

Development of a Setswana tonal minimal pair word list as research tool

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This study reports on the development of a Setswana tonal minimal pair word list, which could be implemented as research tool in the field of Bantu language linguistics and in speech pathology in South Africa. The development of the list was conducted in four phases. These are described as four separate studies. All involved Setswana L1 participants living in the urban areas of Gauteng. In Study 1, a 45-pair preliminary list was compiled from dictionaries. During Study 2, eleven L1 speakers' familiarity with each word was determined. Based on these results the list was narrowed down to 20 pairs. Study 3 entailed the validation of pictorial stimuli, which illustrate the target words. Ten different participants took part. Four pairs were not consistently familiar and were removed, resulting in the experimental list of 16 pairs. This list was validated in Study 4 and involved nine typical L1 speakers and five listeners. Word-specific analyses revealed that some words had a negative impact on the results. Six pairs were removed. A final list of 10 pairs rendered results more aligned to the expectation of typical speakers and listeners. Validation should continue to determine applicability in populations from exclusively rural or urban areas.

Introduction

Setswana, along with other Bantu languages, is a tone language which uses word-level variations in fundamental frequency to convey lexical meaning (Cole, 1992). The term *tone* refers to the distinctive pitch level of a syllable (Crystal, 2008). Tone languages rely on tone

variation at syllable level to change the core meaning of a particular word (Van der Pas, Wissing & Zonneveld, 2000; Yip, 2002; Nguyen, Kenny, Tran & Livesey, 2009). Phonologically similar words could differ in meaning due to a difference in tone pattern, and are known as tonal minimal pairs. In this manuscript the term ‘minimal pair’ will be used to describe such word pairs.

Setswana is a two-level tone language distinguishing only between high and low tones (Zerbian & Barnard, 2008). The two tones, high or low, combine to create ‘tone sequences’ which signal different meanings. This sequence of high and low tones within a word needs to be clearly distinguished from one another to convey the appropriate meaning (Brunelle, 2009). In Setswana, 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). For a Setswana 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 verb stem *-kaba* can be produced with a combination of high-low tone (*-kábà*) which means ‘(to) plug or cork’ or a combination of low-low tone (*-kàbà*) which means ‘(to) shoulder’ (Snyman, Shole & Le Roux, 1990). 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).

Lists of tonal minimal word pairs can serve as a research tool for tone studies in tone languages. Tonal minimal pairs create the opportunity to isolate and study tone variation while the phonological and phonetic contexts (other than tone variation) remain constant. Tonal stimuli and specifically minimal word pairs have been implemented in the field of tone modelling and text-to-speech technology for African tone languages (Louw, Davel, & Barnard, 2005; Odejebi, Wonga, & Beaumonta, 2008). Tone-labelling algorithms are being developed for speech synthesis purposes. Raborife, Zerbian and Ewert (2011), for example, developed a corpus for Sesotho to verify the performance of a tone labelling algorithm. The results are being implemented for the purpose of improving the perceived naturalness and speech intelligibility produced by a text-to-speech synthesiser. Tonal stimuli of a similar nature in the Setswana language could therefore prove useful in furthering such research in this language. Examples of other fields in which Setswana tonal minimal pairs could be implemented, are:

The study of the development of tone production and perception (see for example: Tong, McBride, & Burnham, 2014) in Setswana-speaking children; A study of the effect of language experience on tone production (Liu, Wang, Chen, Liu, Larson, & Huang, 2010) and perception (Francis, Ciocca, & Kei Chit Ng, 2003); Second language learning and teaching of pronunciation (Caldwell-Harris, Lancaster, Ladd, Dediu, & Christiansen, 2015); Exploration of the effect of the surface intonation pattern in a sentence on lexical tone realization (Kügler, 2016: 89-129); Acoustic investigation of tone variation (Mohasi, Mixdorff & Niesler, 2011), for example, the influence of adjacent syllables on fundamental frequency contour shape and height (Xu, 1999). Research in these fields would contribute to the comprehensive analysis and description of micro-typological tonal systems (Marlo, 2013) in Setswana.

