder is one in which there is physiological or structural abnormality of the larynx itself, or where the functioning of the vocal folds is altered by a neurological condition (Aronson & Bless, 2009). Vocal fold paralysis and spasmodic dysphonia are examples of *neurological* voice disorders which interfere with vocal fold mobility and control (Ferrand, 2012). Damage to the superior laryngeal nerve, for example, may affect the longitudinal movement of the vocal fold on the affected side. Since the cricothyroid muscle is innervated by the superior laryngeal nerve, damage to this nerve will have an impact on the tensing and lengthening of the vocal fold. The vibratory motion of the vocal folds can be disturbed by asymmetrical vocal fold movement, as in the case of recurrent laryngeal nerve paralysis. The affected vocal fold can be

immobilised in either adducted, paramedian, or abducted position (Ferrand, 2012). In addition to the abnormal positioning of the vocal fold, the paralysed fold also loses muscle tone, which eventually results in bowing in the midline (Ferrand, 2012). This affects the tension of the vocal fold and therefore the pitch.

Organic voice disorders which are structural in nature include neoplasms such as papillomas and leukoplakia, among others. These pathological conditions can interfere with the normal vibratory cycle of the vocal folds and result in aperiodic or irregular vibration of the vocal folds (Colton, et al., 2011). Aperiodic vocal fold vibration is frequently characteristic of a voice disorder (Berhman, 2013).

6.2. Hyper-functional voice disorders

Hyper-functional voice disorder refers to dysphonia caused by abuse, misuse, or overuse of the voice. This kind of dysphonia may occur as a result of hyper-function in respiration or phonation, or a combination of both (Boone & McFarlane, 2000).

Hyper-function in respiration occurs due to the way that an individual coordinates their breathing pattern with their speech. For example, some individuals tend to speak on inadequate expiration. This can happen if a large amount of air is lost early on in an utterance resulting in a loss of air or shortness of breath by the end of the utterance (Boone & McFarlane, 2000). Abnormal or excessive muscle tension, especially in the shoulders and neck accessory muscles may also contribute to inefficient respiratory control and subsequent laryngeal strain (Boone & McFarlane, 2000).

Hyper-function in phonation generally occurs at the level of the vocal folds. This includes, amongst others, speaking excessively loudly, speaking for prolonged periods of time without rest, speaking with hard glottal attack, speaking in a pitch which is either too high or too low, shouting or screaming, as well as excessive throat-clearing or coughing (Stemple, et al., 2010).

Over time, the accumulative effect of detrimental vocal behaviours will eventually lead to traumatic injury and tissue changes in the vocal folds, otherwise known as secondary organic pathology. Examples of such pathology include vocal polyps, contact ulcers and vocal nodules

(Stemple et al., 2010). These are pathological conditions that may affect the vibration of the vocal folds. A growth, such as a large nodule, may reduce the total amount of contact of the vocal folds and prevent the vocal folds from closing completely along their length, which in turn may hinder glottal closure during vibration (Holmberg, Doyle, Perkell, Hammarberg, & Hillman, 2003). The mucosal wave may also be affected by such growths, with resultant irregularities in vocal fold vibration and therefore a less periodic wave (Ferrand, 2012).

6.3. Psychogenic voice disorders

The term "psychogenic voice disorder" refers to the production of an abnormal voice in the presence of normal laryngeal anatomy and physiology. Psychological conditions such as psychoneuroses or personality disorders may result in a loss of the normal volitional control over phonation (Aronson & Bless, 2009). Examples of different types of psychogenic voice disorders include puberphonia, psychogenic aphonia or dysphonia, and conversion falsetto (Aronson & Bless, 2009).

Puberphonia (also known as mutational falsetto) is a type of psychogenic voice disorder which impacts the pitch of the voice (Baker, 2002; Rubin & Greenberg, 2002). In puberphonia the larynx is held in a slightly elevated position causing the vocal folds to remain stretched and in a state of reduced mass (Baker, 2002). Stretching of the vocal folds naturally results in a reduction of the overall mass of the vocal folds, which subsequently causes the vocal folds to vibrate at a higher frequency. A higher-pitched voice also results when the vocal folds are stretched because on exhalation only the medial edges of the vocal folds vibrate (Baker, 2002).

Ventricular fold phonation (VFP) is a phenomenon that occurs when an individual uses the false (ventricular) vocal folds during phonation in substitution for true vocal fold phonation (Friedrich, Kiesler, & Gugatschka, 2010). VFP is usually ascribed to psychological causes, although it can occasionally represent a compensatory technique following loss or damage to the true vocal folds (Friedrich, et al., 2010; Stemple, et al., 2010). The voice during ventricular phonation usually presents as low-pitched, rattling, rumbling, reduced in intensity, and diplophonic (Verdolini, Rosen, & Branski, 2006). In VFP the individual does not make adequate use of true vocal fold

movement and this lack of involvement of the true vocal folds during phonation may have implications for control over tone variation.

7. A review of previous studies on tone variation in typical speakers and individuals with speech and voice disorders

Internationally, there have been a limited number of studies conducted in the field of voice disorders and tone. The research that has been conducted focused mainly on tone languages in Asia and Scandinavia. To date, there have been no local studies in Bantu languages spoken in Africa or South Africa regarding the effect of tone variation in individuals presenting with a voice disorder. This represents a conspicuous gap given the large number of tone-language speakers in South Africa. There is, however, some international research that has focused on tone variation in various other types of communication disorders.

7.1. Tone variation in individuals with a speech or language disorder

Research has been conducted on the production and perception of tones produced by adult Cantonese individuals with dysarthria associated with cerebral palsy (Ciocca, Whitehill, & Ma Ka Yin, 2004). Cantonese is a tone language spoken in China. It was noted in the study that dysarthria affected the relative fundamental frequency of phonation during production of the monosyllabic tone-contrasted stimuli, resulting in poor speech intelligibility. Dysarthria was found to have a substantial impact on the ability to correctly produce pitch-based linguistic contrasts, with resultant tone misperception. This outcome is not surprising since dysarthric speakers may not have appropriate control over the laryngeal and respiratory mechanisms necessary for the correct production of pitch-related linguistic information (Ciocca, et al., 2004).

The effect of left hemisphere (LH) and right hemisphere (RH) brain injury on the ability to accurately *perceive* and *produce* tones has been studied in speakers of Shona, a Bantu language from Zimbabwe (Kadyamusuma, De Bleser, & Mayer, 2011). The performance of these two groups (LH and RH) was investigated. A confrontational picture-naming task (to assess tone production) and a lexical tone identification task of Shona lexical tone (to assess tone perception) was used and the performance on both of these tasks was compared to that of a control group. The results of the study indicate that tone identification is impaired in both groups (LH and RH)

compared to healthy controls, although those with RH brain injury performed significantly better in the identification task than those with LH brain injury. With regard to the tone production task, both groups were equally impaired in comparison to the control group (Kadyamusuma, et al., 2011).

From these two studies (Ciocca, et al., 2004; Kadyamusuma, et al., 2011), it can be concluded that deficits in tone perception and tone production can occur in association with a motor speech disorder such as dysarthria and in patients with LH and RH brain damage.

7.2. Tone variation in individuals with a voice disorder

A study by Nguyen, et al. (2009) showed some indication of the effect of a voice disorder on tone variation. This study illustrates the effect of a hyper-functional voice disorder, namely muscle tension dysphonia (MTD), on tone production and tone perception in Vietnamese speaking teachers. The results indicate that MTD impairs lexical tone phonation by lowering the tonal fundamental frequency, in high tones specifically. Two possible explanations for impaired lexical tone phonation in individuals with MTD were proposed in a follow-up study by Nguyen and Kenny (2009).

First, it was suggested that the decrease in tonal fundamental frequency during phonation may have been due to significant changes at a histological level in the vocal fold tissue. A biomechanical or structural change to the vocal folds may affect the mucosal vibration of the vocal folds and hence the tonal fundamental frequency (Nguyen & Kenny, 2009).

Another explanation for the impaired lexical tone phonation may have been the increased tension of the laryngeal muscles, which need to perform complicated muscle adjustments during tone production. Since the laryngeal muscles are involved in controlling pitch, it is possible that there was some restriction in the ability of these muscles to vary tonal pitch and achieve high-pitch targets (Nguyen & Kenny, 2009). It was hypothesised that, “because the physiological basis for lexical tones are the laryngeal muscles, functional problems associated with MTD may affect tone production, causing tone misperception” Nguyen, et al., (2009, p. 196).

Although these two studies provided some indication that a voice disorder affects tone variation to some extent, they involved individuals with one type of voice disorder only. It is not known whether these findings can be generalised to other types of voice disorders. In addition, the stimuli for the tone perception task comprised isolated syllables rather than words which would provide more contextual information. It cannot be assumed, therefore, that tone misperception will occur in real-life speaking situations at a word or phrase level.

8. Problem statement and rationale

Fine control is required for the production of syllabic tone variation. Vocal control is likely to be affected by various voice pathologies. Studies have shown that voice pathology interferes with an individual's ability to make vocal pitch changes (Nguyen & Kenny, 2009; Nguyen, et al., 2009). It is possible that various types of voice disorders could have diverse effects on the ability to vary tone, since they affect the movement of the vocal folds in different ways. Yet, few studies have explored the effect of voice disorders on tone variation (Nguyen & Kenny, 2009; Nguyen, et al., 2009). Furthermore, there have been no studies that make use of minimal pair tonal stimuli (as opposed to syllables in isolation) that emphasise tone perception in relation to speech intelligibility.

Most Bantu languages, such as Tswana, rely on tone variation to convey meaning at a word level. A voice disorder which affects vocal control could potentially result in misperception of a word produced by a speaker with a voice disorder. The effects of a voice disorder in individuals who speak tone languages could therefore have implications for effective communication. Speech-language therapists in South Africa should be aware of this complication when treating Bantu-speaking individuals with a voice disorder.

In South Africa the majority of Bantu-speaking individuals frequent hospitals and clinics within the public health care sector rather than private health care institutions (Deumert, 2010). However, most of the health care professionals who work within the public sector, with the exception of nurses, are unable to speak the language of these African patients (Deumert, 2010). Only approximately ten per cent of speech-language therapists who are registered with the South African Speech-Language-Hearing Association are L1 Bantu language speakers (Van der Merwe &

Le Roux, 2014). English or Afrikaans speaking therapists treating individuals who speak a Bantu language might be unaware of the potential impact of the voice disorder on speech intelligibility (inability to produce appropriate syllabic tone variations).

There are currently no standardised assessment tools which can be used for the assessment of tone production and tone perception in any of the Bantu languages of South Africa. In the current study, which ultimately aimed to investigate tone production by speakers who present with a voice disorder, Tswana was targeted as it is commonly spoken in the area where the research was conducted. The first step in any endeavour to study tone production and perception in a given language would have to be the development of material that could be used in the assessment of syllabic word-level tone variation.

As in the case of the potentially diverse effects of various types of voice disorders on the ability to vary tone, there appears to be a lack of research investigating whether any particular voice disorder impacts the production of tone variation to the extent that minimal pairs (i.e. word pairs differing only with regard to tone pattern) cannot be adequately differentiated. If a set of minimal word pair stimuli were developed in the target language (in this case Tswana), it could be used to obtain baseline production data from a group of typical speakers as well as baseline tone perception data from a group of typical Tswana-speaking listeners.

It is evident that clinicians should be aware of the impact of voice disorders on tone variation in tone language speakers. There is, however, no support available for evidence-based practice since there is no published research in the field of tone variation and voice disorders in individuals whose first language is a Bantu language. This is especially important given the great proportion of tone-language speakers in the speech therapist's case load in South Africa.

9. Research questions

The present study addressed a threefold set of research questions. The progression to each subsequent question is determined by the answer elicited by the previous question.

The questions are:

1) Can a given list of minimal pairs, when produced and judged by typical L1 Tswana-speaking individuals, elicit a score of 100%?
2) Does the presence of a voice disorder in the speaker impact the perception of these minimal pairs by other individuals who use Tswana as their first language (L1), and consequently the score obtained by the speaker with a voice disorder?
3) Can any trends be identified in the scores obtained by individuals with different voice disorders, related to the nature of their voice disorder?

The answer to the first question will inform the selection of word pairs to be included in the final word list. Thereafter, this word list can be used to determine whether a voice disorder impacts the ability of a speaker to make sufficient syllabic word-level tone variations in order to differentially produce minimal pairs. This will be achieved by determining whether there is a *significant difference* between L1 Tswana-speaking judges' perception of minimal pairs produced by individuals with a voice disorder, and the production of these minimal pairs by typical L1 Tswana-speaking individuals with no voice disorder.

Finally, the data will be investigated to identify any possible trends that suggest the possibility that varying degrees and types of voice disorders may have a differential effect on tone variation.

CHAPTER 2: METHOD

1. Introduction

This chapter sets out to describe the aims of the present study as well as the research design that was used to achieve these aims. Various ethical considerations will be addressed regarding the inclusion of participants, followed by a description of how the participants were sampled and selected. The methodology for developing the Tswana Stimuli that was used for data capturing will then be described. Finally, the data capturing procedures and data analysis are also explained.

2. Research aims

2.1. Main aim

The purpose of this study was to develop an *experimental* Tswana wordlist (containing minimal pairs which only differ according to tone pattern) for the assessment of tone production and tone perception, and to initiate the process of validation of this word list. This study furthermore intended to determine whether the presence of a voice disorder in the speaker influences the accuracy of tone perception by typical, normal hearing L1 Tswana-speaking individuals.

2.2. Sub-aims

Sub-aim 1

1) To determine whether the minimal pairs within an *experimental* wordlist will elicit a score of 100% when produced and judged by typical L1 Tswana-speaking individuals.
2) To determine the frequency at which each word within the sets of minimal pairs is correctly perceived by calculating and comparing the number of times typical L1 Tswana-speaking judges can correctly perceive the words within the sets of minimal pairs when produced by typical L1 Tswana-speaking individuals.

Sub-aim 2

1) To determine whether the presence of a voice disorder in the speaker influences the accuracy of perception of minimal pairs as judged by L1 Tswana-speaking individuals, by determining if

there is a statistically significant difference between the scores obtained by individuals with a voice disorder and the scores of typical L1 Tswana-speaking individuals.

2) To identify any trends in the scores obtained by individuals with different voice disorders and to investigate/determine the relationship of specific trends to specific voice disorders.

3. Research design

Prior to commencing the data collection procedures, it was necessary to compile stimuli that could be used to elicit a response from the participants for the purposes of investigating tone variation. First, a desk study was conducted, where the Tswana stimuli were extracted from dictionaries and a list of words was compiled. Later, a series of three pilot studies were conducted to compile an *experimental* word list, which was then tested in the present study. A pilot study is a preliminary, small-scale study that can be used as a means of testing the main study's data collection instruments, sample, and method of analysis prior to carrying out the primary investigation (Offredy & Vickers, 2010). The pilot studies therefore played a role in finalising the initial word list, which constituted the data collection instrument. The pilot study consisted of a series of questionnaires which were used to determine the appropriateness of the material before using it to collect data from the participants. The results of the pilot studies allowed the researcher to narrow down the initial word list into *an experimental* word list which could be used for the purpose of data collection.

During the data collection procedures, two groups of participants were used. The *experimental group* comprised L1 Tswana-speaking individuals with a voice disorder, while the *control group* comprised typical L1 Tswana-speaking individuals without a voice disorder or any other communication disorder. A between-group, quasi-experimental design was used, where an experimental group was compared to a control group. The control group allowed for a between-group comparison, where the scores of the experimental and the control group were compared to determine if there was a significant difference in their scores. A significant difference implies that a voice disorder impacts the ability to vary word-level tone. Quasi-experimental research refers to the *non-random* assignment of participants into groups (Mitchell & Jolley, 2010). The

participants in the present study were assigned specifically to either the control group or to the experimental group on the grounds of the presence or absence of a voice disorder.

The control group served two purposes. First, it was used to validate and revise an *experimental* word list. Second, it was used to determine the overall score of typical L1 Tswana-speaking individuals, which could be used as a baseline with which to compare the experimental groups' scores. Both groups were requested to produce a set of 32 Tswana words and their production of each word was recorded and evaluated by five L1 Tswana-speaking *judges*. At no point was the main aim of the study disclosed to the *experimental* or *control* group participants, as this might have prevented the participants from producing the words naturally.

The *judges* received a list of minimal pairs and they were required to indicate which word within the pair they perceived by selecting the relevant word. These options were provided to them on a score sheet which indicated the two possible meanings of each word. Their score sheet also provided them with an option to indicate that the word was unintelligible (that is, it was not perceived to be either one of the two options). This third option was necessary in case the voice disorder affected tone variation so severely that it rendered the word unintelligible. To prevent the *judges* from becoming familiar with or anticipating which word within a pair would be produced; the stimuli were randomly assigned to four different word lists. Each list comprised 32 words. Each of the words was one of a minimal pair which contained exactly the same phonemes but which differed with regard to tone pattern. At the bottom of the list, there were an additional five words which were randomly selected and repeated from the words in the main list. These were not new productions from the participants, but rather a re-play of five of the words that the listener had already scored, which allowed for an intra-judge comparison for the purposes of establishing the reliability of the results.

A quantitative analysis of the data was performed where the total number of correct identifications by judges was counted to provide a percentage score for each participant. Quantitative research utilises quantitative properties to determine the relationship or effect of particular variables (Edmonds & Kennedy, 2013). It represents a measurement of the quantity or amount of a particular variable (Kothari, 2004). In the present study, the independent variables

include the different voice disorders of the participants and the dependent variable is tone variation.

A quasi-experimental *ex post facto design* was used in this study, where the researcher investigated the extent to which specific independent variables affected the dependent variable of interest (Leedy & Ormrod, 2010). Therefore, the researcher identified conditions that were already present (a voice disorder) and then collected data to determine whether a relationship existed between those specific factors and subsequent characteristics or behaviours (Leedy & Ormrod, 2010).

4. Ethical considerations

The following ethical issues were taken into consideration in this study:

4.1. Informed consent

The study took place at the speech therapy and audiology departments of various public-sector hospitals around the Gauteng area. Ethical clearance was obtained from the Faculty Research Ethics Committee of the University of Pretoria before obtaining permission from any other relevant authorities (Appendix A-1). Ethical clearance was then obtained from the Gauteng Department of Health (Appendix A-2), which meant that it was not necessary to obtain permission directly from the Chief Executive Officers of each institution.

It was necessary, however, to obtain permission from each Speech Therapy and Audiology Department where participants were sourced. A letter was sent to the Head of each department requesting permission to conduct research (Appendix A-3) and a signed consent form was received before the study commenced (Appendix A-4).

Over and above the aforementioned ethical clearance procedures, some institutions also requested that permission be obtained from the Hospital's ethics committee before commencing with data collection. This was done as and when requested (Appendix A-5).

Finally, consent was obtained from the participants in the study. Refer to Appendix A-6 for letter of consent for the experimental and control participants and Appendix A-7 for the judges' letter of consent. Precaution was taken for those participants who did not understand or speak English

well, as this would have affected their ability to make an informed decision regarding their participation in the study. Since all the participants who were included in this study have Tswana as a first language, the letter of consent was translated into Tswana (Refer to Appendix A-8 for the two letters of consent which have been translated into Tswana). Each participant was required to sign an informed consent form (Appendix A-9). Informed consent ensures that participants have an understanding of the nature of the research project as well as an understanding of the nature of their participation in it (Leedy & Ormrod, 2010). This implies that their participation in the study was voluntary and that they could either choose to participate or to decline participation at any point throughout the study.

4.2. Confidentiality

Throughout this study, patient confidentiality was maintained, which aimed to protect the privacy of all participants. Maintaining confidentiality throughout the research process implies that all participants in the study have a right to expect that researchers will not divulge their personal information when publishing the results of the study (ASHA, 2013).

The researcher strove to maintain confidentiality by complying with the following procedures, as per ASHA (2013) guidelines:

- Written consent from participants was obtained prior to dissemination of research findings.
- The names of participants and the name of the institutions were kept confidential in the documentation of the research results.
- Access to research data and results was limited to researchers only.
- All personal identifying information was removed, disguised or coded.

4.3. Beneficence

According to ASHA (2005) in a document entitled ‘Protection of Human Subjects’, beneficence involves ensuring the well-being of all participants by protecting them from any form of harm, whether physical or emotional, or discrimination.

Participants participated in data collection procedures on a purely voluntary basis and were not requested to perform any procedures that they felt unable to perform or which made them feel

uncomfortable for whatever reason. Participants were allowed a rest period between data collection procedures, should they feel tired, and if the participant's voice became too fatigued to continue an option was provided to continue the procedure at a later time. Furthermore, participants were given an opportunity to ask questions at any point throughout the study to ensure they did not experience anxiousness or concern. Finally, participants were given the opportunity to withdraw from the study at any point if they no longer wished to participate and they were not pressurised to continue. They did not experience any negative outcomes due to their withdrawal from the study.

To prevent any feelings of stigmatisation or discrimination, the choice of words and pictures used in the stimuli for data collection procedures were carefully considered to ensure that they were socially and culturally acceptable. No words or images were included that may have caused offense to the participants.

4.4. Integrity

Integrity involves honesty throughout the entire research process. Hatcher and Aragon (2000) expand on this definition of integrity by stating that in the publication of research, professionals should not publish false data, fabricate research findings or previously published literature, nor commit plagiarism. Integrity of this study was maintained by ensuring adherence to non-plagiarism throughout the study and by providing full acknowledgement of another person's work or ideas. This honesty was also maintained within the collation of all research findings, which implies that no results were falsified or fabricated to change the outcomes of the research in any way whatsoever.

5. Participants

5.1. Inclusion and exclusion criteria

Specific criteria were set in order for participants to be considered an appropriate candidate for the study. Detailed below are the inclusion and exclusion criteria for the study:

5.1.1. Inclusion criteria for experimental and control group participants:

- Tswana had to be the first acquired language and home language of all of the participants. The reason for including first-language speakers as opposed to second- or third-language speakers was to ensure that the participants were completely familiar with the tone pattern of all the words included in the stimuli. Should a participant not be completely familiar with the tone pattern of a word, it may have caused them to produce a word with incorrect tone, thereby affecting the validity of the results.
- All participants had to live in an urban area at the time of the study to ensure that they had all been exposed to local urban dialects.
- All participants had to present with normal hearing as per a screening audiogram (thresholds not exceeding 25dB at 500Hz, 1000Hz and 2000Hz). It is possible that a speaker who presents with a hearing loss may be unable to get the appropriate auditory feedback that is needed to monitor their tone variation. This was therefore considered to be a potential variable that may have affected tone variation.
- The experimental group participants all had to be diagnosed with a voice disorder, which was classified as either primary organic, psychogenic, or hyper-functional in nature. The type of voice disorders that were included in the study were those on the current case load of patients who were attending voice therapy at the time of data collection. The diagnosis of a voice disorder was made by both a qualified speech-language therapist and an Ear, Nose and Throat (ENT) specialist.
- The experimental group participants were required to have a voice disorder of *moderate* severity. This was judged by means of the *GRBASI Scale* (Hirano, 1981). It was necessary to control this variable as differing severities of voice disorders could possibly affect tone variation in different ways. The GRBASI scale was judged by the primary researcher as well as by another clinician experienced in working with individuals with voice disorders.

5.1.2. Inclusion criteria for judges:

- Tswana had to be the first acquired language and home language of all of the *judges*, who evaluated the responses.

- The *judges* had to have a minimum educational level of Grade 10 in high school. This ensured that they had achieved an appropriate level of literacy to be able to read the options on the score sheets.
- The *judges* had to present with normal hearing as per a screening audiogram (thresholds not exceeding 25dB at 500Hz, 1000Hz and 2000Hz).

5.1.3. Exclusion criteria for experimental and control group participants:

- Experimental group participants could not present with a voice disorder that was characterised by aphonia. Aphonia is present when the listener perceives a lack or absence of voice (vocal fold vibration) (Leydon, Bielamowicz, & Stager, 2005). The presence of aphonia would have prevented the participant from being able to produce the required stimuli.
- Participants in the *experimental* or *control group* could not present with any form of language disorder which may have prevented them from correctly understanding or producing the stimuli presented.
- Participants could not present with a speech disorder of any kind, such as an articulation or fluency disorder or a structural malformation such as cleft lip and/or palate, which may compromise their speech intelligibility.
- Age limits of participants in the *experimental* and *control group*:
    - The participants could not be *younger than 18 years* of age, which ruled out the potential interference of pitch breaks associated with male puberty. A study by Juul, Magnusdottir, Scheike, Prytz and Skakkebæk (2007) indicates that the median age at voice break in Danish Boys is 14.0 years with a standard deviation ranging from 13.9 - 14.6 years. It would therefore be necessary to exclude participants younger than 18 years to prevent the influence of sudden changes in fundamental frequency of the voice, which might have interfered with the ability to produce appropriate pitch variations.
    - The participants could not be *older than 65 years* of age, which ensured that age-related changes to the larynx did not affect the ability to control vocal pitch variations (Ahmad, Yan, & Bless, 2012).

5.2. Sampling methods

5.2.1. Control group participants and judges

A method of purposive sampling was used in the selection of control group participants and judges. A purposive sample is one which contains "people from a pre-specified group who are purposely sought out and sampled" (Procter, Allan, & Lacey, 2010, p. 149). Similarly, in this study, nurses who worked in a hospital based in the Johannesburg area were specifically sampled and requested to participate in the study. In addition, individuals who worked for a tutoring company by providing services for Tswana tutoring were also sought. By sampling nurses and tutors in particular, the researcher ensured that the individuals identified were likely to meet the inclusion criteria of having a minimum qualification of Grade 10 and being within the appropriate age group. Data collection sheets were used to record their medical and biographical information (refer to Appendix B-1).

A hearing screening was then conducted on all of the participants to ensure that they complied with the inclusion criteria. An otoscopic examination was performed as well as pure tone testing at 500Hz, 1000Hz and 2000Hz. Due to the fact that the participants were seen at various different sites, the models of audiometer differed, namely *Orbiter 922 Clinical Audiometer - Version 2; GSI 68 Diagnostic Audiometer;* and *Clinical Audiometer AC40 with Telephonic TDH/39P* headphones. All the audiometers were however used for clinical purposes and calibrated regularly. Results were recorded on the screening audiogram of the data collection sheet (refer to Appendix B-1). Any potential participants who obtained pure tone thresholds higher than 25 dB at these three frequencies were excluded from the study.

5.2.2. Experimental group participants

The experimental group participants included in this study were selected from adult patients attending an out-patient clinic in the Speech Therapy and Audiology Departments of various public-sector hospitals around Gauteng. The sampling procedures for the experimental group participants also took place by means of purposive sampling, where those sampled fell within a pre-specified group, that is, L1 Tswana speakers presenting with a voice disorder who attended a voice clinic at the time of the research. The inclusion and exclusion criteria were considered

during the selection of these individuals to ensure that they were appropriate candidates for the study. These participants were also required to sign a consent form and undergo a hearing screening prior to participating in the study, to ensure that they met all of the inclusion and exclusion criteria. Only those participants who complied with the inclusion and exclusion criteria participated in the word production task.

Once the participants had been selected, data collection sheets were used to record their medical and biographical information (refer to Appendix B-2). This information was obtained by means of a brief interview with the participant or through review of the participant's hospital file. All identifying information was coded numerically on the data collection sheet to ensure confidentiality.

In order to rate the severity of the voice disorder and to ensure that the participants complied with the inclusion criterion of having a *moderate* voice disorder, a perceptual rating scale was performed by the primary researcher. The *GRBASI rating scale* (Hirano, 1981) was used to assess the severity of the voice disorder by listening to the participants' voice during speech production. This rating scale rates various parameters of the voice, namely: overall grade of hoarseness (G); roughness (R); breathiness (B); asthenia (A); strain (S); and instability (I), according to a four-point scale where 0 = absent, 1 = mild, 2= moderate, 3 = severe. To ensure that scores obtained from the GRBASI scale were reliable, another judge, who was experienced in working with voice disorders, was later requested to independently rate each of the five experimental participant's voice using the same scale. This analysis was done in one sitting (not over several days), where the judge listened to a recording of all five experimental participants' production of the minimal pair stimuli. A final score for each participant was obtained by determining a 'consensus' score. Therefore, if each judge selected a different score, a consensus was reached by means of discussion between the two judges. The overall 'grade of hoarseness' (G), was used as a means of classifying the severity of the voice disorder, as this has been found to be the most reliable in eliciting inter-rater agreement, compared to the other five parameters (De Bodt, Wuyts, Van de Heyning, & Croux, 1997).

Throughout the interview process, each participant's speech and language was screened informally by the primary researcher. During conversation with the prospective participant, any speech distortions, dysfluencies, or language disorders were noted. Should the participant have been unable to follow instructions and converse appropriately with clear and intelligible speech during the interview and hearing screening process, he/she was excluded from the study.

5.3. Description of participants

5.3.1. Control group

Ten L1 Tswana-speaking individuals who did not have a voice, speech or hearing disorder were initially selected as participants in the *control group*. All of the control group participants complied with the inclusion and exclusion criteria, however one participant had to be excluded from the study. This participant was excluded after data capturing and data analysis had taken place due to this participant's results being unreliable. The scores obtained were not in keeping with the average scores of the other control group participants. In fact, this participant obtained scores that were far lower than those of the experimental participants. The reason for this is unclear, but a possible explanation might be that this participant may not have been completely truthful about whether her first language was indeed Tswana. The nine remaining control participants are described in Table 1. Five of these participants were nurses and 4 participants were tutors.

5.3.2. Experimental group

Five L1 Tswana-speaking individuals, who presented with a voice disorder, were selected as participants for the study and formed the *experimental group*. These participants are described in Table 2. The data are based on the information captured on the data collection sheets. Two participants did not meet the inclusion criteria regarding hearing status, but a decision was made to include them due to difficulty obtaining an appropriate number of experimental participants. Participant 1 displayed a hearing threshold of 30dB at 2000 Hz in his right ear with pure-tone screening (with all other thresholds at other frequencies being within normal limits). Participant 5

Table 1: Description of control group participants

Participants (Control)	Age (years)	Gender	Area where participant grew up	Second and third language	Frequency at which Tswana is spoken	Highest academic qualification	Reading ability in Tswana	Writing ability in Tswana
C1	46	Female	Soweto (Gauteng Province)	2nd English 3rd isiZulu	All day, every day	Diploma/degree	Good	Good
C2	41	Male	Soweto (Gauteng Province)	2nd English 3rd Southern Sotho	Half of the day	Diploma/degree	Good	Good
C3	60	Female	Soweto (Gauteng Province)	2nd English 3rd Sepedi	Most of the day	Grade 10	Good	Good
C4	57	Female	Soweto (Gauteng Province)	2nd Southern Sotho 3rd English	Half of the day	Diploma/degree	Good	Good
C5	55	Female	Zeerust (North West Province)	2nd English 3rd isiZulu	Most of the day	Diploma/degree	Good	Good
C6	21	Male	Magaliesburg (North West Province)	2nd Xhosa 3rd isiZulu	Most of the day	Matric	Good	Good
C7	18	Male	Mafikeng (North West Province)	2nd English 3rd Xhosa	Most of the day	Matric	Fair	Good
C8	21	Female	Magaliesburg (North West Province)	2nd English 3rd None	All day, every day	Matric	Fair	Fair
C9	20	Female	Mafikeng (North West Province)	2nd English 3rd None	All day, every day	Matric	Fair	Good

Table 2: Description of experimental participants

Participants (Voice)	Age (years)	Gender	Area where participant grew up	Second and third language	Frequency at which Tswana is spoken	Highest academic qualification	Reading ability in Tswana	Writing ability in Tswana	Type of voice disorder	GRBASI Score	Onset of voice disorder
P1	30	Male	Pretoria (Gauteng Province)	2nd Sepedi 3rd English	All day, every day	Matric	Good	Fair	Right vocal fold nodule	$G_1R_1B_0A_0S_0I_1$ (mild hoarseness)	> 2 years ago
P2	51	Male	Rustenburg (North West Province)	2nd English 3rd Afrikaans	All day, every day	Diploma/ Degree	Good	Good	Previously excised nodule with reflux and post-nasal drip	$G_2R_2B_2A_1S_1I_1$ (moderate hoarseness)	1-2 years ago
P3	63	Male	Johannesburg (Gauteng Province)	2nd Zulu 3rd Afrikaans	All day, every day	Primary School	Fair	Poor	TB Larynx	$G_3R_3B_0A_1S_1I_0$ (severe hoarseness)	> 2 years ago
P4	53	Female	Soweto (Gauteng Province)	2nd Southern Sotho 3rd English	All day, every day	Matric	Good	Good	Hoarseness post thyroid surgery	$G_2R_1B_1A_1S_2I_1$ (moderate hoarseness)	1-2 years ago
P5	60	Male	Soweto (Gauteng Province)	2nd English 3rd None	All day, every day	Grade 10	Fair	Fair	Right vocal fold paresis	$G_2R_2B_1A_1S_0I_0$ (moderate hoarseness)	1-4 weeks ago

Table 3: Description of judges

Participants (Judge)	Age (years)	Gender	Area where participant grew up	Second and third language	Frequency at which Tswana is spoken	Highest academic qualification	Reading ability in Tswana	Writing ability in Tswana
J1	60	Female	Johannesburg (Gauteng province)	2nd Sepedi 3rd Zulu	Half of the day	Grade 10	Fair	Fair
J2	22	Male	Taung (North West Province)	2nd English 3rd Zulu	All day, every day	Matric	Fair	Good
J3	22	Male	Shweizer-Reneke (North West Province)	2nd English 3rd Southern Sotho	All day, every day	Matric	Fair	Good
J4	20	Male	Zeerust (North West Province)	2nd Southern Sotho 3rd None	Most of the day	Matric	Fair	Fair
J5	18	Female	Christiana (North West Province)	2nd English 3rd Afrikaans	All day, every day	Matric	Good	Good

obtained thresholds of between 35 and 45dB at 1000 Hz and 2000 Hz bilaterally, with the thresholds at 500 Hz being within normal limits. Both participants reported that they did not experience any difficulties with their hearing and it was not possible to conduct a diagnostic hearing evaluation to confirm their screening thresholds.

