Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia

by

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UNIVERISTY OF PRETORIA

FACULTY OF HUMANITIES

DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY

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Date	October 2018
Title	Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia.

Abstract

Background: Bilingual aphasia forms a significant part of speech-language therapists' (SLT) caseload, globally and specifically in South Africa. Few tools supporting clinical decision-making are available due to limited understanding of typical and disordered cross-linguistic processing (how the languages interact). Speech errors may provide insight about "hidden" bilingual mechanisms.

Objectives: To determine what speech errors can impart about cross-linguistic processing, as well as, associated language and impairment factors in Sepedi-English individuals with aphasia.

Method: The case series included six participants, purposively selected from three rehabilitation sites in Pretoria. Detailed language and clinical profiles were obtained. Participants performed a confrontation naming task in their most dominant language (MDL) and less dominant language (LDL). Responses were audio recorded, transcribed and analysed for overall accuracy and error type in MDL and LDL; verified by a Sepedi-speaking linguist and a qualified SLT.

Results: (1) No statistically significant differences in MDL-LDL naming accuracy were found, supporting recent literature of simultaneous inter-activation of both languages and shared word retrieval mechanisms. All types of speech errors occurred with semantic errors produced most frequently and consistently in each participant's MDL and LDL. (2) Language proficiency, language recovery patterns and aphasia type (Broca's and Anomic) and severity (mild and/or moderate) appeared to be more strongly linked to cross-linguistic processing than Sepedi-English linguistic differences and age of acquisition of both languages.

Conclusions: Participants with bilingual aphasia may use typical cross-linguistic and word retrieval mechanisms, concurring with current theories of bilingualism. Findings are preliminary, warranting investigations of other language tasks, modalities, pairs and related factors.

Keywords: bilingual aphasia; cross-linguistic processing; speech production errors; word retrieval; age of language acquisition; language differences; aphasia type and severity; language recovery; Sepedi and English; South Africa.

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DECLARATION

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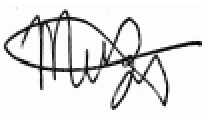

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RESEARCH ETHICS COMMITTEE

Declaration for the storage of research data and/or documents

I, the principal researcher Mianda van Zyl

and supervisor(s) Bhavani Pillay and Alta Kritzinger

of the following study, titled "Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia"

will be storing all the research data and/or documents referring to the above-mentioned study in the following department: Department of Speech-Language Pathology and Audiology

We understand that the storage of the mentioned data and/or documents must be maintained for a minimum of 15 years from the commencement of this study.

Start date of study: 2016

End date of study: 2018

Year until which data will be stored: 2031

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Name of Head of Department	Signature	Date
Jeannie van der Linde		30/10/2018

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List of abbreviations

ASHA	American Speech-Language-Hearing Association
AQ	Aphasia quotient
BNT	Boston Naming Test
CLD	Culturally and linguistically diverse
Error types	
M	Mixed
N	Neologism
O	Omission
P	Phonologic
S	Semantic
S-RAL	-related across language
S-RWL	-related within language
S-UAL	-unrelated across language
S-UWL	-unrelated within language
T	Translation
ICF	International Classification of Functioning, Disability and Health
LDL	Less dominant language
MDL	Most dominant language
RHM	Revised Hierarchical Model
SAT	Spreading Activation Theory
SLT	Speech-language therapist
WAB-R	Western Aphasia Battery Revised

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Terminology as used in the dissertation

Aphasia: A communication disorder that results from damage to the language areas of the brain, typically in the left hemisphere of the brain (American Speech-Language-Hearing Association, 2016; Australian Aphasia Rehabilitation Pathway, 2014).

Balanced bilingual: A bilingual individual who has balanced ability in both his or her languages (Kendall et al., 2015).

Bilingual aphasia: Persons who speak and understand two languages and have aphasia (Kiran & Gray, 2018).

Cross-linguistic processing: Interaction of the two languages within a bilingual individual which is evidenced in the use of language (e.g. receptive or expressive) and other language-relevant actions (e.g. gesture usage) (Jarvis, 2012).

Less dominant language (LDL): The less proficient language, which is not used as often as and/or with less ease than the most dominant language (Kiran & Gray, 2018).

Most dominant language (MDL): The language most used and/or with the greatest ease (Kiran & Gray, 2018).

Multilingual and multicultural: Different languages and cultures within a society.

Pre-stroke: This term refers to “before the stroke occurred”.

Post-stroke: This term refers to “after the stroke occurred”.

Speech production errors: The incorrect production of speech sounds or words. There are different error types as stipulated by Kendall et al. (2015), namely phonologic (e.g. “aerofane” for “aeroplane”), semantic (e.g. “couch” for “chair”), mixed (e.g. “roses” for “horses”), omission (e.g. “aero” for “aeroplane”) and neologisms (e.g. “beba” for “knife”).

Unbalanced bilingual: A bilingual person who has one language which he or she uses more often and with greater ease (MDL) than the other language (LDL) (Gray & Kiran, 2016).

Variable-and-recovery relationship: This term refers to how pre- and post-stroke factors (e.g. age of language acquisition, language proficiency and use, educational exposure, language use environments and type and severity of aphasia) may be associated with patterns of linguistic recovery post-stroke.

Chapter 1

Introduction

"Language is very powerful. Language does not just describe reality. Language creates the reality it describes" – Desmond Tutu.

1.1. Chapter aim and outline

This chapter aims to provide the reader with current theories and models on cross-linguistic processing and speech production errors in the population with mono- and bilingual aphasia. Recent literature, the mixed model of bilingual lexical representation (de Groot, 1992), revised hierarchical model [RHM] (Kroll & Stewart, 1994) and bilingual lexical access model (Costa, 2005) are used to explain evolving theoretical underpinnings of within- and cross-linguistic processing in neurotypical bilinguals. A basis is thus formed to describe word retrieval difficulties and speech production errors in persons with bilingual aphasia. Multilingual and multicultural South Africa is the focus, providing an introduction to the Sepedi-English population with aphasia. This attention is relevant as Africa has the highest prevalence of multilingualism in the world (Khokhlova, 2015). The rationale of the study and research questions are subsequently stated.

1.2. Background to the study

The incidence of stroke is high, with fifteen million strokes annually occurring globally (Australian Aphasia Rehabilitation Pathway, 2014). Aphasia, a communication disorder, commonly results after infarction in the language areas of the brain and presents in almost forty percent of the surviving stroke community (American Speech-Language-Hearing Association [ASHA], 2016; Australian Aphasia Rehabilitation Pathway, 2014). An increase in bilingualism has caused fifty to eighty percent of the global population to be bilingual (Amberber, 2012b; Ansaldo & Saidi, 2014; Croft, Marshall, Pring, & Hardwick, 2011; Kiran & Gray, 2018). Consequently, the number of individuals with bilingual aphasia has grown significantly (Kiran & Gray, 2018).

In considering country-specific stroke statistics, South Africa ranks high as figures of stroke and resultant aphasia are elevated (Penn, 2014; Penn & Armstrong, 2017).

Numbers are especially prominent for marginalized and poverty-stricken communities which are more susceptible to stroke (Penn, 2014; Penn & Armstrong, 2017). Eminent bilingualism and stroke-aphasia statistics have led to a significant number of individuals with bilingual aphasia in South Africa (Barratt, Khoza-Shangase, & Msimang, 2012; Penn, 2014; Penn & Armstrong, 2017; Posel & Zeller, 2016; Statistics South Africa, 2012). It is, however, necessary to consider more than just the communication disorder, because factors such as quality of life and contextual influences are evident when investigating mono- and bilingual aphasia (Amberber, 2012a; Penn, 2014; Penn & Armstrong, 2017; Pike, Kritzinger, & Pillay, 2017).

Lam and Wodchis (2010) considered sixty diagnosed diseases and fifteen health conditions and the outcomes indicate that aphasia has the most negative impact on quality of life. The areas most affected are physical, communication and psychosocial domains of daily functioning (Chiou & Yu, 2018; Hope et al., 2015; Pike et al., 2017; Sinanović, Mrkonjić, & Zečić, 2012). Amberber (2012b) supports this view, stating that mono- and bilingual individuals with aphasia experience reduced well-being, increased stress and limited social participation. Contextual factors, such as life participation, have been widely studied in aphasia literature, but the role that culture plays has been neglected, especially in multilingual and multicultural contexts such as South Africa (Legg & Penn, 2013; Penn, 2014; Penn & Armstrong, 2017; Pike et al., 2017).

South Africa has a colonial past and thus there is often a divide between westernized and indigenous perceptions about disability and disease (Legg & Penn, 2013; Penn, 2014; Penn & Armstrong, 2017). Some communities in South Africa consider causation of disease in relation to supernatural frameworks. For example, not performing rituals in the correct manner may result in misfortune such as stroke (Legg & Penn, 2013). There is also lack of understanding about aphasia and its symptoms, as difficulties in communicating are perceived to arise from the throat (Legg & Penn, 2013). Considering that majority of persons with aphasia have different lived experiences as a result of linguistic and cultural factors, it is necessary that clinicians take heterogeneity into account in order to provide ethical services (Legg & Penn, 2013; Penn & Armstrong, 2017). Research endeavors should be mindful of and elaborate on these factors.

Heterogeneity is the rule rather than the exception in South Africa, as there are eleven official languages (Posel & Zeller, 2016; Statistics South Africa, 2012). One of the three most frequently used official languages is Sepedi, also known as Northern Sotho (Joffe, 2016; Posel & Zeller, 2016; Statistics South Africa, 2012). Sepedi is densely represented in the Gauteng province, amounting to 10.6% of its population (Statistics South Africa, 2012). Just over nine and a half percent of South African citizens have English as their home language (Statistics South Africa, 2012). Although a small proportion of the South African population use English as their home language, it remains an influential language among people with other home languages (Khokhlova, 2015). Acquisition of English is viewed as desirable owing to its common use in business, trading, government, police and public service (Khokhlova, 2015). Therefore, most persons in South Africa are able to speak English, even if at an elementary level only and/or as their second or third language (Khokhlova, 2015).

Linguistic diversity in South Africa suggests that bilinguals have an array of possible language pairs (Penn & Armstrong, 2017; Posel & Zeller, 2016). Kiran and Gray (2018) mention that a bilingual speaker's first and second language do not necessarily correspond to the order in which the languages were acquired, but rather indicate the '"most dominant language"' (MDL) and '"less dominant language"' (LDL). Therefore, regularity of language use rather than the ages at which the languages were acquired is considered. It appears that a third of bilingual Sepedi-speakers use Sepedi as their MDL (Lewis, Simons, & Fennig, 2016; Statistics South Africa, 2012). Almost twenty percent of Sepedi MDL speakers, use English as their LDL (Posel & Zeller, 2016). Frequency of the Sepedi-English language pair gave rise to the present study's impetus to pay attention to these individuals and specifically those with aphasia.

Continuous research in the field of bilingual aphasia is pertinent. Literature indicates a significant rise in bilingualism worldwide, increasing rates of stroke and aphasia and detrimental consequences for quality of life (Amberber, 2012a; Hope et al., 2015; Khachatryan et al., 2016; Kiran & Gray, 2018; Pike et al., 2017; Posel & Zeller, 2016). Furthermore, diverse linguistic and cultural contexts, such as South Africa, should be of special interest as approaches to bilingual aphasia cannot be generalized across contexts (Amberber, 2012b; Ansaldo & Saidi, 2014; Centeno &

Ansaldo, 2016; Khachatryan et al., 2016; Kiran & Gray, 2018; Legg & Penn, 2013; Penn, 2014; Penn & Armstrong, 2017).

1.3. Literature overview on bilingual aphasia

Ansaldo and Saidi (2014) acknowledge the complexity of bilingual aphasia as there are two (or more) languages involved, which may recover similarly or differently (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008; Gray & Kiran, 2013; Khachatryan et al., 2016; Kiran & Gray, 2018). Moreover, linguistic processing in monolinguals appears to be different to that in bilingual persons, with or without language impairment (Kiran & Gray, 2018). The proposed processing difference is supported by a growing body of evidence which concurs that an individual who is bilingual should not be viewed as two monolinguals in one body (Ansaldo et al., 2008; Ansaldo & Saidi, 2014; Khachatryan et al., 2016). Assessment tools and interventions for aphasia may thus not be appropriate for bilingual aphasia, despite its persistent use (Radman, Spierer, Laganaro, Annoni, & Colombo, 2016).

Positive effects of bilingual therapy are noted, but more insight about factors which influence treatment outcomes are needed (Kiran, Grasemann, Sandberg, & Miikkulainen, 2013). Limited knowledge of these variables may also have contributed to lack of suitable resources and therapy approaches for bilingual aphasia (Palero, Manada, Polo, & Sotillo, 2015). The consequence thereof is detrimental as language outcomes may be poorer for bilingual versus monolingual individuals with aphasia (Hope et al., 2015). To inform appropriate management, understanding of language processing in the bilingual brain is imperative.

Cross-linguistic processing is the interaction of two languages within a bilingual and is evidenced in understanding and expression of language, as well as, other language-relevant actions such as gesture usage (Jarvis, 2012). Various models explain cross-linguistic processing; however none describe word retrieval and comprehension in one depiction (de Groot, 1992; Gray & Kiran, 2013; Kroll & Stewart, 1994). Costa's (2005) bilingual lexical access model is drawn upon, as it is in agreement with more recent views on bilingual word retrieval (Kiran & Gray, 2018).

The model has three levels namely the conceptual (semantic) level, where meaning and understanding of word(s) are created and stored. Word (lexical) nodes are responsible for creating and storing whole word(s) of both languages, not individual sounds. Sounds of both languages, which constitute whole words, are created and stored as phonological nodes. A spread of activation between these three levels occur during word retrieval (top-down) and word comprehension (bottom-up) (Gray & Kiran, 2013; Kendall et al., 2015; Meier, Lo, & Kiran, 2016). Figure 1 details mechanisms of word retrieval and comprehension in a Sepedi-English individual while naming a picture.

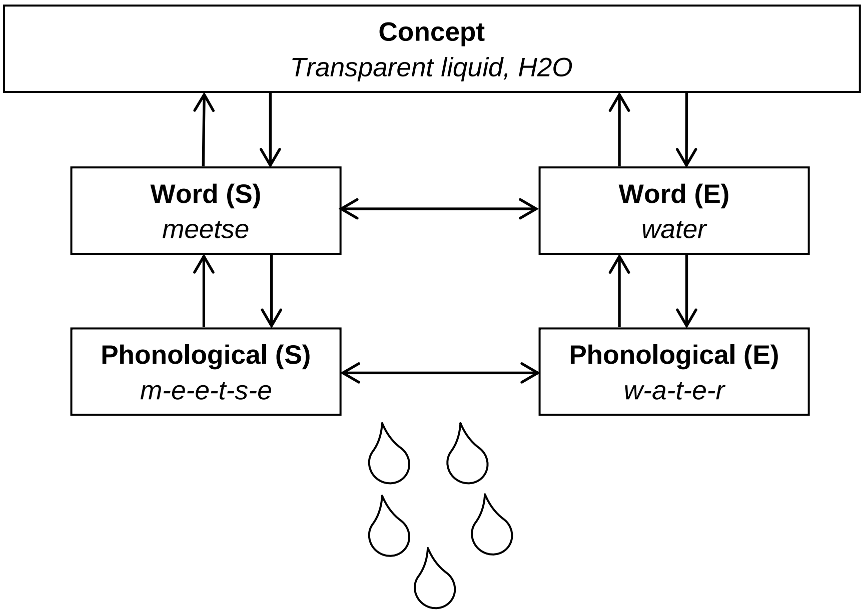

Figure 1. A diagrammatic representation of word retrieval and comprehension during a picture naming task in a Sepedi-English speaker.

First there is activation of a shared conceptual system (*transparent liquid, H2O*), i.e. an identical concept is stored in both languages' semantic memory (Costa, 2005; de Groot, 1992; Isel, Baumgaertner, Thran, Meisel, & Buchel, 2010; Kroll & Stewart, 1994). Activation then spreads to both languages' word nodes (*water* and *meetse*) followed by a spread of activation to sounds of both languages (*w-a-t-e-r* and *m-e-e-t-s-e*). Phonological output is thereafter fed to the articulatory system and the word "water" and/ or "meetse" is spoken (Hickok, 2012). There is continuous bidirectional spread of activation in MDL and LDL during cross-linguistic processing. It is important to understand mechanisms of word retrieval, as difficulty in retrieving words is a pervasive characteristic of mono- and bilingual aphasia (Ecke, 2008; Schwartz & Metcalfe, 2011).

Recent studies of cross-linguistic processing further suggest that both languages are constantly interactive and continuously engage in a process of language selection (Goral, Naghibolhosseini, & Conner, 2013; Kiran, Balachandran, & Lucas, 2014; Kiran & Gray, 2018). The most commonly accepted theory posits that the semantic and phonological system of both MDL and LDL are instantaneously activated in parallel, suggesting non-specific language activation (Costa, 2005; Khachatryan et al., 2016; Kiran et al., 2014; Kiran & Gray, 2018; Radman et al., 2016). Subsequently, cognitive mechanisms inhibit the non-target language to allow language-specific word selections to occur in the target language (Goral et al., 2013; Khachatryan et al., 2016; Kiran et al., 2014; Kiran & Gray, 2018). In this case, if a Sepedi-English individual was naming a picture in Sepedi (MDL) the word "meetse" would be spoken and not "water". Stronger inhibition effects are however required to constrain the non-target language when LDL is being spoken (Goral et al., 2013).

Neurotypical bilingual individuals automatically use their target and non-target language interchangeably, known as code switching and/or translation (Khachatryan et al., 2016). Persons with bilingual aphasia may also use a word in one language to cue the corresponding word in their other language, but attempts are often unsuccessful (Khachatryan et al., 2016). This is not a speech error, but rather a compensatory strategy. Typical translation efforts should not be confused with interference. Language mixing and translation may become disinhibited consequent to a brain lesion resulting in interference from the non-target language when the target language is being spoken (Khachatryan et al., 2016).