In the clinical arena of speech pathology, a minimal pair word list can be utilized to assess tone production and perception ability in individuals with voice, speech, language, and hearing disorders. Recent studies provided evidence that these communication disorders can negatively affect tone manipulation or perception in individuals who speak tone languages (Ciocca, Whitehill & Ma Ka Yin, 2004; Jones, 2016; Kadyamusuma, De Bleser & Mayer, 2011; Nguyen, et al., 2009; Van der Merwe & Le Roux, 2014a: 135-140; 2014b; Wong, Perrachione, Gunasekera, Chandrasekaran, 2009). Tone production ability could be compromised by neuromotor speech disorders like dysarthria due to cerebral palsy, Parkinson's disease or motor neuron disease and apraxia of speech due to stroke. The inability to accurately manipulate the fundamental frequency of voice during speech could potentially impact speech intelligibility of Bantu language speakers negatively. On the other hand, the accurate perception of lexical tone could be compromised by receptive neurogenic language disorders such as aphasia due to stroke or by the presence of a hearing problem (Van der Merwe & Le Roux, 2014a: 135-140; 2014b; Wong et al., 2009). Speech-language pathologists and audiologists should assess tone production and/or perception and for this purpose a minimal pair word list would be a useful clinical tool.

Purpose of the research

The main aim of the research was to develop and validate a list of Setswana tonal minimal pairs which can serve as research and clinical tool. To achieve the main aim, a set of sub-aims were set which were addressed in phases during the research. The first sub-aim was to

compile a preliminary list of minimal pairs from dictionaries. The second sub-aim was to determine familiarity with these words in a group of first language (L1) Setswana-speaking adults living and working in the urban areas of Gauteng. The third sub-aim was to select and determine the appropriateness of a picture and a descriptive sentence for each word. The fourth sub-aim was to validate an experimental minimal pair word list as produced by L1 speakers and judged by other L1 Setswana speakers and then to compile a final validated list from these results. All participants were from urban areas in Gauteng to control for familiarity with the words. The four phases will be described as four separate studies in the Method section.

Ethical clearance was obtained from a Faculty Research Ethics Committee of the University of Pretoria prior to commencement of the research. All participants completed informed consent documentation, which was available in both English and Setswana, before participation.

Method

Study 1: Compilation of a preliminary list of minimal pairs

Aim: To develop a preliminary Setswana minimal pair word list.

Procedures: A desk study was conducted where minimal pair words were extracted from two Setswana dictionaries (Cole & Moncho-Warren, 2011; Matumo, 1993). A list was drawn up according to the following criteria:

- The word list had to comprise minimal pairs which contained the same phonemes but varied only with regard to syllabic tone pattern and therefore meaning.
- Only words that were classified as a noun or a verb were included in the stimuli to facilitate representation of the words in a picture format.
- The specific word category was controlled within pairs – both were nouns or verbs.
- Both noun words within a minimal pair were part of the same Setswana noun prefix class. This was necessary for the word pairs to be classified as *true* minimal pairs.
- Verbs were accompanied by the infinitive prefix *go-*.

Results: A preliminary list containing a total of 45 minimal pairs (90 words) was drawn up.

Study 2: Determining familiarity of each word in the preliminary list in the target population

Aim: To determine whether first language (L1) Setswana-speakers consider all 90 words to be familiar and commonly used in the urban Setswana-speaking population in Gauteng and to compile a narrowed down *experimental* word list from their responses.

Participants: Eleven L1 Setswana-speaking nurses working in the mixed-language context of a large hospital in Gauteng acted as respondents. Nurses were considered to be representative of the typical urban Bantu language speaker who may have differences in language exposure, but who consider themselves as having a first language which was Setswana in the case of the participants.

Procedures: A questionnaire was developed which asked the following question: 'Is this a commonly used word in your language (Setswana)?' The questionnaire used a three-point rating scale with three options: 'I agree completely'; 'I agree somewhat'; or 'I disagree'.