Part of this study's inclusion criteria for experimental participants was to control the severity of their voice disorder by using the *GRBASI scale*. Due to a limited number of available participants, it was not possible to ensure that all participants had a *moderate* severity of voice disorder. It can be seen in Table 2 that the 'overall grade of hoarseness' (G) score varies from 1-3 across participants.

The nature of each experimental participant's voice disorder is described below.

- *Participant 1* was diagnosed with a right vocal fold nodule four months prior to data collection for the present study. Although the diagnosis was recent, the participant had reportedly had difficulty with his voice for just over two years. Since the participant was a student teacher, excessive or inappropriate vocalisation may have been a contributing factor to the presence of functional voice hyperfunction, which includes hyperfunction in phonation and respiration. He reported that his voice generally worsened towards the end of each week. The participant had been receiving voice therapy for several months and had subsequently shown some improvement in his voice quality. There were no other laryngeal abnormalities. The participant had mobile vocal folds bilaterally.
- *Participant 2* was diagnosed with a right vocal fold nodule seven months before participating in the present study and had had the nodule excised one month before participating. In addition to the history of a vocal fold nodule, he had also been diagnosed by the ear-, nose-, and throat- (ENT) specialist as having a chronic post-nasal drip and gastro oesophageal reflux disease (GORD). The ENT findings at the time of his participation in the study indicated no unusual vocal fold masses, slight oedema of the posterior commissure, and mobile vocal folds bilaterally. The participant was taking the following medication that had been prescribed by the ENT specialist: Losec (for treatment of reflux), *Allergex* tablets and *Beconase Spray* (for treatment of seasonal allergic rhinitis).

- *Participant 3* had a four-year history of voice problems before being diagnosed with Tuberculosis (TB) of the larynx two years prior to participating in the present study. He received medical treatment for his condition as well as a period of voice therapy, which resulted in minimal improvement in the voice quality. He suffered chronic and persistent hoarseness due to this primary organic condition. At the time of participation in the present study, he was not receiving any medical treatment from the ENT specialist.
- *Participant 4* presented with a hoarse voice after having thyroidectomy surgery three years previously. Her ENT findings from direct laryngoscopy using a flexible endoscope indicated nothing abnormal. Her vocal folds were mobile bilaterally and were in good condition. The ENT specialist nonetheless recommended a video stroboscopic evaluation, but no equipment was available at the time for such an assessment. It is possible that this participant may have suffered paresis of the superior laryngeal nerve, which may not have been detectable by visual inspection, particularly during direct laryngoscopy. This condition could have resulted in the affected voice quality.
- *Participant 5* was diagnosed by an ENT specialist with paresis of the right recurrent laryngeal nerve, one week prior to participating in the present study. The onset of his voice disorder was 4 weeks prior to being diagnosed. The participant reported no improvement in his voice since onset of the voice disorder. Some fluctuations in voice quality were reported throughout the day.

5.3.3. Judges

Five L1 Tswana-speaking individuals were selected to act as *judges* who evaluated the participants' responses. All of the judges complied with the inclusion and exclusion criteria and are described in Table 3.

6. Stimuli

To achieve the aims of the study, it was necessary to develop stimuli consisting of a list of Tswana minimal pairs which are phonologically similar but which differ according to tone pattern. The stimuli were developed and compiled by the primary researcher. The criteria for the word pair selection as well as the processes involved in developing the stimuli are described in the following sections.

6.1. Criteria for word pair selection

The stimuli for the present study comprise word pairs that contain the same phonemes. The words were extracted from Tswana dictionaries. The word list that was developed had to meet the following criteria:

- The word list had to comprise minimal pairs which contained the same phonemes but varied only with regard to *syllabic tone* and therefore *meaning*. For example, one word from the minimal word pair may have high tone assigned to a particular syllable, while the other word from that minimal word pair may have low tone assigned to the same syllable, thus resulting in a difference in meaning for the two words. The pattern of high and low tone across word pairs could differ.
- To facilitate representation of the words in a picture format, only words that were classified as either a noun or a verb were to be included in the stimuli. This ensured that participants would have a clear understanding of the meaning of the given word.
- All words had to be familiar and commonly used amongst the urban Tswana population within Gauteng.

6.2. Development of the stimuli

There were several steps involved in developing the stimuli for the study. These steps included extracting minimal pairs from Tswana dictionaries (Cole & Moncho-Warren, 2011; Matumo, 1993), finding relevant pictures for each word, and finally, compiling sentences in Tswana which would explain the meaning of each word adequately. The inclusion of a Tswana sentence and picture, together with each word, helped the participant to understand the meaning of the given word and therefore prompted them to produce the word correctly according to its meaning. The intention was not for the participants to produce these sentences during the data collection procedures but rather to serve as an additional guide to ensure that the participant produced the correct word from the minimal word pair.

To determine if the words, pictures, and sentences were valid and reliable, and that they met the requirements of the selection criteria, a series of questionnaires were compiled. The process of developing the stimuli is outlined below in six steps.

6.2.1. Step 1: Compilation of first set of word pairs

The word list was developed and compiled by the primary researcher by extracting words from two Tswana dictionaries (Cole & Moncho-Warren, 2011; Matumo, 1993). In the early stages of development of the stimuli, a word list was drawn up containing a total of 45 minimal pairs (90 words) as per the criteria described in 6.1 (refer to Appendix C-1 for the *initial* word list).

To ensure that the words included in the word list were true minimal pairs, the specific word categories were controlled across pairs. This was achieved by ensuring that the minimal pairs consisted of words that were either both verbs or, both nouns. This ensures that the difference in meaning between the words within a pair is brought about by a change in tone and not by the fact that the words belong to a different word category. For example, the following two word pairs were included in the stimuli: *mafulo* (meaning either "foam" or "pastures") which are both nouns, and *go baka* (meaning "to bake" or "to praise") which are both verbs.

Care was taken when compiling the stimuli to also ensure that both words within a minimal pair were part of the same Tswana noun prefix class. This was necessary for the word pairs to be classified as *true* minimal pairs. Tswana has 18 noun classes, each with its own noun prefix that denotes differences such as plural versus singular form (Cole & Moncho-Warren, 2011). Class 1 for example has the prefix 'mo-' as in the word '*mo*tho' (person), while class 2 has the prefix 'ba-' as in the word '*ba*tho' (people). In this case, the prefixes 'mo-' and 'ba-' differentiate between singular and plural. Although most noun classes have prefixes with different phonemes, such as 'le-', 'se-' or 'di-', some prefix classes use the same phonemes, such as classes 1, 3, and 18, which all start with 'mo-'. Therefore, it was ensured that words within each pair which started with the prefix 'mo-', for example, included words that were both in class 1 or both in class 3.

6.2.2. Step 2: Determining familiarity of the word pairs in the target population

It was necessary to ensure that all the chosen words were considered commonly used and recognisable amongst the urban Tswana-speaking population in Gauteng. A questionnaire was developed which asked the following question: "Is this a commonly used word in your language?" (refer to Appendix C-2). The questionnaires use a three-point rating scale which

falls within a quantitative research framework. They were requested to answer according to three options: '*I agree completely*'; '*I agree somewhat*'; or '*I disagree*'. The respondents were 11 L1 Tswana-speaking nurses working in a mixed-language context in Johannesburg. The purpose of this questionnaire was to narrow down the word list to ensure familiarity and therefore validity of the stimuli.

The results of the familiarity testing (refer to Appendix C-3) were used to compile an *experimental* word list, which indicates each participant's response to the question "Is this a commonly used word in your language?" For each word a score is provided indicating what percentage of respondents stated that they either completely agreed, agreed somewhat, or disagreed. In some instances, where a participant did not provide an answer (that is, all three options were left blank), or if two options were accidentally ticked for one word, this has been marked as *'undefined'*.

From the responses of the 11 L1 Tswana-speaking respondents who filled in the questionnaire, there was not a single word pair which obtained a score of 100% agreement (that is, for *both* words within a pair). In order to obtain at least 20 words which could be used as stimuli, the following criteria was used for selection of minimal pairs:

- The words selected were those where at least 50% of the participants indicated either *'I agree completely'* or *'I agree somewhat'*. Therefore, the percentage score for '*agree completely*' plus the percentage score for *'agree somewhat*' amounted to at least 50% or more in order to be included in the final word list.
- Words which were predominantly marked as *'I disagree*' (more than 50% of the participants indicating *'I disagree'*), were completely excluded from the *experimental* word list.

Based on these criteria, 25 word pairs were excluded as they were not found to be familiar enough within the target population and would therefore have affected the validity of the results. The word pairs were narrowed down from the initial 45 minimal pairs to 20 minimal pairs (total 40 individual words), which were selected to be included in the next stage of stimuli development. The selected words are indicated with a * in the results of the familiarity testing (Appendix C-3).

6.2.3. Step 3: Selection of pictures to match each word

To differentiate between the two meanings of the words within a minimal word pair, a picture was selected to illustrate the meaning of each word. Pictures that best portrayed the given words were found by the primary researcher using the internet search engine of *Google Images*. All the pictures selected were high quality colour photographs. Forty pictures were selected to correspond with 40 target words (20 minimal pairs). These pictures can be viewed in Appendix C-4.

6.2.4. Step 4: Determining appropriateness of selected pictures

To ensure that the pictures were appropriate and that they did not cause any ambiguity, a questionnaire was developed which asked the following question for each picture: "Is this a good picture to represent the given word?" (refer to Appendix C-5). Ten L1 Tswana-speaking volunteers were requested to fill in the questionnaire. They were also randomly selected from the nursing staff who worked at one of the sites where data collection took place, but were not the same individuals who answered the previous questionnaire in Step 2. They were requested to answer the questionnaire according to three options: '*I agree completely*'; *'I agree somewhat'*; or *'I disagree'*. In a case where the respondent answered 'I disagree', they were requested to indicate why they thought that the picture was not appropriate. The use of this questionnaire enabled the researcher to determine which of the chosen pictures were appropriate and also to change some of the pictures based on feedback obtained from the respondents.

The results for the final selection of pictures are provided in Appendix C-6. Out of 40 pictures, five pictures were changed as the results from the questionnaire indicated that some pictures did not adequately represent the given word. The exact reasons given by the respondents are provided in more detail in Appendix C-6. The other 35 words were considered by all of the respondents to have appropriate pictures.

Although the objective of this particular questionnaire was to *validate the pictures* that had been selected for each word, the researcher took note of confusion amongst the respondents regarding some of the words in the list. Although the words were known by all respondents, some offered alternative variations which were more familiar to them. Given that it was not possible to remove these words from the word list altogether, it was decided

that the alternative variation of the word would also be provided, in brackets, next to the original word within the stimulus manuals to reduce any ambiguity regarding its meaning. For example, it was recommended by four participants that the word 'go sêlwa' should be written as 'go sêla'. Changing this word to 'go sêla' would result in the loss of a minimal word pair and it therefore *remained* 'go sêlwa' in the stimulus list, followed by (sêla). This was the case with a total of 6 words (out of 40) in the list.

Finally, a further 7 words (out of 40 words) scored poorly in the questionnaire (that is, they were marked as either *'I agree somewhat'* or '*I disagree'*). The main reason for this appeared to be that many respondents were unfamiliar with the given word and in some instances offered completely different words to match the particular picture provided. These 7 words were considered to be too unreliable to keep in the word list and were therefore removed. Six of the 7 words conveniently formed part of a low-scoring word pair (i.e. both words within the pair scored poorly) and therefore these 3 word pairs were removed. The 7th word had to be removed with its pair, bringing the total number of words removed to 8 so that the word list contained 32 words (16 minimal pairs). The words which were removed from the list are marked with a * in Appendix C-6. Refer to the *experimental* word list of 16 minimal pairs which is provided in Table 4.

These words were randomised by dividing the minimal pairs into four separate lists (Lists A, B, C, & D) so that the experimental group and control group participants did not read the words in the same order. Each word list was represented in four stimulus manuals, which are described in section 6.3. The randomised word lists can be viewed in the four Listener Score Sheets (refer to Appendix E-1).

6.2.5. Step 5: Compilation of Tswana sentences used to describe the words

Finally, Tswana sentences were compiled that would further illustrate the meaning of the given words. The sentences appeared on the bottom of each page of the stimulus manual together with the target word and picture. The sentences aided the participants in understanding the meaning of each word. The sentences were initially written up in English by the primary researcher in a manner which used the words in the context of its definition.

Table 4: Experimental Tswana minimal word pair list (16 pairs)

	Tswana word	Definition
1.	thàká	friend, peer
2.	thàkà	pupil of the eye
3.	go sèlwà	to pick up, find
4.	go sélwà	to oversleep, wake late
5.	pàpá	father
6.	pápà	porridge
7.	màbòkó	brains
8.	màbòkò	praise poems
9.	màfátlhà	twins
10.	màfàtlhà	lungs, chest
11.	màfùlò	pastures
12.	màfúlò	foam, froth
13.	mòkòtlà	spine, back
14.	mòkótlá	bag, sack
15.	mòlàlà	neck of mammal
16.	mòlálá	leftover food
17.	go bákà	to bake bread
18.	go bàkà	to praise in song or word
19.	go dùmà	to roar, eg. lion
20.	go dúmà	to spray with insecticide
21.	lèìsò	large spoon or ladle
22.	lèísò	fireplace, cooking place
23.	go bálélá	to choke
24.	go bàlèlà	to count for
25.	dìnòkò	joints in a cane/reed
26.	dìnòkó	porcupines
27.	thápò	stone or pip of a fruit
28.	thàpò	string, rope
29.	mòsídì	soot; burnt out coal
30.	mòsìdì	person who grinds
31.	go fìtlhà	to arrive
32.	go fítlhà	to hide

The translation of these sentences took place in the following manner:

- A professional Tswana translator translated these sentences into Tswana.
- A L1 Tswana-speaking volunteer (a registered speech therapy assistant who worked in a Department of Speech Therapy and Audiology at a public hospital) suggested changes to shorten some of the translated sentences to make them simpler and more concise, for ease of understanding by participants who may have lower levels of literacy.

6.2.6. Step 6: Determining appropriateness of the Tswana sentences

The accuracy of the translation of the Tswana sentences was validated by means of a questionnaire (Appendix C-7), which was completed by five L1 Tswana-speaking respondents. These individuals comprised a different set of nurses from previous respondents, all of whom worked at a public sector hospital in urban Gauteng. The questionnaire asked the following question for each sentence: *"Is the Tswana translation of this sentence correct?"* The participants were requested to answer by indicating *'I agree'* or *'I disagree'*. In any instances where they disagreed, the respondents were requested to indicate why they disagreed or to make any necessary changes to the sentence/s.

Appendix C-8 shows a summary of the results obtained from the questionnaire, which determined the final list of sentences to be included in the stimuli. The percentage of participants who stated 'I agreed' or 'I disagreed', are indicated in the table of Appendix C-8. The outcome of the questionnaire yielded fairly consistent results, with 26 out of the 32 sentences achieving 100% agreement from all respondents that the translations of the sentences were correct. The remaining sentences achieved 80% agreement and one sentence achieved 60% agreement, with only slight adjustments to the sentences required.

After changes had been made, the sentences were checked for grammatical accuracy and edited by a L1 Tswana-speaking academic working at the Department of African Languages at the University of South Africa.

6.3. Apparatus for data collection

The following apparatus and equipment was used for the word production task and to make a digital audio recording of the participants' responses to the stimuli:

- Stimulus manuals A, B, C, and D were compiled for the word production task. Refer to Appendix D-1 for an example of stimulus manual A. Each stimulus manual contains the same 32 Tswana words, pictures and sentences but in each manual the words appear in a different order. The words were randomised to prevent the judges from becoming familiar with the order in which words appear.
- A *Logitech* USB headset with microphone was used to make an audio recording of the participants' production of the target words.

- A laptop (Acer Aspire E15) was used to record, store and play back the audio recordings of each participant.
- *PRAAT software* (Boersma & Weenink, 2005; Wood, 2005), which is a free scientific computer software programme, was used to record the speech productions of the participants.

6.4. Apparatus for data analysis

The following equipment was used during the word analysis task for the *judges* to score the *experimental group* participants' word productions:

- A laptop (Acer Aspire E15) was used to access the audio data collected.
- *PRAAT software* (Boersma & Weenink, 2005; Wood, 2005), which was installed on the laptop to play back the data.
- External speakers (JVC: UX-P3) were plugged into the laptop to ensure that the intensity and sound quality of the recordings were appropriate for the judges to be able to score the participants' word productions.
- Listener score sheets were used by the *judges,* on which they indicated which word they perceived to have been produced by the speaker (refer to Appendix E-1).

7. Research Procedures

7.1. Data collection procedures for experimental and control groups

Data collection commenced once ethical clearance and permission from the appropriate authorities had been obtained. The participants also had to sign a consent form before they participated in any of the assessment procedures. The letter of consent for the participant was made available for them to read in English or in Tswana, according to their preference.

Each participant was seen individually by the researcher in a quiet room away from any noise which may have interfered with the audio recording of the data. All instructions and procedures were explained to the participant prior to commencement of the data collection. These instructions were written down in a step-by-step format and were also made available in both English and Tswana (refer to Appendix D-2 for English instructions and Appendix D-3 for Tswana instructions).

The participants were then provided with a stimulus manual (either A, B, C or D) with a different Tswana word on each page and were allowed sufficient time to familiarise themselves with all of the words which they were to produce. Before commencing with the audio recording, the participants were given an opportunity to practise with two words, which were not included in the stimulus manual (refer to Appendix D-4 for practise stimuli). The participant was prompted to say the word in such a way that it conveyed the intended meaning according to the picture and Tswana sentence.

The researcher prompted the participants to say each of the target words by using the prompt "please say the next word". Pacing the participants in this manner, allowed them to be ready to produce each word and also allowed the judges at least 5 seconds between each word production to focus on the word to follow whilst doing the listening task. Once the participants were confident that they understood the instructions and procedures, the microphone was switched on and they were requested to produce each of the 32 words upon hearing the prompt. Data collection and recording took place in this manner for both the *control* group participants and the *experimental* group participants.

For the purpose of determining intra-rater reliability, 5 random words out of the 32 words that were produced by each participant, were replayed to the judges during the listening task, bringing the total number of words to be scored to 37. This is explained further in section 7.5.2.

7.2. Data analysis

After completion of the data collection with *experimental* and *control group* participants, the *judges* were required to listen to each participant's audio recording and to score their word productions. The *judges* sat in a quiet room away from any environmental noise for the entire judging procedure. They were each given a page of written instructions in either English or Tswana, according to their preference (refer to Appendix E-2 for instructions in English and Appendix E-3 for instructions in Tswana). The primary researcher went through the instructions step-by-step with the *judges*. The *judges* were shown one of the stimulus manuals and were given sufficient time to familiarise themselves with the stimuli.

The *judges* were each given a listener score sheet (either list A, B, C, or D) which correlated with the specific stimulus manual (A, B, C, or D) that that particular participant had used

during their word production task (refer to Appendix E-1 for the listener score sheets). The *judges* were requested to listen to the audio recording played to them and identify each participant's production by marking one of three options on a score sheet. The first two columns on the score sheet included the two possible meanings for the given word that was produced. The *judges* had to tick the correct box depending on what they perceived. If however the *judges* did not perceive either one of the two definitions provided on the score sheet, they had the option to tick the third column on the score sheet. The third column indicates that the word perceived was unintelligible or not clearly recognised as one of the two options provided. This third column was included in case the experimental participants' voice disorder so severely affected tone variation that the word was rendered meaningless when not produced in the context of a sentence.

Before commencing with the scoring procedures, the *judges* were given an opportunity to ask any questions they might have had. The audio recordings were played back through speakers attached to the laptop. The *judges* only had one opportunity to listen to the stimuli and were not allowed to discuss the stimuli with each other. They were, however, given ample time between words to make their decision before the next word was played. The *judges* were blind to the nature of the disorder of the experimental group and were also unaware of the fact that there were control participants involved. Furthermore, the audio recordings of both the control and experimental participants were randomised when played back to the judges. These measures attempted to reduce listener anticipation and bias whilst judging. The *judges* were given adequate time to rest in between judging each participant's recording.

7.3. Data processing

Data processing involved manually capturing the data from the score sheets and data collection sheets onto electronic spreadsheets for analysis. The statistical processes which involved analysing the results as well as determining intra-rater and inter-rater reliability are described below.

7.3.1. Data capturing

Once the productions had been evaluated by the five *judges*, the total number of utterances judged to be "correct" was determined for each control and experimental group participant,

to provide a score out of thirty-two. Therefore, there were five scores for each participant, as judged by each judge. Variable-numbers (V-numbers) were added onto the data collection sheets, as well as the listener score sheets which assisted in capturing and analysing the data electronically. The marking was facilitated by using a score sheet template (refer to Appendix F-1), which correlated with each of the four word lists. Each *experimental* and *control group* participant obtained a score from each *judge*. These scores were then used to calculate an mean percentage score for each control and experimental group participant. It was expected that participants in the control group would obtain a score of 100% or near to 100% as they did not have a communication disorder that would interfere with their ability to vary the tone of their voice. Furthermore it was also assumed that the lower the percentage score, the greater the effect of the voice disorder on the participant's ability to make tone variations.

7.3.2. Statistical analysis

All data was entered into a statistical software package, *Stata Version 12* (StataCorp, 2011), to analyse the data for statistical significance. The aim was to determine whether there was a statistically significant difference between the performance of the control group and the performance of the experimental group. The scores of the experimental group and the control group respectively were summarised by determining the *mean* and the *standard deviation* for each group. It was expected that the control group would obtain scores of 100% or close to 100% and very little variation in scores between control group participants was anticipated. The mean score for the control group would be used as a baseline for comparison to the experimental group.

When analysing the results, it was noted that the data for both the control and experimental groups did not show normal distribution, that is, the arrangement of the data set did not contain values which cluster mostly in the middle of the range, with the rest tapering off symmetrically toward either extreme (as depicted in a typical 'bell curve'). Therefore, a Wilcoxon Rank test (also known as Mann-Whitney *U* test) was used, which tests whether two independent sample groups of non-normally distributed data show a difference that is statistically significant (Vassarstats, 2012). This is also known as non-parametric testing. The basic procedures followed in the Wilcoxon Rank test were to first group the scores of each participant from both the control and experimental groups

together. The scores used in the calculation of the Wilcoxon Rank test include the mean number of words correctly perceived by all 5 judges for each participant. These scores can be viewed in Table 9 (for control group) and Table 11 (for experimental group). Each score was then ranked in order of lowest to highest and assigned a rank number. Their rank indicated their position in relation to the rest of the participants. The ranks were then separated into control and experimental group and were summed to get an overall score for each group. It should be noted that the ranks, and not the participant scores, were summed in this calculation. Should the sum of ranks be approximately the same for control group participants and experimental group participants, then the two groups would be considered to be similar with no statistical significant difference between the two groups.

In addition to testing for a statistically significant difference between the control group scores and the experimental group scores, the *effect size difference* was also determined, based on the scores obtained from the *final* minimal word pair list. The effect size measures the magnitude of the difference between the control and the experimental groups' results (Tavakoli, 2012). As the data was not normally distributed, the effect size was calculated by determining the *probability* of a randomly drawn control group participant scoring higher than a randomly drawn experimental group participant, rather than by using the standard Cohen's d statistic. The probability is expressed as a percentage, and is determined by comparing the frequency of scores obtained by control group participants to the total number of scores, as produced by participants in both groups.

7.4. Validity of results

Validity refers to the extent to which the methods and procedures of a study measure the variables that they claim to measure (Gravetter & Forzano, 2012). The variable which is being measured in this study is specifically the production of tone variation by individuals with a voice disorder. This is based on subjective evaluation by *judges*. Several measures were taken to ensure that validity was maintained in the measurement and analysis of data:

- Care was taken during the development of the Tswana stimuli as this related directly to obtaining valid results.
- During the data collection procedures, the participants were not only prompted by the Tswana word in isolation, but in addition, each stimulus was very clearly explained by

using three measures to convey the intended meaning of the word. With each word, there was a picture illustrating the word, a Tswana sentence using the word contextually, and an English definition. For example, one page in the stimulus manual contains the Tswana word "*mafulô".* Underneath this word are the English definition *"foam"* and the Tswana sentence "*Bana ba rata go tshameka mo bateng e etletseng mafulô".* This prevented any ambiguity concerning the meaning of the words and the possibility of the participant producing the incorrect word.

- Only L1 Tswana *speakers* and *judges* were used in the study. This ensured that the responses were evaluated accurately.
- At no point throughout data collection was the main aim of the study disclosed to any of the participants. For the experimental and control group participants, it ensured that all of the words were produced naturally without any attempt at changing the tone of their voices. For the judges, it ensured that they listened to the stimuli without any bias.

7.5. Reliability of results

Reliability is concerned with the methods used in order to obtain consistent results (Gravetter & Forzano, 2012). Reliable results are achieved when the test instrument obtains repeatable values (Maxwelle & Satake, 2006).

7.5.1. Measures that ensure reliability

- Five *judges* were used, instead of just one, which allowed the researcher to compare the scores given by each *judge* and average out individual differences.
- The use of four randomised word lists (stimulus manuals A, B, C & D) prevented the *judges* from knowing beforehand which word a participant intended to say. The *judge* was therefore 'blinded' which prevented any biased decisions.
- Inclusion of a *control group* allowed a comparison to be made between the performances of the experimental group participants and a group of speakers without a voice disorder. A control group also allowed the researcher to determine whether typical speakers use the appropriate tone pattern.
- The use of the prompt "please say the next word…" between each production of the Tswana words during data collection helped to obtain reliable results. This phase prepares the participant when to produce each word and also prepares the listener to anticipate the next word to be judged.

- To determine reliability of the results, five of the words in the list were replayed randomly to the *judges*. The judges were unaware of the fact that some of the responses were presented a second time. The *judges* had to evaluate those selected words twice. The two scores for each word were kept separate. A point-to-point intra-rater comparison was carried out to determine reliability. Refer to section 7.5.2 for a detailed analysis of intra-rater reliability.

7.5.2. Intra-rater reliability

In order to evaluate the reliability of the judges' assessments, five of the words in the list were repeated randomly when the recordings were played back to the *judges*. These five words were not new or different word productions by the participants but rather the same words replayed, thus requiring the *judge* to score the same word twice. This brought the total number of words judged for each control group and experimental group participant to 37 words (total of 32 words + 5 repeated words), which therefore yielded two sets of scores for five of the words. It should be noted that only one word out of a pair was repeated, not both words in the pair. The second set of scores was kept separate, for the purpose of determining the reliability of the results. Consistency in the judges' scoring was determined by noting whether these five words received the same score that was previously given by each judge. For a response to be deemed reliable, a word that was judged as being incorrect, for example, should then also have been scored as incorrect on the second playback.

In order to calculate the intra-judge reliability scores, the scores of each control group participant's five repeated words were compared to the scores of their initial judgement. If the judge had demonstrated consistency for the given word (that is, the first and the second judgement were the same), a score of 1 was recorded (indicating a reliable judgement). A score of 0 would indicate an unreliable judgement. A judge could obtain a maximum score of 5 for each participant, indicating that they perceived all 5 repeated words in the same way that it was perceived initially. Each of the five judges was assessed this way for all nine control group participants. Therefore a judge would obtain an overall score out of 45 for reliability (5 repeated words x 9 control group participants). For experimental participants, they could obtain a highest score of 25 (5 repeated words x 5 experimental participants).

The specific intra-rater reliability scores that each judge obtained for each control and experimental participant can be viewed in Appendix F-2.

Table 5 displays the overall intra-rater reliability scores for each judge, for all nine control group participants (Column A) and for all five experimental participants (Column B). A score of 45 in Column A and 25 in Column B would indicate that a judge was perfectly consistent in their scoring of all participants, while a lower score would indicate decreasing levels of intra-rater reliability. The percentage of words that were perceived with consistency is also provided.

Table 5: The total number and the percentage of repeated words that judges perceived with consistency, indicating the reliability in their judgements of each control and experimental group participant

	Column A **Number of repeated words perceived with consistency, as produced by the *control group*** **N = 45**	**Column B** **Number of repeated words perceived with consistency, as produced by the *experimental group*** **N = 25**
Judge 1	43 (95%)	23 (92%)
Judge 2	39 (86%)	21 (84%)
Judge 3	41 (91%)	21 (84%)
Judge 4	32 (71%)	16 (64%)
Judge 5	42 (93%)	23 (92%)

According to Table 5, Judge 4 was the least consistent of the five judges, with only 32 out of 45 (71%) words being scored consistently for the control participants. Consistency was even lower (64%) for the experimental participants. Furthermore, judge 4 had the lowest correlations with the other judges (refer to Table 6). The other four judges obtained consistency in their judgements for at least 39 out of the 45 repeated words (86%). Judge 1 was the most reliable and was consistent 95% of the time for the control group and 92% of the time for the experimental group.

7.5.3. Inter-rater reliability

Inter-rater reliability was calculated in order to determine whether there was good agreement between the 5 judges. Two different measures were used to determine inter-

rater reliability, namely the *Kappa Statistic* and the *Spearman's Rank Correlation Co-efficient.* These statistical procedures both measure inter-rater reliability.

First, a *Kappa Statistic* was calculated, which aimed to provide a quantitative measure of the magnitude of agreement between the judges. Due to the fact that the reliability of the results depended on the agreement between various judges, it was necessary to include a statistic that takes into account that some of the judges' responses or scoring may agree or disagree simply by chance (Viera & Garret, 2005). A kappa of 1 would indicate that there was perfectly precise and accurate agreement between the 5 judges, while a kappa of close to 0 would indicate agreement equivalent to chance. Inter-rater agreement can be classified according to the Landis-Koch Kappa's Benchmark Scale (Landis & Koch, 1977, p. 165). This scale ranks the Kappa scores into the following categories: poor (κ=<0.0); slight (κ=0.0-.20); fair (κ=0.21-0.40); moderate (κ=0.41-0.60); substantial (κ=0.61-0.80); almost perfect (κ=0.81-1.00). A kappa of 0.44 was obtained for the assessment of the control group and 0.41 was obtained for the experimental group. These values indicate a *moderate* level of agreement between the 5 judges.

A second measure was performed to determine inter-rater reliability. A *Spearman's Rank Correlation Coefficient* was calculated, which gives an indication of the linear relationship between two variables (Vassarstat, 2012). The correlation coefficients (r) can fall anywhere between -1 (strong negative linear relationship, that is, as X increases, Y tends to decrease) and +1 (strong positive linear relationship, that is, as X increases, Y also increases). A value near zero means that there is a random, non-linear relationship between the two variables. The correlation coefficients were determined by calculating the number of times a judge correctly perceived each of the 20 words in the *final* minimal word pair list for each of the control and experimental group participants. The number of correct responses for each judge was compared to the number of correct responses for the other 4 judges, to determine whether a correlation existed between their responses for all words. Table 6 shows each judge's correlation coefficients in comparison to the other 4 judges. The statistical significance is also provided (p).

The correlation coefficients obtained, as per Table 6, show that there was a strong positive linear relationship, and a highly significant correlation between the judges in most of their

assessments for words correctly perceived in listening to the control and experimental group participants. This is evident in the fact that most values are generally closer to 1.0 than to zero. It can be concluded that there is generally good agreement between the 5 judges. However, correlations between Judges 1 and 2 were not significant for the control

Table 6: Correlation coefficients (r) and statistical significance (p) between the judges' scores of words correctly perceived using the *final* word list, for both control and experimental participants

Control Group	**Judge 1 r(*p*)**	**Judge 2 r(*p*)**	**Judge 3 r(*p*)**	**Judge 4 r(*p*)**	**Judge 5 r(*p*)**
Judge 1	1.00				
Judge 2	0.57 (0.093)	1.00			
Judge 3	0.68 (0.010)	0.75 (0.001)	1.00		
Judge 4	0.79 (<0.001)	0.61 (0.045)	0.70 (0.007)	1.00	
Judge 5	0.71 (0.005)	0.65 (0.018)	0.87 (<0.001)	0.89 (<0.001)	1.00
Experimental Group					
Judge 1	1.00				
Judge 2	0.61 (0.042)	1.00			
Judge 3	0.68 (0.009)	0.77 (<0.001)	1.00		
Judge 4	0.46 (0.438)	0.67 (0.011)	0.67 (0.002)	1.00	
Judge 5	0.78 (<0.001)	0.43 (0.567)	0.72 (0.004)	0.63 (0.031)	1.00

group (p=0.093), and between Judges 1 and 4 (p=0.438) and Judges 2 and 5 (p=0.567) for the experimental participants. All other correlations were statistically significant ($p < 0.05$).

Given the results of both the *Kappa Statistic* and the *Spearman's Rank Correlation Coefficient* it can be concluded that some judges were more reliable than other judges in their judging performance and the results of these two statistical procedures were similar.

CHAPTER 3: RESULTS AND DISCUSSION OF RESULTS

1. Introduction

The following chapter presents a description of the results of this research study, according to each sub-aim. Tables and figures are provided where relevant. A discussion of all of the results is included for each section.