Language interference may present in two forms: pathological switching and mixing involving swapping between languages from one utterance to the next or using two languages within one utterance, respectively (Khachatryan et al., 2016). The other manifestation is a translation disorder, subdivided into difficulties with translation, translation without being requested to do so and translation of a word without understanding of the word (Khachatryan et al., 2016). For example, a person with bilingual aphasia may involuntarily produce a translation error by saying "meetse" instead of "water" while speaking in English (LDL).

Other types of speech errors may be understood using the bilingual lexical access model (Costa, 2005). Word retrieval difficulties may result from impaired activation of word nodes. Subsequent activation of corresponding phonological nodes may also be negatively affected causing speech errors. For example, partial retrieval of the word "water" may result in a phonological error such as "wat" as seen in Figure 2. Impaired linguistic processing may further manifest as omissions, neologisms, semantic and mixed errors (Kendall et al., 2015). Confrontation naming tasks are therefore frequently used to investigate lexical access in bilingual individuals (Kiran et al., 2014).

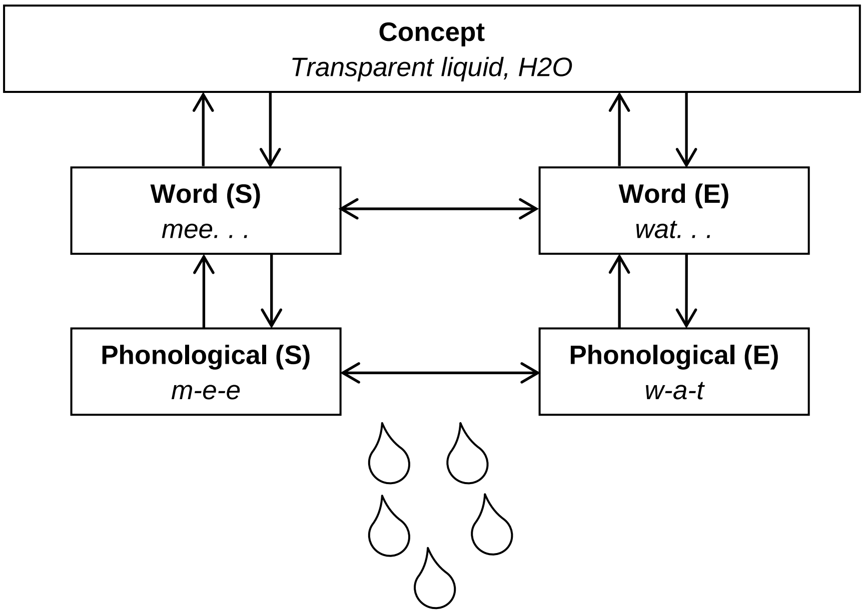

Figure 2. An illustration of a Sepedi-English individual with aphasia producing a speech error due to difficulty in retrieving the words "water" and "meetse".

Similar error patterns may be seen in both languages as a single semantic system is shared by MDL and LDL (Kendall et al., 2015). A decrease in activation of the semantic system spreads to both languages and thus a similar number of semantic errors may occur between MDL and LDL (Kendall et al., 2015). Within-language semantic errors may also occur due to a higher level of activation of a semantically-related concept (Costa, 2005; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997). For example, saying "couch" for "chair" when the concept *piece of furniture that you sit on + living room* is *activated* as opposed to *piece of furniture that you sit on + at a table*. Semantic and phonological errors indicate activation of the semantic and phonological level, despite it being impaired (Kendall et al., 2015). Kendall et al. (2015) suggest that omission errors may result when activation is not sufficient to reach the threshold and therefore no spread of activation between the semantic, lexical and phonological level occurs. It becomes evident how disrupted cross-linguistic processing can result in word retrieval difficulties and consequent speech production errors.

In bilingual aphasia, cross-linguistic processing is not only controlled by the interaction of two languages, but also by additional language and impairment factors (Kiran & Gray, 2018; Kiran & Roberts, 2010). Age of language acquisition, pre- and post-stroke language proficiency and aphasia type and severity have a compound effect on cross-linguistic processing post-stroke. However, the relationship between these factors' influences remains unclear (Khachatryan et al., 2016). Gray and Kiran (2013) suggest that pre-stroke language abilities are one of the strongest predictors of post-stroke outcomes. Language proficiency is thought to be more predictive of semantic and lexical performance post-stroke than age of acquisition of languages (Khachatryan et al., 2016). Therefore, it does not necessarily mean that a bilingual will perform relatively better in English language tasks post-stroke if he or she was exposed to English first and since birth. Yet, another study showed that age of language acquisition impacts linguistic performance post-stroke (Kiran et al., 2014).

Nonetheless, the dominant language pre-stroke may facilitate recovery of MDL to a greater extent than LDL (Kambanaros, 2016; Siyambalapitiya, Chenery, & Copland, 2013). It appears that stronger lexical-semantic connections exist within MDL pre-stroke and if MDL is still the predominant language post-stroke, this strong link remains (Hanulová, Davidson, & Indefrey, 2011; Siyambalapitiya et al., 2013). LDL may be affected to a greater extent post-stroke as weaker pre-morbid connections may persist and thus increased speech errors may result (Hanulová et al., 2011; Siyambalapitiya et al., 2013). There is a difference between production accuracy of balanced (equally proficient in both languages) and unbalanced (more proficient in one language) bilinguals. A balanced bilingual may present with similar accuracy of production in both languages as opposed to an unbalanced bilingual with increased speech errors in LDL (Hanulová et al., 2011; Kendall et al., 2015; Siyambalapitiya et al., 2013). Interaction between languages in a bilingual may change post-stroke (Centeno & Ansaldo, 2016). For example, if an individual mostly used his or her MDL at work pre-stroke, but as a result of aphasia, is not able to return to work, he or she may use MDL less and LDL more frequently. LDL may thus become more dominant.

Strength of lexical-semantic links can be explained theoretically by referring to the mixed model of bilingual lexical representation (de Groot, 1992) and the revised hierarchical model (RHM) (Kroll & Stewart, 1994). It is helpful to draw on these models in addition to the bilingual lexical access model (Costa, 2005), as they have long-standing influence in bilingual aphasia literature (Gray & Kiran, 2013; Kendall et al., 2015; Kiran & Gray, 2018; Kroll, van Hell, Tokowicz, & Green, 2010; Meier et al., 2016). The mixed model suggests that two variables determine strength of lexical-semantic connections within and between MDL and LDL: 1) the characteristics of a word (e.g. frequency of use and familiarity) and 2) how apparent the meaning of a word is (i.e. concrete versus abstract words) (Gray & Kiran, 2013). For example, high frequency words have a stronger lexical-semantic connection that is transferred between MDL and LDL than low frequency words. These words have increased translation potential as both words are easily accessible and switchable (Gray & Kiran, 2013).

RHM theorizes that sturdiness of lexical-semantic links is determined by fluency in MDL and LDL (Gray & Kiran, 2013). This model specifically considers asymmetrical strength of connections in persons who are sequential bilinguals, i.e. who developed their second language after their first language was consolidated (Kroll, van Hell, Tokowicz, & Green, 2010). It is thought that the lexicon of MDL accesses the shared conceptual system directly as opposed to the lexicon of LDL which requires activation of the word in MDL in order to connect to the meaning of the word (Kroll et al., 2010). In other words, a longer latency exists when translating from MDL to LDL in comparison to translating from LDL to MDL (Kroll et al., 2010). Translation errors may thus occur more frequently in a LDL-MDL direction, for example saying “water” for “meetse” when naming in Sepedi (MDL).

Another variable of interest in recent research is the different languages that the bilingual individual with aphasia understands and speaks (Kambanaros, 2016; Kendall et al., 2015; Kiran et al., 2014). It is thought that some semantic tasks have identical organization across languages whereas other activities may be arranged differently from one language to another (Kiran et al., 2014). The latter may cause interference between MDL and LDL during word retrieval of semantically related words (*e.g. meetse-water*) (Kiran et al., 2014). Interference may also result due to substantial structural differences between languages, possibly affecting the extent and pattern of recovery in MDL and LDL (Radman et al., 2016). Connection strength between languages may thus be weaker if the languages differ extensively in terms of typology (Kendall et al., 2015). It is however also proposed that structurally and/or typologically different languages process and retrieve words in a similar manner (Kambanaros, 2016; Wei & Liu, 2018). Therefore, the influence of linguistic differences on cross-linguistic processing and speech errors is not clear.

Sepedi and English differ significantly in typology and structure as they originate from the Bantu (Sotho group) and West Germanic language family, respectively (Joffe, 2016; Moulton & Buccini, 2017; Sesotho sa Leboa National Lexicography Unit, 2015; Steadman, 2015). If the interference view is assumed, linguistic connections between Sepedi and English may be weaker. Conversely, these languages may not always differ considerably, as a number of Sepedi words have been adopted or adapted from English and Afrikaans, another official South African language. Examples of words are nomoro (number-nommer), sekolo (school-skool), galase (glass-glas), wulu (wool-wol) and puku (book-boek). If an “indigenous” Sepedi word does not exist, a “sothoised” loan word is preferred rather than directly borrowing from another language (Nong, de Schryver, & Prinsloo, 2010), such as phitsa (pizza) and aesekhrimi (ice-cream). The direction of adoption or adaptation is not only from English into Sepedi, but from Sepedi into “South African” English as well, for example “morogo” (wild spinach) and “ousie” (used to address a woman) (Khokhlova, 2015).

Poulos (1990) posits that processes of adoption and adaptation are expected when cultures and/or languages are exposed to each other for a period of time. When words are adapted or adopted from one language to the other, they undergo certain changes to adhere to the linguistic structure of the new language (Poulos, 1990). Therefore, although Sepedi and English have different linguistic origins, word adoptions or adaptations may enable Sepedi-English bilingual speakers to make subtle distinctions between the meanings of words (Poulos, 1990). Adopted or adapted word pairs may thus be more resistant to speech errors due to structural and phonological similarities (Costa, Santesteban, & Caño, 2005; Gray & Kiran, 2013; Kendall et al., 2015; Munarriz, Ezeizabarrena, & Gutierrez-Mangado, 2014).

A complex interplay between language and impairment factors exists in Sepedi-English individuals with aphasia. Aphasia type (fluent or non-fluent) and severity (mild to severe) as well as patterns of language recovery should be considered. Parallel recovery is most common and is seen as similar improvement in both languages (Gray & Kiran, 2013; Khachatryan et al., 2016). In contrast, differential recovery occurs when one language improves significantly in comparison to the other language (Gray & Kiran, 2013; Khachatryan et al., 2016). Speech errors may thus assist clinicians and researchers in determining language recovery patterns for persons with bilingual aphasia. For example, when a substantial number of speech errors present in one language as opposed to the other, it may imply that the psycholinguistic mechanisms of the former language are impaired to a greater extent than that of the latter language, implying differential recovery.

Taking into account various pre- and post-stroke factors, individuals with bilingual aphasia may be classified into clinical groups according to language pair, sequence of language development (simultaneous or sequential), age of language acquisition, method of language acquisition (in the classroom or in social settings), pre- and post-stroke language proficiency, use, fluency, and patterns of recovery in MDL and LDL (Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran et al., 2014; Kiran & Gray, 2018). Figure 3 demonstrates factors frequently related to cross-linguistic processing in present literature about bilingual aphasia.

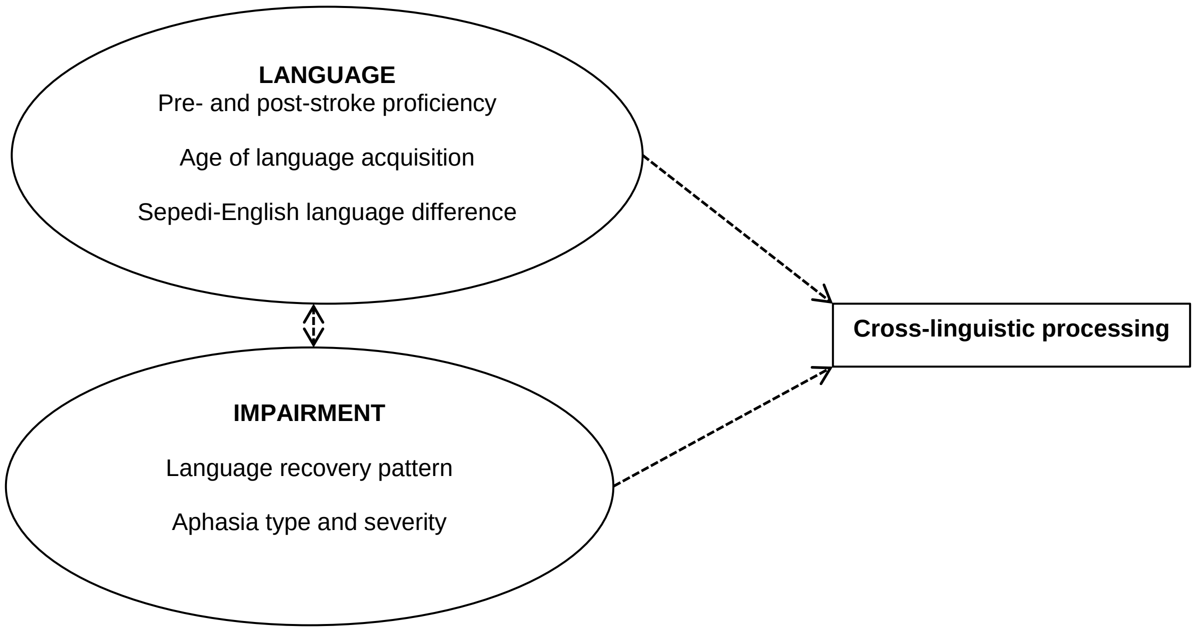

Figure 3. Language and impairment factors possibly linked to cross-linguistic processing in Sepedi-English individuals with aphasia.

1.4. Rationale

Speech errors may provide insight about “hidden” cross-linguistic processes and allow analyses of variable-and-recovery relationships. If a person with bilingual aphasia makes a semantic error within LDL (“chair” for “couch”), it may be due to weaker connections between the lexicon and semantic system within LDL. Language proficiency (i.e. connection strength) may thus have been associated with cross-linguistic processing causing a speech error. It is clear that speech errors can be used as an objective measure to link various language and impairment factors to cross-linguistic processing post-stroke. The clinical implication of this relationship is significant as the absence of valid bilingual aphasia assessment and intervention tools are as a result of limited knowledge about how individual factors influence language recovery patterns (Centeno & Ansaldo, 2016). More research and better understanding of cross-linguistic processing may therefore lead to the development of appropriate clinical tools for bilingual persons with aphasia.

Even though there are numerous advances in bilingual aphasia research, these individuals may still form part of a clinically underserved population, as bilingual speech-language therapists (SLTs) are generally in the minority (Amberber, 2012a). Culturally and linguistically diverse (CLD) countries are not only faced with underrepresented clinicians, but are also subjected to language and cultural barriers between SLTs and clients (Barratt et al., 2012; Legg & Penn, 2013). As a result, non-professional interpreters have been used to overcome the language barrier (Barratt et al., 2012; Centeno & Ansaldo, 2016). Seventy-seven percent of the population in South Africa have a first language other than English or Afrikaans, while clinicians generally have either/or as their dominant language (Barratt et al., 2012; Centeno & Ansaldo, 2016; Statistics South Africa, 2012).

A clinical dilemma presents as SLTs frequently provide intervention in their most dominant language and thus service provision becomes therapist-centered. SLTs may not willingly fail to act in the best interest of the client, but the reality is that persons may be receiving speech-language therapy in their second or third language (Penn, 2014). This study thus intends to use improved insight into cross-linguistic processing as a basis for potentially optimizing clinical services for the plight of persons who may be underserved. Progress within the field of CLD assessment tools has nonetheless been made. The Bilingual Aphasia Test evaluates each language of the bilingual individual by using standardized translated versions of the test which are culturally and linguistically equivalent (Amberber, 2012b; McGill University, 2016). Identified challenges are further complicated for the Sepedi-English population with aphasia, as no standardized Sepedi assessment tool exists.

It is beneficial to focus on Sepedi as Kendall et al. (2015) considered English-Afrikaans individuals with aphasia and thus findings cannot be generalized to African languages. There is also a great need to investigate a wider range of languages to advance knowledge of cross-linguistic processing (Amberber, 2012a). Sepedi is closely linked with two other African languages, Sesotho and Setswana, and all three languages can typically be understood interchangeably (Joffe, 2016). Potential is therefore created to extend research outcomes obtained in Sepedi to other similar African languages, due to structural similarities in phonology and orthography (Joffe, 2016).

An increasing amount of literature suggests a need to move away from traditional, universalist conceptualizations of aphasia and towards a more contextually-based understanding of this condition (Legg & Penn, 2013; Penn, 2014; Penn & Armstrong, 2017). Improved understanding of mechanisms underlying cross-linguistic processing and representation may enable clinical practice that is increasingly effective, comprehensive and promotes language recovery in individuals with bilingual aphasia (Amberber, 2012a; Ansaldo & Saidi, 2014; Kendall et al., 2015).

The following research questions are thus posed:

1. What can speech production errors tell us about cross-linguistic processing in Sepedi-English individuals with aphasia?
2. Which language and impairment factors may be linked to cross-linguistic processing in Sepedi-English individuals with aphasia?

1.5. Concluding statement

This chapter shows the paucity of research on the population with bilingual aphasia, and more so in multilingual and multicultural contexts such as South Africa. Kiran and Gray (2018) maintain that present knowledge about bilingual aphasia is restricted to its prevalence as a communication disorder and an introduction to aspects thought to impact the type of language impairment. Investigations into bilingual aphasia have much to offer as linguistic recovery patterns may improve understanding of cerebral representation and processing of different languages in neurotypical bilinguals (Lee et al., 2016). Influential theories such as the bilingual lexical access model, RHM and mixed model provide a foundation for understanding cross-linguistic processing, word retrieval difficulties and speech production errors in individuals with bilingual aphasia. Nonetheless, questions remain about the nature of the impairment in each of the languages of bilingual individuals with aphasia (Kiran & Gray, 2018). The need for increased and more rigorous studies about bilingual aphasia is clearly illustrated. The rationale of the study and research questions stem from this requisite.