Results: No word pair obtained a score of 100% agreement for *both* words within a pair. To obtain at least 20 minimal pairs of words that could be included in the experimental word list, the following criteria were implemented for selection of these pairs:

- Words which were marked as 'I disagree' by more than 50% of the participants, were excluded from the preliminary word list, along with its pair.
- Of the words which obtained 50% or more agreement, the 20 pairs with the highest scores were included in the experimental word list.

Based on the results of the questionnaire, the *preliminary* list was narrowed down from 45 minimal pairs (90 words) to 20 minimal pairs (40 words).

Study 3: Selection of pictorial stimuli to illustrate the target words in the preliminary list

Aim: (1) To compile a set of pictorial stimuli that adequately represents the 40 target words (20 minimal pairs) and to determine whether typical L1 Setswana-speakers find the pictures to be an accurate representation of the target words; (2) To develop a stimulus manual with the final set of pictures together with descriptive sentences which clarify the meaning of the word.

Participants: Ten L1 Setswana-speaking nurses working in a mixed-language urban context in Gauteng responded to the questionnaire. These were not the same persons involved in Study 2.

Procedures: Pictures that portrayed the given words were found using the internet search engine *Google Images*. All the pictures selected were high quality colour photographs. A questionnaire was developed, which asked the following question: 'Is this a good picture to represent the given word?' A three-point rating scale provided the following options: 'I agree completely'; 'I agree somewhat'; or 'I disagree'. The respondents were also requested to provide a reason should they have not 'agreed completely' with any of the pictures. This feedback was used to make the necessary changes to the pictorial stimuli.

Results: Of the 40 pictures, 19 obtained 100% agreement. The remaining 21 pictures obtained responses which were either 'I agree somewhat' or 'I disagree'. The results indicated that for some participants, some pictures did not adequately represent the given word. The researcher used discretion to change the indicated pictorial stimuli and made changes that would further facilitate understanding of the given words. For example, two participants reported that the picture for the word *mosidi* (person who grinds) was inadequate. It was suggested that the picture specifically needed to show a person grinding with 'rocks'. For this reason, a picture illustrating 'grinding with rocks' was used.

Although the objective of Study 3 was to validate the pictures that had been selected for each word, confusion was noted amongst the participants regarding three of the words in the list. For these words, some participants offered alternative variations which were more familiar to them. For example, it was suggested that the verb stem *selwa* (*go sêlwa*), which is the passive form of *-sêla*, should be written as *go sêla*. Changing this verb stem to *-sêla* would have resulted in the loss of a minimal pair and it therefore remained *-sêlwa* in the experimental list. This was also the case with two other words, namely *leisô* for which 30% of the participants suggested the alternative spelling *lesô* and 20% of the participants suggested that *go balêla* should be written as *go balêlwa*. On the picture cards, the alternative variation of these three words was provided in brackets, next to the original target word from the list, to reduce any ambiguity regarding its meaning. For example, on the relevant picture card, the target word *-sêlwa* was followed by *go sêla* in brackets.

Further, seven words (out of 40 in the preliminary list) yielded conflicting responses from many of the participants. They reported to be unfamiliar with the given word and offered completely different words to match the particular picture. These seven words were considered to be too unreliable to keep in the word list and were therefore removed. Six of

Table 1: *Experimental word list with 16 minimal pairs (32 words)*

	Setswana word	English translation
1.	thàká	friend, peer
2.	thàkà	pupil of the eye
3.	go sèlwà (go *sêlwa)	to pick up, to find
4.	go sélwà (go *sêlwa)	to oversleep, to wake late
5.	pàpá	father
6.	pápà	porridge
7.	màbòkó (*mabôkô)	brains
8.	màbòkò (*mabôkô)	praise poems
9.	màfàtlhà	twins
10.	màfàtlhà	lungs, breasts
11.	màfùlò (*mafulô)	pastures
12.	màfúlò (*mafulô)	foam, froth
13.	mòkòtlà (*mokôtle)	spine, back
14.	mòkótlá (*mokôtle)	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, (e.g. a lion)
20.	go dùmà	to spray with insecticide
21.	lèisò (leisô)	large spoon or ladle
22.	lèísò (leisô)	fireplace, cooking place
23.	go bálélá (go *balêla)	to cause to choke
24.	go bàlèlà (go *balêla)	to count for
25.	dìnòkò	joints in a cane/reed
26.	dìnòkó	porcupines
27.	thápò (*thapô)	stone or pip of a fruit
28.	thàpò (*thapô)	string, rope
29.	mòsídi	soot; burnt out coal
30.	mòsìdi	person who grinds
31.	go fitlhà	to arrive
32.	go fítlhà	to hide