2. Results of the validation process (sub-aim 1)

The first objective (sub-aim 1) was to validate an *experimental* Tswana minimal word pair list, by determining whether it would elicit a score of 100% when produced and judged by typical L1 Tswana-speaking individuals without any communication disorders. It was necessary to validate the word list on typical L1 Tswana-speaking individuals before it could be used to assess tone production by individuals with a voice disorder.

2.1. Description of results for the validation of an experimental and a final word list

The results of sub-aim 1 are described in two parts. Firstly, scores for the control group participants are provided based on the *experimental* word list which was developed during the series of pilot studies that were conducted (see 2.1.1). Based on the results described in 2.1.1, a number of words had to be omitted from the list. This resulted in a *final* word list. In the second part of the description, the results with regard to the words that were taken up in the *final* word list are described (see 2.1.2).

2.1.1. Results for the experimental word list

The *experimental* Tswana minimal pair word list contained sixteen pairs of words (total 32 words). Each of the five judges therefore listened to thirty-two words as produced by nine control participants. The number of words that were correctly perceived by the judges for each control participant was counted and will hereafter be referred to as a 'score' out of thirty-two. The results obtained from the *experimental* Tswana Minimal pair word list are presented in Table 7. Indicated in the first eleven columns of Table 7 are the judges' scores and their percentage scores, which are provided for the nine control participants. The maximum score that could be achieved was 32 (100%), which would indicate that a judge correctly perceived all 32 of the words that were produced by a control participant.

Table 7: The performance of the judges and control participants based on the *experimental* word list, which is indicated by the number and percentage of words correctly perceived by the judges, the standard deviation across the scores of 5 judges, as well as the mean scores and mean percentages of the control participants

Control Participant	Performance of the Judges											Performance of the control participants		
	Judge 1		Judge 2		Judge 3		Judge 4		Judge 5		**Standard Deviation (SD) across 5 judges**	**Mean no. of words correctly perceived by all 5 judges**	**Mean percentage of words correctly perceived by all 5 judges (%)**	**Min; Max score (N=32)**
	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%				
C1	28	88	24	75	29	*91	26	81	27	84	1.92	26.8	84	24; 29
C2	26	81	25	78	26	81	28	88	25	78	1.22	26.0	81	25; 28
C3	28	88	26	81	26	81	25	78	25	78	1.22	26.0	81	25; 28
C4	28	88	28	*88	28	*91	30	*94	25	78	1.79	27.8	87	25; 30
C5	29	*91	28	*88	29	*91	26	81	30	*94	1.52	28.4	89	26; 30
C6	26	81	24	75	26	81	28	88	25	78	1.48	25.8	81	24; 28
C7	22	*69	24	75	25	78	21	*66	20	*63	2.07	22.4	70	20; 25
C8	22	*69	22	*69	23	*72	21	*66	21	66	0.84	21.8	68	21; 23
C9	28	88	27	84	28	*91	28	88	27	84	0.55	27.3	85	27; 28
Mean Score	**26.3**	**83**	**25.3**	**79**	**26.6**	**84**	**25.8**	**81**	**25.0**	**78**	**1.40**	**25.84**	**81**	**21; 30**

*The lowest and highest scores obtained by each judge, across control participants

The standard deviation (SD) across all five judges is also provided for each control participant. This indicates the amount of variability that exists across the five judges' scores. In other words, the greater the standard deviation, the greater the difference between the lowest and highest score obtained across judges.

The performance of each of the control participants is also determined, by averaging the five judges' scores for each participant. This is indicated in Table 7 as the 'mean number of words correctly perceived by all five judges'. This score is also expressed as a percentage, and is indicated in Table 7 as the 'mean percentage of words correctly perceived by all five judges'. The overall performance of each control participant can be viewed in the last column of Table 7, which provides the minimum and maximum score obtained across the five judges. The bottom row of Table 7 indicates the mean scores and the mean percentages for the control group as a whole, which is an average based on the results obtained by all nine control participants. Refer to Appendix F-3 for the raw data of the control group participants obtained during the listening task, when using the *experimental* word list.

2.1.1.1. Performance of the judges

It is possible that listener-related factors may also have had an influence on the score obtained by a control participant and could therefore reflect the performance of a particular judge. It was therefore necessary to analyse the performance of the judges to determine whether they were able to accurately perceive the target words.

The results in Table 7 reveal each judge's performance. It can be seen that none of the judges perceived 32/32 (100%) of the words from the experimental word list correctly. Judge 1 obtained scores, for words correctly perceived, ranging from 22/32 (69%) up to 29/32 (91%), with a mean score of 26.3/32 (83%). The scores for words correctly perceived by Judge 2 were similar to those of Judge 1, and ranged from 22/32 (69%) up to 28/32 (88%). The mean score for Judge 2 was 25.3/32 (79%). Judge 3 obtained a lowest score of 23/32 (72%) and a highest score of 29/32 (91%), with a mean of 26.6/32 (84%). The scores for Judge 4 ranged from a lowest score of 21/32 (66%) up to a highest score of 30/32 (94%). The mean score for Judge 4 was 25.8/32 (81%). Finally, Judge 5 obtained scores ranging from 20/32 (63%) up to a highest score of 30/32 (94%), and a mean of 25/32 (78%).

Based on these results, Judge 3 may be regarded as the best performing out of all five judges, with a highest mean score of 26.6/32 (84%). The lowest score attained by Judge 3 (72%) was also higher than the lowest scores attained by the other four judges. Conversely, Judge 5 obtained the lowest mean score 25/32 (78%), and her lowest score (63%) was lower than that of the other five judges. Although the overall performance of each judge varies, the variation in scores for each individual judge is relatively small, and may be due to each judge's individual perceptual ability to perceive tone variation.

2.1.1.2. Performance of the control participants

The performance of each control participant was analysed and compared to determine whether there were any differences in their scores that might have been a result of speaker-related factors.

Their performance was determined by averaging the five judge's scores for each participant. This is indicated as the *mean* number of words correctly perceived, across five judges. According to Table 7, Control Participant 5 (C5) attained the highest mean score of 28.4/32 (89%). This is also evident from the fact that four out of the five judges obtained their highest scores from C5 (see red font in Table 7). The lowest mean score obtained was 21.8/32 (68%), by C8, followed by C7 with 22.4/32 (70%). Four out of five judges obtained their lowest scores in their judgements of C8 (see blue font in Table 7). The other control participants (C1-4, C6, C9) obtained mean scores of between 25.8/32 (81%) and 27.8 (87%). The mean score achieved by the control group as a whole was 25.84/32 (81%).

Mean scores of 100% or near to 100% from the control group participants were not obtained, as was expected of 'typical speakers'. However, when looking at some of the individual judges' scores of each control participant (as per Table 7), it can be seen that some of these scores are relatively high. Some of the higher scores ranged between 28/32 (88%) and 30/32 (94%) for seven out of nine control participants, and these higher scores also varied across judges. It is possible therefore that most of the control participants are actually 'typical speakers' with the potential to obtain scores of 100% or at least close to 100%, but their results may have been affected by the judges being less reliable listeners. Possible speaker- or listener-related issues affecting the scores are elaborated on in section 2.2 (discussion of results). A factor which had to be taken into consideration as having a

possible influence on the overall scores of the control group participants was the nature of the target words which formed part of the stimuli for the study. It was necessary to look specifically at the individual words within the *experimental* word list to determine whether certain words were consistently being perceived incorrectly by all of the judges, which may have contributed to the control group not achieving high scores.

2.1.1.3. Results for the individual words

To determine whether the target words were valid and reliable in assessing tone production and tone perception, the word-specific scores were analysed. This was done by calculating the total number of times each word within the experimental list was correctly perceived by the five judges. Each word within the list obtained a score out of 45 (nine control participants x five judges = 45). It was therefore possible to compute a percentage score based on this result. If a word was perceived correctly across all nine participants and by all five judges, it would elicit a score of 45/45 (100%). In this case, that specific word would also obtain 100% inter-rater reliability, as all the judges would be in agreement. Words that obtained lower scores were those that were incorrectly perceived more often by the judges. Refer to Appendix C-9 for the results of the individual words according to each judge.

The word-specific scores are displayed in Table 8, where the Tswana words are indicated with their correlating numbers, that is, number 1 to 32. The scores have been calculated on the basis of the results for all five judges and are represented as percentages. They have also been ranked in order of highest score to lowest score. The tone pattern of each word is provided as well as an indication of the presence/absence of inter-rater reliability. Figure 1 provides an overview of the results for each word according to each judge, which allows the amount of agreement between the judges to be easily viewed.

The results in Table 8 show that there was a fair amount of variability in the individual word scores, where some words scored well while other words scored poorly across all judges. Words 5, 6, 15, 19 and 32 obtained an overall score of 100%, with all five judges being in agreement in their scoring of these words. Therefore these five words in particular have good validity and reliability for the purpose of assessing tone production and tone perception.

Some of the other words which also scored well (obtaining mean scores of between 90% and 99%) include words 1, 8, 10, 23, 29 and 31; however, these words did not obtain 100% inter-rater reliability from all five judges. Words which obtained overall poor scores (that is, a mean score of less than 60%) include words 21, 25, 27 and 30. It should also be noted that these four words which obtained the lowest scores, all showed inter-rater disagreement and are therefore less valid and reliable words to be used for assessment of tone production and tone perception by typical urban Tswana speakers. The level of inter-rater agreement seems to be in some way related to the word-specific scores. That is, the highest scoring words all obtained 100% inter-rater agreement, while none of the lowest scoring words achieved 100% inter-rater agreement.

According to the results in Table 8, it can be seen that some words, when produced and perceived by typical L1 Tswana-speaking individuals, scored well while other words obtained lower scores. The highest score obtained was 100%, which occurred in five out of the thirty-two words from the experimental word list. These words included: pàpá (father), pápà (porridge), mòlàlà (neck of mammal), go dùmà (to roar, eg. lion), and go fítlhà (to hide). In addition to this, these five words also attained 100% inter-rater reliability from the five judges. The other twenty-seven words from the experimental word list all scored less than 100% but with varying scores. The lowest scoring word was thápò (stone or pip of fruit), with a score of 42%. The highest scoring words that did not attain 100% included mòsídì (soot; burnt out coal) and thàká (friend, peer), both with 97%.

The performance of each word within a minimal pair also differed, for all except one pair of words. For example, mòlàlà (neck of mammal) scored 100%, while mòlálá (leftover food) scored only 64%. However, the words pàpá (father) and pápà (porridge) were the only two words within a pair which both obtained the same score of 100%. The only other minimal word pair in which both words obtained a similar score consisted of the words go bákà (to bake bread) and go bàkà (praise in song or word), which obtained a score of 86% and 88% respectively. All other minimal pairs within the list contained words with very different scores. This might suggest that one word within a minimal pair is often more commonly known or used within the Tswana language.

Table 8: Results for words from the *experimental* word list, ranked according to the frequency at which they were correctly perceived by five judges, with an indication of their tone pattern and the presence of inter-rater reliability.

Number of word (according to the *experimental* word list)	Frequency at which the words were correctly perceived by 5 judges (%)	Tswana word	Tone pattern	Obtained 100% agreement between judges
Scored **100%**				
5	100	pàpá (father)	LH	X
6	100	pápà (porridge)	HL	X
15	100	mòlàlà (neck of mammal)	LLL	X
19	100	go dùmà (to roar, eg. lion)	LL	X
32	100	go fítlhà (to hide)	HL	X
Mean score between **90-99%** correct responses				
29	97	mòsídì (soot; burnt out coal)	LH	
1	97	thàká (friend, peer)	LH	
31	95	go fìtlhà (to arrive)	LL	
23	93	go bálélá (to choke)	HHH	
8	93	màbòkò (praise poems)	LLL	
10	91	màfàtlhà (lungs, chest)	LLL	
Mean score between **80-89%** correct responses				
13	88	mòkòtlà (spine, back)	LLL	
4	88	go sélwà (to oversleep, wake late)	HL	
18	88	go bàkà (to praise in song or word)	LL	X
17	86	go bákà (to bake bread)	HL	
24	86	go bàlèlà (to count for)	LLL	
26	86	dìnòkó (porcupines)	LLH	
12	84	màfúlò (foam, froth)	LHL	
3	80	go sèlwà (to pick up, find)	LL	
9	80	màfátlhà (twins)	LHL	
Mean score between **70-79%** correct responses				
22	77	lèísò (fireplace, cooking place)	LHL	
11	75	màfùlò (pastures)	LLL	
7	73	màbòkó (brains)	LLH	
20	73	go dúmà (to spray with insecticide)	HL	
Mean score between between **60-69%** correct responses				
28	68	thàpò (string, rope)	LL	
16	64	mòlálá (leftover food)	LHH	
14	64	*mòkótlá (bag, sack)	LHH	
2	60	*thàkà (pupil of the eye)	LL	
Mean score between between **40-59%** correct responses				
30	57	*mòsìdì (person who grinds)	LLL	
21	48	*lèìsò (large spoon or ladle)	LLL	
25	48	*dìnòkò (joints in cane/reed)	LLL	
27	42	*thápò (stone or pip of fruit)	HL	

***Words with the lowest score which were removed.

Figure 1: Number of correct responses for individual words produced by control group participants, as judged using the *experimental* word list

2.1.1.4. Conclusions regarding the results of the experimental word list

It is possible that the words which scored poorly may have impacted negatively on the overall results for the control group. For this reason, words which scored particularly poorly were removed from the list. These included all 4 words in the 40%-49% category as well as the two lowest-scoring words from 60%-69% category. In addition to this, it was necessary to also remove their corresponding pairs, even though they might have scored well. The six words which were identified as being the lowest scoring, are marked with a * in Table 8. Therefore, from the *experimental*, sixteen-pair word list, six pairs were removed which then left ten pairs of words (twenty words) in the *final* word list (refer to Appendix G-1 for the final Tswana minimal word pair list).

2.1.2. Results of the final word list

The *final* word list contained ten pairs of words. Each judge therefore perceived a total of twenty words. When the scores were recalculated based on the *final* word list, the scores were more in keeping with what was expected from typical L1 Tswana-speaking individuals. These scores were then used as a baseline with which to compare the results from the experimental group participants. The results based on the *final* word list can be viewed in Table 9.

2.1.2.1. Performance of the judges

The judges' performance is reflected in the first eleven columns of Table 9, which show the number of words that were correctly perceived for each control participant by each judge. The highest score that could be obtained was 20/20, indicating that a particular judge could identify all 20 of the words in the *final* word list correctly. A percentage score was also calculated. Refer to Appendix F-4 for the raw data of the control group participants obtained during the listening task, when using the *final* word list. The judges' performance, based on the *final* word list, show overall higher scores, compared to the results of the *experimental* word list.

Table 9: The performance of the judges and control participants based on the *final* word list, which is indicated by the number and percentage of words correctly perceived by the judges, the standard deviation across the scores of 5 judges, as well as the mean scores and mean percentages of the control participants

	Performance of the judges											Performance of the control participants		
Control Participant	Judge 1		Judge 2		Judge 3		Judge 4		Judge 5		Standard Deviation (SD) across 5 judges	Mean no. of words correctly perceived by all 5 judges (N=20)	Mean percentage of words correctly perceived by all 5 judges (%)	Min; Max score (N=20)
	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%				
C1	18	90	15	75	20	*100	19	95	20	*100	2.07	18.4	92	15; 20
C2	18	90	17	85	19	95	18	90	18	95	0.71	18.0	91	17; 19
C3	19	95	19	95	19	95	18	90	18	90	0.55	18.6	93	18; 19
C4	20	*100	20	*100	20	*100	20	*100	18	90	0.89	19.6	98	18; 20
C5	20	*100	18	90	19	95	18	90	20	*100	1.00	19.0	95	18; 20
C6	17	85	15	75	17	85	18	90	17	85	1.10	16.8	84	15; 18
C7	14	*70	14	*70	15	*75	14	*70	14	*70	0.45	14.2	71	14; 15
C8	14	*70	15	75	15	*75	14	*70	15	75	0.55	14.6	73	14; 15
C9	20	*100	18	90	19	95	19	95	19	95	0.71	19.0	95	18; 20
Mean score	**17.7**	**89**	**16.7**	**84**	**18.1**	**91**	**17.5**	**88**	**17.6**	**89**	**1.97**	**17.6**	**88**	**14; 20**

*The lowest and highest scores obtained by each judge, across Control Participants

When the *final* word list was used, all five judges were able to perceive 20/20 (100%) of the words correctly for at least one of the control participants. Judges 1, 2, 4, and 5 all obtained scores that ranged from 14/20 (70%) to 20/20 (100%) for words correctly perceived. Judge 3 obtained slightly higher scores that ranged from 15/20 (75%) to 20/20 (100%). The mean score for Judge 1 was 17.7/20 (89%) and she obtained a full score of 20/20 (100%) for three out of nine control participants. Judge 2 obtained the lowest mean score of 16.7/20 (84%) and only obtained a full score of 20/20 (100%) for one out of the nine control participants. Judge 3 obtained the highest mean score of 18.1/20 (84%) and obtained a full score of 20/20 (100%) for two out of the nine controls. Judge 4 and Judge 5 were similar in their performance and obtained mean scores of 17.5/20 (88%) and 17.6/20 (89%) respectively.

Overall Judge 2 appeared to be the least accurate listener. This observation is confirmed by the results in Table 6 (see section 7.5.3 from Chapter 2, which relates to inter-rater reliability), where the correlation coefficients show the lowest correlation (r = 0.57) between Judge 1 and Judge 2. Judge 3 continues to be the best performing of the judges.

2.1.2.2. Performance of the control participants

The control participants' scores are provided in Table 9 as an average of all five judges' scores and are reflected as the 'mean number of words correctly perceived by all five judges'. This mean score is also represented as a percentage. The minimum and maximum scores are provided in the last column of Table 9 for each control participant.

Overall, C4 was the best performer, achieving a mean score of 19.6/20 (98%) from the five different judges. C7 obtained the lowest mean score of 14.2/20 (71%), and was followed closely by C8 and C6, who also obtained relatively poor mean scores of 14.6/20 (73%) and 16.8/20 (84%) respectively. Higher scores ranging from 18/20 (91%) to 19/20 (95%) were attained by C1, C2, C3, C5, and C9. The mean score achieved by the control group as a whole was 88%, which is an improvement on the score of 81% obtained using the *experimental* word list.

2.1.2.3. Conclusions regarding the results for the final word list

The use of the *final* word list elicited improved scores. All of the judges were, at some point, able to attain scores of 100% when listening to the *final* word list, which did not occur when the *experimental* word list was used. This gives an indication that the words selected in the

final list are more reliable and valid to be used in the assessment of tone production and tone perception.

When analysing the results of the individual words within the *final* word list, it can be seen that even with this 'revised' list, not all the words were consistently identified correctly by all the judges. Table 10 presents the results for words based on the *final* word list. According to Table 10, the word-specific scores ranged from 100% (for words 5, 6, 15, 19, and 32) down to 64% (for word 16). The fact that some words were perceived incorrectly by the judges, may either indicate that those words were unfamiliar to the control participants and the judges, or suggest that other speaker- and listener-related factors were exerting an influence.

2.2. Discussion of the results of the validation process

The first objective (sub-aim 1) was to initiate the process of validation of an *experimental* Tswana minimal pair word list which had been developed. From the first set of results obtained, where the control group participants produced the words contained in the *experimental* word list of sixteen minimal pairs, it was noted that none of the control group participants achieved a score of 100%. The assumption was that the control group would obtain scores of 100% or at least near to 100% as they did not present with any form of voice, speech, or language disorder which would affect their ability to vary the tone of their voice. This assumption is in keeping with other research studies, such as the study by Kadyamusuma et al. (2011) where a control group obtained 99% correct responses in a lexical tone perception task.

The mean scores for the current control group participants ranged between 70% and 89% with the *experimental* word list. When some words, which were presumed to be unfamiliar, were removed from the word list, the mean scores for the control group participants increased, to a range of 71% to 98%. Furthermore, using the *final* word list, four control participants were able to achieve a score of 100%, which was not obtained when the *experimental* word list was used. The fact that four out of the nine control group participants achieved scores of 100% from at least one of the judges indicates that the ten minimal pairs which form part of the *final* word list have the potential to effectively assess tone production and tone perception.

Table 10: Results for words from the *final* word list, ranked according to the frequency at which they were correctly perceived by five judges, with an indication of their tone pattern and the presence of inter-rater reliability.

Number of word (according to the *experimental* word list)	Frequency at which the words were correctly perceived by 5 judges (%)	Tswana word	Tone pattern	Obtained 100% inter-rater reliability
Scored **100%**				
5	100	pàpá (father)	LH	X
6	100	pápà (porridge)	HL	X
15	100	mòlàlà (neck of mammal)	LLL	X
19	100	go dùmà (to roar, eg. lion)	LL	X
32	100	go fítlhà (to hide)	HL	X
Mean score between **90-99%** correct responses				
29	97	mòsídì (soot; burnt out coal)	LH	
1	97	thàká (friend, peer)	LH	
31	95	go fìtlhà (to arrive)	LL	
23	93	go bálélá (to choke)	HHH	
8	93	màbòkò (praise poems)	LLL	
10	91	màfàtlhà (lungs, chest)	LLL	
Mean score between **80-89%** correct responses				
13	88	mòkòtlà (spine, back)	LLL	
4	88	go sélwà (to oversleep, wake late)	HL	
18	88	go bàkà (to praise in song or word)	LL	X
17	86	go bákà (to bake bread)	HL	
24	86	go bàlèlà (to count for)	LLL	
26	86	dìnòkó (porcupines)	LLH	
12	84	màfúlò (foam, froth)	LHL	
3	80	go sèlwà (to pick up, find)	LL	
9	80	màfátlhà (twins)	LHL	
Mean score between **70-79%** correct responses				
22	77	lèísò (fireplace, cooking place)	LHL	
11	75	màfùlò (pastures)	LLL	
7	73	màbòkó (brains)	LLH	
20	73	go dúmà (to spray with insecticide)	HL	
Mean score between between **60-69%** correct responses				
28	68	thàpò (string, rope)	LL	
16	64	mòlálá (leftover food)	LHH	

Although the results for sub-aim 1 show that the control group did not obtain the expected scores of 100%, the overall performance of the judges and the control participants was improved when using the *final* word list compared to the *experimental* word list. Possible factors affecting the performance of the judges as well as the control participants are discussed in section 2.2.1. The influence of the specific target words on the results is considered in section 2.2.2.

2.2.1. Participant-specific factors

A possible reason for some of the control participants not obtaining full scores of 100% could be that all five judges may not have been equal in their ability to discriminate tone in their minimal pair contrasts. Based on the judges' biographical information, there was nothing remarkable, in terms of their academic qualifications, literacy levels or proficiency in Tswana, that might have given one judge an advantage over another. It is possible therefore that the difference in performance between the judges may have been due to individual perceptual abilities, where one judge may have been able to perceive tone variation with more ease than another judge. A judge's score might also have been influenced by other individual factors, such as the ability to concentrate for prolonged periods of time throughout the listening task, or by their familiarity with certain words within the word list.

Given that some of the control participants (C6, C7, and C8) did not perform as well as expected, the factors that may have influenced their scores need to be considered. One factor that could potentially influence control participants' scores might be their ability to speak clearly in order to produce the appropriate tone pattern of the target words. Since all of the participants' communication was informally screened, it was unlikely that any speech, language, or voice disorder was present., However, in spite of the fact that the participants did not present with any kind of communication disorder which might have influenced their ability to produce the target words, it is possible that even a typical speaker may simply speak less clearly than another typical speaker. Accurate syllable-level tone variation is a skill that relies on precise manipulation of the length and tension of the vocal folds, and acceptable skill levels may cover a fairly wide spectrum.

Proficiency in Tswana is also a factor that could influence a participant's ability to produce the target words adequately. All three of the more poorly performing control participants (that is, C6, C7, and C8) did report in their case history interview that they spoke Tswana for 'most of the day'. Since these participants use their first language on a daily basis it can be assumed that they are well-practised in Tswana and have a relatively good proficiency in the language. The participants' proficiency in Tswana may be impacted by strong influences from the second or third language.

Another potential influencing factor is the consideration that not all of the control speakers may have been equally familiar with all of the words. Although not all control participants had grown up in the same area, they all worked and lived in an urban area at the time of the study and would presumably all have been exposed to the same words. Furthermore, any possible uncertainty regarding the meaning of specific words was counteracted by the fact that the meaning of each word was clearly depicted by means of a picture and Tswana sentence (see the stimulus manuals). Therefore all of the control participants should have had a good understanding of the target words prior to starting data collection.

2.2.2. Word-specific factors

Although no particular trend was noticed in the scores for participants who came from different geographical regions, the particular target words that were included in the *experimental* word list did appear to have an effect on the control participants' performance. This is evident in that the control group's overall scores improved when some words were removed from the word list. According to the word-specific scores, as indicated in Table 8, some words were consistently perceived incorrectly by the judges, while other words were perceived correctly across all judges. A factor which might have affected these word-specific scores is familiarity of the target words. Each word within a minimal pair has a different tone pattern, which differentiates the meaning of each word. Should that tone pattern not be familiar or known to the speaker, it would likely affect the way that word is produced and ultimately affect its meaning. This would have a knock-on effect in terms of how it is perceived by the listener.

A possible contributing factor to the lack of familiarity of certain words for typical Tswana speakers may be the multi-lingual nature of the South African population. Urbanisation of the indigenous population in South Africa during the late 19th and 20th centuries resulted in large-scale migration of Bantu-speaking people from rural areas into the towns and cities (Christopher, 2004). Urban areas are therefore known as areas of cultural and linguistic diversity. Gauteng in particular has attracted large numbers of people from all over the country where speakers of all 11 official languages can be found, creating a fully multilingual 'mixing-pot' of languages (Christopher, 2004). This situation creates the need for a *lingua franca*, or common language. Due to the fact that English is the language of commerce and

business both nationally and internationally, it has been adopted in South Africa at all levels of education, namely primary, secondary and tertiary education (Mazrui, 2002).

English has been widely adopted as the medium of instruction in all schools with L1 Bantu-speaking pupils, starting as early as Grade 1 (Probyn, Murray, Botha, Botya, Brooks, & Westphal, 2002). English-medium education is thus not only contained to the urban areas. There is emerging evidence which suggests that for L1 Bantu-speaking pupils, who are not widely exposed to English on a daily basis at home, the early adoption of English as a medium of instruction, especially in poorly resourced schools, has negatively affected the acquisition of both English as well as their African home language (Heugh, 2007; Probyn, et al., 2002; Probyn, 2009). It is possible therefore that the influence of English has affected their familiarity with their first language, Tswana. If this is the case, a Tswana-speaking individual may have been less exposed to certain Tswana words.

In addition to the influence of English on L1 Bantu-language acquisition, as described above, a recent phenomenon that has become increasingly evident in Tswana (and other Bantu languages) is the emergence of non-standard language varieties. These mixed, colloquial, township language varieties are often learned by children before they acquire the 'standard' or pure language (Calteaux, 1992). The colloquial variations are characterised by code-switching between various language groups, including English and Afrikaans as well as the dominant local Bantu languages (Slabbert & Finlayson, 1999). For example, it was found in a research study conducted in Botshabelo, a township near Bloemfontein, that code switching between Tswana and Southern Sotho was so extensive that it was very difficult to distinguish a single target language (Slabbert & Finlayson, 1999).

"Street Setswana" has been coined as the epithet for a hybrid non-standard form of Tswana that incorporates the lexical material of English, Afrikaans, and Zulu, among others (Cook, 2009). Although "Street Setswana" differs from the standard form of Tswana in the choice of vocabulary, structurally it differs very little from the standard Tswana syntax (Cook, 2009). "Street Setswana" is the home language within the community but is not treated as a legitimate variety in schools. An example of "Street Setswana" can be seen in the use of the word *baesekele* (bicycle) instead of the word *peretshitswana*. The use of this lexical

borrowing from the English word *bicycle* is considered by most Tswana speakers as normal, whilst the pure Tswana word *peretshitswana* is considered arcane (Cook, 2009).

It was noted that the three lowest scoring participants were significantly younger than the majority of the control group participants. The age range for C6, C7 and C8 was from 18 to 21 years of age, while the other participants fell within the age range of 41 years to 56 years. C9 was an exception, being 20 years of age, and nonetheless achieving a comparatively high mean score of 95%. The combination of aforementioned influences of urbanisation, English-medium instruction in schools, and the development of so-called "Street Setswana" which is characterised by code-switching and lexical borrowing, provides plausible evidence that some of the words within the *experimental* Tswana minimal pair word list might have been unfamiliar to some of the participants. This could be the case especially for younger Tswana-speaking individuals where some of the older, more rural traditions may not be so prominent any more. The lowest-scoring words, which had to be removed from the *experimental* list, included: *mòsìdì* (person who grinds); *lèìsò* (large, traditional wooden spoon/ladle); and *dìnòkò* (joints in cane/reed). These three words are clearly words which are more commonly used in an older, traditional rural setting and may not be familiar or commonly used amongst a younger population of Tswana-speakers. It is possible that some words remaining in the *final* word list may have also been unfamiliar, although less apparently so. For example, the word *lèísò* (fireplace; cooking place), which obtained a relatively low score of 77%, could be one of the less frequently used words, as it relates to a way of cooking with fire as opposed to cooking with an electrical appliance.

The *final* word list did not elicit full scores from the control group, which appears to point to the fact that issues such as perceptual ability of the listener, clarity of speech, and frequency of use of a particular word within a given population or area, may all be contributing factors that could affect performance with this list of words. In spite of the potential influence of some of the less familiar words on the overall performance of the word list, the explicit pictures and Tswana sentences contained in the stimulus manuals aid the individual in understanding the target words and help to differentiate the word from its minimal pair.

3. Results with regard to the experimental participants (Sub-aim 2)

The second objective (sub-aim 2) was to determine whether the presence of a voice disorder in a speaker had an influence on the accuracy of perception by L1 Tswana-speaking judges of minimal word pairs produced by such a speaker. The same five judges, who were involved in the preliminary testing, listened to the minimal pair words produced by five experimental participants who presented with voice disorders.

3.1. Description of results

The results for sub-aim 2 are also described in two parts. First, the scores for the experimental group participants are provided based on the final word list in section 3.1.1. This is followed by a comparison between the scores obtained from the control and from the experimental group participants in section 3.1.2.

3.1.1. Results from the experimental group based on the final word list

Presented in Table 11 are the results obtained from the five experimental participants based on the *final* word list of ten pairs of words (total twenty words). Each of the five judges listened to twenty words as produced by five experimental participants with a voice disorder. The number of words that were correctly perceived by the judges for each experimental participant was counted and will hereafter be referred to as a 'score' out of twenty.

The performance of the judges can be viewed in the first eleven columns of Table 11, where a score with its percentage score is provided for each judge across five experimental participants. The standard deviation (SD) across all five judges is also provided for each experimental participant. This indicates the amount of variability that exists across the five judges' scores for each participant. In other words, the greater the standard deviation, the greater the difference between the lowest and highest score obtained across judges.

The performance of each of the experimental participants is determined by averaging the five judges' scores for that particular participant. This is indicated in Table 11 as the 'mean number of words correctly perceived by all five judges'. The mean percentage score for each experimental participant is also provided alongside. The last column of Table 11 provides the minimum and maximum score obtained across the five judges for each experimental participant. The bottom row of Table 11 indicates the mean scores and the mean

Table 11: The performance of the judges and experimental participants based on the *final* word list, which is indicated by the number and percentage of words correctly perceived by the judges, the standard deviation across the scores of 5 judges, as well as the mean scores and mean percentages of the experimental participants

	Performance of the judges											Performance of the experimental participants		
Experimental Participant	Judge 1		Judge 2		Judge 3		Judge 4		Judge 5		Standard Deviation (SD) across 5 judges	Mean no. of words correctly perceived by all 5 judges (N=20)	Mean percentage of words correctly perceived by all 5 judges (%)	Min; Max score (N=20)
	Score (N=20)	%	Score (N=20)	%	Score (N=20)	%	Score (N=20)	%	Score (N=20)	%				
P1	18	90	17	85	18	90	19	95	18	90	0.71	18.0	90	17; 19
P2	16	80	17	85	14	70	14	70	16	80	1.34	15.4	77	14; 17
P3	12	60	13	65	12	60	12	60	12	60	0.45	12.2	61	12; 13
P4	17	85	17	85	17	85	16	80	18	90	0.71	17.0	85	16; 19
P5	15	75	16	80	17	85	18	90	14	70	1.58	16.0	80	14; 18
Mean score:	**15.6**	**78**	**16**	**80**	**15.6**	**78**	**15.8**	**79**	**15.6**	**78**	***2.20***	***15.7***	***78.6***	***12; 19***

percentages for the experimental group as a whole, which is an average based on the results obtained by all five experimental participants. Refer to Appendix F-5 for the raw data of the experimental group participants obtained during the listening task, when using the *final* word list.

P1 presented with a vocal fold nodule resulting in a relatively mild voice disorder and had a GRBASI score of $G_1R_1B_0A_0S_0I_1$. Of the five experimental participants, P1 obtained the highest mean score of 18/20 (90%), which was calculated by averaging his scores obtained from each of the five judges. His word productions were incorrectly perceived across all judges a total of 10 times out of 100. This relatively good performance by P1 is in keeping with the severity of his voice disorder, which is relatively mild.