Chapter 2
Method

2.1. Research aim:

The present study has two objectives. Firstly, to determine what speech production errors can impart about cross-linguistic processing in Sepedi-English individuals with aphasia. Secondly, to find out which language and impairment factors may be associated with cross-linguistic processing in Sepedi-English persons with aphasia.

2.2. Research design:

The nature of the methodology selected for a study is determined by the research question posed (Ferguson & Armstrong, 2009). A case series was used to explore why and how differences exist within a group of participants with a similar diagnosis, regarding a specific aspect of communication e.g. cross-linguistic processing (Ferguson & Armstrong, 2009; Kooistra, Dijkman, Einhorn, & Bhandari, 2009; Schwartz & Metcalfe, 2011). It is descriptive in nature, is often categorized under observational studies, i.e. non-experimental, and is level IV evidence in the ASHA levels of evidence (Kooistra et al., 2009). Although case series are low on the hierarchy of levels of evidence, this design is frequently used in research as it requires less time, effort and funds as opposed to randomized control trials, case-control and cohort investigations (Chan & Bhandari, 2011; Kooistra et al., 2009).

Information from case series can also be used to create hypotheses that can be examined by research designs which constitute higher levels of evidence (Kooistra et al., 2009). Another benefit of case series is that participants may have different case histories and characteristics, which makes the sample population more representative of the caseload seen in practice and outcomes can thus more reliably be generalized to practice (Kooistra et al., 2009). Case series designs use analyses of impaired or altered processes to make inferences about typical processing mechanisms (Schwartz & Dell, 2010). Improved understanding of cross-linguistic processing in bilingual aphasia may therefore aid in better describing language processing in the bilingual brain, with and without language impairment (Lee et al., 2016).

2.3. Ethical considerations:

Ethical clearance was obtained from the Research Ethics Committee of the Faculty of Humanities at the University of Pretoria (Appendix B). Permission to approach potential participants was obtained from both Pretoria branches of a non-profit organization and two other speech-language therapy rehabilitation units in the city of Pretoria (Appendix A). The non-profit organization provides support, counseling, individual and group therapy services to persons affected by brain injury and their significant others.

The SLTs at the institutions reviewed their own files or records to ascertain which clients meet the inclusion and exclusion criteria of this study. These persons and their significant others were then contacted by the researcher once ethical clearance was obtained from the Research Ethics Committee of the Faculty of Humanities at the University of Pretoria. Informed consent documents and permission letters (Appendix C 1, 2 and 3) were discussed with participants and their significant others after ethical clearance was obtained and before any collection of data commenced.

The following facets of ethical research were taken into consideration throughout this study:

2.3.1. Protection from harm:

Researchers should be mindful of and sensitive to potential harm to participants, whether it is physical or psychological, and attention should be given to possible benefits of participation in the research (Leedy & Ormrod, 2014). The researcher achieved this by considering factors that may negatively influence the participants' participating in the research, such as confidence threats or frustration, which was addressed by having Sepedi-speaking SLT students present during the first session of data collection. This ensured that participants were not restricted to speaking English and being asked questions in English only, as the researcher was able to speak and understand Sepedi merely at a beginner's level. Participants could also ask for certain terms to be clarified in Sepedi or give answers to the interview in Sepedi. Items in the Western Aphasia Battery Revised [WAB-R] (Kertesz, 2006) and Boston Naming Test [BNT] (Kaplan, Goodglass, & Weintrab, 1983) could be clarified using Sepedi. It was also explained that participation may lead to improved clinical understanding of services provided to individuals with bilingual aphasia. Participants were informed beforehand that the study will not cause harm and that their well-being will remain important at all times (Appendix C 1 and 2). Respectful interactions occurred throughout the research process.

2.3.2. Voluntary and informed participation:

Informing participants about the nature of the study is essential in order to obtain informed consent (Leedy & Ormrod, 2014). Participants were informed that their participation is voluntary and that they may withdraw from the study at any time without consequence (Appendix C 1 and 2). Informed consent documents were supplemented with picture-based material from Pearl (2014) (Appendix C 1 and 2) to facilitate understanding of written information, as persons with aphasia often have difficulty reading (Rose, Worral, & McKenna, 2003). The benefits of using aphasia-friendly material when addressing persons with aphasia include reduced anxiety, a greater sense of control and increased compliance (Rose et al., 2003). If a participant was not able to read or provide a signature, he or she could give consent with a thumbs up (agree) or thumbs down (disagree) which was supplemented by a significant other's signature of consent (Appendix C 1 and 2). Verbal consent was thus obtained from the participant in such instances. Two participants were not able to sign and thus verbal consent was given and proxy consent obtained from a significant other. Once the informed consent documentation was perused, a sufficient amount of time was allocated for answering of any questions or queries.

2.3.3. Right to privacy:

Participants should remain anonymous at all times and research findings be kept confidential, as participants have the right to privacy (Leedy & Ormrod, 2014). Participants' personal details were known to the researcher, but their data was kept confidential and reported anonymously by assigning an alphanumeric code to each participant. The codes were used on record forms and for any reporting of data. Research assistants (SLT students) were reminded of confidentiality of participant information. A linguist and SLT who were involved in consensus reliability ratings of the data also received information that protected participants' identities. All data will be electronically stored and password-protected in the Department of Speech-

Language Pathology and Audiology for fifteen years as per policy of the University of Pretoria. Specifics of sharing research data and findings with co-researchers and its use for future studies were included in the informed consent documents (Appendix C 1, 2 and 3) and discussed with participants and their significant others beforehand.

2.3.4. Honesty with professional colleagues:

The researcher should convey research findings in a holistic, comprehensive and honest manner and award appropriate recognition to persons whose ideas and thoughts have been incorporated into current research (Leedy & Ormrod, 2014). All phases of this study were conducted in a transparent and ethical manner. The researcher did not plagiarize any information and reported truthfully on the findings of the study.

2.4. Participants:

2.4.1. Criteria for participant selection:

The current study is based on Kendall et al. (2015) and thus the selection criteria remained similar. Purposive sampling was used to select participants, which involves purposeful participant selection according to predetermined criteria (Kaura, 2013). Selection was guided by the extent to which participants recruited would allow extensive investigation of the research topic (Kaura, 2013). Various inclusion and exclusion conditions were considered.

- Inclusion criteria:

- Presence of a single left hemisphere stroke (confirmed by medical records or MRI/ CT scan)
- Presence of aphasia (verified by the referring SLT and assessment findings obtained by the researcher)
- Participants with chronic aphasia (≥ 6 months post-stroke)
- Participants must be bilingual (participant must be able to understand and speak English and Sepedi)
- Participants must be ≥ 18 years of age (i.e. adult)
- Participants must be younger than 75 years of age to rule out age-related factors such as cognitive decline (Harada, Natelson Love, & Triebel, 2013).

- Participants must have adequate hearing thresholds determined by a hearing screening. Normal hearing thresholds is stipulated as below 25 – 30 dB (Walker, Cleveland, Davis, & Seales, 2013).
- Participants must have adequate receptive language abilities and be able to follow two-step instructions as determined by the WAB-R (Kertesz, 2006).
- Participants must be able to speak at least three- to four-word phrases.
- Participant must pass a visual screening test to ensure adequate visual acuity for naming of picture cards.

• Exclusion criteria:
- Participants with severe aphasia, as determined by the WAB-R (Kertesz, 2006).
- Participants with severely affected receptive language abilities, for example not being able to follow two-step instructions as determined by the WAB-R (Kertesz, 2006).
- Presence of a psychiatric illness (ascertained from medical records).
- Presence of a degenerative neurological disease (as seen in medical records and/ or self-report).
- Presence of impairment in vision or hearing (obtained from medical records/ self-report/ visual or hearing screening).

2.4.2. Description of participants:

Six participants were selected based on the criteria mentioned above. All participants suffered a single left hemisphere stroke, had chronic aphasia and were able to speak Sepedi and English as their main languages. The time since onset of stroke ranged between six months and eight years for all participants. All participants were employed pre-stroke and are currently unable to return to work post-stroke. Table 1, 2, 3 and 4 provide an extended description of each participant. Each participant's most dominant language (MDL) and less dominant language (LDL) was determined by their responses in the interview to language use patterns, age of acquisition, frequency of use, modalities, educational exposure and self-reported rating of language abilities (ranging from very good to not good at all). Participants' responses were corroborated by their significant others.

Table 1. Participants' Demographic Information

	Age	Gender	Pre-stroke occupation	Current occupation
P1	58	Male	Human resource manager at a mine	Did not return to work after stroke
P2	68	Male	Material handler	Did not return to work after stroke
P3	71	Male	Bank cashier and client services manager	Did not return to work after stroke
P4	42	Female	Branch manager at an investment firm	Did not return to work after stroke
P5	48	Female	Home maker	Did not return to work after stroke
P6	55	Male	Police officer	Did not return to work after stroke

Table 2. Participants' Pre-stroke Language Profiles

	Language exposure	MDL	LDL	Balanced bilingual	Age of acquisition		Educational exposure
					Sepedi	**English**	
P1	• Sepedi • English • Afrikaans	English	Sepedi	No	Since birth	6 y/o	• English • Sepedi • Afrikaans
P2	• Sepedi • English • Afrikaans • isiZulu • Southern Sotho	Sepedi	English	No	Since birth	6 y/o	• Sepedi
P3	• Sepedi • English • Afrikaans • isiZulu • TshiVenda • Setswana	English	Sepedi	No	Since birth	7 y/o	• English
P4	• Sepedi • English • Afrikaans			Yes	Since birth	7 y/o	• English • Sepedi • Afrikaans
P5	• Sepedi • English • Setswana • XiTsonga (home language)	Sepedi	English	No	6y/o	14 y/o	• English • Setswana • Afrikaans
P6	• Sepedi • English • Afrikaans • XiTsonga • isiZulu	Sepedi	English	No	Since birth	6 y/o	• English • Sepedi • Afrikaans

It is clear that participants were exposed to multiple languages. Participants explained that it is considered a sign of respect to acknowledge and speak all the languages that they come into contact with, especially in informal settlements. They further stated that as children they learned many languages by playing with friends from the neighborhood. Participants however confirmed that the languages most dominantly spoken were Sepedi and English, with infrequent use of the other languages.

Table 3. Participants' Post-stroke Language Profiles

	Duration since onset of stroke	MDL	LDL	Balanced bilingual	Speech-language therapy
P1	5 years	Sepedi	English	No	Received speech-language therapy in Sepedi and English for one year. Currently attending biweekly group therapy.
P2	4 years	Sepedi	English	No	Received speech-language therapy in Sepedi and English for between three to four months. Currently attending biweekly group therapy.
P3	2 years	English	Sepedi	No	Received in-patient speech-language therapy for one month in English and attends weekly group sessions thereafter.
P4	8 years	Sepedi	English	No	No individual speech-language therapy was received. P4 has been attending group therapy for three years.
P5	7 months	English	Sepedi	No	Received individual speech-language therapy in English since the date of onset and continues to go to individual sessions once a week.
P6	6 months	Sepedi	English	No	Received in-patient speech-language therapy in English since the date of onset and continues to go to individual sessions once a week.

Participant one (P1), a fifty-eight year old male, indicated that his MDL was English and LDL was Sepedi, pre-stroke. However after his stroke, Sepedi is his MDL and English his LDL. P1's communication partners are currently mostly his Sepedi speaking family and friends and thus there was a shift in language proficiency. Participant two (P2), a sixty-eight year old male, has Sepedi as his MDL and English as his LDL, pre- and post-stroke. Participant three (P3), a seventy-one year old male, has English as his MDL and Sepedi as his LDL pre- and post-stroke. Participant four (P4), a forty-two year old female, was a balanced bilingual pre-stroke, but Sepedi is her MDL and English her LDL post-stroke, as she is unable to return to work, and mostly uses Sepedi at home. Participant five (P5), a forty-eight year old female, has XiTsonga as her home language, but as a result of living in an area with mostly Sepedi speaking individuals, Sepedi is the language that she generally spoke before her stroke and continues to speak post-stroke. P5's MDL was therefore Sepedi and English her LDL language pre-stroke. After her stroke, she reported English as her MDL and Sepedi as her LDL. P5 attributes this change in proficiency to her attending speech-language therapy in English only, post-stroke. Participant six (P6), a fifty-five year old male, has Sepedi as his MDL and English as his LDL, pre- and post-stroke.

In review of Table 4, it is of clinical significance that P1 and P6's aphasia quotients are lower. They may have possible speech motor planning difficulties in addition to word retrieval difficulties. This resulted in visible difficulty with expressive language subtests of the WAB-R, such as picture description, object naming and word fluency. The WAB-R makes provision for scoring of acquired apraxia of speech and both participants obtained scores consistent with mild speech motor planning difficulties. Salient characteristics of speech motor planning difficulties are as follows: groping, perseveration, imprecise articulation, inconsistent errors when producing identical words over time, slower rate of speech and prosodic difficulties (Duffy, 2012). P5 obtained the highest aphasia quotient and it was evident during data collection that her level of language functioning is high.

Table 4: Participants' WAB-R and BNT Scores

	Aphasia quotient (*WAB-R*)	**Aphasia type (*WAB-R*)**	**Aphasia severity (*WAB-R*)**	**Confrontation naming ability (*BNT*)**	**Confrontation naming ability with assistance (*BNT*)**
P1	65.7	Broca's	Moderate	40%	60%
P2	79.7	Anomic	Mild	40%	50%
P3	72.7	Anomic	Moderate	30%	92%
P4	71.6	Anomic	Moderate	20%	50%
P5	90.6	Anomic	Mild	50%	62%
P6	64.8	Broca's	Moderate	50%	50%

Notes: As per BNT guidelines, naming accuracy percentages represent the total items known and correctly produced, either spontaneously or in response to stimulus cues (e.g. "used by doctors and nurses" for stethoscope). Naming ability with assistance refers to correct answers after phonemic cues (e.g. "ste" for stethoscope) or multiple choice options were given.

Participants presented with either Broca's or Anomic aphasia. Aphasia can primarily be divided into fluent and non-fluent categories (Mancinelli & Klein, 2014). Broca's aphasia is classified as a non-fluent aphasia and typical speech and language characteristics include effortful speech, imprecise articulation, anomia proportional to verbal fluency and agrammatic speech (Mancinelli & Klein, 2014). It is often challenging to differentiate whether difficulties in speech production occur due to impaired word retrieval or non-fluent expression (Mancinelli & Klein, 2014). Anomic aphasia is categorized as a fluent aphasia and common speech and language features are fluent speech with intermittent hesitations, noticeable difficulties in confrontation naming due to word retrieval errors and frequent use of circumlocutions (Mancinelli & Klein, 2014). Anomic aphasia of increased severity may cause halted speech and limited discourse as word retrieval difficulties are more significant in this case (Mancinelli & Klein, 2014).

The WAB-R and BNT are standardized tests and no Sepedi-English version exists. Modifications and adjustment guidelines by Goldstein (2000) were adhered to in order to make test administration more sensitive to the Sepedi-English participants. For example, rewording of instructions, omission of items that participants have not encountered and allowing participants to respond in Sepedi when they have difficulty retrieving the English word or phrase for a specific test item. In administering the BNT, it was evident that participants did not know what some of the test items were as they are not exposed to it in their cultural-linguistic context. Therefore, these items could not be scored as errors, but were rather excluded on a participant-specific basis (Goldstein, 2000).

P1 had not been exposed to five of the items in the BNT and thus his percentage accuracy was calculated out of ten, instead of fifteen. P1 frequently used Sepedi words to name pictures, such as "*kamo*" for comb and "*skepe*" for canoe. This may have been as a result of Sepedi being P1's MDL post-stroke. P2 also had not been exposed to five of the items in the BNT and thus these items were excluded in determining percentage accuracy. P2 has a relatively high aphasia quotient, but when looking at his confrontation naming ability he was only able to name 50% of the items with assistance. It should, however, be noted that he would describe items that he was not able to name, such as "*for doctor"* for stethoscope and "*steps for the camera"* for tripod. This can be expected as persons with anomic aphasia often have word-finding difficulties and thus make use of circumlocution (Mancinelli & Klein, 2014) as a compensatory strategy. Circumlocutions were scored as incorrect, as the BNT looks at confrontation naming and not descriptive ability. P3 had not been introduced to two of the items in the BNT and thus the sum of correct items was scored out of thirteen. P3's language performance improved significantly when he was provided with external cues. For example, the researcher gave phonemic cues such as "oc" for "octopus" or multiple choice options ("chair", "steps", "bench" and "park" for bench).

P4 was not familiar with five of the items in the BNT and adaptations were made accordingly. It was noted that P4's confrontation naming accuracy was affected by misinterpretations of the pictures and semantic errors, such as "*church*" for house, "*toothpaste*" for toothbrush and "*paint brush*" for palette. He would also use circumlocutions to explain items, such as "*the doctor put them in their ears"* for stethoscope. P5 had not been exposed to seven of the items in the BNT and thus her final score was out of eight. Limited education may be a contributing factor to the lack of exposure to certain test items (Patricacou, Psallida, Pring, & Dipper, 2007). P5 used Sepedi and English circumlocutions to describe items if she was not able to name the picture. For example, she said *"doctor put in ears"* for stethoscope and *"plate ke paint brush"* for palette. These descriptions were scored as errors. P6 was not familiar with seven of the items in the BNT and thus percentage correctness was recorded out of eight. He did not present with improved naming ability when provided with assistance. P6 frequently used Sepedi words to name items in the BNT, such as saying *"ntlo"* for house, *"kamo"* for comb and *"skepe"* for canoe. This may be due to Sepedi being his MDL pre- and post-stroke.

2.4.3. Site for data collection:

The six participants were seen, with permission, either at the non-profit organization or the Department of Speech-Language Pathology and Audiology, University of Pretoria (Appendix A).

2.5. Material and apparatus

2.5.1 Materials used to determine candidacy:

The following tools were used to establish that participants met the inclusion criteria.