**As is customary when both a circumflex and tonal indication are applicable, tonal indication is prioritised and the circumflex, which occurs in ordinary orthography, is not added to the vowel. To ensure that the reader is aware of the specific vowel under discussion, the word, with the vowel/s containing the circumflex, is supplied in brackets.*

the seven words (*mògógà, mògógá, go gwètla, go gwétlà, dikgàrè, dikgárè*) conveniently formed part of a low-scoring word pair (i.e. both words within the pair scored poorly) and therefore these three pairs were removed. The seventh word (*go ámógá*) also had to be removed with its pair, bringing the total number of words removed to eight. This resulted in an *experimental* word list containing 32 words (16 minimal pairs). The *experimental* word list is provided in Table 1.

Preparation of the stimulus manual: To further clarify the meaning of the target words portrayed in the pictures, an English definition of each word or alternative English terms and also a Setswana sentence, using the word in context, were prepared. The English definition and Setswana sentence were to appear with each picture in the stimulus manual. Sentences were initially written up in English and a professional Setswana translator then translated these sentences into Setswana. A L1 Setswana-speaking speech therapy assistant who worked 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. After changes had been made, the sentences were checked for grammatical accuracy and edited by a L1 Setswana-speaking academic working at the Department of African Languages at the University of South Africa. The pictures and sentences can be viewed in Jones (2016).

Study 4: Validation of the experimental Setswana minimal pair word list

Aim: To determine whether the minimal pairs within the experimental word list will elicit a score of 100% when produced and judged by typical L1 Setswana-speaking individuals and to determine the frequency at which each word within the experimental word list was correctly identified.

Participants: A group of nine typical L1 Setswana speakers and five L1 Setswana-speaking judges (listeners) participated in the study. The inclusion criteria were:

- Setswana had to be the first acquired language and home language of all the participants (speakers and judges);
- All participants had to live in an urban area in Gauteng at the time of the study to control exposure to local vocabulary as far as possible;

- All participants had to present with normal hearing as per a screening audiogram (thresholds not exceeding 25dB at 500Hz, 1000Hz and 2000Hz);
- All participants had to present with typical (normal) speech and language ability as subjectively judged by a qualified speech-language pathologist during a brief conversation and speech screening;
- All participants had to be between 18 and 65 years of age to rule out the occurrence of voice pitch breaks which may occur during puberty particularly in males and which ensured that age-related changes to the larynx did not affect the ability to control vocal pitch variations (Ahmad, Yan, & Bless, 2012; Boone, McFarlane & Von Berg, 2005:75).
- 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.

Purposive sampling was used in the selection of typical L1 Setswana speakers and judges. Nurses who worked in a hospital, based in an urban area of Gauteng, were sampled and requested to participate in the study. None of them had participated in any of the previous studies. In addition, individuals who worked for a tutoring company and provided tutoring services in Setswana were approached. All individuals were randomly assigned to the speaker or listener groups. Nine typical speakers, of which five were nurses and four were tutors, were selected. A further five individuals were selected to act as judges who evaluated the speakers' responses. All participants are described in Table 2.