P2 presented with persistent dysphonia after having a vocal fold nodule removed. He presented with a moderate voice disorder with a GRBASI score of $G_2R_2B_2A_1S_1I_1$. The mean score obtained by P2 was 15.4/20 (77%). His word productions were perceived incorrectly across all the judges a total of 23 times out of 100. The fact that more words were incorrectly perceived compared to those of P1, correlates with the fact that his voice disorder was of a slightly more serious nature than that of P1.

P3 obtained the lowest scores and the lowest *mean* score of 12.2/20 (61%). He presented with TB of the larynx which resulted in a severe dysphonia, as indicated by a GRBASI score of $G_3R_3B_0A_1S_1I_0$. A total of 39 out of 100 of his word productions were incorrectly perceived by the judges. The poor score obtained by P3 correlates with the fact that he had a severe voice disorder and that his overall performance was worse than that of other participants with slightly better voice qualities.

P4 presented with dysphonia following thyroidectomy surgery and obtained a *mean* score of 17/20 (85%) as well as the highest individual score of 19/20 (95%). Out of 100 words, 15 were incorrectly perceived by the judges. Her voice disorder was moderately severe and she obtained a GRBASI score of $G_2R_1B_1A_1S_2I_1$.

P5 obtained a mean score of 16/20 (80%). This performance was similar to that of P4. The total number of words produced by P5 which were incorrectly perceived by the judges, was 20 out of 100 words. This participant also had a moderate voice disorder, with a GRBASI score of $G_2R_2B_1A_1S_0I_0$.

3.1.2. Comparison of the control and experimental group participants' scores

The scores of the control and experimental groups were compared in terms of the number of words that were correctly perceived (see section 3.1.2.1) and the number of words that were perceived as unintelligible (see section 3.1.2.2)

3.1.2.1. The number of words that were correctly perceived

This study aimed to determine whether there was a significant difference between the scores obtained by individuals with a voice disorder and the scores of typical L1 Tswana-speaking individuals, based on the *final* minimal word pair list. The mean score for the control group as a whole was 17.6/20 (88%) compared to 15.7/20 (78.6%) for the experimental group as a whole (refer to Table 9 and Table 11 respectively). The difference between the two mean scores is 9.4%. A Wilcoxon Rank (Mann-Whitney) test indicated no significant difference in scores between the two groups (p=0.109).

Although no significant difference was found between the two groups, the effect size of the difference between the two groups was 76.7%. The effect size measures the magnitude of the difference between the control and the experimental groups' results (Tavakoli, 2012, p. 185). The effect size implies that there is a 76.7% probability that a control participant will achieve a higher *true score* than a participant with a voice disorder. A *true score* refers to an individual's or a group's expected score, should there be no errors in measurement (Jackson, 2015, p. 63). An effect size inferring 76.7% probability corresponds to a 'medium-sized' effect. This effect size shows some indication that there may well be a *clinical* significance and that the presence of a voice disorder could negatively impact tone variation.

The mean scores of the control and experimental participants were compared and analysed to determine whether there was a difference between the control group and experimental group

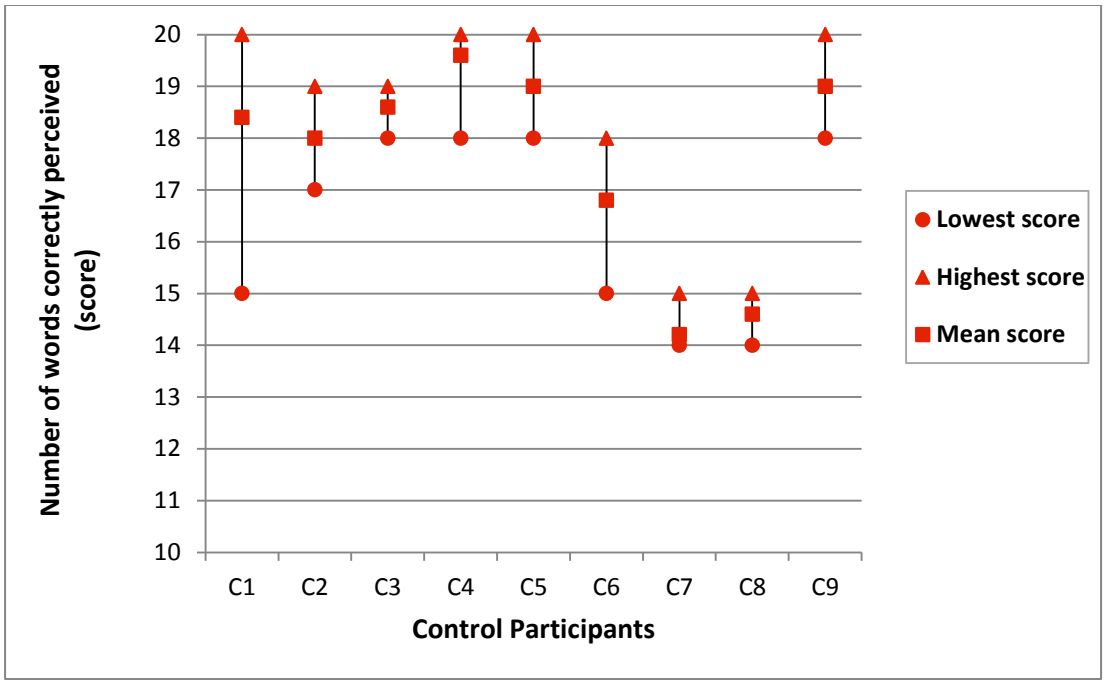


Figure 2: The mean scores for control participants, as well as the range from the lowest to the highest scores obtained across judges.

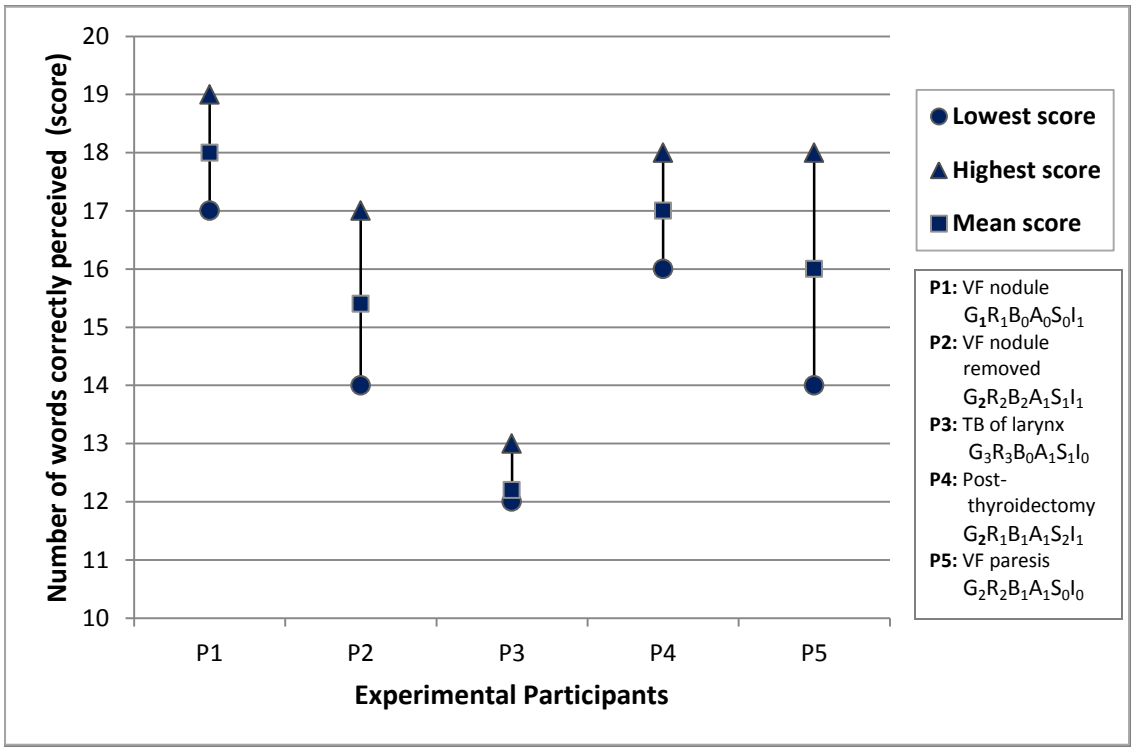


Figure 3: The mean scores for experimental participants, as well as the range from the lowest to the highest scores obtained across judges.

participants' performance. Figure 2 and Figure 3 display an overview of each participant's performance for both the control and the experimental group, respectively. The figures provide each participant's highest and lowest score that was obtained across all five judges as well as the mean score, which is an average of all five judge's scores.

The general trend when comparing the results in Figure 2 and Figure 3 is that six out of the nine control participants had higher scores than the experimental group participants. Mean scores of close to 100% (that is, 20/20) were achieved by C1, C2, C3, C4, C5, and C9, while C6, C7 and C8 obtained lower mean scores compared to the rest of the control group. However, four control participants, that is, C1, C4, C5, and C9, were all able to attain individual scores of 100% (20/20). None of the lowest scores obtained by control participants were less than 70% (14/20).

With regard to the experimental group participants, Figure 3 shows that their mean scores were quite varied; on the whole, however, their mean scores were lower than those of the majority of the control group participants. All of the experimental participants obtained mean scores that were lower than six out of the nine control participants' scores. P1, who presented with a vocal fold nodule, performed the best of all of the experimental group participants, obtaining a mean score of 18/20 (90%) and a highest score of 19/20 (95%). P1 had a mild voice disorder (as indicated by a score of '1' for Grade (G) on the GRBASI scale). Although this was the highest mean score out of all of the experimental group participants, it was still lower than that of the majority (six out of nine) of control group participants whose mean scores were above 90%. The poorest performance was from P3, who obtained a mean score of 12.2/20 (61%). P3 presented with TB of the larynx, resulting in a severe voice disorder, where the overall 'grade' (G) of voice, according to the GBRASI scale, was scored as a '3'. The lowest individual score that was obtained was from P3, who scored 12/20 (61%). This is less than the lowest score of 14/20 (70%), obtained by both C7 and C8, who were the worst performing control participants.

It can be concluded that the overall performance of the control group was better than the overall performance of the experimental group, given that the majority of the control participants obtained higher mean scores than the experimental group participants. Furthermore, three control participants attained full scores of 100% while none of the experimental participants

attained scores of 100%. Finally, the worst performing participant, who achieved the lowest *mean* score and the lowest individual scores, was an experimental participant with a voice disorder.

3.1.2.2. The number of words that were perceived as unintelligible

In addition to analysing the number of words that were either correctly or incorrectly perceived for each participant, the number of words which were judged to have been produced 'unintelligibly' were also analysed. During the data collection procedures, the judges were given a 'listener score sheet' on which to indicate their responses during the listening task. The score sheet provided three options which could be selected. The first two options (columns) provided the judge with two meanings for each word within the minimal pair. The third option provided the judge with an opportunity to indicate whether the target word was perceived to be unintelligible. For example, should a word be produced with a tone pattern that is completely incorrect, the word may be rendered meaningless and the first two options would therefore not be applicable. This third option was specified on the score sheet in the third column as "word not produced intelligibly". The selection of this option by a judge has specific implications for speech intelligibility since the target word would have been deemed completely meaningless, complying with neither of the two plausible meanings provided.

Table 12 shows the total number of words, as produced by both experimental and control participants that were perceived by the judges to have been unintelligible. These data are based on the results of the *experimental* word list. The GRBASI scores of the experimental participants are also included in Table 12 for the purposes of comparison.

Table 12 reveals that C3 and C4, who are typical speakers, each produced one word which was perceived as unintelligible. None of the other control participants produced words that were perceived as unintelligible. Although two of the nine control participants rendered "unintelligible" word productions, it can be seen that there were more participants with a voice disorder than control participants whose words were perceived as unintelligible.

Five of the 32 words produced by P3 were perceived by the judges to be unintelligible. Three out of these five words were perceived by more than one judge to be unintelligible. P2 and P4

performed better, with a total of 3 words and 2 words out of 32, respectively, which is slightly weaker than the score of 1 obtained by two of the typical speakers. P2 and P4 display a GRBASI rating of 'G_2', indicating a moderate severity of voice disorder. P1, who had a mild voice disorder with a GRBASI rating of 'G_1', only produced 1 word that was perceived to be unintelligible, and his performance is in line with that of the controls.

Table 12: The total number of words, as produced by experimental and control participants, that were perceived by the judges to be unintelligible, and the GRBASI score of each experimental participant.

Participant	Number of words that were perceived as unintelligible	GRBASI score
C1	0	Not applicable
C2	0	Not applicable
C3	1	Not applicable
C4	1	Not applicable
P1	1	$G_1R_1B_0A_0S_0I_1$
P2	3	$G_2R_2B_2A_1S_1I_1$
P3	5	$G_3R_3B_0A_1S_1I_0$
P4	2	$G_2R_1B_1A_1S_2I_1$
P5	0	$G_2R_2B_1A_1S_0I_0$

There are no clear trends in these results except for the data of P3 who presented with TB of the larynx and who displayed the worst performance with regard to intelligibility of word production. In the case of P3, who has been classified as having a severe voice disorder (GRBASI rating of 'G_3'), three of the judges perceived 5 words to be unintelligible. This suggests that the presence of a severe, organic voice disorder might have influenced these results.

Table 13 indicates which specific words were perceived to have been unintelligible. These results are based on the *experimental* word list of 32 words, as judged for each participant. Five out of the eleven words which were perceived to have been unintelligible formed part of the *final* word

list (these are indicated by a * in Table 13). The participants who produced the words 'unintelligibly', as well as the judges who perceived the words, are also indicated.

Table 13: Words from the experimental word list, which were perceived by the judges as unintelligible, as well as an indication of which judge and which participant was involved

Tswana word	Judge 1	Judge2	Judge 3	Judge 4	Judge 5
* **Word 3:** go sèlwà (pick up/find)				P3	
* **Word 4:** go sélwà (oversleep)			P3	P3	
* **Word 7:** màbòkó (brains)		P3	P3	P3	
Word 14: mòkótlá (bag, sack)				P4	
* **Word 19:** go dùmà (to roar)				P2	
* **Word 20:** go dúmà (spray with insecticide)		P1			
Word 21: lèìsò (large spoon)				P3	
Word 25: dìnòkò (joints in a reed)				P2	
Word 26: dìnòkó (porcupines)				**C4**	
Word 29: mòsídì (soot; burnt out coal)			P3	P2 P3 P4	
Word 30: mòsìdì (person who grinds)		**C3**			

*** Words that form part of the *final* word list**

The results in Table 13 suggest that certain words were more likely to be perceived as unintelligible. This is the case for words 4, 7, and 29 in particular, which were perceived as unintelligible by more than one judge. Words 4 and 29 were perceived to be unintelligible by two judges, while word 7 was perceived by 3 judges to be unintelligible. Furthermore two different

words (words 26 and 30), produced by two different control speakers (C3 and C4), and judged by two different judges, were also perceived as unintelligible.

3.2. Discussion of results

The results for sub-aim 2 show that although there is no statistically significant difference between the control and experimental group with regard to the mean number of words that were correctly perceived for each participant, the majority of the control group performed better than the experimental group participants. Furthermore the words that were perceived by the judges as being unintelligible were mostly produced by experimental participants with a voice disorder. Therefore it is likely that a voice disorder does have an influence on an individual's ability to accurately vary the tone of their voice.

International research in the field of tone variation in individuals with a voice disorder has shown that the presence of a specific voice disorder, namely muscle tension dysphonia, does impact negatively on tone variation in Vietnamese speech (Nguyen, et al., 2009; Nguyen & Kenny, 2009). Based on these findings, it was therefore hypothesised that the present study might obtain similar findings in a group of individuals with a voice disorder who speak a different tone language, namely Tswana.

3.2.1. Performance of the experimental participants

The results obtained from the five experimental participants with a voice disorder varied somewhat. Although the results showed generally lower scores in the experimental group compared to the majority of the control participants, one of the individuals with a voice disorder obtained scores that were in keeping with those obtained by control group participants. It is necessary to look further at these results to determine some of the contributing factors that could have caused the experimental group participants' scores to have been so varied. For example, the type of voice disorder as well as the severity of the voice disorder may have played a role in the participants' ability to vary the tone of their voice. For this reason, each experimental participant will be discussed in detail below.

3.2.1.1. Experimental participant 1

P1, who presented with a vocal fold nodule, obtained the highest score out of the five participants with a voice disorder. He obtained a score of 18/20 (90%) which is in keeping with some of the scores obtained by the control group participants. Furthermore, none of his word productions were perceived by any of the judges as unintelligible. A possible explanation for this much higher-than-expected score and overall good performance may be the fact that he presented with a relatively mild voice disorder compared to the other participants. The other four participants had either a moderate or a severe voice disorder as rated according to the GRBASI scale. His scores obtained on the GRBASI scale were $G_1R_1B_0A_0S_0I_1$. A score of 1 for 'grade' (G) indicates that the individual has a mild severity of voice disorder. This participant also obtained a score of 1 for 'roughness' (R) and 'instability' (I). Therefore, he had mild roughness to his voice quality and a slight or mild instability in his voice. All of the other areas of the scale, that is, 'breathiness' (B), 'asthenia' (A) and 'strain' (S) were rated as being within normal limits. The fact that his voice disorder was relatively mild suggests that his vocal nodule might have been relatively small thereby minimising the negative effects on his voice quality. It is also possible that the histological changes to the vocal folds as a result of the vocal fold nodule may not have been sufficiently altered to pose a challenge in varying the tone of his voice.

3.2.1.2. Experimental participant 2

P2 obtained the second lowest mean score, namely 15.4/20 (77%), out of the five participants with a voice disorder. He presented with a history of a vocal fold nodule which had been surgically excised before his participation in the present study. Although the nodule was no longer present, he continued to have post-surgery dysphonia. There may have been some residual vocal fold scarring after having the nodule excised, which may have contributed to continued dysphonia. Surgical treatments for laryngeal growths have in some cases been found to cause vocal fold scarring (Hansen & Thibeault, 2006). It is possible that vocal scarring may have caused damage to the lamina propria (vocal fold mucosa), thereby inhibiting periodic vocal fold vibration and resulting in difficulty with tone variation. The participant's scores on the GRBASI scale were $G_2R_2B_2A_1S_1I_1$. The degree of severity of his voice disorder was slightly higher than for P1, with a 'grade' (G) of 2 that indicates an overall moderate severity of voice disorder. Both the

'roughness' (R) and 'breathiness' (B) aspects of his voice were also rated as moderate. However, he only presented with mild difficulty with regard to asthenia, strain, and instability. The fact that he presented with some vocal strain may be indicative of the presence of hyperfunction in phonation, which could also impact his ability to vary the tone of his voice. He was perceived by Judge 4 as having produced three words unintelligibly, due to an incorrect tone pattern.

3.2.1.3. Experimental participant 3

P3 obtained the lowest score out of all five participants with a voice disorder. His mean score was 12.2/20 (61%). He presented with a two-year history of TB of the larynx. Although medical treatment had resolved the TB, he presented with chronic and severe hoarseness. The most common symptom of TB to the larynx is hoarseness as a result of the ulcerative laryngeal lesions (Fagundes, Cury, Anelli-Bastos, Silva, & Duprat, 2011). His GRBASI scores were $G_3R_3B_0A_1S_1I_0$. The overall 'grade' (G) of voice was scored as a 3, indicating a severe voice disorder, which was worse than in the case of the other experimental participants. He also had severe 'roughness' (R), and a mild effect on 'asthenia' (A) and 'strain' (S). 'Instability' (I) was rated as 0 indicating that his vocal quality remained stable throughout. He also did not present with any breathiness. It is very likely that the severity of his voice disorder and the fact that it was a severe primary organic voice disorder impacted greatly on his ability to achieve the tone variation necessary to convey the intended meaning during production of the target words. This is also evident from the fact that P3 produced the highest number of words out of all the experimental participants that were perceived to be unintelligible by the judges (Table 12 of section 3.1.1.2).

3.2.1.4. Experimental participant 4

P4 obtained a mean score of 17/20 (85%). This score is slightly better than the scores of the other experimental participants, although not as high as P1. She had undergone a total thyroidectomy just over one year prior to participating in the study. Although she presented with normal laryngeal findings, according to an Ear- Nose- and Throat (ENT) Specialist who assessed the participant using a flexible endoscope, she continued to suffer from persistent dysphonia. Her vocal folds were seen to be mobile bilaterally, indicating a functional recurrent laryngeal nerve, with no other abnormalities visible when the vocal folds were viewed with a flexible endoscope.

The cause of her dysphonia could not be confirmed due to lack of access to videostroboscopy equipment. However, it has been found that other post-operative causes for voice alterations following thyroid surgery can include slight modifications in the vascular supply of the larynx resulting in mucosal changes (Stojadinovic, Shaha, Orlikof, & Nissan, 2002). It is possible that changes to the mucosal wave might have affected the voice quality of P4 as this is something that is not visible from a flexible endoscope. A superior laryngeal nerve paresis may also have been a possibility, but this condition would not have been identified by using a flexible endoscope. Her GRBASI scores were $G_2R_1B_1A_1S_2I_1$. These scores indicate that the voice was affected somewhat across all parameters of the GRBASI scale, resulting in an overall moderate voice disorder as indicated by a score of 2 for 'grade' (G). Her voice quality was mildly rough and breathy at times. She had difficulty projecting a loud voice and was thus scored as having mild 'asthenia' (A). Her voice also sounded moderately strained.

3.2.1.5. Experimental participant 5

P5 had been diagnosed with a right vocal fold paresis of the recurrent laryngeal nerve (RLN), which had been acquired three weeks prior to participating in the study. His mean score was 16/20 (80%). Although a total of 20 out of 100 of his word productions were perceived incorrectly by the judges, none of his word productions were perceived to have been unintelligible (Table 12 of section 3.1.1.2). His GRBASI scores were in keeping with his diagnosis and were judged to be $G_2R_2B_1A_1S_0I_0$. He had a moderate voice disorder, characterised by moderate 'roughness' (R) and mild 'breathiness' (B). As a result of the paresis, he also had mild 'asthenia' (A). There were no signs of strain or instability in his voice quality. A RLN paresis can cause asymmetrical vocal fold movement, thereby affecting the vibratory motion of the vocal fold. This can affect the pitch of the voice which is a necessary component in varying the tone of the voice. His vocal fold paresis may therefore have prevented him from attaining a score higher than 80%.

3.2.2. Summary of the performance of the control and experimental participants

The fact that the mean score of the control group (88%) was higher than the mean score of the experimental group (78.6%) indicates that a voice disorder could have some effect on the ability to make the variations in vocal pitch necessary for tone variation. Many of the control group

participants were able to achieve scores of 100% or close to 100%. None of the experimental participants were able to achieve scores of 100%, in spite of the fact that they were judged by the same five judges, using the same word list as the control participants. This suggests that it was neither the specific words within the list nor the performance of the judges that yielded better results for the control group as a whole, but rather the influence of a voice disorder that impacted the results of the experimental participants. Figures 2 and 3 (in section 3.1.2.1) illustrate the differences between the scores of the participants in each group and show that the scores for the experimental group were generally lower than the scores for the control group. Furthermore, the experimental participant who had the poorest performance was an individual who presented with a severe primary organic voice disorder that effected change in the structure of the vocal folds themselves, which had the greatest impact on tone variation.

In terms of the number of words that were perceived as unintelligible by the judges, it was found that there were more experimental participants with a voice disorder who produced words that there perceived as unintelligible, compared to the control group participants. There were two control speakers who produced a *single* word each that was perceived as unintelligible, and these two words were perceived as unintelligible by different judges. This suggests the possibility that a judge, or any typical listener, might occasionally perceive tone incorrectly. Therefore in some instances a typical listener may have to rely on the context of a sentence to deduce the meaning of an utterance.

It is also noteworthy that certain words that were produced by experimental participants were more frequently perceived to be unintelligible. An example of this can be viewed in Table 13, in the case of word 29, where two judges could not identify this word when it was produced by three experimental participants. Furthermore, five out of the eleven words that were perceived to be unintelligible, formed part of the *final* word list (in which some of the less familiar words had been removed). The fact that these five words were all produced by *experimental* participants, suggests that the influence of a voice disorder may have impacted the accurate perception of these words, more than a lack of familiarity, for example.

4. Summary

Chapter 3 provided a description of the results of the present study. Sub-aim 1 generated the results that started with the *experimental* word list and then culminated in the *final* word list, through the process of validating the word list. A discussion regarding the reasons for revising the experimental word list was provided. The *final* word list was employed to generate a set of results for the control group participants, which was described and discussed. The outcomes of sub-aim 2 were then presented and discussed, with the focus on the performance of the experimental participants in comparison to the control group. The chapter is rounded off with a summary.

CHAPTER 4: CONCLUSIONS

1. Introduction

This final chapter provides the main conclusions based on the results of the present study, along with the implications of these results for research. The study is evaluated by providing a description of its limitations and potential contributions. Finally, the recommendations for future research are also provided.

The study centres on the nature of tone or tonal languages, where a different tone pattern will change the meaning of a word. Since tone is produced by the vibrating vocal cords of the speaker, the relationship between a speaker's performance and the condition of that speaker's vocal folds would intuitively seem to be an intimate connection.

Tswana is a tone language which relies on skilful manipulation of the vocal folds to elicit accurate tone variation necessary for speech. This study aimed to develop a Tswana minimal pair word list that could be used to assess tone variation in typical tone language speakers. Furthermore, the developed Tswana minimal pair word list was then used to determine whether the presence of a voice disorder affected an L1 Tswana-speaking individual's ability to successfully manipulate their vocal folds in order to vary the tone of their voice so that their intended message could be correctly perceived by a typical L1 Tswana-speaking listener. This was achieved by comparing the results obtained in a tone production and perception task completed by typical L1 Tswana-speakers and Tswana-speaking listeners to the results obtained by Tswana speakers with a voice disorder and the same typical Tswana-speaking listeners.

2. Conclusions

Several conclusions are based on the results of the current study.

- The word list that was developed during this study appears to be appropriate for the assessment of tone production and tone perception. The finding that four out of the nine control group participants achieved scores of 100% from at least one of the judges, suggests that the 10 minimal pairs that form part of the *final* word list have the potential

to effectively assess tone production and tone perception. Although not all of the typical speakers attained full scores when using the *final* word list, the results indicated the range of performance of typical speakers and listeners to be between 100% and 70%.

- There are various listener- and speaker-related variables that may affect performance on a task of tone perception and tone production, such as familiarity with certain words as well as perceptual demands of the task where listeners are required to judge words that occur in isolation. It is possible that some typical listeners may require the context of a sentence to add meaning to the word.
- Since the word list did not elicit full scores of 100% consistently across all control participants and judges, it seems possible that not all typical speakers produce word-level tone variation in a way that makes identification possible in a single word context.
- The judges varied in their ability to identify minimal pair words correctly. This implies that typical listeners may not always be able to identify minimal pair words in isolation.
- A lack of familiarity with certain words within the *experimental* and *final* word lists is suggested as being a possible contributing factor to the inability to accurately produce and perceive tone in the case of the two word lists. This is likely to have resulted in a lack of full scores by some of the control group participants. The influence of exposure to English, the use of so-called "Street Setswana" (which is characterised by lexical borrowing from other languages), and the effect of urbanisation may result in a loss of 'lexical purity' and familiarity with some words (Ljubesic & Kranjcic, n.d.).
- The results suggest that a voice disorder may impact the ability to produce syllable-level tone variation. The majority of the control participants obtained higher mean scores than the experimental group participants. This resulted in a better overall performance by the control group, which obtained a mean score 9.4% higher than that of the experimental group. In addition to this, none of the experimental participants were able to achieve full scores when using the *final* word list, while at least four control participants could achieve scores of 100%. Although no significant difference in tone variation ability was found between the control and experimental participants, these results do indicate that the presence of a voice disorder may be of *clinical* significance.

- Even though the experimental group performed more poorly overall, it was also found that not *all* individuals with a voice disorder appeared to display defective tone variation. It cannot be conclusively stated what contributing factors lead to such a variation in scores by individuals with a voice disorder.
- There are indications that the more severe a voice disorder, especially one that significantly affects the structure of the vocal folds as in the case of P3 who presented with TB of the larynx, the greater the impact it will have on tone variation. This was deduced from the fact that P3 presented with a severe primary organic voice disorder and obtained the lowest scores, while P1, who had a mild voice disorder, performed well.

3. Implications of the study

The research findings of this study present several implications for research and for clinical practice in South Africa and in other African countries where Bantu tone languages are spoken:

- The outcomes of sub-aim 1, which involved investigating tone variation in L1 Tswana-speaking individuals, provide some indication that even typical-speakers may not always have the necessary skills to produce or perceive tone with 100% accuracy, without the context of the sentence to add meaning. This has implications for future research when using data obtained from a control group of tone language speakers to compare with experimental participants with a communication disorder. Results obtained from a control group may need to be used only as a base-line with which to compare the results of an experimental group.
- The results of the present study highlight the fact that Tswana-speaking individuals with a voice disorder may also present with compromised speech intelligibility due to defective tone variation. This has implications for the assessment and management of these patients, given the fact that the majority of Bantu-speaking individuals in South Africa are receiving speech-language therapy services from clinicians who do not speak a Bantu language. These clinicians may frequently be unaware of the potential effect that a voice disorder, and other communication disorders, may have on speech intelligibility.

- The results serve as evidence that in at least *some* individuals with voice disorders, tone variation may be compromised, thus impacting intelligibility. Clinicians should be aware of this fact when treating such individuals.
- Since many Tswana-speaking individuals in South Africa are often exposed to a variety of languages even in some rural settings, certain words, such as the words on the *final* Tswana minimal pair word list, may be less familiar to them. This may have implications for using the list to assess tone variation in individuals with a communication disorder as it would be difficult to ascertain whether incorrect tone production is a result of poor ability to vary tone or due to unfamiliarity of certain words.

4. Evaluation of the study

It is necessary to critically evaluate the results of the present study to identify limitations and potential contributions. Research that is conducted in a relatively new field, as was the case with the current study, will inevitably have some limitations due to the fact that there is a lack of previous studies in the area which may provide guidance and suggested recommendations for continued research. In contrast, however, novel research also has many benefits in filling gaps in the literature and providing a starting point for similar topics to be explored further. Some of the limitations of the current research study are summarised below, followed by the contributions to research.

4.1. Limitations

The following limitations of the results of this research have been identified:

- The sample size of this study was limited, specifically with regard to the experimental participants. It was not possible to determine the presence of any statistical significance in the results due to the small numbers of participants.
- One of the study's exclusion criteria, that is, a 'pass' on hearing screening, was not entirely complied with due to limited numbers of experimental participants that were available. It was therefore necessary to keep two participants in the study who did not pass their hearing screening. The hearing thresholds of P1 on pure tone screening were within normal limits, except for one frequency in his right ear, where he obtained a

threshold of 30dB at 2000Hz. In spite of this, P1 obtained the highest mean scores compared to the other experimental participants. P5 obtained thresholds of between 35 and 45dB at 1000 Hz and 2000 Hz bilaterally, while the thresholds at 500 Hz were within normal limits. P5 obtained a mean score that was higher than P2, who presented with hearing within normal limits, according to the hearing screening thresholds. Although it cannot be assumed with certainty that the participants' hearing status did not have an effect on tone variation, based on the results it unlikely that their hearing had a negative effect on their results.

- An inclusion criterion that required experimental participants to present with a moderate voice disorder, aimed to control the severity of each participant's voice disorder. The severity of the voice disorder as judged by a panel of listeners varied from mild (with GRBASI scores of 1) to severe (with GRBASI scores of 3) and could not be controlled due to a limited available sample size. This did however allow for interesting observations to be made regarding the effect of the severity of a voice disorder and the scores that each experimental participant obtained.
- There was a lack of access to high definition equipment, such as videostroboscopy, that allows for high-quality visualisation of the larynx. This would have provided more information about the condition of the vocal folds and the exact mechanism of phonation that may have been impaired during variations of vocal tone.
- In order to make more robust conclusions regarding the performance of the control group in the tone production and tone perception task, it would have been beneficial to have controlled some variables that might be involved in tone variation. For example, due to the multi-lingual nature of the Bantu-speaking population, it was difficult to completely control the various dialectical differences that exist in a multi-lingual community, and to control the differences in exposure to specific words in the living and social environment that might have existed between the participants and the judges. However, at the time of study, all participants, including the judges, lived or worked in an urban area and were assumed to have had some exposure to the words in the *final* word list.

4.2. Contributions

The following potential contributions to research have been identified:

- The Tswana minimal pair word list that was developed in the present study provides a valuable tool for the continuation of research regarding the tonal aspects of Tswana. There have, for example, been recent advancements in the field of linguistics and information technology, whereby text-to-speech technology in South African Bantu languages is being explored and developed, based on tone-labelling algorithms (Raborife, Zerbian & Ewert, 2011). In these studies the use of tonal stimuli, specifically minimal pair words in Sesotho, were used in the assessment of tone production by typical Sesotho-speakers, and these results were used for the purposes of improving the perceived naturalness and speech intelligibility of speech produced by a text-to-speech synthesiser. Minimal pair stimuli, such as the developed Tswana minimal pair word list, could prove useful in furthering such research studies in this area.
- Continued research on the effects of voice disorders in tone variation of L1 Tswana-speaking individuals can be furthered with the use of the developed Tswana minimal pair word list.
- The results of the present study have provided the first body of evidence that implicates the negative effect of voice disorders in first language Bantu-speaking individuals who present with a voice disorder. This contributes to creating awareness for clinicians working with Bantu-speaking patients with voice, speech, or language disorders.
- The first "Tswana minimal pair word list for the assessment of tone production and tone perception", which is also accompanied by pictorial and Tswana sentence stimuli, is a useful clinical tool. It can be used for assessment and management of Tswana-speaking individuals with a communication disorder, including voice disorders, motor speech disorders such as apraxia or dysarthria, language disorders, or hearing impairment. It should be noted, however, that this word list is limited to use by L1-Tswana speaking clinicians (or possibly L1 speakers of other South African Bantu languages, which are all tone languages) as it will require the skills to be able to *perceive* tone accurately. Alternatively, clinicians who are not L1 Tswana-speakers can make use of the services of

an interpreter when using this list for the assessment of tone production and tone perception.