- Vision Test (Rocktime Ltd, 2014) and hearScreen application (Swanepoel, Myburgh, Howe, Mahomed, & Eikelboom, 2014) were used to ascertain adequate vision and hearing thresholds.
- WAB-R (Kertesz, 2006), which is a formal tool used to determine the linguistic abilities of an individual with aphasia, as well as, the type and severity of aphasia.
- BNT (Kaplan et al., 1983), which is a formal tool used to assess confrontation naming ability of an individual with aphasia. This type of evaluation is suggested to be an integral part of aphasia testing and is often an outcome measure for intervention (Kendall et al., 2015).

- **Interview**

A structured interview questionnaire was formulated by referring to relevant literature (Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran et al., 2014; Kiran & Gray, 2018). The interview was used to determine each participant's case history as well as his or her language and clinical profile (e.g. age of language acquisition, education, language use contexts, language modalities, pre- and post-stroke linguistic proficiency and use) (Appendix D).

2.5.2 Picture naming stimuli:

Fifty-five high and low frequency English words were identified from Kendall et al.'s (2015) word list and www.talkenglish.com. The linguist from the Department of African Languages (University of Pretoria) translated these words into Sepedi. Seven predominantly Sepedi-English neurotypical healthy adults were recruited to name each of the colour picture cards. This ensured picture-word correlation and that the vocabulary in the list represented the most commonly used names for the pictures in Sepedi and English.

2.6. Procedures

2.6.1. Development of picture naming stimuli

The picture naming stimuli were first validated by five Sepedi-English healthy neurotypical adults. Fifty-five colour picture cards were presented to each individual to name in Sepedi and English. Their answers were audio recorded and matched against the word list to ensure 100% correlation. The word list together with the corresponding colour picture cards were amended based on the feedback from this initial validation phase (Appendix E). The findings of the validation process revealed that seven words were not known in Sepedi and hence were excluded from the word list. Furthermore, some revisions had to be made where an additional word was included as a second option or the most common name used for the corresponding picture.

Therefore, the final word list consisted of forty-five low- and high-frequency English and Sepedi words (Appendix F). Two healthy Sepedi-English neurotypical adults were recruited to validate the final word list by naming forty-five colour picture cards to ensure 100% correlation. The validation process thus resulted in a forty-five item word list and corresponding colour picture cards which were used during the second data collection session.

2.6.2. Data collection and recording

Formal data collection, involving the six participants, took place during two sessions. Kendall et al.'s (2015) study was retrospective and the present study is prospective. Therefore this research study could determine in-depth pre- and post-stroke clinical profiles for each participant during the first data collection session. Procedures for collection, recording and transcription of picture naming responses during the second session remained as in Kendall et al. (2015). Additional statistical analyses were conducted to address the second research question.

A brief, structured interview was conducted in the first session. The researcher used visual cues and gestures when asking questions to ensure participants understood the questions asked (Luck & Rose, 2007). In this way information about factors suggested to influence language recovery post-stroke (e.g. pre- and post-stroke language proficiency, age of language acquisition, educational exposure) was obtained (Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016). Leedy and Ormrod (2014) raise caution when conducting interviews as participants are expected to recall past events (e.g. pre-morbid language proficiency) and thus an element of human error may be introduced. The researcher controlled for this by corroborating information given by the participants with answers given by a significant other.

The interview was followed by a language assessment using the WAB-R and BNT in order to obtain information about the aphasia type and severity, as well as, confrontation naming abilities of the participants. The language assessment showed that all participants met inclusion and not exclusion criteria. Goldstein (2000) provides guidelines for modifications or adjustments which may be necessary to make when administering standardized tests with culturally and linguistically diverse populations. In this case, participants were allowed to provide answers in Sepedi if they had difficulty retrieving the words or phrases in English. These responses indicate that the participant has the concept and/or word in his or her mental lexicon and were thus scored as correct.

In administering the BNT, items were excluded on a participant-specific basis as participants were clearly not exposed to them in their cultural-linguistic context. Certain instructions or questions were reworded in order to make it more relevant to the cultural and linguistic setting in which it took place, for example, a question in the WAB-R is “What is your occupation?” which then became “What work do you do?”. All reworded instructions were indicated on record forms. Sepedi-speaking speech-language therapy students from the University of Pretoria were present during the first session, in order to minimise confidence threats, frustration and language barriers. All information from session one was audio recorded, allowing the researcher to refer back to the recordings for data recording purposes.

The second session was implemented as follows:

- This session occurred in a quiet, brightly lit room.
- Each participant was presented with forty-five picture cards, one-by-one, and expected to first name the pictures in his or her MDL.
- The second presentation of cards required the participants to name the picture cards in their second language (LDL).
- Identical pre-recorded audio instructions were given in MDL and LDL respectively i.e. if the participant was expected to name the picture in MDL then instructions were provided in MDL.
- A correct or incorrect (√/ X) response was recorded verbatim.
- No phonemic and semantic cues were given during this phase to aid any participant in naming.
- Visual cues were only given when it was clear that the participant misinterpreted the picture, for example, “look at the whole picture”.
- All answers were audio recorded and no time constraints were applied.
- Speech production errors were transcribed.

2.6.3. Data processing and analysing:

Data were as far as possible recorded in a comprehensive, systematic and accurate manner (Leedy & Ormrod, 2014). Picture naming responses were written down, audio recorded and speech errors were then coded. Errors were processed as in the study by Kendall et al. (2015), which considered errors in terms of overall accuracy, raw number of errors and error types (Table 5). Participants' first responses were recorded, unless it was clear that they were self-correcting. Only correct lexical units (single words) were deemed correct. Interjections, such as "um" and "let me think" were not noted down. Items were excluded on a participant-specific basis in the event that it was clear that the participant misinterpreted the picture card. The linguist listened to all the word list audio recordings to ensure participants' responses were accurately recorded. A hundred percent inter-rater reliability was obtained for responses recorded.

Table 5. Error Coding Description

Error type	Description
1. Phonologic (P)	Substitutions, additions, transpositions, omissions.
2. Semantic (S)	- Related within language (RWL): 'desk' for 'table' - Unrelated within language (UW): 'knife' for 'tomato' - Related across language (RAL): English 'animal' for Sepedi 'pere', which means horse - Unrelated across language (UAL): English 'horse' for Sepedi 'mpša', which means dog
3. Mixed (M)	Actual words with a phonological relationship to target words, for e.g. wind for window.
4. Omission (O)	Circumlocutions and nonresponses.
5. Neologism (N)	Non-words that are not phonologically related to target words, for e.g. 'beba' for 'tomato'.
6. Translation (T)	Sepedi responses for items to be named in English and vice versa, for example; 'tomato' for 'tamati' and 'tafola' for 'table'.

As stipulated by Kendall et al. (2015), errors were depicted according to six error types.

Consensus reliability for overall accuracy and error type was obtained for a third of the data by the linguist and qualified SLT. 97% and 98% for accuracy and 90% and 92% for error type was achieved, respectively. McHugh (2012) regards 90% to 100% consensus as an "almost perfect" level of agreement. The Shapiro-Wilk test of normality was run for each variable of interest. If the normality assumption held, parametric tests (Pearson correlation and paired t-tests) were performed for those variables. On the other hand, when the normality assumption was violated, nonparametric tests (Spearman correlation and signed-rank tests) were performed on those variables. The level of significance was set at 0.05.

Three participants MDL and LDL changed post-stroke, yet the Wilcoxon signed-rank test indicated that no significant difference existed between naming accuracy in MDL ($p = 0.285$) and LDL ($p = 0.180$), pre and post-stroke. Statistical analyses thus considered post-stroke MDL and LDL only. This test was also used to see whether significant differences in naming accuracy existed between MDL and LDL for all participants.

3. Reliability, validity and trustworthiness:

Leedy and Ormrod (2014) state that reliability can be obtained by making sure that the instruments are administered in a standardized manner across situations and over time. The use of specific criteria which delineate and control the researcher's judgments is also warranted (Leedy & Ormrod, 2014). The current study adhered to these guidelines as both data collection sessions were described in detail and set criteria were constructed and implemented during data collection, coding and analysis, as used in Kendall et al. (2015). A percentage of the analysis was rated by the linguist and SLT to enhance the reliability of results obtained. An interview was conducted beforehand to obtain a detailed language and clinical profile of each participant.

Validity of a study can be supported by consulting literature in search of validated tools and conducting a pilot study in order to determine the effectiveness and strength and weaknesses of specific instruments (Leedy & Ormrod, 2014). Validation of the picture naming stimuli resulted in appropriate modification and/or adjustments to this tool. The current study used the WAB-R and BNT which are commonly used, effective tools in the assessment of aphasia (Australian Aphasia Rehabiliation Pathway, 2014b).

Internal validity considers the extent to which a design and data collected allow the researcher to precisely draw conclusions (Leedy & Ormrod, 2014). The researcher used triangulation (Leedy & Ormrod, 2014) to enhance internal validity by obtaining numerous sources of data (interview, formal tools and self-constructed picture-naming stimuli). Significant others also corroborated interview data. Furthermore, answers were audio recorded for analysis and this is preferred as it reduces the likelihood of human error which may occur in instances of only noting answers down in real time (Markle, West, & Rich, 2011).

Chapter 3
Article

This article was resubmitted to Topics in Stroke Rehabilitation, as per style and format guidelines of the journal. The article is currently under review.

Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia: A case series analysis

Background: Bilingual aphasia forms a significant part of speech-language pathologists' (SLP) caseload, globally and specifically in South Africa. Few tools supporting clinical decision-making are available due to limited understanding of typical and disordered cross-linguistic processing (how the languages interact). Speech errors may provide insight about "hidden" bilingual mechanisms.

Objectives: To determine what speech errors can impart about cross-linguistic processing, as well as, associated language and impairment variables in Sepedi-English individuals with aphasia.

Method: The case series included six participants, purposively selected from three rehabilitation sites in South Africa. Detailed language and clinical profiles were obtained. Participants performed a confrontation naming task in their most dominant (MDL) and less dominant language (LDL). Responses were audio recorded, transcribed and analyzed for overall accuracy and error type in MDL and LDL; verified by a Sepedi-speaking linguist and a qualified SLP.

Results: (1) No statistically significant differences in MDL-LDL naming accuracy were found, supporting recent literature of simultaneous inter-activation of both languages and shared word retrieval mechanisms. All types of speech errors occurred and semantic errors were produced most frequently and consistently in each participant's MDL and LDL. (2) Language proficiency, language recovery patterns and aphasia type (Broca's and Anomic) and severity (mild and/or moderate) appeared to be more strongly linked to cross-linguistic processing than Sepedi-English linguistic differences and age of acquisition of both languages.

Conclusions: Participants with bilingual aphasia may use typical cross-linguistic and word retrieval mechanisms, concurring with current theories of bilingualism. Findings are preliminary, warranting investigations of other language tasks, modalities, pairs and related variables. (**249**)

Keywords: case series; bilingual aphasia; cross-linguistic processing; speech production errors; language recovery; Sepedi and English; South Africa.

Introduction

Aphasia presents in forty percent of the surviving stroke population, with higher statistics in South Africa (SA) due to increased stroke rates.[1–3] An elevated number of strokes in SA is attributed to poverty, inaccessibility of health services and a high incidence of conditions such as hypertension, diabetes mellitus and HIV.[2,3] Fifty to eighty percent of the global populace is bilingual and Africa has the highest prevalence of multilingualism.[4–8] Clinicians thus evidence a significant increase in bilingual individuals with aphasia.[4–7]

Bilingual aphasia is complex. Bilingual processing is different to that in monolinguals, with or without language impairment, where two (or more) languages may recover similarly (parallel) or differently (differential).[5,7,9,10] Lack of suitable bilingual therapy approaches persists.[7,11] The consequence thereof is far reaching as language outcomes are generally poorer for persons with bilingual aphasia, negatively impacting quality of life.[12,13] To inform appropriate management, improved understanding of bilingual processing is imperative.[7,10,14–16]

Cross-linguistic processing is the interaction of two languages within a bilingual individual.[17] Literature, particularly, Costa's[18] bilingual lexical access model explains word retrieval (top-down) and comprehension (bottom-up) during confrontation naming (Figure 1).[7,10,14,19–22] The conceptual level, shared by both languages, is activated first.[23–25] Activation then spreads to both languages' lexical (word) and phonological nodes, followed by production of the word(s).[18,26] Language-specific word selections in the target language occur by inhibiting the non-target language.[10,14,18,20] Therefore, "meetse" and not "water" is produced when naming in Sepedi.

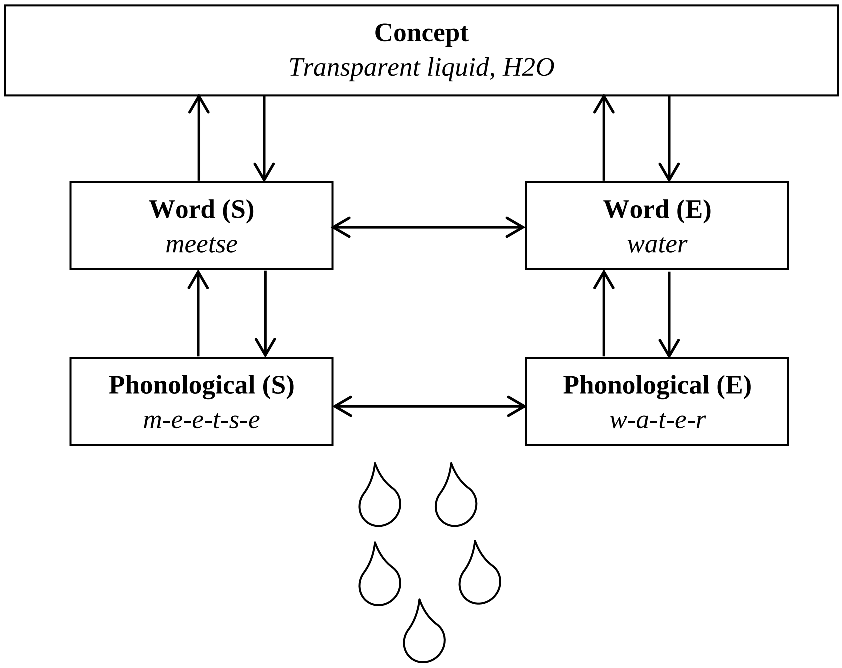

Figure 1: The mechanisms of word retrieval (↓) and comprehension (↑) in a Sepedi-English individual while naming a picture.

Notes: The conceptual level is where meaning and understanding of word (s) are created and stored (semantics). The lexical node is responsible for creating and storing whole word(s), not individual sounds. Lastly, the phonological node creates and stores individual sounds which make up word(s) which are then spoken.

Speech errors also have potential to link language and impairment factors with cross-linguistic recovery post-stroke. Language proficiency pre-stroke is one of the best predictors of post-stroke outcomes.[10,28–30] In unbalanced language proficiency, stronger lexical-semantic connections exist within the pre-stroke most dominant language (MDL) and persist if this language remains the MDL post-stroke.[29,31] Increased connection strength between the conceptual, lexical and phonological levels may result in more successful word retrieval and less speech errors in MDL.[21] This suggests recovery of MDL may be facilitated to a greater extent than the less dominant language (LDL).[21,29,31] MDL and LDL may however change post-stroke due to not being able to return to work or reduced social networks.[13,32,33]

Another factor influencing language recovery is the degree of similarity between languages that the person with aphasia speaks and understands.[14,21,34] If two languages differ extensively in structure (e.g. Sepedi and English), interference between these languages may occur when retrieving words that are identical at the conceptual level (e.g. meetse-water) causing speech errors.[14,35,36] This possibly affects the extent and pattern of language recovery in both languages.[15]

Impairment variables such as recovery patterns and aphasia type and severity also impact language recovery.[10,21] Speech errors may assist SLPs in determining the degree of impairment in each of the individual's languages.[7,10] If a bilingual person with aphasia produces significantly more errors in his or her LDL, it may be assumed that the degree of impairment is greater for that language indicating differential recovery.[7,10,37] Therefore, cross-linguistic recovery is controlled not only by interaction of the two languages, but also by external influences.[7,30] Questions remain regarding these language and impairment factors and how they are related.[7,10,21,37]

Individuals with bilingual aphasia remain a clinically underserved population despite advances in research.[4,32,38,39] In SA, 77% of the population have a first language other than English or Afrikaans, while clinicians generally have either/or as their MDL.[32,38,39] Sepedi is one of the top three frequently used official languages of SA,[39,40] yet lack of Sepedi-English standardized aphasia tools persists.

Kendall et al.[21] investigated the significance of speech errors on cross-linguistic processing in English-Afrikaans individuals with aphasia, which is one of the language pairs in SA. The current study elaborates by focusing on a different language pair. Therefore, the following research questions are asked:

1. What can speech production errors tell us about cross-linguistic processing in Sepedi-English individuals with aphasia?
2. Which language and impairment variables may be associated with cross-linguistic processing in Sepedi-English individuals with aphasia?

Method

A case series was used as it considers participants with similar diagnoses and determines reasons for variance in the group by looking at specific aspects of communication.[41–43] Kendall et al.[21] was a retrospective investigation while the present research is prospective, allowing in-depth pre- and post-stroke clinical profiles to be determined for participants. Procedures for data collection and transcription were similar to Kendall et al.[21], but additional statistical analyses were conducted to answer the second research question. Guidelines were followed to prevent certain pitfalls implicit in case series analyses.[43,44]

Ethical clearance was obtained. Permission to interview and assess six Sepedi-English individuals with aphasia from three clinical sites was granted. Picture-based aphasia friendly material was used to obtain informed consent from participants.[45]

Participants

Six participants were purposively selected based on the following criteria: (1) single left hemisphere stroke (confirmed by MRI and/or medical records) (2) presence of aphasia verified by the referring SLP (3) chronic aphasia i.e. ≥ 6 months post-stroke (4) understands and is able to speak Sepedi and English (5) between the ages of 18 and 75 (6) adequate hearing and vision (7) able to follow two-step instructions (8) speaks at least three- to four-word phrases. Exclusion criteria were stipulated as follows: severe aphasia, hearing and/or visual impairment, psychiatric illness and degenerative neurological disease. Table 1, 2 and 3 provide pre- and post-stroke accounts for participant 1 (P1) to participant six (P6).