Stimuli: Four stimulus manuals (manual A, B, C, and D) were compiled from the experimental word list. Each manual contained the same 32 Setswana words, but in each the words appeared in a different order. Words from a minimal pair never appeared successively. The words were randomised to prevent the judges from becoming familiar with the order in which words appear during the listening task. Each page of a stimulus manual contained the target word at the top of the page, an English definition or alternative words to describe the picture

Table 2: Description of L1 Setswana-speaking speakers (S1 to S9) and judges (J1 to J5) who took part in the validation of the experimental word list (Study 4)

Speakers and Judges	Age (years)	Gender	Area where individual grew up	Second and third language	Frequency at which Setswana is spoken	Highest academic qualification	Reading ability in Setswana	Writing ability in Setswana
S1	46	Female	Soweto (G.P)	English; isiZulu	All day, every day	Diploma/degree	Good	Good
S2	41	Male	Soweto (G.P)	English; S-Sotho	Half of the day	Diploma/degree	Good	Good
S3	60	Female	Soweto (G.P)	English; Sepedi	Most of the day	Grade 10	Good	Good
S4	57	Female	Soweto (G.P)	S-Sotho; English	Half of the day	Diploma/degree	Good	Good
S5	55	Female	Zeerust (N.W)	English; isiZulu	Most of the day	Diploma/degree	Good	Good
S6	21	Male	Magaliesburg (N.W)	Xhosa; isiZulu	Most of the day	Matric	Good	Good
S7	18	Male	Mafikeng (N.W)	English; Xhosa	Most of the day	Matric	Fair	Good
S8	21	Female	Magaliesburg (N.W)	English; None	All day, every day	Matric	Fair	Fair
S9	20	Female	Mafikeng (N.W)	English; None	All day, every day	Matric	Fair	Good
J1	60	Female	Johannesburg (G.P)	Sepedi; Zulu	Half of the day	Grade 10	Fair	Fair
J2	22	Male	Taung (N.W)	English; Zulu	All day, every day	Matric	Fair	Good
J3	22	Male	Schweizer-Reneke (N.W)	English; S-Sotho	All day, every day	Matric	Fair	Good
J4	20	Male	Zeerust (N.W)	S-Sotho; None	Most of the day	Matric	Fair	Fair
J5	18	Female	Christiana (N.W)	English; Afrikaans	All day, every day	Matric	Good	Good

S-Sotho = Southern Sotho; G.P = Gauteng Province; N.W = North West Province

and a picture that represented the target word. At the bottom of the picture was a Setswana sentence in which the target word was used. Speakers had to produce only the target word.

Procedures: Data collection involved two procedures, the first being the recording of the minimal pairs produced by the nine typical speakers and the second a listening task by the five judges.

Each speaker was seated individually in a quiet room away from any noise which may have interfered with the audio recording. All procedures were explained and instructions were also presented in a step-by-step written format in both English and Setswana prior to data collection. The speakers were then provided with a stimulus manual (either A, B, C or D). They were allowed sufficient time to familiarise themselves with all of the words. After having practised with two non-experimental words, the microphone was switched on and the participant was requested to produce each of the 32 target words upon hearing the prompt 'please say the next word'. A delay of five seconds was imposed before a next word was presented and the prompt repeated. Pacing the participants in this manner, allowed them to be ready to produce each word and also allowed the judges at least five seconds to perform the listening task. The participants were requested to produce the word in such a way that it conveyed the intended meaning portrayed in the picture and sentences. Participants were not informed about the exact objective of the study and the importance of differential tone production of minimal pairs was not pointed out to them.

The recordings of all nine speakers were judged by the five judges during one occasion. Judges were given step-by-step verbal and written instructions and they received sufficient time to familiarise themselves with the stimulus manuals before the listening task commenced. Each was given a listener score sheet (for either list A, B, C, or D) which correlated with the specific stimulus manual that the particular participant had used during their word production task. The judges were requested to listen to the audio recording played to them and identify the word they heard by marking one of two options on a score sheet, that is, the two possible meanings for the given word that was produced. They also had an option to tick a third column which was for unintelligible words or words they could not recognize.

Apparatus and equipment: A Logitech USB headset with microphone and an Acer Aspire E15 laptop were used to make the audio recordings. PRAAT software (Boersma & Weenink, 2005)

was used to record and play back the recordings. External speakers (JVC: UX-P3) were plugged into the laptop to ensure adequate intensity and good sound quality during the listening task. *Data processing:* The *experimental* list contained 16 pairs of words (32 words in total) and each of the five judges listened to 32 words produced by nine speakers. The number of words that were correctly identified by a judge for each speaker was counted and will hereafter be referred to as a *score*. For each speaker the standard deviation across judges, the mean number and percentage of words correctly identified, and also the range of scores were determined.