5. Recommendations for future research

This study opens up a large window of opportunity to conduct further research in the area of communication disorders and Bantu tone languages. Based on the results of the current study, the following recommendations are made for continued research:

- It is recommended that continued development and validation of the final Tswana minimal pair word list take place to expand the number of words in the list, since many words had to be removed in the process of validating the stimuli.
- Furthermore, it would be beneficial to continue revising and validating the word list for different populations, for example, individuals from an exclusively rural area, as well as individuals from an exclusively urban area. This can be done by controlling variables such as where they were born, which schools they attended, and how long they have lived in a certain area. Validating the word list for populations from specific socio-economic classes might also influence the words included in the word list as certain words might be more familiar to one group of people and less so to another group of individuals in a different socio-economic class.
- It is also recommended that this study be repeated with a larger sample size of individuals who present with a voice disorder, with an attempt to group them according to the type and severity of voice disorder. This would allow for conclusions to be drawn regarding the specific effect that a certain vocal pathology may have on the movement of the vocal folds and therefore the ability to make syllabic word level variations in tone.
- The inclusion of experimental participants who have had a video-stroboscopic evaluation by an ENT-specialist would allow for more detailed conclusions to be made regarding the specific mechanism of phonation that may result in deviant tone variation.
- There is benefit in repeating/conducting a similar study in one of the other South African Bantu languages, as Tswana is currently the first and only South African language which

has been studied to determine the effect of a voice disorder on an individual's ability to vary the tone of their voice.

- It is suggested that future research focus on the abilities of both Germanic language speakers and other South African Bantu-language speakers to identify correct and incorrect productions of tone. This is recommended due to the fact that non tone-language speaking clinicians in South Africa, mainly English and Afrikaans speaking clinicians, are not easily able to benefit from using the '*final* minimal pair word list' to assess tone production as they may not necessarily possess the skills needed to identify tone correctly. Furthermore, it cannot be assumed that a Zulu-speaking clinician, for example, will definitely be able to correctly perceive tone produced by Tswana-speaking individuals, merely by the fact that they are also tone language speakers. Research into this field would provide valuable insights into the effect of word unfamiliarity that may be more prominent in an individual who speaks a different Bantu language.
- Finally, an acoustic analysis of the data from a similar research study may elucidate the nature of deviant tone patterns of individuals with a voice disorder, or any other communication disorder. This may be especially worthwhile in identifying relatively small amounts of variation in tone patterns, that are not easily be perceived by a panel of judges. An acoustic analysis of typical speakers will also provide information regarding the amount of change in fundamental frequency, which could then be used to compare to the amount of change in frequency of speakers with a communication disorder.

6. Summary

Chapter 4 addressed various conclusions of this research study. The implications as well as limitations and contributions of the results relating to Sub-aims 1 and 2 were discussed. These results provide a starting point for an evidence base of research on the effect of voice disorders in Bantu tone languages. Given the paucity of research in this field, several recommendations were made for continued research in the future.

REFERENCES

Aaronson, A. E., & Bless, D. M. (2009). *Clinical voice disorders* (4th ed.). Thieme: New York.

Adler, R. K., Hirsch, S., & Mordaunt, M. (2012). *Voice and communication therapy for the transgender/transsexual client: A comprehensive clinical guide* (2nd ed.). San Diego: Plural Publishing.

Ahmad, K., Yan, Y., & Bless, D. M. (2012). Vocal Fold Vibratory Characteristics of Healthy Geriatric Females—Analysis of High-Speed Digital Images. *Journal of Voice, 26(*6), 751-759.

American Speech-Language-Hearing Association (ASHA). (2005). *Protection of human subjects* [Issues in Ethics]. Available from www.asha.org/policy.

American Speech-Language-Hearing Association. (2013). *Confidentiality* [Issues in Ethics]. Available from www.asha.org/policy.

ANSI (1960). ANSI S1.1-1960, ‘‘Acoustical terminology’’ (American National Standards Institute, New York).

Baker, J. (2002). Persistent dysphonia in two performers affecting the singing and projected speaking voice: A report on a collaborative approach to management. *Logopedics, Phoniatrics, Vocology, 27*(4), 179-87.

Behrman, A. (2013). *Speech and voice science* (2nd ed.). Plural Publishing: San Diego.

Boersma, P., & Weenink, D. (2005). Praat: Doing phonetics by computer (Version 4.3.01) [Computer program]. Retrieved from http://www.praat.org/

Boone, D. R., & McFarlane, S. C. (2000). *The voice and voice therapy* (6th ed.). Needham Heights: Prentice-Hall.

Brunelle, M. (2009). Tone perception in Northern and Southern Vietnamese. *Journal of Phonetics, 37*, 79–96.

Calteaux, K. (1992). *Standard and non-standard African language varieties in the urban areas of South Africa: Main report for the STANON research programme.* Pretoria: HSRC Publishers.

Childers, D. G., Hicks, D. M., Moore, G. P., & Alsaka, Y. A. (1986). A model for vocal fold vibratory motion, contact area, and the electroglottogram. *Journal of the Acoustic Society of America, 80*(5), 1309-1320.

Christopher, A. J. (2004). Linguistic segregation in urban South Africa, 1996. *Geoforum, 35*, 145-156.

Ciocca, V., Whitehall, T. L., & Ma Ka Yin, J. (2004). The Impact of cerebral palsy on the intelligibility of pitch-based linguistic contrasts. *Journal of Physiological Anthropology and Applied Human Science, 23*, 283-287.

Clements, G. N., & Railland, A. (2008). Africa as a phonological area. In Heine, B., & Nurse, D. *A linguistic geography of Africa.* New York: Cambridge University Press.

Coetzee, A. W., & Pretorius, R. (2010). Phonetically grounded phonology and sound change: The case of Tswana bilabial plosives. *Journal of Phonetics, 38*(3)*,* 404-421.

Cole, D. T. (1955). *An introduction to Tswana grammar.* Cape Town: Longmans, Green and Co.

Cole, D. T. (1992). *An introduction to Tswana grammar*. Johannesburg: Longman Penguin SA.

Cole, D. T., & Moncho-Warren, L. M. (2011). *Setswana and English illustrated dictionary.* Northlands: Macmillan.

Colton, R. H., Casper, J. K., & Leonard, R. (2011). *Understanding voice problems: A physiological perspective for diagnosis and treatment* (4th ed.). Philadelphia: Lippinkott Williams & Wilkins.

Cook, S. E. (2009). Street Setswana vs. school Setswana: Language policies and the forging of identities in South African Classrooms. In J. A. Kleifgen & G. C. Bond (Ed.s), *The languages of Africa and the diaspora: Educating for Language Awareness* (pp. 96-107). Bristol: Multilingual Matters.

Cruttenden, A. (1997). *Intonation* (2nd ed.). Melbourne: Cambridge University Press.

Crystal, D. (2008). *A dictionary of linguistics and phonetics* (6th ed.). Malden: Blackwell Publishing Ltd.

De Bodt, M. S., Wuyts, F. L., Van de Heyning, P. H., & Croux, C. (1997). Test-retest study of the GRBAS scale: Influence of experience and professional background on perceptual rating of voice quality. *Journal of Voice, 11*(1), 74-80.

Deumert, A. (2010). 'It would be nice if they could give us more language' - Serving South Africa's multilingual patient base. *Social Science & Medicine, 71*, 53-61.

Edmonds, W. A., & Kennedy, T. D. (2013). *An applied reference guide to research designs: Quantitative, qualitative, and mixed methods.* Los Angeles: SAGE publications, Inc.

Fagundes, R. D., Cury, R. I., Anelli-Bastos, W., Silva, L., & Duprat, A. (2011). Laryngeal tuberculosis: proposal of Speech-Language Pathology intervention in voice disorders following pharmacological treatment. *Revista da Sociedade Brasileira de Fonoaudiologia, 16*(1), 99-103.

Ferrand, C. T. (2012). *Voice disorders*. Boston: Pearson Education Inc.

Fletcher, J. (2013). The prosody of speech: Timing and Rhythm. In Hardcastle, W. J., Laver, J., & Gibbon, F. E. (Ed.s), *The handbook of phonetic sciences* (2nd ed.). West Sussex: Wiley-Blackwell.

Friedrich, G., Kiesler, K., & Gugatschka, M. (2010). Treatment of functional ventricular fold phonation by temporary suture lateralization. *Journal of Voice, 24*(5), 606-609.

Gandour, J. (1998). Aphasia in tone languages. In Coppens, P., Lebrun, Y., & Basso, A. *Aphasia in Atypical Populations.* New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Gravetter, F. J., & Forzano, L. B. (2012). *Research methods for the behavioural sciences* (4th ed.). Belmont: Wadsworth.

Gregory, N. D., Chandran, S., Lurie, D., & Sataloff, R. T. (2011). Voice disorders in the elderly. *Journal of Voice, 26*(2), 254-258.

Hansen, J. K., & Thibeault, S. L. (2006). Current understanding and review of the literature: Vocal fold scarring. *Journal of Voice, 20*(1), 110-120.

Hatcher, T., & Aragon, S. R. (2000). A code of ethics and integrity for HRD research and practise. *Human Resource Development Quarterly, 11*(2), 179.

Haviland, W. A., Prins, H. E. L., McBride, B., & Walrath, D. (2014). *Cultural anthropology: The human challenge* (14th ed.). Belmont: Wadsworth Cengage Learning.

Herbert, R. K., & Bailey, R. (2002). Language in South Africa. In Mesthrie, R. (Ed.), *The Bantu languages: Sociohistorical perspectives* (p.73). Cambridge: Cambridge University Press.

Heugh, K. (2007) Language and Literacy Issues in South Africa. In Rassool, N. (Ed.), *Global issues in language, education and development* (pp. 187-217). Clevedon: Multilingual Matters Ltd.

Hirano, M. (1974). Morphological structure of the vocal cord as a vibrator and its variations. *Folia Phoniatrica et Logopaedica, 26*(2), 89-94.

Hirano, M. (1981). *Clinical examination of voice.* New York: Springer-Verlag.

Hirst, D., & Di Cristo, A. (1998). *Intonation systems: A survey of twenty languages.* Cambridge: Cambridge University Press.

Hodge, M., & Whitehill, T. (2013). Intelligibility impairments. In Damico, J. S., Müller, N., & Ball, M. J. (Ed.s) *The handbook of language and speech disorders*. Oxford: Blackwell Publishing Ltd.

Holmberg, E. B., Doyle, P., Perkell, J. S. Hammarberg, B., & Hillman, R. E. (2003). Aerodynamic and Acoustic Voice Measurements of Patients with Vocal Nodules: Variation in Baseline and Changes Across Voice Therapy. *Journal of Voice, 17*(3), 269-282.

Honda, K., Hirai, H., Masaki, S., & Shimada, Y. (1999). Role of vertical larynx movement and cervical lordosis in F0 control. *Language and Speech, 42*(4), 401-411.

Jackson, S. L. (2015). *Research methods and statistics: A critical thinking approach* (5th ed.). Boston: Cengage Learning.

Jürgens, U. (2002). Neural pathways underlying vocal control. *Neuroscience and Biobehavioural Reviews, 26,* 235-258.

Juul, A., Magnusdottir, S., Scheike, T., Prytz, S., & Skakkebæk, N. E. (2007). Age at voice break in Danish boys: Effects of pre-pubertal body mass index and secular trend. *International Journal of Andrology, 30,* 537-542.

Kadyamusuma, M. R., De Bleser, R., & Mayer, J. (2011). Lexical tone disruption in Shona after brain damage. *Aphasiology, 25*(10), 1239–1260. http://dx.doi.org/10.1080/02687038.2011.590966

Kent, R. D., & Kim, Y. (2011). Assessment of intelligibility in motor speech disorders. In Lowit, A., & Kent, R. D. (Ed.s) *Assessment of motor speech disorders*. Oxfordshire: Plural Publishing Inc.

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). Delhi: New Age International Publishers.

Kreiman, J., Vanlancker-Sidtis, D., & Gerratt, B. R. (2005). Perception of voice quality. In Pisoni, D. B. & Remez, R. E. (Ed.s) *The handbook of speech perception.* Malden: Blackwell Publishing Ltd.

Krischke, S., Weigelt, S., Hoppe, U., Köllner, V., Klotz, M., Eysholdt, U., & Rosanowski, F. (2004). Quality of life in dysphonic patients. *Journal of Voice, 19*(1), 132-137.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement and categorical data. *Biometrics, 33*, 159-174.

Leedy, P. D., & Ormrod, J. E. (2010). *Practical research: Planning and design* (9th ed.). Boston: Pearson Education Inc.

Leydon, C., Bielamowicz, S., & Stager, S. V. (2005). Perceptual ratings of vocal characteristics and voicing features in untreated patients with unilateral vocal fold paralysis. *Journal of Communication Disorders, 38,* 163-185.

Discriminating between closely related languages on twitter. (n.d.) >The Free Library. (2014). Retrieved Apr 04 2016 from http://www.thefreelibrary.com/Discriminating+between+closely+related+languages+on+twitter.-a0417022256

Ludlow, C. L. (2005). Central nervous system control of the laryngeal muscles in humans. *Respiratory Physiology & Neurobiology, 147*(2-3), 205-222.

Matumo, Z. I. (1993). *Setswana English Setswana Dictionary*. Botswana: Macmillan.

Maxwell, D. L., & Satake, E. (2006). *Research and statistical methods in communication sciences and disorders*. Canada: Thomson Delmar Learning.

Mazrui, A. M., (2002). The English language in African education: Dependency and decolonization. In Tollefson, J. W. (Ed.). *Language Policies in Education: Critical Issues*. Lawrence Erlbaum: Mahwah, 267–281.

Mitchell, M. L., & Jolley, J. M. (2010). Research Design Explained (7th ed.). Belmont: Wadsworth Cengage Learning.

Moen, I. (2007). Production and perception of tones in patients with brain damage. In Ball, M. J., & Damico, J. S. (Ed.s) *Clinical aphasiology: Future directions.* New York: Psychology Press.

Murry, T., Medrado, R., Hogikyan, N., & Aviv, J. (2003). The relationship between ratings of quality of life and life measures. *Journal of Voice, 19*(2), 183-192.

Nguyen, D. D., Kenny, D. T., Tran, N. D., & Livesey, J. R. (2009). Muscle tension dysphonia in Vietnamese female teachers. *Journal of Voice, 23*(2), 195-208.

Nguyen, D. D., & Kenny, D. T. (2009). Effects of muscle tension dysphonia on tone phonation: Acoustic and perceptual studies in Vietnamese female teachers. *Journal of Voice, 23*(4), 446-459.

Nurse, D., & Philippson, G. (2003). Introduction. In Van de Velde, M., Nurse, D., Bostoen, K., & Philippson, G. (Ed.), *The Bantu languages* (pp. 7-9). London: Routledge.

Offredy, M., & Vickers, P. (2010). *Developing a healthcare research proposal: An interactive student guide*. Malaysia: Wiley-Blackwell.

Peppé, S. J. E. (2009). Why is prosody in speech-language pathology so difficult? *International Journal of Speech-Language Pathology, 11*(4), 258-271.

Plant, R. L., & Younger, R. M. (2000). The interrelationship of subglottic air pressure, fundamental frequency, and vocal intensity during speech. *Journal of Voice, 14*(2), 170-177.

Pontes, P., Brasolotto, A., & Behlau, M. (2005). Glottic characteristics and voice complaint in the elderly. *Journal of Voice, 19*(1), 84-94.

Probyn, M. (2009). 'Smuggling the vernacular into the classroom': Conflicts and tensions in classroom codeswitching in township/rural schools in South Africa. *International Journal of Bilingual Education and Bilingualism, 12*(2), 123-136.

Probyn, M., Murray, S., Botha, L., Botya, P., Brooks, M., & Westphal, V. (2002). Minding the gaps – an investigation into language policy and practice in four Eastern Cape districts. *Perspectives in Education, 20*(1), 29-46.

Procter, S., Allan, T., & Lacey, A. (2010). Sampling. In Gerrish, K., & Lacey, A. (Eds.), *The research process in nursing* (6th ed.) (pp. 149). Singapore: Blackwell Publishing Ltd.

Raborife, M., Zerbian, S., & Ewert, S. (2011). Developing a corpus to verify the performance of a tone labelling algorithm. *The 22nd Annual International Symposium of the Pattern Recognition Association of South Africa (PRASA)*, Vanderbijlpark, 22-25 November 2011.

Raphael, L. J., Borden, G. J., & Harris, K. S. (2011). *Speech science primer: Physiology, acoustics, and perception of speech* (6th ed.). Philedelphia: Lippincott Williams & Wilkins.

Rubin, J. S., & Greenberg, M. (2002). Psychogenic voice disorders in performers: A psychodynamic model. *Journal of Voice, 16*(4), 544-548.

Sataloff, R. T., Heman-Ackah, Y. D., & Hawlshaw, M. J. (2007). Clinical anatomy and physiology of the voice. *Otolaryngolic Clinics of North America, 40*(5), 909-929.

Siegal, R. J. (1965). A replication of the mel scale of pitch. *The American Journal of Psychology, 78*(4), 615-620.

Slabbert, S., & Finlayson, R. (1999). A socio-historical overview of codeswitching studies in the African languages. *South African Journal of African Languages, 19*(1), 60-72.

Snyman, J. W. (1989). An introduction to Tswana phonetics. Hout Bay: Marius Lubbe.

Snyman, J. W., Shole, J. S., & le Roux, J. C. (1990). *DikiSinare ya Setswana English Afrikaans dictionary woordeboek.* Pretoria: Via Afrika

StataCorp LP. Stata release 12. (2011). Texas, USA.

Statistics South Africa. (2012). *Census 2011:* Census in brief. Retrieved January 25, 2015, from http://www.statssa.gov.za/publications/sastatistics/sastatistics2012.pdf

Stegen, O. (2005). Tone in eastern Bantu orthographies: Paper presented at SIL Bantu orthography meeting. *Dodoma, Tanzania: SIL*.

Stemple, J. C., Glaze, L. E., & Klaben, B. G. (2010). *Clinical voice pathology: Theory and management* (4th ed.). Oxfordshire: Plural Publishing.

Stojadinovic, A., Shaha, A. R., Orlikoff, R. F., & Nissan, A. (2002). Prospective functional voice assessment in patients undergoing thyroid surgery. *Annals of Surgery, 236*, 823-832.

Story, B. H., & Titze, I. R. (1995). Voice simulation with a body-cover model of the vocal folds. *Journal of the Acoustic Society of America, 97*(2), 1249-1260.

Tavakoli, H. (2012). *A dictionary of research methodology and statistics in applied linguistics.* Tehran: Rahnama Press.

Timmermans, B., De Bodt, M. S., Wuyts, F. L., Boudewijns, A., Clement, G., Peeters, A., & Van der Heyning, P. H. (2002). Poor voice quality in future elite vocal performers and professional voice users. *Journal of Voice, 16*(3), 372-382.

Vaissière, J. (2006). Perception of intonation. In Pisoni, D. B. & Remez, R. E. (Ed.s). *The handbook of speech perception.* Cornwall: Blackwell Publishing.

Van den Berg, J. (1958). Myoelastic-aerodynamic theory of voice production. *Journal of Speech, Language and Hearing Research, 3*(1), 227-244.

Van der Merwe, A., & Le Roux, M. (2014). Idiosyncratic sound systems of the South African Bantu languages: Research and clinical implications for speech-language pathologists and audiologists. *South African Journal of Communication Disorders, 61*(1), Art. #86, 8 pages. http://dx.doi.org/10.4102/sajcd.v61i1.86

Van der Merwe, A., & Le Roux, M. (2014). Dysarthria and apraxia of speech in selected African languages: Zulu and Tswana. In Miller, N. & Lowit, A. (Ed.), *Motor speech disorders: A cross-language perspective* (p.125). Ontario: Multilingual Matters.

Van der Pas, B., Wissing, D., & Zonneveld, W. (2000). Parameter resetting in metrical phonology: The case of Setswana and English. *South African Journal of Linguistics, 18*(38), 55-87.

Vassarstats (2012). *Concepts and Applications of Inferential Statistics.* Retrieved October, 22, 2015, from http://vassarstats.net/textbook/index.html.

Verdolini, K., Rosen, C. A., & Branski, R. C. (2006). *Classification manual for voice disorders.* New Jersey: Psychology Press.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine, 37*(5), 360-363.

Villanueva-Reyes, A. (2009). Voice disorders in the metropolitan area of San Juan, Puerto Rico: Profiles of occupational groups. *Journal of Voice, 25*(1), 83-87.

Wells, J. C. (2006). *English Intonation: An introduction*. Cambridge: Cambridge University Press.

Wood, S. (2005). Praat for beginners [Manual]. Retrieved from http://www.ling.lu.se/persons/Sidney/praate/

Yavaş, M. (2011). *Applied English Phonology* (2nd ed.). Oxford: Wiley-Blackwell.

Yip, M. (2002). *Tone.* Cambridge: Cambridge University press.

Yu, K. M., & Lam, H. W. (2014). The role of creaky voice in Cantonese tonal perception. *Journal of Acoustic Society of America, 136* (3), 1320-1333.

Zeller, J. (2004). Relative clause formation in Bantu languages of South Africa. *Southern African Linguistics and Applied Language Studies, 22*(1-2), 75-93.

Zerbian, S., & Barnard, E. (2008). Phonetics of intonation in South African Bantu languages. *Southern African Linguistics and Applied Language Studies, 26*(2), 235-254.

Zhang, J. (2008). The role of contrast-specific and language-specific phonetics in contour tone distribution. In Hayes, B., Kirschner, R., & Steriade, D. (Ed.s), *Phonetically based phonology.* Cambridge: Cambridge University Press.

APPENDICES

A-1: Ethical clearance certificate from the research ethics committee of the University of Pretoria

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

10 July 2014

Dear Prof van der Merwe

Project:	**Tone variation in Tswana-speaking individuals: the effect of voice disorders**
Researcher:	**GL Jones**
Department:	**Speech-Language Pathology and Audiology**
Reference numbers:	**26018889**

Thank you for your response to the Committee's letter of 25 April 2014.

I am pleased to be able to inform you that the above application was **approved** by the **Research Ethics Committee** at an *ad hoc* meeting on9 July 2014. Data collection may therefore commence.

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 the 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 Karen Harris
Acting Chair: Postgraduate Committee &
Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:Karen.harris@up.ac.za

Appendix A-2: Ethical clearance certificate from the Gauteng Department of Health

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

OUTCOME OF PROVINCIAL PROTOCOL REVIEW COMMITTEE (PPRC)

Researcher's Name (Principal investigator)	Gail Lorna Jones
Organization / Institution	University of Pretoria
Research Title	Tone variation in Tswana-speaking individual's: The effect of voice disorders
Protocol number	P030414
Date submitted	01/04/2014
Date reviewed	05/30/2014
Outcome	APPROVED
Date resubmitted	N/A
Date of second review	N/A
Final outcome	N/A

It is a pleasure to inform that the Gauteng Health Department has approved your research on "Tone variation in Tswana-speaking individuals: The effect of voice disorders ".

The Provincial Protocol Review Committee kindly requests that you to submit a report after completion of your study and present your findings to the Gauteng Health Department.

Approves / ~~not approves~~

Dr. B Ikalafeng
Research and epidemiology Manager
Date 23/06/2014

Appendix A-3: Letters requesting permission to conduct research: Head of Departments

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Faculty of Humanities
Department of Communication Pathology

13 June 2013

Dr Sadna Balton
Head of Department: Speech Therapy and Audiology
Chris Hani Baragwanath Academic Hospital

Dear Dr Balton

Letter of permission to conduct research in the Speech Therapy and Audiology Department

I am a post-graduate student enrolled for the M. Communication Pathology Degree at the Department of Communication Pathology, University of Pretoria. The title of my study is: **Tone variation in Tswana speaking individuals: The effect of voice disorders.**

It would be greatly appreciated if you would allow me the opportunity to conduct my research in the Speech Therapy and Audiology Department, at Chris Hani Baragwanath Academic Hospital. The aim of my study is to determine the effect of a voice disorder on an individual's ability to produce vocal tone variations that are necessary for conveying the meaning of a word in tone languages. The study applies specifically to tone-language speakers. For the purposes of my study, I will be investigating tone variation in Tswana speaking individuals with a voice disorder.

It will be necessary to obtain at least 15 Tswana-speaking participants between the ages of 20 and 60 years who have a voice disorder. Patients who have been referred to this department will be involved in the study. They will be required to participate in a case history interview, a hearing screening evaluation and a short task requiring them to produce a set of 20 words in Tswana. During this task, their responses will be recorded using a dictaphone for analysis. The results of an ear-, nose- and throat examination by an ENT specialist will be noted to determine the nature of the voice disorder. In addition to the 15 participants with a voice disorder, another 5 Tswana-speaking individuals who do not have a voice disorder (family members of the participants), will be requested to participate in the same procedure as mentioned above to constitute a control group. Finally, 10 Tswana-speaking individuals who work in Speech Therapy and Audiology Department and other out-patient departments, will be requested to act as listeners for the study.

The entire process should not take longer than about 30 minutes and participants will be given adequate rest periods and a refreshment should it be necessary. A letter of informed consent will be provided to each participant explaining the aims and procedures of the study. It will also be explained that participation in the study is completely voluntary and that there will be no negative consequences should they wish to withdraw from the study at any time. In order to maintain privacy and confidentiality, the names of participants will not be published with the results of the study. Instead, identity codes will be allocated to each participant as a means of identification.

Data collection will not take place during the researcher's normal working hours but will be done during a period of approved annual/study leave. It is requested that one room be made available in the Department of Speech Therapy and Audiology for data collection to take place.

University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel: 012 420 2355
Fax: 012 420 3517

anita.vandermerwe@up.ac.za
www.up.ac.za

Should you grant permission for this research study to take place in your department, kindly fill in the attached consent form indicating your consent to commence with the research project.

Thank you for showing interest in this research project. Should you have any queries, please contact me on 0720213339 or via email at gaillornajones@gmail.com.

Yours sincerely

Gail L. Jones
Speech Therapist & Audiologist

Professor Anita van der Merwe
Dept. of Communication Pathology

Professor Bart Vinck
Head: Dept. of Communication Pathology

University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel: 012 420 2355
Fax: 012 420 3517

bart.vinck@up.ac.za
www.up.ac.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

19 January 2015

Mrs Ntsatsi Mokushane
Head of Department: Speech Therapy and Audiology
Tembisa Hospital

Dear Mrs Mokushane

Letter of permission to conduct research in the Speech Therapy and Audiology department

I am a post-graduate student enrolled for the M. Communication Pathology Degree at the Department of Speech-Language Pathology and Audiology, University of Pretoria. The title of my study is: **Tone variation in Tswana speaking individuals: The effect of voice disorders.**

It would be greatly appreciated if you would allow me the opportunity to conduct my research in the Speech Therapy and Audiology Department, at Tembisa Hospital. The aim of my study is to determine the effect of a voice disorder on an individual's ability to produce vocal tone variations that are necessary for conveying the meaning of a word in tone languages. The study applies specifically to tone-language speakers. For the purposes of my study, I will be investigating tone variation in Tswana speaking individuals with a voice disorder.

It will be necessary to obtain at least 15 Tswana-speaking participants between the ages of 20 and 60 years who have a voice disorder. Patients who have been referred to this department will be involved in the study. They will be required to participate in a case history interview, a hearing screening evaluation and a short task requiring them to produce a set of 32 words in Tswana. During this task, their responses will be recorded using an audio recorder for analysis. The results of an ear-, nose- and throat examination by an ENT specialist will be noted to determine the nature of the voice disorder. In addition to the 15 participants with a voice disorder, another 10 Tswana-speaking individuals who do not have a voice disorder (family members of the participants), may be requested to participate in the same procedure as mentioned above to constitute a control group.

The entire process should not take longer than about 30-45 minutes and participants will be given adequate rest periods and refreshment should it be necessary. A letter of informed consent will be provided to each participant explaining the aims and procedures of the study. It will also be explained that participation in the study is completely voluntary and that there will be no negative consequences should they wish to withdraw from the study at any time. In order to maintain privacy and confidentiality, the names of participants will not be published with the results of the study. Instead, identity codes will be allocated to each participant as a means of identification.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac..za
www.up.ac.za

It is requested that one room be made available in the Department of Speech Therapy and Audiology for data collection to take place as well as 5 minutes use of an audio booth in order to perform a short hearing screening test.

Should you grant permission for this research study to take place in your department, kindly fill in the attached consent form indicating your consent to commence with the research project. Please also see the attached documents from the Research Ethics Committee of the University of Pretoria and an ethical clearance certificate from the Gauteng Department of Health.

Thank you for showing interest in this research project. Should you have any queries, please contact me on 0720213339 or via email at gaillornajones@gmail.com.

Yours sincerely

Gail L. Jones
Speech Therapist & Audiologist

Professor Anita van der Merwe
Dept. of Speech-Language Pathology and Audiology

Professor Bart Vinck
HEAD: Dept. of Speech-Language Pathology and Audiology

Consent from the Head of Department: Speech Therapy and Audiology at Tembisa Hospital

I, _____ (Head of Department: Speech Therapy and Audiology) hereby agree to allowing Gail Jones to conduct her post-graduate research study in the Department of Speech Therapy and Audiology at Tembisa Hospital. I acknowledge the fact that patients who attend the out-patient clinic will be used as participants of the study on a completely voluntary basis. I am aware of the fact that the data collection procedure should not take longer than approximately thirty to forty-five minutes. It is also acknowledge that all data collection procedures will be structured in such a way as to not interrupt service delivery within the Speech Therapy and Audiology Department in any way. I am aware of the fact that all research data will be securely stored at the University of Pretoria for a minimum of 15 years.

_____
Signature: Mrs Ntsatsi Mokushane

_____
Date

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

19 January 2015

Mrs A. Lloyd-Jones
Head of Department: Speech Therapy and Audiology
Steve Biko Academic Hospital

Dear Mrs Lloyd-Jones

Letter of permission to conduct research in the Speech Therapy and Audiology department

I am a post-graduate student enrolled for the M. Communication Pathology Degree at the Department of Speech-Language Pathology and Audiology, University of Pretoria. The title of my study is: **Tone variation in Tswana speaking individuals: The effect of voice disorders.**

It would be greatly appreciated if you would allow me the opportunity to conduct my research in the Speech Therapy and Audiology Department, at Steve Biko Academic Hospital. The aim of my study is to determine the effect of a voice disorder on an individual's ability to produce vocal tone variations that are necessary for conveying the meaning of a word in tone languages. The study applies specifically to tone-language speakers. For the purposes of my study, I will be investigating tone variation in Tswana speaking individuals with a voice disorder.

It will be necessary to obtain at least 15 Tswana-speaking participants between the ages of 20 and 60 years who have a voice disorder. Patients who have been referred to this department will be involved in the study. They will be required to participate in a case history interview, a hearing screening evaluation and a short task requiring them to produce a set of 32 words in Tswana. During this task, their responses will be recorded using an audio recorder for analysis. The results of an ear-, nose- and throat examination by an ENT specialist will be noted to determine the nature of the voice disorder. In addition to the 15 participants with a voice disorder, another 10 Tswana-speaking individuals who do not have a voice disorder (family members of the participants), may be requested to participate in the same procedure as mentioned above to constitute a control group.

The entire process should not take longer than about 30-45 minutes and participants will be given adequate rest periods and refreshment should it be necessary. A letter of informed consent will be provided to each participant explaining the aims and procedures of the study. It will also be explained that participation in the study is completely voluntary and that there will be no negative consequences should they wish to withdraw from the study at any time. In order to maintain privacy and confidentiality, the names of participants will not be published with the results of the study. Instead, identity codes will be allocated to each participant as a means of identification.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac..za
www.up.ac.za

It is requested that one room be made available in the Department of Speech Therapy and Audiology for data collection to take place as well as 5 minutes use of an audio booth in order to perform a short hearing screening test.

Should you grant permission for this research study to take place in your department, kindly fill in the attached consent form indicating your consent to commence with the research project. Please also see the attached documents from the Research Ethics Committee of the University of Pretoria and an ethical clearance certificate from the Gauteng Department of Health.

Thank you for showing interest in this research project. Should you have any queries, please contact me on 0720213339 or via email at gaillornajones@gmail.com.

Yours sincerely

Gail L. Jones
Speech Therapist & Audiologist

Professor Anita van der Merwe
Dept. of Speech-Language Pathology and Audiology

Professor Bart Vinck
HEAD: Dept. of Speech-Language Pathology and Audiology

Consent from the Head of Department: Speech Therapy and Audiology at Steve Biko Academic Hospital

I, _____ (Head of Department: Speech Therapy and Audiology) hereby agree to allowing Gail Jones to conduct her post-graduate research study in the Department of Speech Therapy and Audiology at Steve Biko Academic Hospital. I acknowledge the fact that patients who attend the out-patient clinic will be used as participants of the study on a completely voluntary basis. I am aware of the fact that the data collection procedure should not take longer than approximately thirty to forty-five minutes. It is also acknowledge that all data collection procedures will be structured in such a way as to not interrupt service delivery within the Speech Therapy and Audiology Department in any way. I am aware of the fact that all research data will be securely stored at the University of Pretoria for a minimum of 15 years.