Table 1. Participant Demographics

	Age (years)	Gender	Educational level	Occupation (pre-stroke)	Occupation (post-stroke)
P1	58	Male	Degree in human resource management (university)	Human resource manager at a mine	–
P2	68	Male	Grade 7	Material handler in a factory	–
P3	71	Male	Grade 9	Client services manager and cashier at a bank	–
P4	42	Female	Diploma in human resource management (technical college)	Human resource manager at an investment firm	–
P5	48	Female	Grade 12	Home maker	–
P6	55	Male	Grade 10	Police officer	–

Table 2. Participants' Pre-stroke Clinical Profile

	Most dominant (MDL) and less dominant language (LDL) or balanced dominance	Age of acquisition (years)	Language exposure	Educational exposure
P1	English (MDL) Sepedi (LDL)	Sepedi (birth) English (6)	Sepedi, English, Afrikaans	Sepedi, English, Afrikaans
P2	Sepedi (MDL) English (LDL)	Sepedi (birth) English (6)	Sepedi, English, Afrikaans, Zulu, Southern Sotho	Sepedi
P3	English (MDL) Sepedi (LDL)	Sepedi (birth) English (7)	Sepedi, English, Afrikaans, Zulu,Venda, Setswana	English, Sepedi, Afrikaans
P4	Balanced	Sepedi (6) English (7)	Sepedi, English, Afrikaans	Sepedi, English, Afrikaans
P5	Sepedi (MDL) English (LDL)	Sepedi (birth) English (14)	Sepedi, English, Setswana, Tsonga (home language)	Setswana, English, Afrikaans
P6	Sepedi (MDL) English (LDL)	Sepedi (birth) English (6)	Sepedi, English, Afrikaans, Tsonga, Zulu	Sepedi, English, Afrikaans

Table 3. Participants' Post-stroke Clinical Profile

	Time since onset	Most dominant (MDL) and less dominant language (LDL) or balanced dominance	Aphasia type (*WAB-R*)	Aphasia severity and quotient (*WAB-R*)	Confrontation naming accuracy % (*BNT*)	Speech-language therapy; individual (I) and/ or group (G)
P1	5 years	Sepedi (MDL) English (LDL)	Broca's	Moderate (65.7)	40 60 (wa)	English (I and G)
P2	4 years	Sepedi (MDL) English (LDL)	Anomic	Mild (79.7)	40 50 (wa)	English and Sepedi (I); English (G)
P3	2 years	English (MDL) Sepedi (LDL)	Anomic	Moderate (72.7)	30 92 (wa)	English (I and G)
P4	8 years	Sepedi (MDL) English (LDL)	Anomic	Moderate (71.6)	20 50(wa)	English (G)
P5	7 months	English (MDL) Sepedi (LDL)	Anomic	Mild (90.6)	50 62 (wa)	English (I)
P6	6 months	Sepedi (MDL) English (LDL)	Broca's	Moderate (64.8)	50 50 (wa)	English (I)

Notes: The BNT considers correct responses as those which are spontaneously correct and/or the right answer in response to a stimulus cue (e.g. "used by doctors and nurses" for stethoscope). Phonemic cues (e.g. "hou" for house) and multiple choice options may also be given and were thus noted as responses with assistance (wa).

Participants were exposed to multiple languages, as they reported that it is a sign of respect to acknowledge different languages of community members. Sepedi and English were however their main languages. All participants suffered a single left hemisphere stroke. The MDL and LDL of P1, P4 and P5 changed due to differences in language exposure post-stroke. P1 and P4 reported that they rarely spoke English post-stroke due to not being able to return to work. Their communication partners were thus mostly Sepedi speaking family and friends, which resulted in Sepedi being their MDL post-stroke. P5 received speech therapy only in English and thus she preferred to mostly speak English (MDL) post-stroke. Participants' time since onset of stroke ranged between six months and eight years. Aphasia type and severity was noted as either moderate Broca's (non-fluent: effortful, slow speech and limited verbal output) or mild to moderate Anomic aphasia (fluent: marked word-retrieval difficulties; continuous speech in search of the target word). All participants received individual speech-language therapy for a few months post-stroke, except P4, and attended weekly group therapy. P5 and P6 continued to receive individual speech-language therapy at the time of data collection.

Materials and procedures

The Western Aphasia Battery Revised (WAB-R)[46], Boston Naming Test (BNT)[47] and visual and hearing screening tools[48,49] were used to establish that participants met inclusion criteria. During a structured interview (with visual supports), a detailed language and clinical profile for each participant was obtained. Self-reported information was corroborated by a significant other to confirm trustworthiness.[44] The first author, who collected the data, has a basic ability to speak and understand Sepedi. A Sepedi-speaking senior SLP student was thus present during each first data collection session to ensure participants were provided the opportunity to answer and ask for clarification in Sepedi.

Goldstein[50] provides adjustment guidelines when administering standardized tests with culturally and linguistically diverse populations. Modifications were as follows: allowing participants to give answers to WAB-R and BNT items in Sepedi (e.g. saying "lebakere" for a picture of a cup in the WAB-R), participant-specific exclusion of BNT test items that were clearly not encountered in his or her cultural-linguistic context (e.g. "octopus", "volcano", "beaver", "hammock" and "sphinx") and rewording of instructions. All changes were indicated verbatim on record forms and BNT naming accuracy was calculated as a percentage for each participant.

Picture naming stimuli were constructed using high and low frequency of use words from www.talkenglish.com and Kendall et al.[21] English words were translated by a qualified linguist into Sepedi. Seven Sepedi-English neurotypical adults validated stimulus items by ensuring picture-name correspondence in both languages before data gathering commenced.

Data collection for this study occurred in a quiet, brightly lit room at the clinical sites. Identical pre-recorded audio instructions were given in MDL and LDL, respectively. Each participant named 45 color picture cards first in their post-stroke MDL, followed by the LDL. Responses were written on the validated word list and audio recorded. No cues were given to aid the participants in naming, unless clear misinterpretation of the picture card was observed.

Data processing and analyses

Recorded picture naming responses were transcribed for each participant and verified by the linguist, proficient in Sepedi and English. Speech production in MDL and LDL was scored for overall accuracy and error types (Table 4).[21] Only correct lexical units (single words) and final responses were noted.[21] Interjections such as "um" and "let me think" were omitted.[21]

Table 4. Error Types in Sepedi-English

Error type	Description
1. Phonologic (P)	Substitutions, additions, transpositions, omissions.
2. Semantic (S)	- Related within language (RWL): 'desk' for 'table'. - Unrelated within language (UW): 'knife' for 'tomato'. - Related across language (RAL): English 'animal' for Sepedi 'pere', meaning horse. - Unrelated across language (UAL): English 'horse' for Sepedi 'mpša', meaning dog.
3. Mixed (M)	Actual words with a phonological relationship to target words, for example, 'wind' for 'window'.
4. Omission (O)	Circumlocutions and nonresponses.
5. Neologism (N)	Non-words that are not phonologically related to target words, 'beba' for 'tomato'.
6. Translation (T)	Sepedi responses for items to be named in English and vice versa, 'tomato' for 'tamati' and 'tafola' for 'table'.

Note: Error types one to six are similar to Kendall et al.[21]

Statistical analyses

A third of the data sets were used for consensus reliability ratings of overall accuracy and types of errors by the linguist as well as a qualified SLP. Accuracy resulted in 97% and 98%

and 90% and 92% for error type scoring. According to McHugh[51], 90% to 100% consensus is an "almost perfect" level of agreement. Error proportions were calculated statistically. The Shapiro-Wilk test of normality was run for each variable of interest indicating parametric and non-parametric tests were to be used. Although the MDL and LDL of three participants changed post-stroke, there was no significant difference between overall naming accuracy in MDL ($p = 0.285$) and LDL ($p = 0.180$) pre- and post-stroke. All statistical analyses resultantly considered post-stroke MDL and LDL only. The level of significance was set at 0.05.

Results

Q1. Speech production errors and cross-linguistic processing

Overall naming accuracy in MDL and LDL

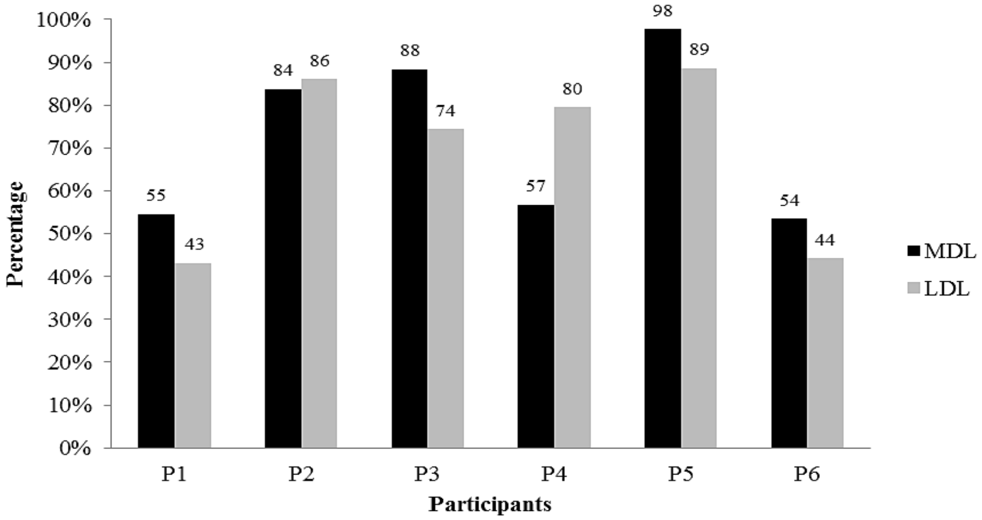

Figure 2. Overall accuracy of production in the most dominant language (MDL) and less dominant language (LDL) for P1 to P6.

Notes: No significant differences existed between MDL-LDL naming accuracy, as p-values varied from 0.125 – 1.000.

The Wilcoxon signed-rank test showed no significant differences in MDL-LDL naming accuracy for all participants. P1, P3, P5 and P6 had better accuracy in their MDL and P2 had one more item correct in LDL. In contrast, P4 clearly had higher naming accuracy in LDL and the largest difference in MDL-LDL percentage accuracy (23%). P5 had the highest overall naming accuracy and least severe aphasia of the participants. P1 and P6 had the lowest overall naming accuracy and more severe aphasia than the other participants.

Error types

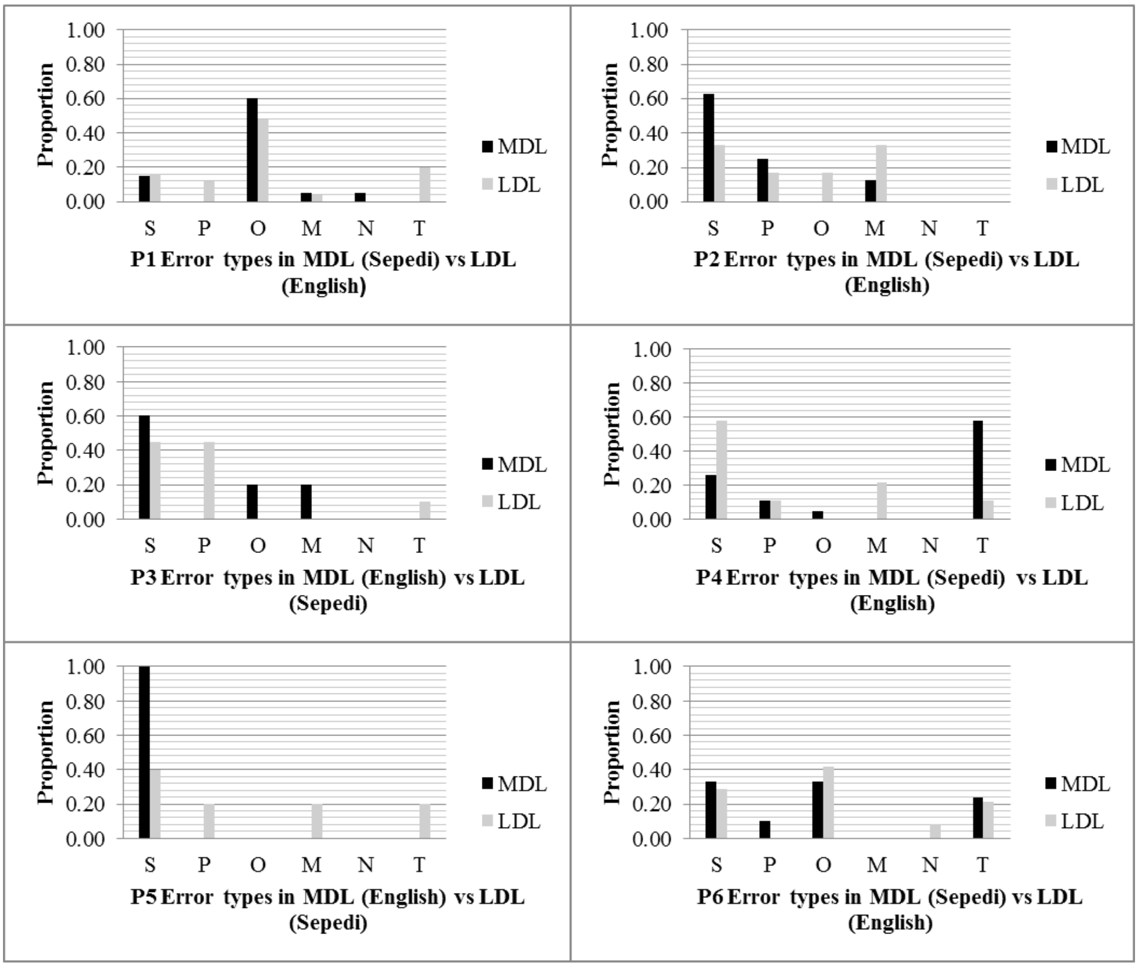

Figure 3 (P1) – (P6). Graphs detailing proportion of error types in participants' post-stroke MDL and LDL.

All participants consistently produced semantic errors in both MDL and LDL. It was the most frequently produced error overall, with proportions ranging between 0.15 and 1.00. Phonological errors were also shown by all participants, but inconsistently in MDL and LDL. P1 and P6 produced the largest proportions of omissions (MDL = 0.6 and 0.42; LDL = 0.48 and 0.42) and neologisms (P1's MDL = 0.05 and P6's LDL = 0.08). P1 and P6 also presented with more severe aphasia in comparison to the other participants. P2, P3, P4 and P5 produced relatively more mixed errors (ranging between 0.125 to 0.22 across MDL and LDL) than P1

(MDL= 0.05 and LDL = 0.04), and P6 had none. P4 and P6 were the only participants who produced translation errors in both MDL and LDL. P1, P3 and P5 had translation errors in their LDL only.

Q2. Impairment and language factors influencing cross-linguistic processing

Table 5. Descriptive Correlations for Overall Accuracy, Aphasia Severity and Age of Acquisition

Variable 1	**Variable 2**	**n**	**Pearson correlation**	**p-value**
		Significant correlation		
Overall accuracy (Sepedi)	Overall accuracy (English)	6	0.855	0.030*
Severity of aphasia (AQ)	Overall accuracy (Sepedi)	6	0.917	0.010*
Severity of aphasia (AQ)	Overall accuracy (English)	6	0.842	0.035*
		No significant correlation, but relevant in literature		
Age of acquisition (Sepedi)	Overall accuracy (Sepedi)	6	0.143	0.788
Age of acquisition (English)	Overall accuracy (English)	6	0.075	0.887

Notes: A significant correlation is indicated with an asterisk (*) and the level of significance is set at 0.05.

Language recovery pattern

For all participants a significant positive correlation (Pearson) presented between overall naming accuracy in Sepedi and English. As naming accuracy increased (or decreased) in Sepedi/English, accuracy also improved (or lowered) in English/Sepedi, respectively.

Aphasia severity (WAB-R)

A significant positive correlation was seen between AQ and overall accuracy in Sepedi and English. This indicates the higher the AQ (less severe aphasia), the higher the naming accuracy in Sepedi and English; the lower the AQ (more severe aphasia), the lower the naming accuracy in Sepedi and English.

Age of language acquisition

Age of acquisition was calculated as years of exposure to Sepedi and English. Participants had more years of exposure to Sepedi (mean = 56.00) than to English (mean = 49.00). No significant correlation between years of exposure and naming accuracy presented for Sepedi or English. Therefore, the age at which participants acquired Sepedi or English could not be linked to their naming ability in that language. The acquisition-performance correlation was however stronger for Sepedi than for English.

Discussion

1. Speech production errors may inform us about cross-linguistic processing in Sepedi-English individuals with aphasia.

Speech production errors found in this study may show that cross-linguistic connections (e.g. spread of activation and connection strength) relate to symptoms of bilingual aphasia, rather than damage to the entire language processing system.[10] Individuals with bilingual aphasia may thus use typical bilingual word retrieval.[7]

Higher MDL naming accuracy, in most cases, supports the assumption that stronger lexical-semantic connections exist in MDL which facilitate more efficient word retrieval and reduce speech errors.[7,21,29,31] Both languages may however remain connected post-stroke, accounting for the lack of a statistically significant MDL-LDL naming difference. Processing difficulties in either language may thus spread to the other language causing a similar number of errors.[21] Another explanation for MDL-LDL naming similarity may be that both languages' word retrieval mechanisms were comparably impaired in participants, known as parallel language recovery.[7,10,37] P4 was the only participant with differential recovery, which may explain higher naming accuracy in her LDL.[7,10,37]

Semantic and phonological error proportions across all participants may indicate activation of both conceptual and phonological systems despite linguistic impairment.[21] Semantic errors may have resulted when a competing non-target concept received a higher level of activation than the target concept.[18,21] For example, activation of the concept transparent liquid (H20) versus transparent liquid (H20) + bottle may cause the error "water" for "bottle". Inconsistency of phonological errors across MDL and LDL may be expected. Sepedi-English word pairs often differ in phonology and structure, as these languages stem from Bantu (Sotho group) and West Germanic linguistic families, respectively.[35,36,52,53] Limited overlap between phonological nodes of both languages and reduced co-activation of sounds may have occurred (e.g. window-lefastere).[18,19,21,54] This is in contrast to semantic errors which occurred consistently. Therefore, Sepedi-English word pairs possibly share a conceptual level which may have caused processing difficulties to present in both languages (e.g. saying "children" or "bana" instead of "school" due to impaired activation of place of learning for children).