Results

Results of the experimental word list

The results obtained from the experimental list are presented in Table 3. In the first eleven columns the judges' scores and their percentage scores are indicated for each of the nine speakers. None of the judges identified 32/32 (100%) of the words in the experimental word list correctly. Mean scores per judge varied between 78% and 83% and the mean percentage words correctly identified per speaker varied between 68% and 89%. These results did not meet the expectations for typical L1 speakers or judges. The nature of the speaking and listening task and individual-specific factors may have influenced the results, but as the main aim of the study was to compile a minimal pair word list for Setswana, word-specific results were subsequently analysed. The purpose of this analysis was to determine if some words were more often incorrectly identified by the judges.

Results of the individual words in the experimental list

To determine whether all target words were 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 in the *experimental* list was identified correctly by the five judges. Each word within the list obtained a score out of 45 (nine speakers x five judges = 45) and it was therefore possible to compute a percentage correct identification for each word. If a word was identified correctly by the five judges, across all nine speakers, a score of 45/45

Table 3: Performance of speakers and judges on the *experimental* word list containing 32 words (number and percentage of words correctly identified by the judges, the standard deviation across the five judges, as well as the mean scores and mean percentages of the speakers)

Speakers	Performance of each individual speaker as scored by each judge										Performance of each speaker across judges			
	Judge 1		Judge 2		Judge 3		Judge 4		Judge 5		Standard Deviation (SD) across 5 judges	Mean number of words correctly identified by all 5 judges	Mean percentage of words correctly identified by all 5 judges (%)	Range of scores
	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%	Score (out of 32)	%				
S1	28	88	24	75	29	91	26	81	27	84	1.92	26.8	84	24 - 29
S2	26	81	25	78	26	81	28	88	25	78	1.22	26.0	81	25 - 28
S3	28	88	26	81	26	81	25	78	25	78	1.22	26.0	81	25 - 28
S4	28	88	28	88	28	91	30	94	25	78	1.79	27.8	87	25 - 30
S5	29	91	28	88	29	91	26	81	30	94	1.52	28.4	89	26 - 30
S6	26	81	24	75	26	81	28	88	25	78	1.48	25.8	81	24 - 28
S7	22	69	24	75	25	78	21	66	20	63	2.07	22.4	70	20 - 25
S8	22	69	22	69	23	72	21	66	21	66	0.84	21.8	68	21 - 23
S9	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 percentage scores obtained by each judge across speakers are presented in **bold**

Table 4: Results of words from the *experimental* word list, ranked according to the frequency at which they were correctly identified by the five judges

*Words from experimental list that were removed to get a final list	Frequency at which the words were correctly identified by five judges (%)	Setswana word (N32)	Tone pattern	Obtained 100% agreement between judges
		Scored 100%		
	100	pàpá (father)	LH	X
	100	pápà (porridge)	HL	X
	100	mòlàlà (neck of mammal)	LLL	X
	100	go dùmà (to roar, e.g. a lion)	LL	X
	100	go fítlhà (to hide)	HL	X
		Mean score between 90 and 99%		
X	97	mòsídi (soot; burnt out coal)	LHL	
X	97	thàkà (friend, peer)	LH	
	95	go fitlhà (to arrive)	LL	
	93	go bálélá (to cause to choke)	HHH	
	93	màbòkò (praise poems)	LLL	
	91	màfàtlhà (lungs, breasts)	LLL	
		Mean score between 80 and 89%		
X	88	mòkòtlà (spine, back)	LLL	
	88	go sélwà (to oversleep, to wake late)	HL	
	88	go bàkà (to praise in song or word)	LL	
	86	go bákà (to bake bread)	HL	
	86	go bàlèlà (to count for)	LLL	
X	86	dìnòkó (porcupines)	LLH	
	84	màfulò (foam, froth)	LHL	
	80	go sèlwà (to pick up, to find)	LL	
	80	màfàtlhà (twins)	LHL	
		Mean score between 70 and 79%		
X	77	lèisò (fireplace, cooking place)	LHL	
	75	màfulò (pastures)	LLL	
	73	màbòkó (brains)	LLH	
	73	go dúmà (to spray with insecticide)	HL	
		Mean score between 60 and 69%		
X	68	thàpò (string, rope)	LL	
	64	mòlálá (leftover food)	LHH	
X	64	mòkótlá (bag, sack)	LHH	
X	60	thàkà (pupil of the eye)	LL	
		Mean score between 40 and 59%		
X	57	mòsídi (person who grinds)	LLL	
X	48	lèisò (large spoon or ladle)	LLL	
X	48	dìnòkò (joints in cane/reed)	LLL	
X	42	thápò (stone or pip of fruit)	HL	