_____
Signature: Mrs A. Lloyd-Jones

_____
Date

Appendix A-4: Consent from Heads of Departments

Consent from the Head of Department: Speech Therapy and Audiology at Steve Biko Academic Hospital

I, Leanie Engelbrecht (Head of Department: Speech Therapy and Audiology) hereby agree to allowing Gail Jones to conduct her post-graduate research study in the Department of Speech Therapy and Audiology at Steve Biko Academic Hospital. I acknowledge the fact that patients who attend the out-patient clinic will be used as participants of the study on a completely voluntary basis. I am aware of the fact that the data collection procedure should not take longer than approximately thirty to forty-five minutes. It is also acknowledge that all data collection procedures will be structured in such a way as to not interrupt service delivery within the Speech Therapy and Audiology Department in any way. I am aware of the fact that all research data will be securely stored at the University of Pretoria for a minimum of 15 years.

(Acting HOD)

Signature: Mrs A. Lloyd-Jones

04/03/2015

Date

Consent from the Head of Department: Speech Therapy and Audiology at Tembisa Hospital

I, Ntsatsi Mokushane (Head of Department: Speech Therapy and Audiology) hereby agree to allowing Gail Jones to conduct her post-graduate research study in the Department of Speech Therapy and Audiology at Tembisa Hospital. I acknowledge the fact that patients who attend the out-patient clinic will be used as participants of the study on a completely voluntary basis. I am aware of the fact that the data collection procedure should not take longer than approximately thirty to forty-five minutes. It is also acknowledge that all data collection procedures will be structured in such a way as to not interrupt service delivery within the Speech Therapy and Audiology Department in any way. I am aware of the fact that all research data will be securely stored at the University of Pretoria for a minimum of 15 years.

Mokushane .N.

Signature: Mrs Ntsatsi Mokushane

29 | May | 2015

Date

Consent from the Head of Department: Speech Therapy and Audiology at Chris Hani Baragwanath Academic Hospital

I, Dr S. Balton (Head of Department: Speech Therapy and Audiology) hereby agree to allowing Gail Jones to conduct her post-graduate research study in the Department of Speech Therapy and Audiology at Chris Hani Baragwanath Academic Hospital. I acknowledge the fact that patients who attend the out-patient clinic will be used as participants of the study on a completely voluntary basis. I am aware of the fact that the data collection procedure should not take longer than approximately thirty minutes. It is also acknowledge that all data collection procedures will be structured in such a way as to not interrupt service delivery within the Speech Therapy and Audiology Department in any way.

Signature: Dr Sadna Balton

24/03/2015

Date

University of Pretoria
PRETORIA 0002
Republic of South Africa

Tel: 012 420 2355
Fax: 012 420 3517

bart.vinck@up.ac.za
www.up.ac.za

Appendix A-5: Clearance from hospital's ethics committee

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 16th February 2015

TITLE OF PROJECT:

Tone Variation in Tswana-speaking Individuals: The Effect of Voice Disorders

UNIVERSITY: PRETORIA

Principal Investigator: G L JONES

Department: Speech Therapy and Audiology

Supervisor : Prof A Van der Merwe

Permission Head Department (where research conducted): Yes

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Academic Hospital. The CEO / management of Chris Hani Baragwanath Academic Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- The Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- The MAC will be informed of any serious adverse events as soon as they occur
- Permission is granted for the duration of the Ethics Committee Approval.

Recommended
(On behalf of the MAC)
Date: 16/02/2015

Approved/Not Approved
Hospital Management
Date: 04/03/15

Appendix A-6: Letter of consent for experimental and control participants

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

March 2015

Dear Participant

Thank you for showing interest in my research project. I am a post-graduate student enrolled for the M. Communication Pathology Degree at the Department of Speech-Language Pathology and Audiology, University of Pretoria. The title of my study is: **The effect of voice disorders in Tswana speaking individuals.**

What will be expected of you should you agree to participate?

After informed consent has been obtained, you will be requested to participate in the following procedures:

- A case history interview in order to obtain information regarding your medical history, voice history and biographical details.
- A task requiring you to read and produce a set of 32 words in Tswana. We will go through these words before we make a recording.
- A hearing screening will be conducted to obtain hearing thresholds. This should not take longer than 10 minutes. Should the results of the hearing screening evaluation indicate that you have a hearing loss, you will be given an appointment for a diagnostic hearing test and you will be excluded from the research study.

Risks and discomfort

There are no risks involved in the above mentioned tasks. Although it may be possible that you experience some vocal fatigue or discomfort associated with increased voice use in the presence of a voice disorder. Should this be the case, you will be given ample time to rest your voice by taking breaks when necessary and obtain a drink of water. If you feel that you cannot continue with the testing, you may agree to come back on another day for completion of the task.

What will happen with the collected data?

All of the information and results obtained from the interview and testing procedures will be kept highly confidential and will only be seen by the researcher. You will be assigned a code number which will be used in place of your personal identifying information. The results of the study will be published in a journal article with only the corresponding code number visible to readers.

Participant's rights

Involvement in the study is completely voluntary and you will be required to sign a consent form agreeing to participate in the study. At any time throughout the study, you have the right to withdraw participation for whatever reason without any negative consequences. Results of the study will be made available to you should you request it.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac..za
www.up.ac.za

The data obtained from this research study will be securely stored for a minimum of fifteen years in the archives room of the Department of Speech-Language Pathology and Audiology, University of Pretoria. Should this data be used again in future for further research, permission will be obtained directly from the participant.
Should you have any further queries, please feel free to contact me on (011) 933 9263/5 or 0720213339 during office hours.

Yours sincerely

Gail L. Jones
M. Communication Pathology student

Professor Anita Van der Merwe
Supervisor

Professor Bart Vinck
Head: Department of Speech-Language Pathology and Audiology

Consent from the participant

I, _____ (full name and surname of participant) hereby agree to participate in the research study entitled: **The effect of voice disorders in Tswana speaking individuals.** I acknowledge the fact that my participation in this research is entirely voluntary and that I may choose to withdraw from participation at any stage. I am aware of the fact that my personal and biographical information will be kept completely confidential.

_____
Signature: Participant

_____
Date

Appendix A-7: Letter of consent for judges

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

March 2015

Dear Participant

Thank you for showing interest in my research project. I am a post-graduate student enrolled for the M. Communication Pathology Degree at the Department of Speech-Language Pathology and Audiology, University of Pretoria. The title of my study is: **The effect of voice disorders in Tswana speaking individuals**

What will be expected of you should you agree to participate?

After informed consent has been obtained, you will be requested to participate in the following procedures:

- A hearing screening will be conducted to obtain hearing thresholds. This should not take longer than 10 minutes. Should the results of the hearing screening evaluation indicate that you have a hearing loss, you will be given an appointment for a diagnostic hearing test and you will be excluded from the research study.
- You will be requested to listen to a set of 37 Tswana words, each produced by 25 individuals. A sheet will be provided with two English definitions for each word and you are requested to mark which word out of the two options you heard. This should not take longer than 1 hour.

Risks and discomfort

There are no risks involved in the above mentioned tasks. It may be possible that you experience some mental fatigue associated with listening and concentrating. Should this be the case, you will be given ample time to rest before continuing. If you feel that you cannot continue with the listening process, you may agree to come back on another day for completion of the task.

What will happen with the collected data?

All of the information and results obtained from the interview and testing procedures will be kept highly confidential and will only be seen by the researcher. You will be assigned a code number which will be used in place of your personal identifying information. The results of the study will be published in a journal article with only the corresponding code number visible to readers.

Participant's rights

Involvement in the study is completely voluntary and you will be required to sign a consent form agreeing to participate in the study. At any time throughout the study, you have the right to withdraw participation for whatever reason without any negative consequences. Results of the study will be made available to you should you request it.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac..za
www.up.ac.za

The data obtained from this research study will be securely stored for a minimum of fifteen years in the archives room of the Department of Speech-Language Pathology and Audiology, University of Pretoria. Should this data be used again in future for further research, permission will be obtained directly from the participant.

Should you have any further queries, please feel free to contact me on (011) 933 9263/5 or 0720213339 during office hours.

Yours sincerely

Gail L. Jones
M. Communication Pathology student

Professor Anita Van der Merwe
Supervisor

Professor Bart Vinck
Head: Department of Speech-Language Pathology and Audiology

Consent from the participant

I, _____ (full name and surname of participant) hereby agree to participate in the research study entitled: **The effect of voice disorders in Tswana speaking individuals.** I acknowledge the fact that my participation in this research is entirely voluntary and that I may choose to withdraw from participation at any stage. I am aware of the fact that my personal and biographical information will be kept completely confidential.

_____
Signature: Participant

_____
Date

Appendix A-8: Letters of consent translated into Tswana

March 2015

Motsayakarolo yo o rategang

Ke go lebogela go bontsha kgatlhego ya go tsaya karolo mo thutong ya me ya dipatlisiso. Ke mothuti wa dithuto tsa morago ga gerata mme ke ikwadiseditse gerata ya the M. Communication Pathology, mo lefapheng la Speech-Language Pathology and Audiology, University of Pretoria. **Setlhogo sa thuto ya me ke: Go farologana ga digalo magareng ga batho bao ba buang Setswana: Ditlamorago tsa bogole ba mantswe**.

Maikaelelo a thuto

Maikaelelo a thuto ke go tlhomamisa ditlamorago tsa bogole jwa mantswe ka bokgoni ba gago ba go farologanya bogodimo ba lentswe la gago le go dira dipharologanyo tsa segalo, tse di leng botlhokwa mo go tliseng bokao jwa mafoko.

Go tlhokega eng fa o dumela go tsaya karolo

Morago ga go bonwa ga tetla, o tla kopiwa go tsaya karolo mo ditirwaneng tse di latelang:

- Dipotsolotso go bona hisetori ya gago ya tsa pholo, hisetori ya lentswe le dintlha tsa gago tsa bonno.
- Thaseke e e go tlhokang go buisa dibedi tsa mafoko a le 37 a Setswana.
- Go tla dirwa teko ya kutlwelelo go dira ditlhatlhobo tse di mabapi. Seno gankitla se feta bokana ka metsotso e le 10 go ya go e le 15. Fa ditlhatlhobo tseno tsa kutlo di ka bontsha fa o latlhegetswe ke kutlo, o tla neelwa letsatsi leo ka lona o tla tshwanelwang ke go dira ditlhatlhobo tsa kalafo mabapi le kutlo mme gankitla o akarediwa mo thutong ya dipatlisiso.

Matshosetsi le go utlwa botlhoko

Ga go matshosetsi a a ka nnang teng mo ditirwaneng tse di tlhalositsweng fa godimo. Le fa e le gore o ka itemogela go lapa ga lentswe kgotsa go se ikutlwe sentle ka ntlha ya tiriso e e oketsegileng ya lentswe mme e le gore o na le bogole ba lentswe. Fa go ka nna jalo, o tla newa nako e e lekaneng ya go kgwa mowa fa go tlhokega le go nwa metsi. Fa o ikutlwa gore ga o kgone go tswelela ka diteko, o ka nna wa boa letsatsi lengwe go tla go feleletsa thaseke.

Go tla diragalang ka tshedimosetso e e kokoantsweng?

Tshedimosetsi yotlhe e e kokoantsweng go tswa mo dipotsolotsong e tla tsholwa e le ya sephiri mme e tla bonwa fela ke mmatlisisi. O tla neelwa khoutu eo e tla diriswang mo boemong jwa dintlha tsa gago tsa boitshupo. Dipoelo tsa thuto di tla phasaladiwa mo atikeleng ya jenale eo e tla beng e na fela le dikhoutu e seng maina a batho.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac..za
www.up.ac.za

Ditshiamelo tsa motsayakarolo

Botsayakarolo mo thutong ga bo gapelediwe mme o tla tshwanelwa ke go saena foromo ya tetla fa o dumela go tsaya karolo. O ka ikgogela morago nako nngwe le nngwe fela ka ntlha ya mabaka a gago ntle le ditlamorago dipe tse di sa siamang. O tla neelwa dipoelo tsa thusto fa o ka di kopa.

Kitso kgobokanyo e e tla sireletswa mengwaga ee kannang some le botlhano mo lefapheng la Speech-Language Pathology and Audiology, University of Pretoria. Ga re ka tlhoka go dirisa kitso kgobo kanyo ee gape mo bokamosong go dira dipatlisisa, tetla e tla kopiwa go motsaya karolo.

Fa o ka nna le dipotso tse dingwe gape, gololosega go ka ikgolaganya le nna mo go (011) 933 9263/5 kgotsa 0720213339 ka nako ya tiro.

Ke nna

Gail L. Jones
(Speech Therapist & Audiologist)

Moporofesara Anita Van der Merwe
Professor: Department of Speech-Language Pathology and Audiology

Moporofesara Bart Vinck
Head: Department of Speech-Language Pathology and Audiology

March 2015

Motsayakarolo yo o rategang

Ke go lebogela go bontsha kgatlhego ya go tsaya karolo mo thutong ya me ya dipatlisiso. Ke mothuti wa dithuto tsa morago ga gerata mme ke ikwadiseditse gerata ya the M. Communication Pathology, mo lefapheng la Speech-Language Pathology and Audiology, University of Pretoria. **Setlhogo sa thuto ya me ke: Ditlamorago tsa bogole ba mantswe magareng ga batho bao ba buang Setswana**

Maikaelelo a thuto

Maikaelelo a thuto ke go tlhomamisa ditlamorago tsa bogole jwa mantswe ka bokgoni ba gago ba go farologanya bogodimo ba lentswe la gago le go dira dipharologanyo tsa segalo, tse di leng botlhokwa mo go tliseng bokao jwa mafoko.

Go tlhokega eng fa o dumela go tsaya karolo

Morago ga go bonwa ga tetla, o tla kopiwa go tsaya karolo mo ditirwaneng tse di latelang:

- Go tla dirwa teko ya kutlwelelo go dira ditlhatlhobo tse di mabapi. Seno gankitla se feta bokana ka metsotso e le 10 go ya go e le 15. Fa ditlhatlhobo tseno tsa kutlo di ka bontsha fa o latlhegetswe ke kutlo, o tla neelwa letsatsi leo ka lona o tla tshwanelwang ke go dira ditlhatlhobo tsa kalafo mabapi le kutlo mme gankitla o akarediwa mo thutong ya dipatlisiso.
- O tla kopiwa go reetsa dibedi tsa mafoko a Setswana di le 37, mme sebedi sengwe le sengwe se builwe ke batho ba le 25. O tla neelwa letlakala leo le nang le ditlhaloso di le pedi tsa Sekgowa tsa lefoko lengwe le lengwe mme wena o tla tshwanela ke go tshwaya lefoko le o le utlwileng go tswa go mo go a mabaedi. Se Se kase tseye metsotso ele masome a matlhano.

Matshosetsi le go utlwa botlhoko

Ga go matshosetsi a a ka nnang teng mo ditirwaneng tse di tlhalositsweng fa godimo. Le fa e le gore o ka itemogela go lapa ga tlhaloganyo ka ntlha ya go reetsa ka tlhoafalo. Fa go ka nna jalo, o tla newa nako e e lekaneng pele o tswela pele. Fa o ikutlwa gore ga o kgone go tswelela ka dikutlweleo, o ka nna wa boa letsatsi lengwe go tla go feleletsa thaseke.

Go tla diragalang ka tshedimosetso e e kokoantsweng?

Tshedimosetsi yotlhe e e kokoantsweng go tswa mo dipotsolotsong e tla tsholwa e le ya sephiri mme e tla bonwa fela ke mmatlisisi. O tla neelwa khoutu eo e tla diriswang mo boemong jwa dintlha tsa gago tsa boitshupo. Dipoelo tsa thuto di tla phasaladiwa mo atikeleng ya jenale eo e tla beng e na fela le dikhoutu e seng maina a batho.

Communication Pathology Building
Dept. of Speech-Language Pathology and Audiology
Corner of Lynnwood Road and Roper Street, Hatfield
Private Bag X20, Hatfield, 0028
University of Pretoria
PRETORIA
Republic of South Africa

Tel: 012 420 2948
Fax: 012 420 3517

Jeannie.vanderlinde@up.ac.za
www.up.ac.za

Ditshiamelo tsa motsayakarolo

Botsayakarolo mo thutong ga bo gapelediwe mme o tla tshwanelwa ke go saena foromo ya tetla fa o dumela go tsaya karolo. O ka ikgogela morago nako nngwe le nngwe fela ka ntlha ya mabaka a gago ntle le ditlamorago dipe tse di sa siamang. O tla neelwa dipoelo tsa thusto fa o ka di kopa.

Kitso kgobokanyo e e tla sireletswa mengwaga ee kannang some le botlhano mo lefapheng la Speech-Language Pathology and Audiology, University of Pretoria. Ga re ka tlhoka go dirisa kitso kgobo kanyo ee gape mo bokamosong go dira dipatlisisa, tetla e tla kopiwa go motsaya karolo.

Fa o ka nna le dipotso tse dingwe gape, gololosega go ka ikgolaganya le nna mo go (011) 933 9263/5 kgotsa 0720213339 ka nako ya tiro.

Ke nna

Gail L. Jones
Speech Therapist & Audiologist

Moporofesara Anita Van der Merwe
Professor: Department of Speech-Language Pathology and Audiology

Moporofesara Bart Vinck
Head: Department of Speech-Language Pathology and Audiology

Appendix A-9: Participants' informed consent form (English and Tswana)

Consent from the participant

I, _____ (full name and surname of participant) hereby agree to participate in the research study entitled: **The effect of voice disorders in Tswana speaking individuals.** I acknowledge the fact that my participation in this research is entirely voluntary and that I may choose to withdraw from participation at any stage. I am aware of the fact that my personal and biographical information will be kept completely confidential.

_____
Signature: Participant

_____
Date

Tetla go tswa go motsayakarolo

Nna, _____)leina ka botlalo le sefane sa motsayakarolo) ke dumela go tsaya karolo mo thutong ya dipatlisiso e e bidiwang **The effect of voice disorders in Tswana-speaking individuals (Go farologana ga digalo magareng ga batho bao ba buang Setswana: Ditlamorago tsa bogole ba mantswe). Ke dumela gore botsayakarolo jwa me mo thutong eno ya dipatlisiso ga bo gapelediwe le gore nka ikgogela morago ka nako nngwe le nngwe fela. Ke lemoga gore dintlha tsa me tsa bonno di tla tsholwa e le sephiri.**

_____
Tshaeno ya motsayakarolo.

_____
Letlha

Appendix B-1: Data collection sheet: Questionnaire for control participants and judges

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Data collection sheet: Control participant/Listener

For official use:

Date:_____

Section A: Biographical information

1. Participant number: V1 ☐☐
2. Date of birth: _____ (dd/mm/yy) V2 ☐☐☐☐☐☐

3. Residential area (town/city) where you grew up: V3 ☐☐

_____

4. Residential area (town/city) where you currently live: V4 ☐☐

_____

5. What is your gender? (please circle) V5 ☐

Male	1
Female	2

6. Telephone numbers:_____

7. What is your **home** (first) language? (please circle) V6 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

For official use:

7a. How often do you speak this **first** language? (please circle) V7 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

8. What is your **second** language? (please circle) V8 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

8a. How often do you speak this **second** language? (please circle) V9 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

For official use:

8b. When were you first exposed to this **second** language? (please circle)

V10 ☐

From birth/ very young age	1
In primary school	2
In high school	3
After high school/ after 18 years of age	4

9. What is your **third** language? (please circle)

V11 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

9a. How often do you speak this **third** language? (please circle)

V12 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

9b. When were you first exposed to this **third** language? (please circle)

V13 ☐

From birth/ very young age	1
In primary school	2
In high school	3
After high school/ after 18 years of age	4

For official use:

Section B: Educational background

10. What is your highest level of education obtained? (please circle) V14

No formal schooling	1
Primary school (less than grade 8)	2
Grade 8-10	3
Grade 11-12	4
Diploma/Degree	5
Postgraduate qualification	6

11. In what language were you educated? (please circle) V15

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

12. What is your reading ability in Tswana? (Please circle) V16

Poor	1
Fair	2
Good	3

13. What is your writing ability in Tswana? (Please circle) V17

Poor	1
Fair	2
Good	3

For official use:

Section C: Medical background

14. Do you have any of the following conditions?

V18 ☐

Speech disorder	1
Language disorder	2
Voice disorder	3

Section D: Screening Audiogram (to be filled in by researcher)

15. Otoscopic evaluation:

Left:	Right:

16. Pure tone thresholds:

Frequency	**Left ear threshold**	**Right ear threshold**
500Hz		
1000Hz		
2000Hz		

Pass	1	Refer	2

V19 ☐

Appendix B-2: Data collection sheet: Questionnaire for experimental participants

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Data collection sheet: Experimental participant

For official use:

Date:_____

Section A: Biographical information

1. Participant number: V1 ☐☐
2. Date of birth: _____ (dd/mm/yy) V2 ☐☐☐☐☐☐

3. Residential area (town/city) where you grew up: V3 ☐☐

_____

4. Residential area (town/city) where you currently live: V4 ☐☐

_____

5. What is your gender? (please circle) V5 ☐

Male	1
Female	2

6. Telephone numbers:_____

7. What is your **home** (first) language? (please circle) V6 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

For official use:

7a. How often do you speak this **home** language? (please circle)

V7 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

8. What is your **second** language? (please circle)

V8 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

8a. How often do you speak this **second** language? (please circle)

V9 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

For official use:

8b. When were you first exposed to this **second** language? (please circle) V10 ☐

From birth/ very young age	1
In primary school	2
In high school	3
After high school/ after 18 years of age	4

9. What is your **third** language? (please circle) V11 ☐

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

9a. How often do you speak this **third** language? (please circle) V12 ☐

All day, every day	1
Most of the day	2
Half of the day	3
Less than half of the day	4
Occasionally in a week	5

9b. When were you first exposed to this **third** language? (please circle) V13 ☐

From birth/ very young age	1
In primary school	2
In high school	3
After high school/ after 18 years of age	4

For official use:

Section B: Educational background

10. What is your highest level of education obtained? (please circle) V14

No formal schooling	1
Primary school (less than grade 8)	2
Grade 8-10	3
Grade 11-12	4
Diploma/Degree	5
Postgraduate qualification	6

11. In what language were you educated? (please circle) V15

Setswana	1
Sepedi	2
isiZulu	3
English	4
Afrikaans	5
Venda	6
Ndebele	7
Xhosa	8
Southern Sotho	9
SiSwati	10
Tsonga	11
Other:	12

12. What is your reading ability in Tswana? (Please circle) V16

Poor	1
Fair	2
Good	3

13. What is your writing ability in Tswana? (Please circle) V17

Poor	1
Fair	2
Good	3

For official use:

Section C: Medical background

14. Do you have any of the following conditions?

V18

Reflux (GORD)	1
Sinusitis	2
Allergies	3
Post-nasal drip	4
Laryngitis	5
Chronic colds	6
Psychological conditions	7
Speech/language disorder	8
Other:	9

15. What medications do you take?

V19

Section D: Voice History (16 -24 to be filled in by researcher)

16. Type of voice disorder

V20 ☐

Primary Organic	1
Secondary Organic	2
Psychogenic	3
Specify type of vocal pathology:	

17. Date of onset of voice disorder

V21 ☐

1-4 weeks ago	1
1-3 months ago	2
3-6 months ago	3
1-2 years ago	4
> 2 years ago	5
> 5 years ago	6

18. When was the voice disorder diagnosed?_____ (dd/mm/yy)

V22

For official use:

19. Has your voice changed?

V23 ☐

Stayed the same	1
Worsened	2
Improved	3
Fluctuates	4

20. IDL/flexible scope findings:

21. Previous ENT management

V24 ☐

Surgical	1
Medical	2
Specify:	

22. GRBASI results: (circle)

G	0	1	2	3
R	0	1	2	3
B	0	1	2	3
A	0	1	2	3
S	0	1	2	3
I	0	1	2	3

V25	
V26	
V27	
V28	
V29	
V30	

Section E: Screening Audiogram (to be filled in by researcher)

23. Otoscopic evaluation:

Left:	Right:

24. Pure tone thresholds:

Frequency	**Left ear threshold**	**Right ear threshold**
500Hz		
1000Hz		
2000Hz		

Pass	1	Refer	2

V31 ☐

Appendix C-1: Initial Tswana list of 45 minimal pairs

Initial Tswana word list – 45 minimal pairs (page 1)

	Word	Tone	Word description	English definition
1.	thaka	LH	Noun, Cl. 9, Singular	Companion; mate; pal
	“	LL	Noun, Cl. 9, Singular	Pupil of the eye
2.	go sêlwa	LL	Verb	To gather; pick up; find
	“	HL	Verb	To oversleep; wake late
3.	go phaka	LL	Verb	To eat quickly and greedily
	“	HL	Verb	To obstruct by standing the way (eg. Doorway)
4.	papa	LH	Noun, Cl. 1a, singular	Father
	“	HL	Noun, Cl 9, singular	Porridge
5.	pata	LL	Noun, Cl 9, singular	Pocket in a shirt, skirt or trousers
	“	HL	Noun, Cl 9, singular	Wide main road
6.	leboa	LLL	Noun, Cl 5, singular	Edible mushroom
	“	LHL	Noun, Cl 5, singular	An open, treeless plain
7.	mabôkô	LLH	Noun, Cl 6, plural	Brains
	“	LLL	Noun, cl 6, plural	Praise poems
8.	mafatlha	LHL	Noun, cl 6, plural	Twins
	“	LLL	Noun, cl 6, plural	Lungs; chest
9.	mafulô	LLL	Noun, cl 6, plural	Pastures
	“	LHL	Noun, cl 6, plural	Types of foam; froth
10.	mokôtla	LLL	Noun, cl 3, singular	Backbone; spine; back
	“	LHH	Noun, cl 3, singular	Purse; bag; sack
11.	molala	LLL	Noun, cl 3, singular	Neck (especially of a mammal)
	“	LHH	Noun, cl 3, singular	Food left over from previous day
12.	go amoga	LLL	Verb	To deprive; take something away from someone
	“	HHH	Verb	To become pulled away; become broken off (eg. Handle of cup)
13.	babadi	LLL	Noun, cl 2, plural	People who read or count
	“	LHL	Noun, cl 2, plural	First inhabitants or settlers in a place
14.	go baka	HL	Verb (loan from Afr)	To bake bread or cake
	“	LL	verb	To praise in word or song
15.	lebala	LLL	Noun, cl 5, singular	Belly of a person from navel to just above pubes
	“	LHL	Noun, cl 5, singular	Sports field; treeless plain; large open flat area
16.	sebalamakgolo	LLLLLL	Noun cl 7, singular	Steps for climbing over a fence
	“	LLLLHL	Noun cl 7, singular	Calculator
17.	go bela	LL	Verb	To boil (eg. Water)
	“	HL	verb	To shout joyfully
18.	lebole	LLL	Noun cl 5, singular	Very large blanket
	“	LHL	Noun cl 5, singular	Fist
19.	go duma	LL	Verb	To roar (eg. Lion)
	“	HL	Verb (loan from Eng)	To spray with insecticide
20.	moêpi	LLL	Noun cl 1, singular	Digger; person who digs
	“	LHL	Noun cl 1, singular	Person who calls together/ convenes (a meeting)
21.	lefata	LHL	Noun cl 5, singular	y-shaped fork in the branch of a tree, where they diverge
	“	LHH	Noun cl 5, singular	Boiled sorghum
22.	go fena	HL	Verb	To bend, curve, turn upwards (pig’s snout)
	“	LL	Verb	To give in easily; lack stamina
23.	go fêra	HL	Verb	To half close (a door)
	“	LL	Verb	To bend fingers in counting; indicate numbers by hand
24.	go fora	LL	Verb	To bluff; cheat; deceive by lying
	“	HL	Verb	To feed a sick person or animal

Initial Tswana word list – 45 minimal pairs (page 2)

	Word	Tone	Word description	English definition
25.	go fuba	LL	Verb	To rest; take a break; remain in same place for a while
	"	HL	Verb	To become dwarfed; fail to grow to natural size (child or plant)
26.	go fula	LL	Verb	To graze; browse (on leaves or plants)
	"	HL	Verb	To shoot (with a gun)
27.	legala	LLL	Noun cl 5, singular	Anger; aggressive shouting/screaming
	"	LHL	Noun cl 5, singular	Ember; piece of burning coal
28.	mogôga	LHL	Noun, cl 3, singular	Drag-mark of anything which has been dragged on the ground
	"	LHH	Noun, cl 3, singular	Bovine slaughtered for funeral/feast
29.	segôgwane	LLLL	Noun cl 7, singular	Frog
	"	LHHH	Noun cl 7, singular	Velcro plant (shrub with bur-like fruit)
30.	magôgwê	LHH	Noun, Cl. 1a, singular	Honey badger
	"	LHL	Noun, Cl. 1a, singular	Solitary old male impala, kudu etc
31.	go gôpa	LL	Verb	To creep/crawl on the stomach (baby/snake)
	"	HL	Verb	To suck (from straw)
32.	go gwetla	LL	Verb	To wave to call a person
	"	HL	Verb	To scream; shriek; cry loudly
33.	leiso	LLL	Noun cl 5, singular	Large spoon; ladle
	"	LHL	Noun cl 5, singular	Fire-place; cooking-place
34.	go itshuba	HHL	Verb	To hide/conceal oneself
	"	HHH	Verb	To burn; set oneself alight
35.	go rêma	LL	verb	To curdle (milk)
	"	HL	verb	To chop, fell, cut down with an axe
36.	go balêla	HHH	Verb	To cough deeply, like when choking
	"	LLL	Verb	To count for; read for
37.	dikgare	LLL	Noun cl 10, plural	Peels, rinds of empty shell of watermelon, pumpkin etc.
	"	LHL	Noun cl 10, plural	Razor blades
38.	dikhukhu	LLL	Noun, cl 8, plural	Umbrellas
	"	LHH	Noun, cl 10, plural	Dung beetles
39.	dinoko	LLL	Noun, cl 10, plural	Joints in a cane/reed
	"	LLH	Noun, cl 10, plural	Porcupines
40.	go tsua	LL	Verb	To cut hair unevenly
	"	HL	Verb	To call goats or cattle with a whistling sound
41.	go kopa	LL	Verb	To beg; ask for
		HL	Verb	To skip; jump; hop
42.	mokui	LHL	Noun, cl 1, singular	One who shouts to a distant person to attract attention
	"	LHH	Noun, cl 1a, singular	Long-crested eagle
43.	thapô	HL	Noun, cl 9 , singular	Stone or pip of a fruit
	"	LL	Noun, cl 9 , singular	Rope; string; cord; line
44.	mosidi	LHL	Noun, cl 3, singular	Soot; burnt out coal
	"	LLL	Noun cl 1, singular	Person who grinds
45.	go fitlha	LL	Verb	To arrive
	"	HL	Verb	To hide

Appendix C-2: Pilot study 1: Questionnaire used to determine which words were commonly used

Pilot Study 1 – Questionnaire (page 1)

Is this a commonly used word in your language? (Please tick)

Word	Definition	I agree *completely*	I agree *somewhat*	I disagree
thaka	Companion; mate; pal			
thaka	Pupil of the eye			
go sêlwa	To gather; pick up; find			
go sêlwa	To oversleep; wake late			
go phaka	To eat quickly and greedily			
go phaka	To obstruct by standing in the way (eg. Doorway)			
papa	Father			
papa	Porridge			
pata	Pocket in a shirt, skirt or trousers			
pata	Wide main road			
leboa	Edible mushroom			
leboa	An open, treeless plain			
mabôkô	Brains			
mabôkô	Praise poems			
mafatlha	Twins			
mafatlha	Lungs; chest			
mafulô	Pastures			
mafulô	Types of foam; froth			
mokôtla	Backbone; spine; back			
mokôtla	Purse; bag; sack			
molala	Neck (especially of a mammal)			
molala	Food left over from previous day			
go amoga	To deprive; take something away from someone			
go amoga	To become pulled away; become broken off (eg. Handle of cup)			
babadi	People who read or count			
babadi	First inhabitants or settlers in a place			
go baka	To bake bread or cake			
go baka	To praise in word or song			
lebala	Belly of a person from navel to just above pubes			
lebala	Sports field; treeless plain; large open flat area			
sebalamakgolo	Steps for climbing over a fence			
sebalamakgolo	Calculator			
go bela	To boil (eg. Water)			
go bela	To shout joyfully			
lebole	Very large blanket			
lebole	Fist			
go duma	To roar (eg. Lion)			
go duma	To spray with insecticide			
moêpi	Digger; person who digs			
moêpi	Person who calls together/ convenes (a meeting)			
lefata	y-shaped fork in the branch of a tree, where they diverge			
lefata	Boiled sorghum			

Pilot Study 1 – Questionnaire (page 2)