Patterns of omission, neologism and mixed errors seen may be associated with aphasia type and severity. Omissions result from insufficient semantic and lexical activation and thus no spread of activation between the processing levels occur (Figure 4).[21] Neologisms may be caused by severe lexical-phonological processing difficulties, suggesting a degree of disconnect between the conceptual and lexical-phonological levels.[54] P1 and P6 produced the most omissions and neologisms, which may be linked to more severe Broca's aphasia. Verbal output is often proportional to the degree of word retrieval difficulties in Broca's aphasia.[55]

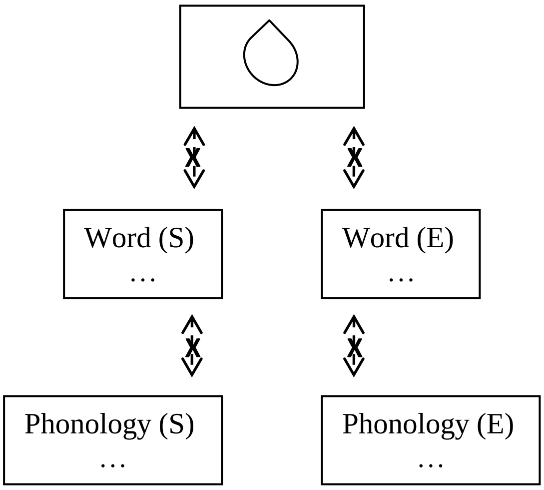

Figure 4. A theoretical account of an omission error when a Sepedi-English person with aphasia is expected to name a picture of water.

Mixed errors signify bidirectional activation of the semantic, lexical and phonological levels.[54,56] P2 and P5 present with mild and P3 and P4 with moderate Anomic aphasia. These participants had mixed errors in MDL and/or LDL. Strength of connectivity within and between languages of a person with aphasia may thus be compromised with an increase in aphasia severity.[10,30,54]

P4 presented with many translation errors in MDL due to interference from LDL, which may be as a result of her differential language recovery. Cognitive control involved in cross-linguistic processing is less preserved in differential as opposed to parallel recovery.[10] Cognitive mechanisms involved in inhibiting the non-target language, when naming occurs in the target language, may thus also have been affected in P4.[7,10,14,20] P6 produced many translation errors in his MDL (Sepedi). He received speech-language therapy only in English (LDL) post-stroke, which may have facilitated stronger connections in English thereby increasing LDL interference seen during picture naming.[7]

2. Language and impairment variables may be associated with cross-linguistic processing in Sepedi-English individuals with aphasia.

Pre- and post-stroke language proficiency appeared to be linked to cross-linguistic processing post-stroke,[10,28–30,32] as more participants had better naming accuracy in their MDL. Age of language acquisition was not significantly correlated with naming accuracy in either language ($p = 0.788$ and 0.887). Language proficiency may thus be more strongly associated with post-stroke linguistic performance than age of acquisition.[7,10] A stronger acquisition-performance correlation in Sepedi may be due to longer years of exposure to Sepedi. The age at which participants acquired Sepedi may still be connected to their post-stroke performance in this language, even though the relation is weak. This supports findings of Kiran and Roberts[30].

Another variable was phonological and structural differences between Sepedi and English as they have different linguistic origins.[52,53] It is proposed that increased interference between these languages will result when attempting to retrieve word pairs with a similar conceptual level.[14,35,36] However, interference may not be observed for all Sepedi-English word pairs, as processes of word adoption and adaptation between Sepedi and English (e.g. sekolo-school and aesekhrimi-ice-cream) may cause similarity in sounds and structure. Dissimilar words may thus be subjected to more interference than adopted/adapted word pairs (e.g. bana-children versus aesekhrimi-ice-cream). The validated word list contained similar and dissimilar word pairs, which may account for inconsistency in MDL-LDL translation errors across participants. Preliminary data in this study indicate that structural language differences may not necessarily be linked to patterns of language recovery and cross-linguistic processing in Sepedi-English persons with aphasia.

Language recovery patterns may be related to the degree of impairment in both languages of an individual with aphasia.[7,10,21] Participants with parallel language recovery had more similar accuracy of production in MDL and LDL as opposed to P4 with differential recovery. Therefore, word retrieval mechanisms of both languages may be equally impaired in parallel language recovery, whereas unequal damage to these mechanisms may be seen in differential language recovery.[10,37]

Aphasia type and severity may have interacted with cross-linguistic processing and recovery.[7,10,21] Statistically significant correlations showed that an increase in aphasia severity resulted in more frequent word retrieval difficulties and thus more speech errors in both languages. P1 and P6 with moderate Broca's aphasia produced the largest number of errors, whereas P5 with mild Anomic aphasia produced the least errors. Figure 5 indicates different language and impairment variables that may have been associated with participants' cross-linguistic processing post-stroke.

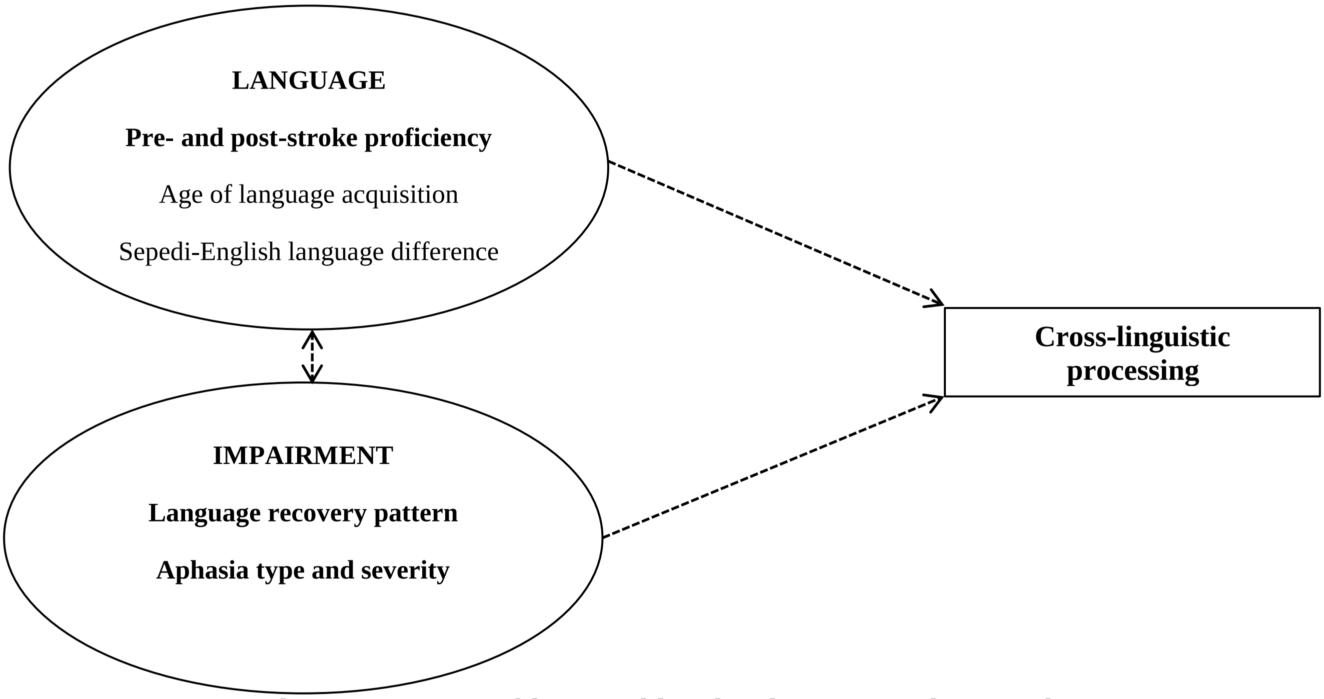

Figure 5. Language and impairment variables possibly related to post-stroke cross-linguistic processing.

Notes: Items in bold may have a stronger association with cross-linguistic processing.

Kendall et al.[21] remarked that statistical differences in three of their four participants' MDL-LDL naming accuracy were unexpected. However, lack of baseline data may have prevented their investigations of possible associated variables. This study's prospective data could therefore expand on their work by examining MDL-LDL accuracy and relating it to these factors.

Future research

This study had a small sample size due to a lack of availability of persons who meet the selection criteria. Future research should thus aim to obtain larger number of participants and investigate other language pairs to verify replication of results. Exploration of other language tasks and modalities may permit in-depth understanding of cross-linguistic processing which in turn guides appropriate diagnosis and intervention in bilingual aphasia.[37] Intervention studies concerning language and impairment variables, standardized Sepedi-English bilingual aphasia tests and objective language proficiency measures should be developed.

Conclusion

Preliminary data regarding important variables to cross-linguistic processing were provided. This study drew attention to the complexity of impaired processing in individuals with bilingual aphasia, which is significantly more intricate than in monolingual aphasia.[5,7,9,10] Improved knowledge of the circumstances surrounding aphasia in SA (i.e. elevated aphasia incidence, multilingualism and language barriers) may contribute to research in the complex field of bilingual aphasia.[2,3]

Disclosure of interest

The authors report no conflict of interest.

Ethical clearance

GW20180115HS

TOTAL WORD COUNT: 3193

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Chapter 4
Discussion and conclusion

“A different language is a different vision of life” – Federico Fellini.

5.1. Aim of the chapter and outline

The aim of the chapter is to provide a synopsis and further analysis of the central findings underpinned by relevant literature. A critical discussion of theoretical and clinical implications follows. This research’s outcomes are preliminary and thus study limitations and directions for future research are explained. The conclusion is stated thereafter.

5.2. Synopsis and further analysis of central findings

Kendall et al. (2015) reported that a statistically significant naming accuracy difference between the MDL and LDL in three of their four participants was unforeseen, as both languages (English and Afrikaans) were presumed to share a semantic system. Lack of baseline data in their study prevented further exploration of this difference. Present research expanded on their investigation by considering various language and impairment factors that may be linked to cross-linguistic processing post-stroke. Table 6 offers a structured synopsis of the results as it pertains to the two research questions posed. This study confirmed that speech errors do impart information about cross-linguistic processing in Sepedi-English persons with aphasia. Furthermore, it appears that different pre- and post-stroke factors may be connected to bilingual processing and recovery in this population. Researchers and clinicians may consult this table when working with Sepedi-English individuals, and other clinically and linguistically diverse persons, with aphasia.

Table 6. Structured Synopsis of Study Findings

Speech errors and cross-linguistic processing	**1. Overall naming accuracy**
	1.1. Participants' MDL and LDL may be linked by a *shared conceptual system*, as well as *similar word processing mechanisms* despite structural differences in Sepedi and English. Recent literature supports this finding (Goral et al., 2013; Isel et al., 2010; Kambanaros, 2016; Kendall et al., 2015; Kiran et al., 2014; Kiran & Gray, 2018; Wei & Liu, 2018).
	1.2. More participants had better naming in their MDL, which supports current views that *MDL may have stronger lexical-semantic connections than LDL* (Gray & Kiran, 2013; Hanulová et al., 2011; Kendall et al., 2015; Khachatryan et al., 2016; Kiran & Gray, 2018; Kroll & Stewart, 1994; Siyambalapitiya et al., 2013). *Stronger links* facilitate *more efficacious word retrieval attempts and an increase in correct productions* (i.e. less speech errors) (Kendall et al., 2015).
	1.3. Findings expand on views of the influence of language proficiency by suggesting that *recovery patterns may also be associated with cross-linguistic processing post-stroke* (Gray & Kiran, 2013). In participants with parallel language recovery, linguistic processing within and between both languages may have been similarly impaired (or preserved) as opposed to differential recovery where linguistic processing of one language was affected to a greater extent (Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran & Gray, 2018). Even though more participants had higher MDL naming accuracy, performance was not significantly better than in LDL. The largest MDL-LDL difference was found in P4 with differential recovery. Researchers and clinicians alike should thus *consider proficiency and recovery when exploring robustness of linguistic links* as a basis for successful word retrieval in bilingual aphasia.
	2. Error types
	2.1. Semantic errors may be caused by a *semantically-related concept* receiving a higher level of activation than the target concept, indicating that the *conceptual level remains accessible* despite impairment (Costa, 2005; Dell et al., 1997; Kendall et al., 2015). This type of error occurred most frequently of all errors and was consistent across MDL and LDL; supporting the understanding that the shared conceptual system is continuously activated.
	2.2. *Phonological errors* may show that *phonological nodes of both languages are constantly activated* (Dell et al., 1997; Kendall et al., 2015). However, Sepedi-English word pairs rarely share sounds and thus *difficulty in activation of certain sounds may not readily spread between phonological nodes of the two languages* (Costa, 2005). This is substantiated by inconsistency of phonological errors in each participant's MDL and LDL.
	2.3. *Omission errors* may occur when *activation of the lexical and semantic levels are insufficient*, hindering interaction between the conceptual-lexical-phonological levels, as seen in Figure 4 in the article (Kendall et al., 2015). Omissions were seen more often in P1 and P6 who had moderate

	Broca's aphasia. This is consistent with research, as the degree of verbal output is often proportional to word retrieval difficulties in Broca's aphasia (Mancinelli & Klein, 2014). Therefore, *more severe expressive language difficulty may be associated with a higher prevalence of omission errors* in aphasia. 2.4. *Neologisms* may result from *significant processing difficulties between corresponding lexical and phonological nodes*, as it is known that this type of error *lacks resemblance to "real" words* (Dell et al., 1997; Kendall et al., 2015). Neologisms presented more frequently in P1 and P6 and may thus *occur more frequently with an increase in aphasia severity.* 2.5. *Mixed errors* may suggest that *processing between the conceptual, lexical and phonological levels still occur* in a top-down (word retrieval) and bottom-up (word comprehension) manner (Dell et al., 1997; Schwartz, 2014). Participants with relatively less severe Anomic aphasia produced more mixed errors than P1 and P6. As a result, mixed errors may *present more regularly when the aphasia, and expressive language difficulty, is less severe*. 2.6. *Translation errors* may result from *pathological and involuntary interference* between MDL and LDL (Khachatryan et al., 2016; Kiran & Gray, 2018). MDL-LDL interference in P4 may have been due to impairment of cognitive mechanisms involved in cross-linguistic processing, which is implicit in *differential language recovery* (Khachatryan et al., 2016). LDL interference in P6 may be as a result of him *receiving speech-language therapy in LDL only*, which is in agreement with Kiran and Gray (2018). There are conflicting views about whether intervention should be received in LDL, MDL or both languages (Amberber, 2012b; Khachatryan et al., 2016; Kiran & Gray, 2018; Kiran, Sandberg, Gray, Ascenso, & Kester, 2013) and this warrants further investigation.
Associated factors	**1. Pre- and post-stroke language proficiency**
	1.1. Three of the participants' MDL and LDL changed post-stroke and the other half had the same MDL and LDL pre- and post-stroke. Only post-stroke language proficiency was therefore considered in all analyses. Four out of the six participants had higher MDL than LDL naming accuracy and P4 had better naming performance in LDL by one item only. *Pre- and/or post-stroke language proficiency may thus be related to cross-linguistic processing in bilingual aphasia* (Centeno & Ansaldo, 2016; Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran, Grasemann, et al., 2013; Kiran & Roberts, 2010; Siyambalapitiya et al., 2013). 1.2. Results show that a *switch in post-stroke language proficiency may not have detrimental consequences for language recovery and may also depend on the type of recovery pattern present*. Out of the three participants whose MDL and LDL changed post-stroke, both languages of two participants recovered similarly post-stroke (parallel recovery).

	2. Age of language acquisition
	2.1. The age at which participants acquired Sepedi and English could not be linked to their confrontation naming ability in that language post-stroke. It was however seen that a stronger acquisition-performance correlation presented for Sepedi. All participants were exposed to Sepedi for longer years and thus *age of language acquisition may be related to cross-linguistic processing post-stroke, although the relationship is unclear* (Kiran & Roberts, 2010). 2.2. *Language proficiency* was more strongly related to participants' naming accuracy than age of language acquisition, as higher naming accuracy was seen more frequently in MDL as opposed to in the language that participants acquired first. This concurs with research suggesting that *language proficiency may be a greater determiner of semantic processing and word retrieval than age of acquisition* in bilinguals (Khachatryan et al., 2016).
	3. Structural differences in Sepedi and English
	Lack of statistically significant differences in MDL-LDL naming accuracy for all participants may suggest that *Sepedi and English use comparable word retrieval mechanisms post-stroke, despite differences in linguistic origin*. This is supported by authors proposing that structural and typological dissimilarities between languages may not change the way in which these languages retrieve words (Kambanaros, 2016; Wei & Liu, 2018). Sepedi and English may thus use *top-down (conceptual-lexical-phonological) processing* for word retrieval. It is possible that *structurally different languages may not cause interference* in cross-linguistic processing and language recovery post-stroke.
	4. Language recovery patterns
	The five participants with parallel language recovery had more similar MDL-LDL production accuracy than P4 with differential recovery of her languages. This may be accounted for by the view that *cognitive mechanisms involved in cross-linguistic processing are relatively more intact in parallel recovery in comparison to differential recovery* (Hope et al., 2015; Khachatryan et al., 2016).
	5. Aphasia type and severity
	A *statistically significant correlation was found between aphasia severity and naming accuracy* in Sepedi and English. An increase in aphasia severity resulted in more speech errors being produced, whereas a decrease in aphasia severity corresponded with less speech errors. It may therefore be possible that an increase in aphasia severity is related to increased difficulty in cross-linguistic processing resulting in frequent speech errors. Meier, Lo and Kiran (2016) found that the semantic level was activated regardless of aphasia severity. It may thus be that *aphasia severity is associated with connection strengths between processing levels rather than activation of the semantic, lexical and phonological levels* (Dell et al., 1997). For example, more severe aphasia may be linked to reduced strength of semantic-lexical-phonological inter-connections.