* The six lowest scoring words together with its pair were removed.

(100%) was assigned and 100% agreement between judges was achieved. Words were ranked in order of highest to lowest score.

The word-specific scores are displayed in Table 4. The highest score of 100% was obtained in 5 of the 32 words. These words included: *pàpá* (father), *pápà* (porridge), *mòlàlà* (neck of mammal), *go dùmà* (to roar, e.g. a lion), and *go fítlhà* (to hide). The remaining 27 words scored less than 100%. Eight of these words attained a score of 60% or lower.

To reduce the impact of specific words on the results, the six lowest scoring words were removed from the experimental word list. These included all four words in the 40%-49% category as well as the two lowest-scoring words from the 60%-69% category. In addition to this, it was necessary to also remove their corresponding pairs, even though they might have scored well. Two words, *mòlálá* and *mòkótlá* both scored 64%. The latter was excluded as it had the lowest scoring pair (88% as opposed to 100%). Six minimal pairs were removed. Ten pairs of words (20 words) remained in the *final* word list. The final word list can be viewed in Table 5.

Results of the final word list

Data were re-analysed using only the words in the *final* list. Table 6 displays the number and percentage of words that were correctly identified for each speaker by each judge. When the *final* word list was used, all five judges were able to identify 20/20 (100%) of the words correctly for at least one of the speakers. The mean percentage of words correctly identified for the *final* list was 88% as opposed to 81% for the *experimental* list. The standard deviation across judges, however, did not decrease for the final list. Four of the speakers achieved 100% correct identification from at least one judge. On average across judges, three speakers scored 71%, 73% and 84% while the remaining six scored between 91% and 98% correct identification for the *final* list.

Discussion

The compilation and preliminary validation of a Setswana tonal minimal pair word list progressed across four phases. The 90 words (45 pairs) of a *preliminary* list compiled from

Table 5: *Final* minimal pair word list with 10 minimal pairs (20 words)

	Setswana word	English translation
1.	go sèlwà (go *sêlwa)	to pick up, to find
2.	go sélwà (go *sêlwa)	to oversleep, to wake late
3.	pàpá	father
4.	pápá	porridge
5.	màbòkó (*mabôkô)	brains
6.	màbòkò (*mabôkô)	praise poems
7.	màfátlhà	twins
8.	màfátlhà	lungs, breasts
9.	màfùlò (*mafulô)	pastures
10.	màfúlò (*mafulô)	foam, froth
11.	mòlàlà	neck of a mammal
12.	mòlálá	leftover food
13.	go bákà	to bake bread
14.	go bàkà	to praise in song or word
15.	go dùmà	to roar, e.g. a lion
16.	go dúmà	to spray with insecticide
17.	go bálélá (go *balêla)	to cause to choke
18.	go bàlèlà (go *balêla)	to count for
19.	go fitlhà	to arrive
20.	go fítlhà	to hide

**As is customary when both a circumflex and tonal indication are applicable, tonal indication is prioritised and the circumflex, which occurs in ordinary orthography, is not added to the vowel. To ensure that the reader is aware of the specific vowel under discussion, the word, with the vowel/s containing the circumflex, is supplied in brackets.*

Table 6: Performance of the speakers and judges on the *final* word list containing 20 words (number and percentage of words correctly identified by the judges, the standard deviation across the five judges, as well as the mean scores and mean percentages of the speakers)