Word	Definition	I agree *completely*	I agree *somewhat*	I disagree
go fena	To bend, curve, turn upwards (pig's snout)			
go fena	To give in easily; lack stamina			
go fêra	To half close (a door)			
go fêra	To bend fingers in counting; indicate numbers by hand			
go fora	To bluff; cheat; deceive by lying			
go fora	To feed a sick person or animal			
go fuba	To rest; take a break; remain in same place for a while			
go fuba	To become dwarfed; fail to grow to natural size (child or plant)			
go fula	To graze; browse (on leaves or plants)			
go fula	To shoot (with a gun)			
legala	Anger; aggressive shouting/screaming			
legala	Ember; piece of burning coal			
mogôga	Drag-mark of anything which has been dragged on the ground			
mogôga	Bovine slaughtered for funeral/feast			
segôgwane	Frog			
segôgwane	Velcro plant (shrub with bur-like fruit)			
magôgwê	Honey badger			
magôgwê	Solitary old male impala, kudu etc			
go gôpa	To creep/crawl on the stomach (baby/snake)			
go gôpa	To suck (from straw)			
go gwetla	To wave to call a person			
go gwetla	To scream; shriek; cry loudly			
leiso	Large spoon; ladle			
leiso	Fire-place; cooking-place			
go itshuba	To hide/conceal oneself			
go itshuba	To burn; set oneself alight			
go rêma	To curdle (milk)			
go rêma	To chop, fell, cut down with an axe			
go balêla	To cough deeply, like when choking			
go balêla	To count for; read for			
dikgare	Peels, rinds of empty shell of watermelon, pumpkin etc.			
dikgare	Razor blades			
dikhukhu	Umbrellas			
dikhukhu	Dung beetles			
dinoko	Joints in a cane/reed			
dinoko	Porcupines			
go tsua	To cut hair unevenly			
go tsua	To call goats or cattle with a whistling sound			
go kopa	To beg; ask for			
go kopa	To skip; jump; hop			
mokui	One who shouts to a distant person to attract attention			
mokui	Long-crested eagle			
thapô	Stone or pip of a fruit			
thapô	Rope; string; cord; line			
mosidi	Soot; burnt out coal			
mosidi	Person who grinds			
go fitlha	To arrive			
go fitlha	To hide			

Appendix C-3: Results of pilot study 1

Results of pilot study 1 (Page 1)

Tswana Word	I agree completely	I agree somewhat	I disagree	Undefined
***thaka**	91%	9%	0%	0%
***thaka**	36%	18%	45%	0%
***go sêlwa**	36%	27%	36%	0%
***go sêlwa**	91%	0%	0%	9%
go phaka	91%	0%	0%	9%
go phaka	27%	36%	36%	0%
***papa**	91%	9%	0%	0%
***papa**	64%	27%	9%	0%
pata	55%	27%	18%	0%
pata	18%	45%	27%	9%
leboa	27%	27%	27%	18%
leboa	18%	27%	36%	18%
***mabôkô**	64%	18%	9%	9%
***mabôkô**	82%	9%	0%	9%
***mafatlha**	100%	0%	0%	0%
***mafatlha**	91%	9%	0%	0%
***mafulô**	91%	0%	9%	0%
***mafulô**	45%	36%	18%	0%
***mokôtla**	82%	9%	9%	0%
***mokôtla**	82%	0%	18%	0%
***molala**	100%	0%	0%	0%
***molala**	64%	9%	27%	0%
***go amoga**	91%	9%	0%	0%
***go amoga**	45%	55%	0%	0%
babadi	100%	0%	0%	0%
babadi	9%	27%	64%	0%
***go baka**	73%	9%	18%	0%
***go baka**	82%	18%	0%	0%
lebala	9%	18%	73%	0%
lebala	100%	0%	0%	0%
sebalamakgolo	18%	9%	73%	0%
sebalamakgolo	64%	18%	18%	0%
go bela	100%	0%	0%	0%
go bela	0%	27%	64%	9%
lebole	0%	36%	64%	0%
lebole	91%	0%	9%	0%
***go duma**	91%	9%	0%	0%
***go duma**	36%	36%	18%	9%
moêpi	100%	0%	0%	0%
moêpi	9%	36%	45%	9%
lefata	18%	36%	45%	0%
lefata	36%	45%	18%	0%
go fena	64%	18%	9%	9%
go fena	0%	9%	82%	9%

*** Words which were selected to be included in the next stage of stimuli development**

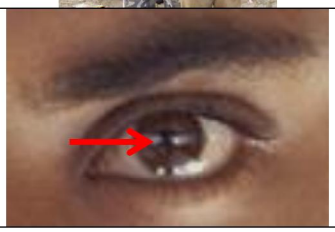
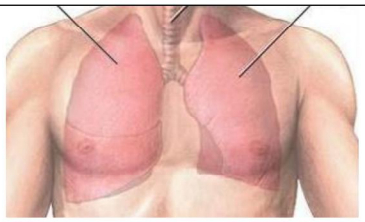
Results of pilot study 1 (Page 2)

Tswana Word	I agree completely	I agree somewhat	I disagree	Undefined
go fêra	9%	9%	64%	18%
go fêra	27%	27%	36%	9%
go fora	100%	0%	0%	0%
go fora	36%	0%	64%	0%
go fuba	0%	18%	73%	9%
go fuba	27%	27%	36%	9%
go fula	100%	0%	0%	0%
go fula	18%	18%	64%	0%
legala	18%	36%	27%	18%
legala	100%	0%	0%	0%
***mogôga**	27%	36%	36%	0%
***mogôga**	64%	18%	18%	0%
segôgwane	91%	9%	0%	0%
segôgwane	0%	36%	64%	0%
magôgwê	18%	18%	45%	18%
magôgwê	0%	36%	45%	18%
go gôpa	36%	45%	0%	18%
go gôpa	27%	36%	18%	18%
***go gwetla**	45%	18%	18%	18%
***go gwetla**	45%	27%	9%	18%
***leiso**	36%	27%	27%	9%
***leiso**	82%	18%	0%	0%
go itshuba	9%	36%	45%	9%
go itshuba	100%	0%	0%	0%
go rêma	0%	18%	82%	0%
go rêma	100%	0%	0%	0%
***go balêla**	55%	9%	36%	0%
***go balêla**	82%	18%	0%	0%
***dikgare**	64%	0%	27%	9%
***dikgare**	36%	27%	27%	9%
dikhukhu	27%	9%	45%	18%
dikhukhu	18%	18%	55%	9%
***dinoko**	45%	18%	36%	0%
***dinoko**	55%	27%	9%	9%
go tsua	45%	9%	27%	18%
go tsua	9%	18%	45%	27%
go kopa	100%	0%	0%	0%
go kopa	0%	27%	73%	0%
mokui	91%	0%	9%	0%
mokui	9%	55%	36%	0%
***thapô**	55%	18%	27%	0%
***thapô**	100%	0%	0%	0%
***mosidi**	91%	0%	9%	0%
***mosidi**	73%	27%	0%	0%
***go fitlha**	91%	9%	0%	0%
***go fitlha**	100%	0%	0%	0%

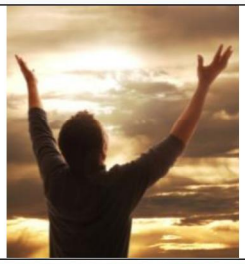
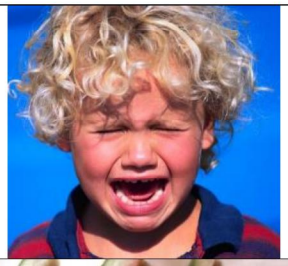
*** Words which were selected to be included in the next stage of stimuli development**

Appendix C-4: Pictures of Tswana Stimuli

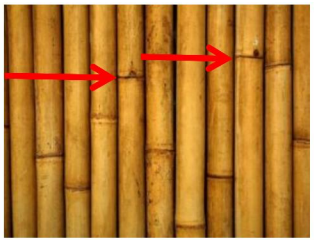
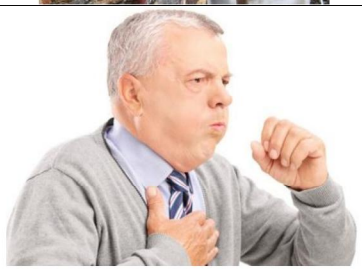
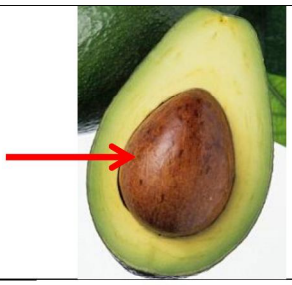
Pictures to match 20 Minimal pairs (page 1)

thaka (friend/peer)		mafatlha (twins)	
thaka (pupil of the eye)		mafatlha (chest/lungs)	
go sêlwa (pick up/find)		mafulô (foam)	
go sêlwa (oversleep)		mafulô (pastures)	
papa (father)		mokôtla (back/spine)	
papa (porridge)		mokôtla (bag/purse)	
mabôkô (brains)		molala (neck of a mammal)	

Pictures to match 20 Minimal pairs (page 2)

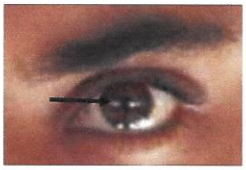
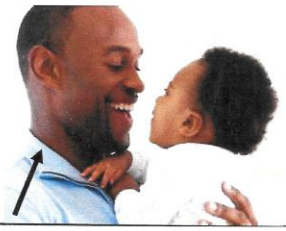
mabôkô (praise poems)		molala (left overs)	
go amoga (deprive/take away)		mogôga (drag mark in the ground)	
go amoga (to become broken off)		mogôga (Bovine slaughtered for funeral/feast)	
go baka (to bake)		go gwetla (to wave to call a person)	
go baka (to praise)		go gwetla (scream, shriek, cry loudly)	
go duma (to roar)		dikgare (peels/rinds of empty fruit/vegetable shell)	

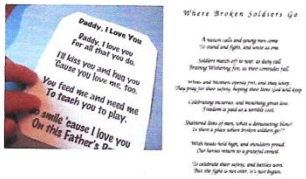
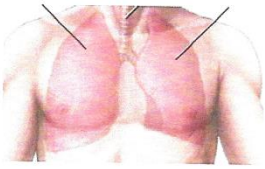
Pictures to match 20 Minimal pairs (page 3)

go duma (to spray)		dikgare (razor blades)	
leiso (large spoon/ladle)		dinoko (joints in a cane/reed)	
leiso (fire place/ cooking place)		dinoko (porcupines)	
go balêla (to choke)		thapô (stone/pip of a fruit)	
go balêla (to count for)		thapô (string/rope)	
go fitlha (to arrive)		mosidi (burnt out coal or soot)	
go fitlha (to hide)		mosidi (person who grinds)	

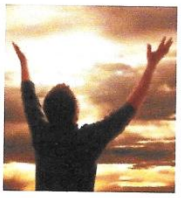
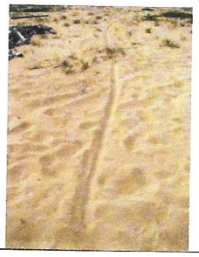
Appendix C-5: Pilot study 2: Questionnaire used to determine appropriateness of selected pictures

This a good picture to represent the given word?

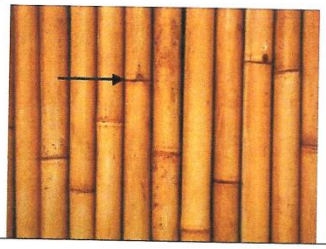
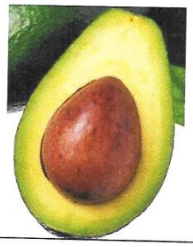
Picture	Tswana word	Answer (please tick)
1. 	thaka	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
2. 	thaka	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
3. 	go sêlwa	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
4. 	go sêlwa	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
5. 	papa	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
6. 		I agree ☐ I agree somewhat ☐ If you disagree, please state why?

7. 	mabôkô	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
8. 	mabôkô	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
9. 	mafatlha	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
10. 	mafatlha	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
11. 	mafulô	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
12. 	mafulô	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?

13. 	mokôtla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
14. 	mokôtla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
15. 	molala	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
16. 	molala	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
17. 	go amoga	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
18. 	go amoga	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?

19. 	go baka	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
20. 	go baka	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
21. 	go duma	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
22. 	go duma	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
23. 	mogôga	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
24. 	mogôga	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?

25. 	go gwetla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
26. 	go gwetla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
27. 	leiso	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
28. 	leiso	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
29. 	go balêla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
30. 	go balêla	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?

31. 	dikgare	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
32. 	dikgare	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
33. 	dinoko	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
34. 	dinoko	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
35. 	thapô	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
36. 	thapô	I agree ☐ I agree somewhat ☐ If you disagree, please state why?

37. 	mosidi	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
38. 	mosidi	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
39. 	go fitlha	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?
40. 	go fitlha	I agree ☐ I agree somewhat ☐ I disagree ☐ If you disagree, please state why?

Appendix C-6: Results of pilot study 2

Results of Pilot Study 2 (page 1)

Word	I agree	I agree somewhat	I disagree	Reason for not marking 'I agree' (number of participants)
thaka	100%	0%	0%	
thaka	100%	0%	0%	
go sêlwa	40%	10%	50%	4x incorrect spelling (should be 'sela'); 1x incorrect word (should be 'go lema'); 1x no reason
go sêlwa	100%	0%	0%	
papa	100%	0%	0%	
papa	80%	0%	20%	1x incorrect picture (“picture must show firm pap, not porridge”); 1x incorrect word
mabôkô	100%	0%	0%	
mabôkô	100%	0%	0%	1x all responses left blank
mafatlha	100%	0%	0%	
mafatlha	100%	0%	0%	
mafulô	100%	0%	0%	
mafulô	100%	0%	0%	
mokôtla	100%	0%	0%	
mokôtla	100%	0%	0%	
molala	100%	0%	0%	
molala	70%	10%	20%	3x incorrect word (should be 'malatsa')
*go amoga	100%	0%	0%	
*go amoga	50%	10%	40%	4x incorrect word (3x should be 'kgomoga'; 1x should be 'gkaoga'); 1x unfamiliar
go baka	90%	0%	10%	1x incorrect spelling (should be 'go baaka')
go baka	90%	0%	10%	1x incorrect spelling (should be 'go boka')
go duma	100%	0%	0%	
go duma	80%	0%	20%	2x incorrect word (1x 'go fafatsa')

*** Words excluded from the final word list**

(See key on page 2)

Results of Pilot Study 2 (page 2)

Word	I agree	I agree somewhat	I disagree	Reason for not marking 'I agree' (number of participants)
*mogôga	63%	0%	38%	1x incorrect word (should be 'motlhala'); 4x unfamiliar
*mogôga	70%	20%	10%	3x incorrect picture; ("picture does not indicate food at funeral")
*go gwetla	60%	0%	40%	1x incorrect word; 2x unfamiliar; 1x incorrect picture ("picture must show *calling*, not waving")
*go gwetla	40%	10%	50%	2x unfamiliar; 1x incorrect word; 3x incorrect spelling ('goletsa', 'goeletsa','gweletsa')
leiso	90%	0%	10%	3 x incorrect spelling (1x 'leeso'; 2x 'leso')
leiso	100%	0%	0%	
go balêla	80%	10%	10%	2x incorrect spelling (should be 'balelwa')
go balêla	90%	10%	0%	1x incorrect picture ("picture must show 2 people - i.e counting *for* someone")
*dikgare	60%	0%	40%	1 x unfamiliar; 2 x incorrect word ("given word means flowers")
*dikgare	50%	10%	40%	4x incorrect spelling (should be 'legare'); 1x unfamiliar
dinoko	89%	0%	11%	1x unfamiliar; 1x all responses left blank
dinoko	90%	10%	0%	1x incorrect picture ("picture should show *2* porcupines")
thapô	100%	0%	0%	
thapô	90%	0%	10%	1x incorrect word ("*thapo* is a sotho word- should be *mogala*")
mosidi	100%	0%	0%	
mosidi	70%	10%	20%	1x incorrect word; 2x incorrect picture ("picture should show grinding with *rocks"*)
go fitlha	100%	0%	0%	
go fitlha	100%	0%	0%	

*** Words excluded from the final word list**

Key for 'reason' column:

Incorrect picture: The participant feels that the picture does not adequately represent the given word - provides suggestions on how to improve/change picture

Incorrect word: The participant feels that the given word and picture are completely unrelated

Incorrect spelling: The participant feels that the given word is spelt incorrectly but the picture is correct

All responses left blank: For whatever reason, the participant failed to fill in any of the blocks (gave no response)

Unfamiliar: The participant is completely unfamiliar with the given word, therefore cannot comment on adequacy of picture

No reason: The participant did not provide a reason as to why he/she did not agree

Appendix C-7: Pilot study 3: Questionnaire used to validate Tswana translations

Pilot Study 3: Questionnaire used to validate Tswana translations (page 1)

Is the Tswana translation of the English sentence correct?
(Please mark with an X)
If you disagree, please correct the sentence accordingly.

English Sentence	Tswana sentence	I agree	I disagree
I see my friend at school every day.	Ke bôna **thaka** ya ka ko sekôlông letsatsi le letsatsi.		
The pupil of my eye is small and black	**Thaka** ya leitlhô laka e nnye gape e ntsho.		
I pick up fruit that fell from the tree.	Ke **sêlwa** (sêla) maungô a wêleng mo setlhareng.		
You will be late if you oversleep.	O tla **sêlwa** fa o robala bosigo thata		
My father bought me a bicycle for my birthday.	**Papa** waka o ntheketse baesekele ka letsatsi lame la matsalô.		
I like to eat porridge in winter.	Ke rata go ja **papa** ka mariga.		
The children must think carefully and use their brains if they are to pass the test.	Bana ba tshwanetse go nagana sentle le go dirisa **mabôkô** a bone go falola diteko.		
The man writes praise poems.	Monna o kwala **mabôkô** a tlotlô.		
The twins dress the same every day.	**Mafatlha** ba apara go tshwana malatsi otlhe.		
He has strong and healthy lungs.	O na le **mafatlha** a tiileng ebile a e tekanetse.		
Cows and sheep like to graze on the green pastures.	Dikgomo le dinku di rata **mafulô** a matala.		
Children enjoy playing in a bath full of foam.	Bana ba rata go tshameka mo bateng e tletseng **mafulô**.		
The man injured his back in soccer.	Monna o gobetse **mokôtla** a tshameka bolo.		
He is carrying the bag on his back.	O rwele **mokôtla** wa gagwe mo mokwatleng.		
The giraffe's neck is long.	**Molala** wa thutlwa o motelele.		
I like to eat leftovers for lunch.	Ke rata go ja **molala** motshegare.		

Pilot Study 3: Questionnaire used to validate Tswana translations (page 2)

English Sentence	Tswana sentence	I agree	I disagree
The lady bakes bread in her new oven	Mosadi o **baka** borotho ja gagwe mo ontong e ntšwa		
The people praise in song when they go to church.	Batho ba **baka** ka go opela ko kerekeng.		
The lion roars loudly.	Tau e **duma** thata.		
I spray the cockroach with insecticide.	Ke **duma** mafele ka setlhare sa mafele.		
I dish up food with a large spoon.	Ke tshola dijo ka **leiso** (leso)		
We cook our supper on the fire place.	Re dirisa **leiso** go apeya dijo tsa rona tsa maitseboya.		
The man chokes on a chicken bone.	Monna o **balêla** (balêlwa) ke lesapo la koko.		
The boy counts out his money for his friend.	Mosimane o **balêla** tsala ya gagwe madi.		
There are many small joints in the reed.	Letlhaka le na le **dinoko** tse dintsi.		
The porcupines have long quills to protect themselves.	**Dinoko** dina le mafuka a tiileng go itshereletsa.		
The avocado pip is large and hard.	**Thapô** ya avocado e kgolo ebile e tiile.		
I use rope to fasten the couch onto the Bakkie.	Ke dirisa **thapô** go bofelela setilo mo koloing.		
The soot from the fire place makes my hands black when I clean it.	**Mosidi** o dira matsogo a ka mantsho ga ke phepafatsa leiso.		
The person who grinds is preparing sorghum.	**Mosidi** wa mabela o apeya bojalwa.		
The family arrive home.	Ba lelapa ba **fitlha** mo gae.		
He hides his money under the mattress.	O **fitlha** madi a gagwe ka fa tlase ga materase.		

Appendix C-8: Results of pilot study 3

Pilot Study 3 – Results from questionnaire (page 1)

Word	Tswana sentence provided in questionnaire	Comments and suggested changes if 'I disagree' was marked (see changes in bold)	I agree	I disagree
thaka	Ke bôna **thaka** ya ka ko sekôlông letsatsi le letsatsi.	Ke bôna thaka ya ka **kwa** sekolong letsatsi le letsatsi.	80%	20%
thaka	**Thaka** ya leitlhô laka e nnye gape e ntsho.		100%	0%
go sêlwa	Ke **sêlwa** (sêla) maungô a wêleng mo setlhareng.	2x participants confirm that the word 'sêla' as in brackets is the correct word to use.	100%	0%
go sêlwa	O tla **sêlwa** fa o robala bosigo thata	O tla sêlwa fa o robala thata' (remove the word **bosigo**)/2x participants weren't familiar with the word 'sêlwa' and therefore one did not comment.	60%	20%
papa	**Papa** waka o ntheketse baesekele ka letsatsi lame la matsalô.		100%	0%
papa	Ke rata go ja **papa** ka mariga.		100%	0%
mabôkô	Bana ba tshwanetse go nagana sentle le go dirisa **mabôkô** a bone go falola diteko.		100%	0%
mabôkô	Monna o kwala **mabôkô** a tlotlô.	Monna o kwala mabôkô a **thapelo**.	80%	20%
mafatlha	**Mafatlha** ba apara go tshwana malatsi otlhe.		100%	0%
mafatlha	O na le **mafatlha** a tiileng ebile a e tekanetse.		100%	0%

Pilot Study 3 – Results from questionnaire (page 2)

mafulô	Dikgomo le dinku di rata **mafulô** a matala.		100%	0%
mafulô	Bana ba rata go tshameka mo bateng e tletseng **mafulô**.	participant is not familiar with the word 'mafulô' as used in this context but agrees that sentence is correct	100%	0%
mokôtla	Monna o gobetse **mokôtla** a tshameka bolo.		100%	0%
mokôtla	O rwele **mokôtla** wa gagwe mo mokwatleng.	O rwele mokôtla wa gagwe mo **mokokotlong**	80%	20%
molala	**Molala** wa thutlwa o motelele.		100%	0%
molala	Ke rata go ja **molala** motshegare.	3x participant agree that sentence is correct but reports that 'molala' should be replaced with 'molatsa'	100%	0%
go baka	Mosadi o **baka** borotho ja gagwe mo ontong e ntšwa		100%	0%
go baka	Batho ba **baka** ka go opela ko kerekeng.	1x participant agrees that the sentence is correct but that the word 'baka' should be changed to 'boka'.	100%	0%
go duma	Tau e **duma** thata.		100%	0%
go duma	Ke **duma** mafele ka setlhare sa mafele.		100%	0%
leiso	Ke tshola dijo ka **leiso** (leso)	3x particiapnts confirm that the word 'leso' as in brackets is the correct word to use/ Ke tshola dijo ka **leso le legolo**.	80%	20%
leiso	Re dirisa **leiso** go apeya dijo tsa rona tsa maitseboya.	2x participants are not familiar with the word 'leiso' as used in this context but agrees that sentence is correct	100%	0%

Pilot Study 3 – Results from questionnaire (page 3)

go balêla	Monna o **balêla** (balêlwa) ke lesapo la koko.	2x particiapnts confirms that the word 'balêlwa' as in brackets is the correct word to use.	100%	0%
go balêla	Mosimane o **balêla** tsala ya gagwe madi.	participant is not familiar with the word 'balêla' as used in this context but agrees that sentence is correct	100%	0%
dinoko	Letlhaka le na le **dinoko** tse dintsi.		100%	0%
dinoko	**Dinoko** dina le mafuka a tiileng go itshereletsa.		100%	0%
thapô	**Thapô** ya avocado e kgolo ebile e tiile.		100%	0%
thapô	Ke dirisa **thapô** go bofelela setilo mo koloing.		100%	0%
mosidi	**Mosidi** o dira matsogo a ka mantsho ga ke phepafatsa leiso.		100%	0%
mosidi	**Mosidi** wa mabela o apeya bojalwa.	Mosidi wa **mabele** o apeya bojalwa.	80%	20%
go fitlha	Ba lelapa ba **fitlha** mo gae.		100%	0%
go fitlha	O **fitlha** madi a gagwe ka fa tlase ga materase.		100%	0%

Appendix C-9: Word-specific scores indicating the number of times a word within the experimental word list was correctly perceived by all five judges

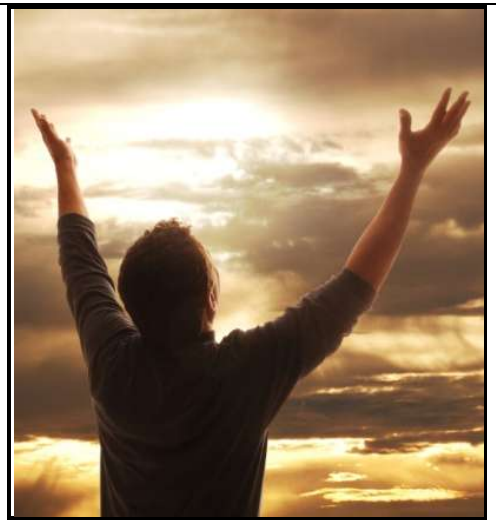
Word-specific scores indicating the number of times a word within the experimental word list was correctly perceived by all five judges, indicating the average and percentage scores for each word

	Tswana word	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5	Avg.	%
1	Thàká (friend, peer)	9	9	9	9	8	8,8	97
2	Thàkà (pupil of the eye)	5	6	5	7	4	5,4	60
3	Sèlwà (pick up, find)	9	6	6	8	7	7,2	80
4	Sélwà (oversleep, wake late)	8	8	9	7	8	8	88
5	Pàpá (father)	9	9	9	9	9	9	100
6	Pápà (porridge)	9	9	9	9	9	9	100
7	Màbòkó (brains)	7	6	7	7	6	6,6	73
8	Màbòkò (praise poems)	8	9	9	8	8	8,4	93
9	Màfátlhà (twins)	8	7	8	6	7	7,2	80
10	Màfàtlhà (lungs, chest)	8	7	9	8	9	8,2	91
11	Màfùlò (pastures)	7	7	7	6	7	6,8	75
12	Màfúlò (foam, froth)	8	6	8	8	8	7,6	84
13	Mòkòtlà (spine, back)	8	8	8	9	7	8	88
14	Mòkótlá (bag, sack)	6	5	6	6	6	5,8	64
15	Mòlàlà (neck of mammal)	9	9	9	9	9	9	100
16	Mòlálá (leftover food)	6	5	6	6	6	5,8	64
17	Bákà (to bake bread)	7	8	8	8	8	7,8	86
18	Bàkà (praise in song or word)	8	8	8	8	8	8	88
19	Dùmà (to roar, eg. lion)	9	9	9	9	9	9	100
20	Dúmà (to spray with insecticide)	6	6	7	7	7	6,6	73
21	Lèìsò (large spoon or ladle)	4	5	5	4	4	4,4	48
22	Lèísò (fireplace, cooking place)	9	6	6	8	6	7	77
23	Bálélá (to choke)	9	6	9	9	9	8,4	9
24	Bàlèlà (to count for)	7	8	8	8	8	7,8	86
25	Dìnòkò (Joints in a cane/reed)	5	3	5	6	3	4,4	48
26	Dìnòkó (porcupines)	9	8	8	6	8	7,8	86
27	Thápò (Stone or pip of a fruit)	2	7	5	3	2	3,8	42
28	Thàpò (string, rope)	8	7	6	4	6	6,2	68
29	Mòsídì (Soot; burnt out coal)	9	9	9	8	9	8,8	97
30	Mòsìdì (person who grinds)	5	4	5	7	5	5,2	57
31	Fìtlhà (to arrive)	9	9	9	8	8	8,6	95
32	Fítlhà (to hide)	9	9	9	9	9	9	100

Appendix D-1: Tswana stimulus manual A

go baka

(Praise in song or word)



Batho ba **baka** ka go opela fa ba ya kerekeng.

go sêlwa

(pick up, find)

Ke **sêlwa** (sêla) maungo a weleng mo setlhareng.

go fitlha

(to arrive)

O **fitlha** madi a gagwe ka fa tlase ga materase.

mafulô

(foam, froth)

Bana ba rata go tshameka mo bateng e etletseng **mafulô**.

leiso

(Fire-place, cooking-place)

Re dirisa **leiso** go apaya dijo tsa rona tsa maitseboa.

mafatlha
(twins)

Mafatlha a apara go tshwana malatsi otlhe.

go fitlha

(to hide)

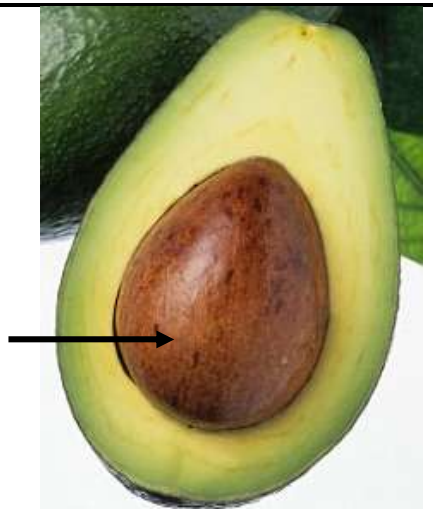
O **fitlha** madi a gagwe ka fa tlase ga materase.

mokôtla
(spine, back)

Monna o gobetse **mokôtla** a ntse a tshameka bolo.

thapô

(stone or pip of a fruit)



Thapô ya avocado e kgolo e bile e tiile.

mosidi
(person who grinds)
 
Mosidi wa mabela o apaya bojalwa.

thaka

(friend, peer)

Ke kopana le **thaka** ya ka kwa sekolong letsatsi le letsati.

molala
(leftover food)

Ke rata go ja **molala** motshegare.

mabôkô

(brains)


Bana ba tshwanetse go nagana sentle le go dirisa **mabôkô** a bone go falola diteko.

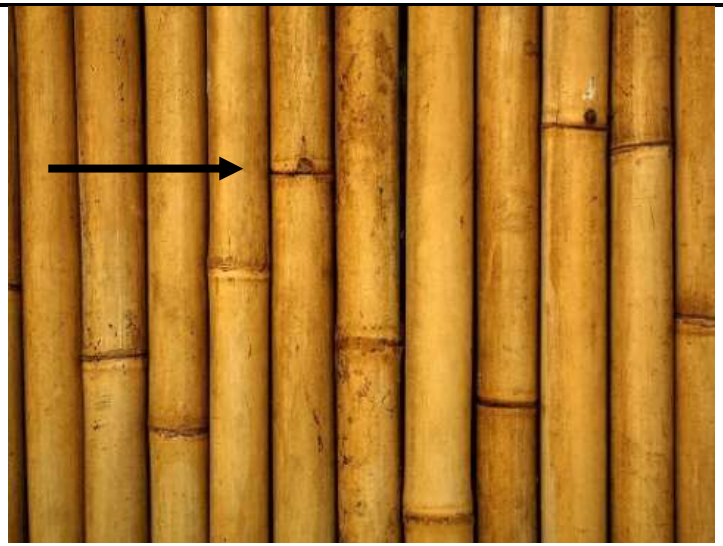
leiso

(large spoon or ladle)

Ke tshola dijo ka **leiso** (leso).

dinoko

(joints in a cane or reed)



Letlhaka le na le **dinoko** tse dintsi.

go balêla

(to choke)

Monna o **balêla** (balêlwa) ke lesapo la koko.

papa
(porridge)

Ke rata go ja **papa** ka mariga.

mabôkô

(praise poems)

Where Broken Soldiers Go

A nation calls and young men come
To stand and fight, and unite as one.

Soldiers march off to war, as duty call
Braving Withering fire, as their comrades fall.

Wives and Mothers openly fret, and they weep.
They pray for their safety, hoping their lives God will keep.

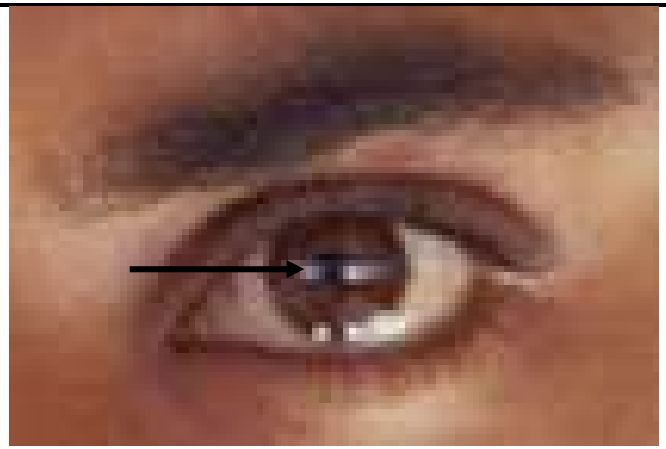
Celebrating victories, and mourning great loss.
Freedom is paid at a terrible cost.

Shattered lives of men, what a devastating blow!
Is there a place where broken soldiers go??

With heads held high, and shoulders proud.
Our heroes return to a grateful crowd.

To celebrate their safety, and battles won.
But the fight is not over, it's just begun.

Monna o kwala **mabôkô**.

thaka
(pupil of the eye)

Thaka ya leitlho la ka e nnye gape e ntsho.

mosidi

(soot, burnt out coal)

Mosidi o dira matsogo a ka mantsho ga ke phepafatsa leiso.

go baka

(to bake bread or cake)

Mosadi o **baka** borotho mo ontong ja gagwe e ntšwa.

mafulô
(pastures)

Bana ba rata go tshameka mo bateng e etletseng **mafulô**.

go duma

(to roar)

Tau e **duma** thata.

papa

(father)

Papa wa ka o ntheketse baesekele ka letsatsi la me la matsalo.