As shown in Table 6, there is a complex interplay between factors in the two research questions posed. It was seen that overall naming accuracy as well as types and proportions of errors produced were associated with the different language and impairment factors discussed. More participants had better naming in their MDL as opposed to in their LDL, proposing that pre- and post-stroke language proficiency are connected to success of word retrieval and cross-linguistic processing post-stroke (Centeno & Ansaldo, 2016; Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran, Grasemann, et al., 2013; Kiran & Roberts, 2010; Siyambalapitiya et al., 2013). Age of language acquisition was not directly linked to naming accuracy in Sepedi or English for any of the participants, yet a relationship may still exist. Khachatryan et al. (2016) propose that the age at which languages are acquired may be more strongly related to morphological (word formation) and syntactical (sentence structure) aspects of language processing post-stroke. This study explored lexical access and not morphology and syntax. These aspects should form the focus of future research endeavors. Absence of an acquisition-performance correlation may therefore be attributed to focusing on word retrieval only.

Additionally, structural and typological differences in Sepedi and English does not appear to be directly associated with word retrieval, cross-linguistic processing and language recovery post-stroke. Five out of the six participants' MDL and LDL recovered in parallel and no significant difference between MDL-LDL naming accuracy was found. There seems to be divided views about the influence of linguistic difference on bilingual processing post-stroke. Some authors theorize that different languages process and retrieve words similarly, as was seen in the findings of this research study (Kambanaros, 2016; Wei & Liu, 2018). In contrast, language differences are said to cause interference during word retrieval and negatively affect recovery patterns (Kiran et al., 2014; Radman et al., 2016). This warrants further investigation with larger samples.

The degree and nature of language impairment also appeared to interact with cross-linguistic processing of participants. P1 and P6, with more severe Broca's aphasia (lowest aphasia quotients), had lower naming accuracy in MDL and LDL. P5 with less severe Anomic aphasia (highest aphasia quotient) presented with the highest naming accuracy in MDL and LDL. Therefore, a statistically significant positive correlation ($p = 0.010$ and 0.035) was seen between aphasia severity and naming accuracy in Sepedi and English. Error types and proportions further support this finding. Omissions and neologisms are implicit in more severe aphasia, as there is a greater breakdown in connection strength between processing levels (semantic, lexical and phonological) (Dell et al., 1997; Kendall et al., 2015). Consistent with this view, P1 and P6 produced many omissions and neologisms. Both errors are also thought to result from limited spread of activation and/or processing difficulty between levels of representation (Dell et al., 1997; Kendall et al., 2015). In contrast, other participants had more semantic and mixed errors than P1 and P6. These errors are typically present in less severe aphasia, as underlying linguistic links are stronger and there is more successful spread of activation between the levels (Dell et al., 1997; Schwartz, 2014). Dell et al. (1997) refer to semantic and mixed errors as "smart" errors, as they indicate agreement across semantic, lexical and phonological levels and resemble the target word. Aphasia severity may thus be linked to strength of linguistic connections and resultant speech error types.

Findings of this study show that pre- and post-stroke language proficiency, aphasia type and severity, and language recovery patterns may be related to strength of linguistic connections, success of word retrieval and cross-linguistic processing post-stroke. It is a complex task to determine relationships between these factors. Literature offers descriptions of this relationship by proposing hypothetical models of bilingual aphasia, but the association between factors remains unclear (Abutalebi, Rosa, Tettamanti, Green, & Cappa, 2009; Gray & Kiran, 2013; Khachatryan et al., 2016). Even though the current study was exploratory, results may have implications for current theoretical models of cross-linguistic processing.

5.3. Theoretical implications

Theories and models of cross-linguistic processing have evolved over time, yet much remains to be known about the complexity of bilingualism in persons with aphasia (Gray & Kiran, 2013; Hope et al., 2015; Khachatryan et al., 2016; Kiran & Gray, 2018). Influences of language and impairment factors render linguistic processing in bilingual aphasia significantly more intricate than that of neurotypical bilinguals (Kiran & Gray, 2018). Proficiency, age and sequence of acquisition as well as other language aspects (e.g. word frequency and meaning) are the premise of the mixed model of bilingual lexical representation (de Groot, 1992), RHM (Kroll & Stewart,

1994) and the bilingual lexical access model (Costa, 2005). All three models explain typical bilingual word retrieval and access. Although they do not account for language impairment, current research uses these models to explain how word retrieval difficulties and speech errors may occur in individuals with bilingual aphasia. According to Gray and Kiran (2013) theoretical models assist the interpretation of results.

The findings of this study support the bilingual lexical access model (Costa, 2005) and recent research. As depicted in Figure 1, linguistic processing occurs simultaneously and bi-directionally across three levels (semantic, lexical and phonological) within and between both languages (Goral et al., 2013; Gray & Kiran, 2013; Kendall et al., 2015; Kiran et al., 2014; Kiran & Gray, 2018; Radman et al., 2016). Wei and Liu (2018) considered many studies of typical bilingual processes (e.g. code switching). Based on this exploration, they theorized that the lexical levels of both languages are not separate, but combined, resulting in a "bilingual mental lexicon" which contains language-specific lexemes (words). Present research did not inspect code-switching and could thus not determine whether participants' languages shared a lexical level in addition to a possibly mutual conceptual system.

To contribute to the long-standing influence of the mixed model, RHM and bilingual lexical access model, it is important to explore how linguistic deficits may alter the typical bilingual processing structures assumed by these models (Gray & Kiran, 2013). The current study achieved this by investigating the nature and severity of participants' language impairment as it relates to the bilingual lexical access model (Costa, 2005). Based on overall accuracy data of the participants, it appeared that parallel and differential language recovery may have the opposite effect on word retrieval mechanisms in both languages. The former may have caused similar word retrieval difficulty in both languages of the five participants, whereas the latter may have favoured word retrieval efficacy and efficiency in one language over the other in P4. Furthermore, P1 and P6 with relatively more severe expressive difficulties (moderate Broca's) produced omissions and neologisms. These errors are attributed to lack of spread of activation and a possible disconnect between processing levels (Dell et al., 1997; Kendall et al., 2015). For example, a neologism "eka" for "water" may be produced when the word "water" is retrieved, suggesting that activation did not spread from the word node to the phonological node. The non-word “eka” thus showed inconsistency between the word and phonological nodes. Other participants, with relatively less severe aphasia (mild or moderate Anomic), showed mixed errors which are thought to represent inter-activation across the semantic, lexical and phonological levels despite impairment (Dell et al., 1997; Schwartz, 2014).

Future theoretical models of bilingual aphasia should consider that factors such as language proficiency and age of acquisition may not be the only determinants of lexical-semantic connection strengths (i.e. MDL may not always show stronger linguistic links than LDL). Speech error types and proportions as well as type and severity of aphasia, and language recovery patterns may also be associated with bilingual processing and strength of linguistic links in both languages (Kiran & Gray, 2018). Furthermore, languages from different linguistic families (such as Sepedi and English) may use similar mechanisms of word retrieval (Kambanaros, 2016; Wei & Liu, 2018).

Individuals with bilingual aphasia and neurotypical bilingual adults implement similar word retrieval mechanisms (Kiran & Gray, 2018). The mixed model, revised hierarchical model (RHM) and the bilingual lexical access model may therefore still have merit in describing cross-linguistic processing in bilingual aphasia. Meier et al. (2016) supports these models by positing that the meaning, category and frequency of a word indeed affect linguistic processing. Results of the current study, supported by publications of Gray and Kiran (Gray & Kiran, 2013; Kiran & Gray, 2018), however indicate that various language and impairment factors should be taken into account when illustrating cross-linguistic processing in bilingual aphasia. Updated theoretical models will be advantageous for the development of suitable assessment and intervention materials for this population (Gray & Kiran, 2013).

5.4. Clinical implications

This study offers insight that may benefit speech-language therapy for Sepedi-English persons with aphasia. Lack of knowledge has resulted in SLTs giving mono-lingual therapy, usually in a language that they are proficient in such as English or Afrikaans (Barratt et al., 2012). This is in conflict with best practice, as questions remain about the success of monolingual intervention for the community with bilingual aphasia (Khachatryan et al., 2016; Kiran & Gray, 2018).

In an effort to move towards person-centered management, SLTs may use findings of this study to guide clinical decision making. A detailed case history, including language and impairment factors explored in this study, should be gathered during initial contact with clients and their significant others. Information can be obtained efficiently by using a structured interview schedule (Appendix F). Interpretations about pre- and post-stroke language proficiency should be made with reference to age of language acquisition, manner of acquisition, educational exposure, language modalities, language use contexts, frequency of use and self-rated abilities in each language (Gray & Kiran, 2013; Kendall et al., 2015; Khachatryan et al., 2016; Kiran et al., 2014).

Special attention should be given to language recovery patterns, aphasia type and severity, and language proficiency, as all three factors may be linked to clients' cross-linguistic processing. It may be difficult to ascertain a client's MDL and LDL accurately, as this judgment is usually made based on self-report (Kiran & Gray, 2018). Data from the current study also indicated that participants' languages may remain interconnected post-stroke (for example, a shared conceptual system and similar word processing mechanisms). This is relevant for interventions targeting semantic and word retrieval aspects of linguistic processing (Meier et al., 2016). Furthermore, SLTs should understand the importance of providing therapy in the appropriate language(s). For example, the language(s) used most frequently by the individual post-stroke or the language(s) that he or she feels most comfortable speaking and/or wants to receive intervention in (Amberber, 2012a; Khachatryan et al., 2016). Client autonomy in decision-making should be honoured.

This research focused mainly on impairment in body function, as in the International Classification of Functioning, Disability and Health [ICF] framework (World Health Organization, 2001). SLTs should however remain cognizant of quality of life, contextual factors and functional outcomes for persons with aphasia and bilingual aphasia as this ultimately leads to level of participation (Amberber, 2012a; Chiou & Yu, 2018; Pike et al., 2017). A client's aphasia severity may thus not offer an accurate account of his or her level of life participation or communication confidence (Chiou & Yu, 2018). Aphasia-friendly materials should therefore be used during assessment, joint goal setting and intervention to ensure that the client's needs and concerns remain at the forefront of all clinical efforts.

An area of concern that arose from present research is a lack of follow-up speech-language therapy. Most participants briefly received individual intervention and intermittent group therapy thereafter. This finding relates to a nationwide trend as speech-language rehabilitation in the post-acute phase is often absent (Penn, 2014). The onus is on South African SLTs to ensure continuous access to services by making appropriate referrals (for example, considering the distance to be travelled and associated costs), if they are no longer able to see a client after discharge. Persons with mono- and bilingual aphasia may benefit from suitable and prolonged access to speech-language therapy, as they have the potential to work, enjoy a better quality of life and improved life participation (Amberber, 2012; Chiou & Yu, 2018; Penn, 2014; Pike et al., 2017).

Preliminary findings of the current study may be valuable to SLTs and other professionals serving CLD populations, but further research is required to increase evidence. Suggestions for clinical practice should nonetheless be implemented to improve services to South Africans with bilingual aphasia. More specifically for individuals with languages other than English and/ or Afrikaans, as they form majority of the population seeking speech-language therapy services in South Africa (Barratt et al., 2012).

5.5. Limitations of the study and future research

The current study had a small sample size and thus larger studies should follow to replicate results. It is necessary to conduct the same study with other official South African languages and language pairs, such as isiZulu, isiXhosa, Sesotho and Setswana, allowing comparison of study outcomes. These advances may support development of standardized assessment tools, objective measures of language proficiency and intervention studies for Sepedi-English clients, and other underserved populations in South Africa, with aphasia (Penn, 2014). Endeavors should be guided by theoretical explanations of cross-linguistic processing as well as neuroimaging data (Khachatryan et al., 2016).

There are no comprehensive bilingual models and as a result current theoretical discussions of cross-linguistic processing are limited (Gray & Kiran, 2013). Future research should explore a variety of language tasks (e.g. naming, discourse, narrative) and modalities (e.g. speaking, reading and writing) in order to address this concern. Findings of this study may not be generalized to other linguistic tasks and modalities, as confrontation naming only was investigated.

Statistical analyses of confrontation naming data showed that participants' cross-linguistic processing may be associated with various language and impairment factors. More information about these and other factors, and their interaction, is required before robust connections to bilingual processing and language recovery can be determined. Another variable briefly examined in the present study was Sepedi-English language differences and similarities. The aim was to see whether this language aspect may be linked to participants' naming abilities post-stroke. Data should be used to further investigate relationships between bilingual processing and structural and phonological similarity of Sepedi-English word pairs (for example, "helicopter" and "helikoptere").

Prospective research should take into account and explore lived experiences of individuals with aphasia and bilingual aphasia (Amberber, 2012a; Chiou & Yu, 2018; Pike et al., 2017). It is not sufficient to focus on language and communication impairment secondary to aphasia only, as this often does not reflect everyday challenges that clients face (Chiou & Yu, 2018). CLD populations should be of particular interest, as literature about the effect of life participation and contextual factors on service provision for these communities is rare (Penn & Armstrong, 2017).

5.6. Conclusion

Equitable access to health services remains a challenge in South Africa, especially for persons with aphasia in the public health sector (Penn, 2014). The disparity is raising awareness in SLTs, other professionals and researchers about contextual influences (e.g. bi- or multilingualism, poverty, cultural beliefs) on aphasia (Penn, 2014). This study provides introductory knowledge of speech errors and how it relates to cross-linguistic processing in Sepedi-English individuals with aphasia.

Preliminary evidence about language and impairment factors that may interact with cross-linguistic recovery in this population is also offered. Findings draw attention to the complexity and impairment of bilingual processing in aphasia. Advances in research about underserved CLD communities are of global significance, as it allows unique comprehension of aphasia (Penn & Armstrong, 2017; Penn, 2014).[1]

[1] Prof Claire Penn made remarkable contributions to the field of aphasia as well as speech-language pathology and audiology research at large. Her many publications had local and global influence, and were instrumental in creating positive views of multilingual and multicultural contexts.

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APPENDIX A – PERMISSION LETTER TO INSTITUTIONS

10/01/2018

To whom it may concern,

I am currently in the process of completing my Master's Degree at the University of Pretoria (Department of Speech-Language Pathology and Audiology). The research study is entitled: **"Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia."**

This study will recruit bilingual individuals that have aphasia and adhere to the inclusion and exclusion criteria (see attached – Appendix C). Therefore a review of hospital records is warranted in order to obtain a sample population. The selection process will not involve viewing of any personally-relevant documentation of the patient without prior permission by them (see attached – Appendix C). Please find attached an informed consent letter to the participant explaining the rationale of the study and potential benefits of their participation (see attached – Appendix C).

It is with this that permission to access hospital records is requested. Authorization to do so can be given by providing a signature below. Additionally, if there are any questions the researcher (Mianda van Zyl – miandavanzyl@gmail.com) or supervisor (Bhavani Pillay - Bhavani.Pillay@up.ac.za) can be contacted.

Thank you for your consideration in advance.

Regards,
Mianda van Zyl

____

AUTHORITY SIGNATURE

____

DATE SIGNED

APPENDIX B – ETHICAL CLEARANCE

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

9 March 2018

Dear Ms van Zyl

Project:	**Significance of speech production errors on cross-linguistic processing in English/ Sepedi individuals with Bilingual aphasia**
Researcher:	**M van Zyl**
Supervisor:	**Ms D Pillay**
Department:	**Speech-Language Pathology and Audiology**
Reference number:	**14157081 (GW20180115HS)**

Thank you for your response to the Committee's letter of 20 February 2018.

I have pleasure in informing you that the Research Ethics Committee formally **approved** the above study at an *ad hoc* meeting held on 9 March 2018. 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 your actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely

Prof Maxi Schoeman
Deputy Dean: Postgraduate and Research Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: tracey.andrew@up.ac.za

cc: Ms D Pillay (Supervisor)
Ms J van der Linde (HoD)

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YUNIBESITHI YA PRETORIA

Faculty of Humanities
Department of Speech-Language Pathology and Audiology

APPENDIX C 1 – INFORMED CONSENT

10/01/2018

Dear Prospective Participant,

I am completing my Master's Degree at the University of Pretoria (Department of Speech-Language Pathology and Audiology). The research study is entitled: **"Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia."**

1. Introduction to the topic:

The world's population has become increasingly bilingual (in other words, people speak and understand two languages). This means that there are more bilingual people who have aphasia. *Aphasia* is a difficulty in *speaking and/ or understanding language* after someone has, for example, *had a stroke*. *Bilingual aphasia* can simply be explained as difficulties experienced in *one or both language(s),* after damage to the *language parts of the brain* (typically the left half of the brain).

Many studies have looked at the way language is managed in bilingual people, especially those who have aphasia. The interaction between the two languages is of particular interest, because it is still not clear how this interaction may be affected after injury to the brain. Difficulties in finding the right words when speaking is one of the main aspects of aphasia and may result in a person saying a word or sound incorrectly. *Speech production errors* are *mistakes in saying certain sounds or words*, for example; if one says "kair" instead of "chair". These mistakes can help us understand how the two languages interact.

2. What is expected of the participant:

The participant will be expected to attend **two sessions** of approximately an hour and a half each.

Session 1	Assessment using brief tests to help us see the participant's over-all language ability.
Session 2	The participants will have to name a number of picture cards in both their first and second languages. For example; the participant will be shown a picture of a nose and they will then have to respond first with "nose" (if English is their first language). Then, the researcher will shuffle the cards and when the picture of the nose appears again, the individual will have to respond with "nko" (if Sepedi is their second language).

3. Who can participate?

We will need some documents, for example; a speech-language therapist's report. If the report shows that the requirements are met, the participant will kindly be invited to participate in this study.

4. What this study promises:

4.1. This study promises that all information gathered and findings obtained will be handled in a **confidential** manner. Only the researcher (Mianda van Zyl), supervisor (Bhavani Pillay) and participant will have access to this information. If, for future research or other purposes information obtained in this study must be disclosed (shared) to other sources, the individual will remain **anonymous** at all times.