Speakers	Performance of each individual speaker as scored by each judge										Performance of each speaker across judges			
	Judge 1		Judge 2		Judge 3		Judge 4		Judge 5		Standard Deviation (SD) across 5 judges	Mean number of words correctly identified by all 5 judges	Mean percentage of words correctly identified by all 5 judges (%)	Range of scores
	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%	Score (out of 20)	%				
S1	18	90	15	75	20	100	19	95	20	100	2.07	18.4	92	15 - 20
S2	18	90	17	85	19	95	18	90	18	95	0.71	18.0	91	17 - 19
S3	19	95	19	95	19	95	18	90	18	90	0.55	18.6	93	18 - 19
S4	20	100	20	100	20	100	20	100	18	90	0.89	19.6	98	18 - 20
S5	20	100	18	90	19	95	18	90	20	100	1.00	19.0	95	18 - 20
S6	17	85	15	75	17	85	18	90	17	85	1.10	16.8	84	15 - 18
S7	14	70	14	70	15	75	14	70	14	70	0.45	14.2	71	14 - 15
S8	14	70	15	75	15	75	14	70	15	75	0.55	14.6	73	14 - 15
S9	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 percentage scores obtained by each judge across speakers are presented in **bold***

dictionaries, was verified for familiarity in the urban areas of Gauteng and was reduced to 32 words to constitute an *experimental* list. This list was validated in a study which involved nine typical L1 Setswana speakers and five L1 listeners (judges). Word-specific analyses revealed the negative impact of some words on the results. These words may have been less familiar to the speakers, but other factors could also have influenced the results. The six lowest scoring words with its pair were omitted, culminating in a final list with 10 pairs. The use of the *final* word list elicited improved scores, which were more closely aligned with what was expected from typical L1 speakers and listeners.

A lack of familiarity with words to be taken up in a corpus for research purposes appears to be a challenge. There are various factors contributing to this lack of familiarity with certain words. Language exposure in the area where the person grew up, the geographical dialect, the school environment and language of instruction, as well as the effect of ‘Street Setswana’ in the multilingual urban areas will all influence familiarity with certain words or a specific form of a word (Heugh, 2007; Probyn, 2009). A phenomenon that has become increasingly evident is the emergence of non-standard language varieties of Black South African languages. 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 and lexical borrowing between various languages, including English, Afrikaans and the dominant local Bantu languages (Slabbert & Finlayson, 1999). Although ‘Street Setswana’ differs from the standard form of Setswana in the choice of vocabulary, structurally it differs very little from the standard Setswana syntax (Cook, 2009).

Participant-specific results for the *final* list suggest that speaker and listener factors also had an effect on the scores. No judges or speakers consistently attained 100%. Judge 1 attained 100% identification for three speakers, Judges 3 and 5 for two, and Judges 2 and 4 for only one speaker. Two speakers, S7 and S8, did not attain a score higher than 75% from any judge. The results appear to suggest that not all typical L1 users of a tone language are equally able to produce or perceive tone variation. The nature of the single word production or identification task, as was implemented in the current study, may have contributed to the lower than 100% scores. The results of this study indicate normal variation, which could be expected in typical speakers of tone languages. A tonal minimal pair word list could act as

stimuli to determine acoustically the typical fundamental frequency contour of low and high-pitched syllables across speakers and conversely the ability of typical listeners to accurately perceive a minimal distance in fundamental frequency change.

Conclusion

The outcome of this study is a Setswana minimal pair word list, which appears to be suitable as a research tool in future studies involving participants living in the urban areas of Gauteng. Through a process of validation, 10 minimal pairs, which in the final analysis attained high scores across judges, were identified. The words that remain in the final list could be instrumental in research regarding the tonal aspects of Setswana. A further contribution of the study is the indication of the range of performance that can be expected from typical speakers and listeners in their ability to produce and perceive tone variations. Although the word list appears to be appropriate for assessment of tone production and tone perception, validation needs to continue in populations from exclusively rural or urban areas and from different socio-economic classes.

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