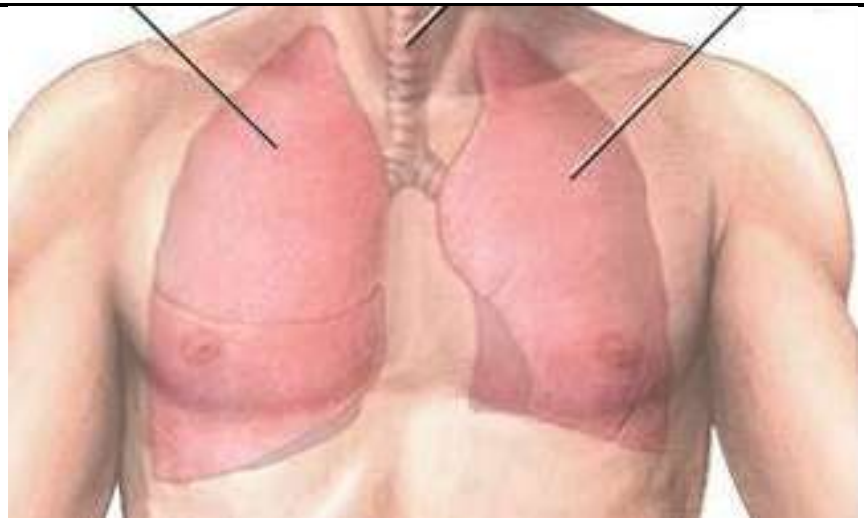
go balêla

(to count for)

Mosimane o **balêla** tsala ya gagwe madi.

mafatlha

(lungs, chest)



O na le **mafatlha** a atiileng e bile a e tekanetse.

thapô

(string, rope, cord)

Ke dirisa **thapô** go bofelela setilo mo beneng.

go duma

(to spray with insecticide)

Ke **duma** mafele ka setlhare sa mafele.

dinoko
(porcupines)
 
Dinoko dina le mafuka a tiileng go itshereletsa.

mokôtla
(purse, bag, sack)

O rwele **mokôtla** mo mokwatleng.

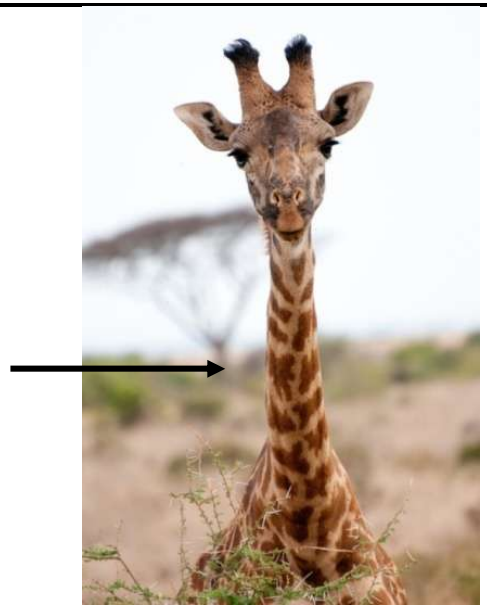
go sêlwa

(oversleep or wake late)

O tla selwa fa o robala bosigo thata.

molala

(neck of a mammal)



Molala wa thutlwa o motelele.

Appendix D-2: Instructions for word production task (English)

English Instructions for participants (word production task)

INSTRUCTIONS TO PARTICIPANTS

Thank you for agreeing to participate in this study. The data collection procedures will take place in 3 sections, as indicated below. I will remain with you throughout the entire process to answer any questions should you be uncertain. You may take a break at any point throughout this process should you request it.

1. Section 1 (data collection sheet)

Please complete the questionnaire provided, together with the researcher, in order to obtain your biographical information as well as medical and educational background.

2. Section 2 (hearing screening)

A short hearing test will be conducted. I will first use an otoscope to look inside your ears. Thereafter, you will be requested to listen to soft sounds through a set of headphones and press a button each time a sound is heard, even if it is very soft. This should only take 5-10 minutes. More detailed instructions will be provided to you at the time and you will have the opportunity to ask any questions you may have.

3. Section 3 (word production)

You will be provided with a stimulus book (either A, B, C or D). On each page of this book, there will be a Tswana word, which you will be requested to produce. To guide you, there will be an accompanying picture, English definition and Tswana sentence which uses this word. You will be given appropriate time to familiarise yourself with all the words in the book. There will be a total of 32 words to be produced. Before you say each word, you will be requested to say, “Ke” before each word. For example, “Ke *mabôkô*”. Your production of the words will be recorded with an audio recorder. You will also be given the opportunity to ask questions should you require clarification.

Let us first practise what you have to do with these two words that are not on your list. Here is the picture of the word, its English definition and a Tswana sentence which explains the meaning of the word. You only have to produce the target word after you have read the sentence and looked at the picture. Once you are sure that you know what the word means, you may say ‘Ke’ followed by the given word. Then turn the page and continue to the next word, following the same procedure.

Appendix D-3: Instructions for word production task (Tswana)

Tswana Instructions for participants (word production task)

Ditaelo go batlhakanedi

Ke lebogela gale dumetse go tsaya karolo mo thutong e. kgokobanyo ya dintlha e tla tsamaisiwa kadi karolo tse tharo, jaaka go tlhalositswe mo fatshe. Ketlabe kena le lona mo dikarolong tsotlhe go araba dipotso tsotlhe tse le kannang le tsone. Le a letlelelwa go ikhutsa nako engwe le engwe e le batlang go I khutsa mo dikarolong tse di farologaneng tsa thuto ee.

1. SeKarolo 1 (letlha la kgobokanyo ya dintlha)

Ke kopa gore otlatse dipotso tse o difilweng ke motlhotlhomisi, gore retle reitse ka bowena, tsa bophelo le di thuto tsa gago.

2. Karolo 2 (Teko ya go utlwa)

Re tlile go dira teko ya go utlwa e kgutshwane. Pele ga re ka simolola teko e ke tlile go dirisa otoscope go lebelela mogare ga ditsebe tsa gago. Gare fetsa o tlile go kopiwa gore o retse medumo ee kwa tlase o dirasa di headphone, ga utlwa modumo o tobetse go bontsha gore gonna le modumo oo utlwileng laele modumo oo kwa tlase. Sena se tlile go tsaya metsotso ekanna metlhano (5) go ya go lesome (10). Ga nako eo e fitlha o tla fiwa ditaelo tse di tlhamaletseng gape otla fiwa le monyetla wa go botsa dipotso tse o ka nnang le tsone.

3. Karolo 3 (Poiso ya mantswe)

O tlile go fiwa bukana e tlileng go go thusa (bukanna e ekanna ya A,B,C kgotsa D). Go tlile gonna le lentswe la Setswana mo letlhareng le lengwe le lengwe la dibuka tse re tlile go go kopa gore ole buise. Otlile go fiwa senepe se se go thusang sena le tlhaloso le sekao sa tiriso ya lefoko leo ka sekgoa le Setswana. Go tla bo gonale mafoko a 32 a otla bo o tshwanetse go a buisa. Pele ga o ka buisa lentswe le lengwe le lengwe o kopiwa gore o simolole ka”Ke”. Sekao “Ke *mabôkô*”. Puiso ya mafoko a gago e tlile go gatiswa ka audio recorder. O tlile go fiwa monyetla gape wa go botsa dipotso ga ele gore oka tlhoka tlhaloso e maleba.

Are simole ka go I kwetlisa ka mantswe a mabedi a seyong mo palong ya mantswe a retlileng go a dirisa. Ke se senepe sa lentswe, le tlhaloso ya yona ka sekgoa le Setswana e e bontshang gore lefoko leo le ra goreng. O buisa lentswe le o le filweng ga o fetsa go bala ka lone gape o lebeletse senepe. Ga o setse onale ntlha ya gore lentswe leo le ra goreng otla tshwanelwa ke gore ore ‘Ke’ obe o bua lentswe leo. Obe o phetlhola letlha gore o kgonne go yako lentsweng le le latelang, otla dira fela jalo go fitlhela o fetsa.

Appendix D-4: Practise stimuli for word production task

Practise stimuli for control and experimental participants

go bela
(to boil)

Motogo o a bela
(The porridge is boiling)

go fula
(to graze/browse)

Kgomo e fula mo tlhageng e telele
(The cow grazes on the long grass)

Appendix E-1: Listener score sheets (List A, List B, List C, List D)

Listener Score Sheet – page 1
List A

Participant's identifying code: V1
Listener's identifying code: V2

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
a.	Go bàkà (to praise in song or word)	1	Go bákà (to bake bread)	2		V3	
b.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V4	
c.	Go fítlhà (to hide)	1	Go fitlhà (to arrive)	2		V5	
d.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V6	
e.	Lèisò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V7	
f.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V8	
g.	Go fitlhà (to arrive)	1	Go fítlhà (to hide)	2		V9	
h.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V10	
i.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2		V11	
j.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V12	
k.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V13	
l.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V14	
m.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V15	
n.	Lèísò (fireplace, cooking place)	1	Lèisò (large spoon or ladle)	2		V16	
o.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V17	
p.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V18	
q.	Pàpá (father)	1	Pápà (porridge)	2		V19	
r.	Màbòkò (praise poems)	1	Màbòkó (brains)	2		V20	
s.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V21	
t.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V22	
u.	Go bákà (to bake bread)	1	Go bàkà (to praise in song or word)	2		V23	
v.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V24	
w.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V25	
x.	Pápà (porridge)	1	Pàpá (father)	2		V26	
y.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V27	
z.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V28	
aa.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V29	

Listener Score Sheet – page 2
List A

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V30	
cc.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V31	
dd	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V32	
ee.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V33	
ff.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V34	
Score out of 32:_____						V35	
gg.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V36	
hh	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V37	
ii.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V38	
jj.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V39	
kk.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V40	
Score out of 5:_____						V41	

Listener Score Sheet – page 1
List B

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
a.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V3	
b.	Lèísò (fireplace, cooking place)	1	Lèìsò (large spoon or ladle)	2		V4	
c.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V5	
d.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V6	
e.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V7	
f.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V8	
g.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V9	
h.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V10	
i.	Pàpá (father)	1	Pápà (porridge)	2		V11	
j.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V12	
k.	Mòsìdì (person who grinds)	1	Mòsídì (soot; burnt out coal)	2		V13	
l.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V14	
m.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2		V15	
n.	Màbòkò (praise poems)	1	Màbòkó (brains)	2		V16	
o.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V17	
p.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V18	
q.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V19	
r.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V20	
s.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V21	
t.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V22	
u.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V23	
v.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V24	
w.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V25	
x.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V26	
y.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V27	
z.	Pápà (porridge)	1	Pàpá (father)	2		V28	
aa.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V29	

Listener Score Sheet – page 2
List B

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V30	
cc.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V31	
dd	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V32	
ee	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V33	
ff.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V34	
Score out of 32: _____						V35	
gg.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V36	
hh	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V37	
ii.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V38	
jj.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V39	
kk.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V40	
Score out of 5: _____						V41	

Listener Score Sheet – page 1
List C

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
a.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V3	
b.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V4	
c.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V5	
d.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V6	
e.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V7	
f.	Go bákà (to bake bread)	1	Go bàkà (to praise in song or word)	2		V8	
g.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V9	
h.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V10	
i.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V11	
j.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V12	
k.	Mòsìdì (person who grinds)	1	Mòsídì (soot; burnt out coal)	2		V13	
l.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V14	
m.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V15	
n.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V16	
o.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V17	
p.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V18	
q.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V19	
r.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V20	
s.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V21	
t.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V22	
u.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V23	
v.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V24	
w.	Pápà (porridge)	1	Pàpá (father)	2		V25	
x.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V26	
y.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V27	
z.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2		V28	
aa.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V29	

Listener Score Sheet – page 2
List C

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb.	Màbòkò (praise poems)	1	Màbòkó (brains)	2		V30	
cc.	Go sélwà (to oversleep, wake late)	1	Go sèlwà (to pick up, find)	2		V31	
dd.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V32	
ee.	Pápà (porridge)	1	Pàpá (father)	2		V33	
ff.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V34	
Score out of 32: _____						V35	
gg.	Pápà (porridge)	1	Pàpá (father)	2		V36	
hh.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V37	
ii.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V38	
jj.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V39	
kk.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V40	
Score out of 5: _____						V41	

Listener Score Sheet – page 1
List D

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
a.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V3	
b.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V4	
c.	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V5	
d.	Pàpá (father)	1	Pápà (porridge)	2		V6	
e.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V7	
f.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V8	
g.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V9	
h.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V10	
i.	Go sélwà (to oversleep, wake late)	1	Go sèlwà (to pick up, find)	2		V11	
j.	Lèísò (fireplace, cooking place)	1	Lèìsò (large spoon or ladle)	2		V12	
k.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V13	
l.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V14	
m.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V15	
n.	Pápà (porridge)	1	Pàpá (father)	2		V16	
o.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V17	
p.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V18	
q.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V19	
r.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V20	
s.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V21	
t.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V22	
u.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V23	
v.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V24	
w.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V25	
x.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V26	
y.	Bálélá (to choke)	1	Go bàlèlà (to count for)	2		V27	
z.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V28	
aa.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V29	

Listener Score Sheet – page 2
List D

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V30	
cc.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V31	
dd.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V32	
ee.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V33	
ff.	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V34	
Score out of 32: _____						V35	
gg.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V36	
hh.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V37	
ii.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V38	
jj.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V39	
kk.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V40	
Score out of 5: _____						V41	

Appendix E-2: Instructions for listening task (English)

English instructions for participants (listening task)

Thank you for agreeing to participate in this study. The data collection procedures will take place in 3 sections, as indicated below. I will remain with you throughout the entire process to answer any questions, should you be uncertain. You may take a break at any point throughout this process, if you request it.

1. Section 1 (data collection sheet)

Please complete the questionnaire provided in order to obtain your biographical information as well as medical and educational background.

2. Section 2 (hearing screening)

A short hearing test will be conducted. I will first use an otoscope to look inside your ears. Thereafter, you will be requested to listen to soft sounds through a set of headphones and press a button each time a sound is heard, even if it is very soft. This should only take 5-10 minutes. More detailed instructions will be provided to you at the time and you will have the opportunity to ask any questions you may have.

3. Section 3 (listening task)

You will be required to listen to a set of 37 words, each produced by 25 different participants. You may familiarise yourself with the words that you will be listening to by going through this stimulus book. You can see on each page of this book, there will be a Tswana word, which the participants will be requested to produce. To guide them in how to produce each word, there will be an accompanying picture, English definition and a Tswana sentence which uses this word in context *(researcher goes through the stimulus book with listener).* You will also see that there are two words spelt in the same way but each word has a different meaning. The participants will be requested to produce all of these words but not in this order – the words will be randomised onto four separate word lists (List A, B, C or D). Therefore, in each word list you may hear the same word as many as three times and you will have to decide in each case which word was produced (according to the definitions provided).

This is the score sheet which you will use to score the participants *(researcher goes through score sheet with listener).* You will see three columns containing word pairs. Each word will have the English definition with it and you will be requested to tick which word out of the word pair you heard the participant produce. If however you did not perceive the participant to produce either of the two options provided on the score sheet, you may tick the option in the third column which indicates 'word was not produced intelligibly'. The participants' productions will be played through this speaker. You will have only one opportunity to listen to each word and you will be given ample time to make your decision. When you are ready, I will play the next word. Before you start with the listening task, you will be given an opportunity to practise with a couple of words that are not in the participant's word list using a score sheet that looks just like this one.

Appendix E-3: Instructions for listening task (Tswana)

Tswana instructions for participants (listening task)

Ditaelo go bareetsi

Ke lebogela gale dumetse go tsaya karolo mo thutong e. kgokobanyo ya dintlha e tla tsamaisiwa kadi karolo tse tharo, jaaka go tlhalositswe mo fatshe. Ketlabe kena le lona mo dikarolong tsotlhe go araba dipotso tsotlhe tse le kannang le tsone. Le a letleletswe go ikhutsa nako engwe le engwe e le batlang go I khutsa mo dikarolong tse di farologaneng tsa

Karolo 1 (letlha la kgobokanyo ya dintlha)

Ke kopa gore otlatse dipotso tse o difilweng ke Motlhotlhomisi, gore retle reitse ka bowena, tsa bophelo le di thuto tsa gago.

1. **Karolo 2 (Teko ya go utlwa)**

Re tlile go dira teko ya go utlwa e kgutshwane. Pele ga re ka simolola teko e ke tlile go dirisa otoscope go lebelela mogare ga ditsebe tsa gago. Gare fetsa o tlile go kopiwa gore o retse medumo ee kwa tlase o dirisa di headphone, gao utlwa modumo o tobetse go bontsha gore gonna le modumo oo utlwileng laele modumo oo kwa tlase. Sena se tlile go tsaya metsotso ekanna matlhano (5) go ya go Masome (10). Ga nako eo e fitlha o tla fiwa ditaelo tse di tlhamaletseng gape otla fiwa le monyetla wa go botsa dipotso tse o ka nnang le tsone.

2. **Karolo 3 (Tiro ya go reetsa)**

Otlile go kopiwa go reeta mantswe a kanna 37, le lengwe le lengwe le le tlabe le buisitswe ke batlhakanedi bale 25. Oka lebelela mantswe a o tla bo o a reetsa ka go lebelela bukana ena ya sekao. Ga o ntse o phetlha mo bukeng e otla bona lentswe la Setswana le batlhakanedi batlile go le buisa. Go ba thusa gore lentswe le buisiwa jang go tla nna le senepe, le tlhaloso ka sekgoa le Setswana gape batla bontsiwa sekao gore lefoko leo leka dirisiwa jang (Motlhotlhomisi otlile go tlhalosetsa moretsi gore bukana e ya sekao e dirisiwa Jang). Otlile go bona gape gore gona le mantswe a mangwe a a kwadilweng ka go tshwana mme a emetse dilo tse di farologaneng. Batlhakanedi batla tshwanelwa ke go buisa mafoko a otlhe mme eseng ka tatalano e – Mantswe a tlile go tlhakatlhakangwa aba a sala a kgaogangwa mo di bukaneng dile nne (buka ya mantswe A,B,C kgotsa D). Jaanong mo bukaneng ya mantswe okanna wa utlwa lentswe le le losi ga raro otla tshwanna ke gore o tsee tshwetso ya gore ke lefe lefoko lele buisitsweng (ka go latelela ditlhaloso tse o di neilweng).

Ena ke pampiri e o tlile go e dirisa go kwala dipholo tsa batsaya karolo (motlhotlhomisi o tlile go tlhalosetsa moretsi ka pampiri ya dipholo). O tlile go bona pilara tse tharo the dinang le mafoko a a tsamayang ale mabedi. Lefoko le lengwe le le lengwe le tlile gonna le tlhaloso ya sekgoa, wena otlile go kopiwa gore o tshwae lefoko le o utlwileng le bidiwa ke motlhakanedi gotswa mo mafokong a mabedi a. Ga ele gore gawa utlwa motlhakanedi a bitsa mafoko a kabobedi a a leng mo tsebeng ya dipholo o tla tshwanelwa ke go tshwa mo pilareng ya boraro e e supang gore lefoko gale a berekisiwa sentle kgotsa ka mogwa o tlhalefileng. Di puiso tsa batlhakanedi di tlile go tshamikiwa gore o diutlwe mo. Otlile gonna le monyetla wa go reetsa mafoko a mme otla fiwa nako e lekaneng gore o tseye tshwetso. Gao feditse ke tla tshameka lefoko lele latelang. Pele ga o simolola ka tiro e ya go reetsa, otlile go fiwa monyetla wa go ikwetlisa ka mafoko a mmalwa a seng mo tshobakanyong ya mafoko a tlileng go dirisiwa ke batlhakanedi re berekisa tsebe ya dipholo ee tshwanang lee.

Appendix F-1: Score sheet templates for marking (List A, List B, List C, List D)

Listener Score Sheet Marking Template– page 1
List A

Participant's identifying code: V1
Listener's identifying code: V2

						Word not produced intelligibly	For Official use	
Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.								
a.	Go bàkà (to praise in song or word)	1	Go bákà (to bake bread)	2			V3	
b.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2			V4	
c.	Go fítlhà (to hide)	1	Go fitlhà (to arrive)	2			V5	
d.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2			V6	
e.	Lèisò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2			V7	
f.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2			V8	
g.	Go fitlhà (to arrive)	1	Go fítlhà (to hide)	2			V9	
h.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2			V10	
i.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2			V11	
j.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2			V12	
k.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2			V13	
l.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2			V14	
m.	Màbòkó (brains)	1	Màbòkò (praise poems)	2			V15	
n.	Lèísò (fireplace, cooking place)	1	Lèisò (large spoon or ladle)	2			V16	
o.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2			V17	
p.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2			V18	
q.	Pàpá (father)	1	Pápà (porridge)	2			V19	
r.	Màbòkò (praise poems)	1	Màbòkó (brains)	2			V20	
s.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2			V21	
t.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2			V22	
u.	Go bákà (to bake bread)	1	Go bàkà (to praise in song or word)	2			V23	
v.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2			V24	
w.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2			V25	
x.	Pápà (porridge)	1	Pàpá (father)	2			V26	
y.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2			V27	
z.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2			V28	
aa.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2			V29	

Listener Score Sheet – page 2
List A

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V30	
cc.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V31	
dd	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V32	
ee.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V33	
ff.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V34	
Score out of 32:_____						V35	
gg.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V36	
hh	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V37	
ii.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V38	
jj.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V39	
kk.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V40	
Score out of 5:_____						V41	

Listener Score Sheet Marking Template – page 1
List B

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	For Official use	
a.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V3	
b.	Lèísò (fireplace, cooking place)	1	Lèìsò (large spoon or ladle)	2		V4	
c.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V5	
d.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V6	
e.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V7	
f.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V8	
g.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V9	
h.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V10	
i.	Pàpá (father)	1	Pápà (porridge)	2		V11	
j.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V12	
k.	Mòsìdì (person who grinds)	1	Mòsídì (soot; burnt out coal)	2		V13	
l.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V14	
m.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2		V15	
n.	Màbòkò (praise poems)	1	Màbòkó (brains)	2		V16	
o.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V17	
p.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V18	
q.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V19	
r.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V20	
s.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V21	
t.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V22	
u.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V23	
v.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V24	
w.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V25	
x.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V26	
y.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V27	
z.	Pápà (porridge)	1	Pàpá (father)	2		V28	
aa.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V29	

Listener Score Sheet – page 2
List B

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V30	
cc.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V31	
dd	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V32	
ee	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V33	
ff.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V34	
Score out of 32: _____						V35	
gg.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V36	
hh	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V37	
ii.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V38	
jj.	Thàká (friend, peer)	1	Thàkà (pupil of the eye)	2		V39	
kk.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V40	
Score out of 5: _____						V41	

Listener Score Sheet Marking Template – page 1
List C

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	For Official use	
a.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V3	
b.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V4	
c.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V5	
d.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V6	
e.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V7	
f.	Go bákà (to bake bread)	1	Go bàkà (to praise in song or word)	2		V8	
g.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V9	
h.	Dìnòkò (joints in a cane/reed)	1	Dìnòkó (porcupines)	2		V10	
i.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V11	
j.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V12	
k.	Mòsìdì (person who grinds)	1	Mòsídì (soot; burnt out coal)	2		V13	
l.	Màfúlò (foam, froth)	1	Màfùlò (pastures)	2		V14	
m.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V15	
n.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V16	
o.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V17	
p.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V18	
q.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V19	
r.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V20	
s.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V21	
t.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V22	
u.	Go fítlhà (to hide)	1	Go fìtlhà (to arrive)	2		V23	
v.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V24	
w.	Pápà (porridge)	1	Pàpá (father)	2		V25	
x.	Go bàlèlà (to count for)	1	Go bálélá (to choke)	2		V26	
y.	Mòkòtlà (spine, back)	1	Mòkótlá (bag, sack)	2		V27	
z.	Thápò (stone or pip of a fruit)	1	Thàpò (string, rope)	2		V28	
aa.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V29	

Listener Score Sheet – page 2
List C

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	For Official use	
bb.	Màbòkò (praise poems)	1	Màbòkó (brains)	2		V30	
cc.	Go sélwà (to oversleep, wake late)	1	Go sèlwà (to pick up, find)	2		V31	
dd.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V32	
ee.	Pápà (porridge)	1	Pàpá (father)	2		V33	
ff.	Go dùmà (to roar, eg. lion)	1	Go dúmà (to spray with insecticide)	2		V34	
Score out of 32: _____						V35	
gg.	Pápà (porridge)	1	Pàpá (father)	2		V36	
hh.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V37	
ii.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V38	
jj.	Màfátlhà (twins)	1	Màfàtlhà (lungs, chest)	2		V39	
kk.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V40	
Score out of 5: _____						V41	

Listener Score Sheet Marking Template – page 1
List D

Participant's identifying code:
Listener's identifying code:

V1	
V2	

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**		
a.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V3		
b.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V4		
c.	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V5		
d.	Pàpá (father)	1	Pápà (porridge)	2		V6		
e.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V7		
f.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V8		
g.	Dìnòkó (porcupines)	1	Dìnòkò (joints in a cane/reed)	2		V9		
h.	Mòlàlà (neck of mammal)	1	Mòlálá (leftover food)	2		V10		
i.	Go sélwà (to oversleep, wake late)	1	Go sèlwà (to pick up, find)	2		V11		
j.	Lèísò (fireplace, cooking place)	1	Lèìsò (large spoon or ladle)	2		V12		
k.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V13		
l.	Go bákà (to bake bread)	1	Go bàkà (praise in song or word)	2		V14		
m.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V15		
n.	Pápà (porridge)	1	Pàpá (father)	2		V16		
o.	Lèìsò (large spoon or ladle)	1	Lèísò (fireplace, cooking place)	2		V17		
p.	Thàkà (pupil of the eye)	1	Thàká (friend, peer)	2		V18		
q.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V19		
r.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V20		
s.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V21		
t.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V22		
u.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V23		
v.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V24		
w.	Mòkótlá (bag, sack)	1	Mòkòtlà (spine, back)	2		V25		
x.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V26		
y.	Bálélá (to choke)	1	Go bàlèlà (to count for)	2		V27		
z.	Màfùlò (pastures)	1	Màfúlò (foam, froth)	2		V28		
aa.	Go fìtlhà (to arrive)	1	Go fítlhà (to hide)	2		V29		

Listener Score Sheet – page 2
List D

Please tick which word you heard for each production (either 1 or 2). However, if you did not hear either one of the two options, tick the column titled *'word not produced intelligibly'*. Please do not make any markings in the last grey column.					Word not produced intelligibly	**For Official use**	
bb.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V30	
cc.	Thàpò (string, rope)	1	Thápò (stone or pip of a fruit)	2		V31	
dd.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V32	
ee.	Mòsídì (soot; burnt out coal)	1	Mòsìdì (person who grinds)	2		V33	
ff.	Màfàtlhà (lungs, chest)	1	Màfátlhà (twins)	2		V34	
Score out of 32: _____						V35	
gg.	Mòlálá (leftover food)	1	Mòlàlà (neck of mammal)	2		V36	
hh.	Go dúmà (to spray with insecticide)	1	Go dùmà (to roar, eg. lion)	2		V37	
ii.	Go bálélá (to choke)	1	Go bàlèlà (to count for)	2		V38	
jj.	Go sèlwà (to pick up, find)	1	Go sélwà (to oversleep, wake late)	2		V39	
kk.	Màbòkó (brains)	1	Màbòkò (praise poems)	2		V40	
Score out of 5: _____						V41	

Appendix F-2: Intra-rater reliability scores obtained by the judges for each control and experimental participant

Judges' intra-rater reliability scores for control and experimental participants

Participant	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5
C1	4	4	4	2	4
C2	5	3	5	2	5
C3	5	5	5	5	5
C4	5	5	5	4	5
C5	5	5	4	5	4
C6	5	4	4	3	5
C7	5	4	5	4	5
C8	4	4	4	2	4
C9	5	5	5	5	5
Total (45):	**43**	**39**	**41**	**32**	**42**
Percentage (%):	**95**	**86**	**91**	**71**	**93**

Participant	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5
P1	4	4	4	4	5
P2	5	4	4	2	5
P3	4	3	4	3	5
P4	5	5	5	4	5
P5	5	5	4	3	3
Total (45):	**23**	**21**	**21**	**16**	**23**
Percentage (%):	**92**	**84**	**84**	**64**	**92**

Appendix F-3: Raw data for listening task conducted with control group participants, using experimental word list

Raw data for listening task conducted with control group participants: Number of words correctly perceived across judges, using the *experimental* word list

Participant	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19
C1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1
C2	2	1	1	1	1	1	1	1	1	2	1	2	1	2	1	1	1
C3	1	1	1	1	1	1	2	1	1	1	2	1	1	1	2	1	1
C4	1	2	1	1	1	2	1	1	1	1	1	2	1	1	1	1	1
C5	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	1	1
C6	1	1	1	1	1	2	1	1	2	2	1	2	1	1	1	1	1
C7	2	2	1	1	1	2	1	1	1	2	1	1	1	1	2	2	2
C8	2	1	2	1	1	1	2	1	2	1	1	1	1	1	2	2	2
C9	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Participant	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33	V34	Total (32)
C1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	**28**
C2	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	**26**
C3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**28**
C4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**28**
C5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**29**
C6	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	**26**
C7	2	1	1	1	1	1	1	2	1	1	1	1	1	1	2	**22**
C8	1	2	2	1	1	1	1	1	1	1	1	1	1	1	2	**22**
C9	1	1	1	1	1	2	1	1	1	1	1	2	1	2	1	**28**

Key:
1 = Word correctly perceived
2 = Word incorrectly perceived
3 = Word perceived to be unintelligible
V = Refers to the 'variable' number assigned to each word, correlating with listening score sheet

Appendix F-4: Raw data for listening task conducted with control group participants, using final word list

Raw data for listening task conducted with control group participants: Number of words correctly perceived across judges, using the *final* word list

Participant	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19
C1			1	1	1	1	1					1	1		1		1
C2			1	1	1	1	1					2	1		1		1
C3			1	1		1		1	1		2	1	1	1			1
C4	1		1		1		1	1	1	1				1	1	1	1
C5	1	1	1	1		1	1					1	1			1	1
C6	1	1	1	1		2	1					2	1			1	1
C7	2		1		1		1	1	1	2				1	2	2	2
C8			2	1	1	1	2					1	1		2		2
C9			1	1		1		1	1		1	1	1	1			1

Participant	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33	V34	Total (20)
C1	1		1	1	1	1	1			1	2	1		1	2	**18**
C2	1		1	1	1	1	2			1	1	1		1	1	**18**
C3		1		1	1		1	1	1	1	1		1		1	**19**
C4			1		1	1	1	1	1	1	1			1		**20**
C5	1			1	1	1	1	1	1		1			1	1	**20**
C6	1			2	1	1	1	1	1		1			1	1	**17**
C7			1		1	1	1	2	1	1	1			1		**14**
C8	1		2	1	1	1	1			1	1	1		1	2	**14**
C9		1		1	1		1	1	1	1	1		1		1	**20**

*** Data for 12 words (6 pairs) per participant have been removed from the 16-pair experimental word list to calculate scores for the 10-pair final word list**

**** The V-number for each word that was removed varied across participants to allow for randomisation of the 4 word lists (refer to Appendix E-1)**

Key:
1 = Word correctly perceived
2 = Word incorrectly perceived
3 = Word perceived to be unintelligible
V = Refers to the 'variable' number assigned to each word, correlating with listening score sheet

Appendix F-5: Raw data for listening task conducted with experimental group participants, using final word list

Raw data for listening task conducted with experimental group participants: Number of words correctly perceived across judges, using the *final* word list

Participant	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19
P1	1	2	1	1		1	1					1	1			1	1
P2	1		1		1		1	2	1	1				1	1	2	1
P3	1	2	1	1		1	1					2	1			2	1
P4			1	1	1	1	2					1	1		1		1
P5	2	2	2	1		1	1					1	1			1	1

Participant	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33	V34	Total (20)
P1	1			1	1	1	1	1	2		1			1	1	**18**
P2			1		2	1	2	1	1	1	1			1		**16**
P3	2			1	2	1	1	1	2		1			2	2	**12**
P4	1		1	2	1	1	1			2	1	1		1	1	**17**
P5	1			1	1	1	1	2	1		1			1	2	**15**

*** Data for 12 words (6 pairs) per participant have been removed from the 16-pair experimental word list to calculate scores for the 10-pair final word list**

**** The V-number for each word that was removed varied across participants to allow for randomisation of the 4 word lists (refer to Appendix E-1)**

Key:
1 = Word correctly perceived
2 = Word incorrectly perceived
3 = Word perceived to be unintelligible
V = Refers to the 'variable' number assigned to each word, correlating with listening score sheet

Appendix G-1: Final Tswana minimal pair word list for the assessment of tone production and tone perception

Final Tswana minimal pair word list for the assessment of tone production and tone perception

(20 words)

Sèlwà (pick up, find)

Sélwà (oversleep, wake late)

Pàpá (father)

Pápà (porridge)

Màbòkó (brains)

Màbòkò (praise poems)

Màfátlhà (twins)

Màfàtlhà (lungs, chest)

Màfùlò (pastures)

Màfúlò (foam, froth)

Mòlàlà (neck of mammal)

Mòlálá (leftover food)

Bákà (to bake bread)

Bàkà (praise in song or word)

Dùmà (to roar, eg. lion)

Dúmà (to spray with insecticide)

Bálélá (to choke)

Bàlèlà (to count for)

Fìtlhà (to arrive)

Fítlhà (to hide)