4.2. Participants will not be referred to by their name in any documentation or write-ups that will be seen by others. They will simply be known as Participant 1, 2, 3, etc.

4.3. This study does not have the potential to create any physical, emotional, psychological or other types of harm and the well-being of the participant will remain very important at all times.

4.4. The participant should know that their **participation is voluntary** and that they have **the right to withdraw at any time** (stop at any time), without any consequences.

4.5. If the participant gives consent that the findings of this research may be used for future research purposes, please sign the attached form with the heading **PERMISSION LETTER FOR ACCESS TO DOCUMENTATION** (Appendix C 3).

5. Benefits of participation:

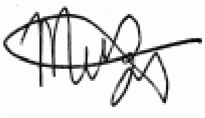
Your participation in this study will be a valuable contribution to the treatment services provided to people with bilingual aphasia. In order to improve therapies, professionals need to better understand what speech production errors can tell us about how the languages interact in people with bilingual aphasia.

6. Contact information:

If there are any further questions or queries, please feel free to contact the researcher (Mianda van Zyl – 076 145 1780) or the supervisor (Bhavani Pillay – 082 552 0643). Once you have signed below, it will be assumed that you have had the opportunity to clarify any uncertainties, understand that your participation is voluntary and that you may withdraw at any time.

It is with much thanks that we appreciate you considering participating in this study.

Please sign at the end of this letter (and Appendix C 2) and the attached letter with the heading **PERMISSION LETTER FOR ACCESS TO DOCUMENTATION** (Appendix C3), if you consent to participate.



RESEARCHER
MIANDA VAN ZYL

SUPERVISOR
BHAVANI PILLAY

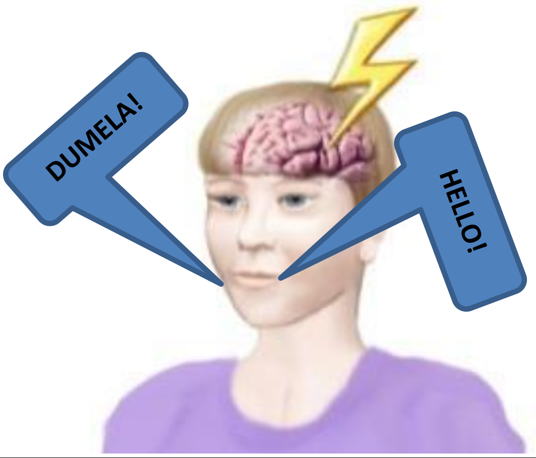
DR. JEANNIE VAN DER LINDE
HEAD: DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLGY

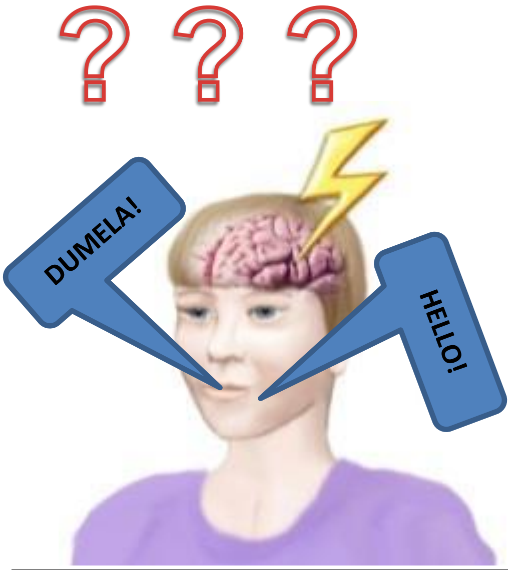
PARTICIPANT

SIGNIFICANT OTHER

DATE SIGNED: ________________________________

WHAT IS THE RESEARCH?

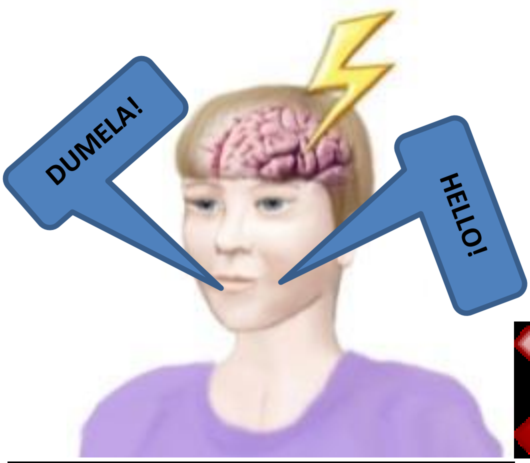
	We are doing some **research.**
	It is about **bilingual** individuals with **aphasia.**
	A person who has **aphasia** and can **speak two languages.**
	We need to **know** more about **how to help**.



Speech-language therapists need to **know more** about **bilingual aphasia.**

There are **many questions** about **bilingual aphasia.**

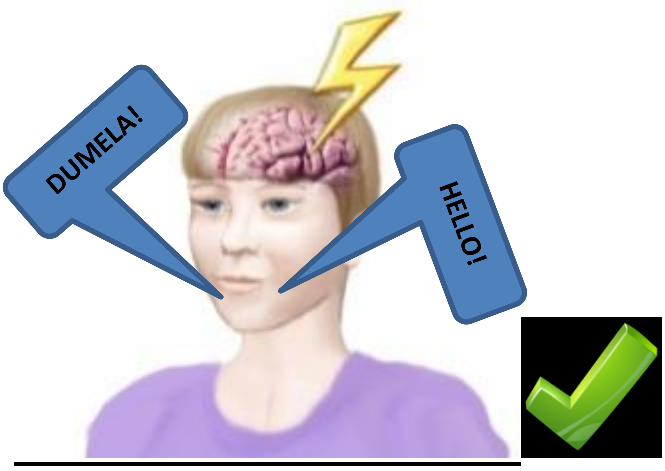
WHY ME?



You are **bilingual** and have **aphasia.**

You speak **Sepedi and English.**

WHY ARE WE DOING THE RESEARCH?

 	To find **solutions** to treat **bilingual aphasia.**

WHAT MUST I DO?

	Attend **two sessions**.

 	1. The **speech therapist** will use **short tests.** 2. The **speech therapist** will ask you to **name pictures.**
	You can **stop** at **any time**.
 	You must **sign** to give **permission.**

WILL SOMEONE KNOW IT IS ME?

	We will **record** what you say. This helps us to **remember** what you say.
	We will keep the **records safe.**
 	**Only the researcher** will listen to the recording. [2]

[2] Many images in this document were used from Pearl, G. (2014). Engaging with people who have aphasia: A set of resources for stroke researchers. Newcastle, UK. Retrieved from http://www.crn.nihr.ac.uk/wp-content/uploads/stroke/sites/Aphasia/Aphasia resources project v2-2.3 in sections - whole doc (1).pdf

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APPENDIX C 2 – INFORMED CONSENT (PICTURE-BASED)

I will take part in **research** about **bilingual aphasia** in order to find **solutions** for **treatment.**

–

yes ☐ no ☐

Please **tick** yes ☐ no ☐ for **each sentence** below:

WHAT IS THE RESEARCH?

1. I **understand** what the **research** is about. yes ☐ no ☐

   I know what **bilingual aphasia** means.

WHY ME?

2. I know **why** I have been asked to **take part**. yes ☐ no ☐

WHY ARE WE DOING THE RESEARCH?

3. I understand **why** the **research** is being done. yes ☐ no ☐

WHAT MUST I DO?

4. I know **what** I must **do.**
   I know **where** to go and **what** will happen. yes ☐ no ☐

5. I realize that I can **stop** at **any time**. yes ☐ no ☐

6. I must **sign** to give **permission.** yes ☐ no ☐

WILL SOMEONE KNOW IT IS ME?

7. I know that **what I say** will be **recorded.**
   I understand **why** it will be **recorded.** yes ☐ no ☐

8. I realize that the **records** will be **kept safe.** yes ☐ no ☐

9. I understand that **only the researcher** will **listen** to the **recording**. yes ☐ no ☐

---

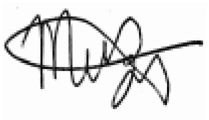
10. I have had the **chance** to **ask questions.**
   I **understand** the **answers** to my **questions.** yes ☐ no ☐

11. I **will take part** in the research. 

PARTICIPANT: ______________________________

SIGNIFICANT OTHER: _______________________

DATE SIGNED: ______________________________



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APPENDIX C 3 - PERSMISSION LETTER FOR ACCESS TO DOCUMENTATION

I, **(name and ID number)** ________________________________, hereby give consent to Mianda van Zyl (researcher) and Bhavani Pillay (supervisor) to access and review personally-relevant documentation (e.g. hospital records, speech-language therapists' reports) required for the purposes of the current research study. In doing so, I also give permission for data obtained from the study to be saved in electronic copy (anonymity and confidentiality maintained) in the Department of Speech-Language Pathology and Audiology (University of Pretoria) for future research purposes.

If the individual is unable to sign (for whatever reason), permission may be obtained verbally and a signature be given by the individual's caregiver and/ or a significant other.

Full name and ID number of significant other:

____

Signature: ____________________

Date signed: ____________________

Signature: ______________________

____
RESEARCHER
MIANDA VAN ZYL

____
SUPERVISOR
BHAVANI PILLAY

____
DR. JEANNIE VAN DER LINDE
HEAD: DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLGY

APPENDIX D – INTERVIEW SCHEDULE

Date: ____

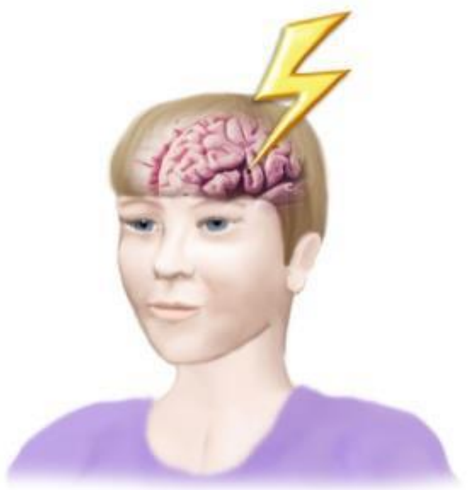
Participant's name*: ____

1. What is your date of birth?

____

BEFORE

PELE



2. What languages did you speak before your stroke?

____

3. Did you speak and understand Sepedi before your stroke?

☐ Yes
☐ No

4. Did you speak and understand English before your stroke?

☐ Yes
☐ No

5. Before your stroke, which language did you understand better?

☐ Sepedi
☐ English

6. Before your stroke, which language did you use more often?

☐ Sepedi
☐ English

7. Before your stroke, what did you use Sepedi for?
- ☐ Speaking
- ☐ Reading
- ☐ Writing

8. Before your stroke, what did you use English for?
- ☐ Speaking
- ☐ Reading
- ☐ Writing

9. Were you able to understand and speak Sepedi and English equally well?
- ☐ Yes
- ☐ No

10. Before your stroke, how often would you use Sepedi?
- ☐ Every day, mostly
- ☐ At work
- ☐ Only if the person I was talking to only understood Sepedi
- ☐ Not often

11. Before your stroke, how often would you use English?
- ☐ Every day, mostly
- ☐ At work
- ☐ Only if the person I was talking to only understood English
- ☐ Not often

12. Before your stroke, in which situations would you mostly speak Sepedi?
- ☐ With family members and friends
- ☐ At work
- ☐ At school

13. Before your stroke, in which situations would you mostly speak English?
- ☐ With family members and friends
- ☐ At work
- ☐ At school

14. How old were you when you started speaking Sepedi?

____

15. How old were you when you started speaking English?

____

16. Did you learn to speak English and Sepedi at the same time?
- ☐ Yes
- ☐ No

17. What language were you taught in at school?
- ☐ English
- ☐ Sepedi
- ☐ Other

18. How many years did you go to school (i.e. until what grade)?

____

19. Did you study further after school? If so, where did you study and what?

____

20. Before your stroke, how would you rate your language abilities in Sepedi?
- ☐ Very good
- ☐ Good
- ☐ Okay
- ☐ Not very good
- ☐ Not good at all

21. Before your stroke, how would you rate your language abilities in English?
- ☐ Very good
- ☐ Good
- ☐ Okay
- ☐ Not very good
- ☐ Not good at all

22. Did you work before your stroke?
- ☐ Yes
- ☐ No

23. What work did you do before your stroke?

____

AFTER

KO MORAO

24. Did you have a stroke?
- ☐ Yes
- ☐ No

25. When did you have your stroke?

____

26. To which hospital did you go?

____

27. How long were you in the hospital?

____

28. After your stroke, did you receive speech therapy?

____

29. How long did you go to speech therapy?

____

30. Which language did you receive speech therapy in?
- ☐ English
- ☐ Sepedi

31. After your stroke, which language do you understand better?
- ☐ Sepedi
- ☐ English

32. After your stroke, which language do you speak better?
- ☐ Sepedi
- ☐ English

33. After your stroke, do you feel that you speak English and Sepedi equally well?
- ☐ Yes, I speak both languages equally well.
- ☐ No, I speak Sepedi better than English.
- ☐ No, I speak English better than Sepedi.

34. After your stroke, do you feel that you understand English and Sepedi equally well?
- ☐ Yes, I understand both languages equally well.
- ☐ No, I understand Sepedi better than English.
- ☐ No, I understand English better than Sepedi.

35. After your stroke, which language do you feel more comfortable speaking?
- ☐ English
- ☐ Sepedi

36. After your stroke, in which situations do you mostly speak Sepedi?
- ☐ With family and friends
- ☐ At work

37. After your stroke, in which situations do you mostly speak English?
- ☐ With family and friends
- ☐ At work

38. After your stroke, how often do you speak Sepedi?
- ☐ Every day, mostly
- ☐ Only when the person I am talking to only understands Sepedi
- ☐ Not often

39. After your stroke, how often do you speak English?
- ☐ Every day, mostly
- ☐ Only when the person I am talking to only understands English
- ☐ Not often

40. After your stroke, which language difficulties do you experience?
- ☐ It is difficult to repeat words or sentences that someone has said.
- ☐ I have difficulty understanding what people say.
- ☐ I know what I want to say, but have difficulty finding the right word.
- ☐ It is difficult to name pictures and objects.

- ☐ Sometimes the words that I say don't come out right (e.g. teeste for meetse)
- ☐ Sometimes I say a word that is similar to what I want to say, but not the right word (e.g. chair for couch).
- ☐ It requires a lot of effort to speak.
- ☐ I speak slow and use short sentences.
- ☐ Other. *Please describe.*

____

____

41. How did speech therapy help with your language difficulties?

- ☐ I could repeat words or sentences that other people said after speech therapy.
- ☐ I could better understand what people were saying after speech therapy.
- ☐ I could better find the right word for what I wanted to say after speech therapy.
- ☐ I could better name pictures and objects after speech therapy.
- ☐ I made less speech errors e.g. teetse for meetse and couch for chair after speech therapy.
- ☐ It requires less effort to speak after speech therapy.
- ☐ I speak a faster and use longer sentences after speech therapy.
- ☐ Other. *Please describe.*

____

____

APPENDIX E – VALIDATION OF INITIAL WORD LIST

	English			Sepedi		
	Word	**Response (√ / X)**	**Alternative**	**Word**	**Response (√ / X)**	**Alternative**
1.	child			ngwana		
2.	day			letšatši		ntsihare/ mosara (today)/ mosarare
3.	money			tšhelete		
4.	night			bošego		
5.	number			nomoro		
6.	school			sekolo		
7.	television/ TV			thelebišene		TV/ televisioneX2
8.	cigarette			sekerete		
9.	newspaper			kuranta		
10.	flower			letšoba		leblomo X 5
11.	bread			borotho		
12.	church			kereke		
13.	glass			galase		glass/ komiki (cup)
14.	watch			sešupanako		watch/ watchiX3
15.	fish			hlapi		
16.	man			monna		
17.	heart			pelo		
18.	children		Kids	bana		
19.	table			tafola		
20.	tomato			tamati		
21.	snail			kgopa	don't know	
22.	baby			lesea		Baby only referred to as lesea for the first few weeks after birth.
23.	book			puku		puka/ buka
24.	telephone			mogala/ motato		phone X2, phono

				(both correct)		
25.	wool			wulu		
26.	butterfly			serurubele		
27.	leaf			letlakala/ lehlare		
28.	strawberries			distroperi		
29.	hat			mongatse (woolen cap)		kefa/ kuane X4
30.	athlete	don't know		moatletiki	don't know	mothu kitima (person who runs)/ ramabelo/ hošiana/ monna ke kitima
31.	dog			mpša		
32.	ice-cream			aesekhrimi		
33.	horse			pere		
34.	eye			leihlo		
35.	robot	don't know		roboto	don't know	robot, robote
36.	door			lebati		monyako X2/ lebati X3
37.	cat			katse		
38.	window			lefastere		
39.	rainbow	don't know		molalatladi	don't know	
40.	computer			khomphutha		
41.	soup			sopo		
42.	razor	don't know	shaver/ shaving machine/ shaving stick	legare		razor X2/ lehare
43.	comb			sekamo		kamo X2/ kama
44.	pineapple			phaeneapola		
45.	zip			zipi		
46.	helicopter		aeroplane/ fly machine	helikoptere		helicopter X2/ sefofane X 4
47.	star			naledi		
48.	microwave			maekroweibi		microwave X 2 / microwaevie X3

49.	nose			nko		
50.	earring			lengina		
51.	house			ntlo		
52.	pizza			phitsa		
53.	knot	don’t know X 3		lehuto	don’t know X2	
54.	chair			setulo		Setilo
55.	puzzle	don’t know		marara/ mararankodi	don’t know X2	mararankodi X2/ both

Key: ● - words that were excluded

APPENDIX F – VALIDATED WORD LIST

	English	Sepedi
1.	child/boy	ngwana/ mošemane
2.	money	tšhelete
3.	night	bošego
4.	number	nomoro
5.	school	sekolo
6.	cigarette	sekerete
7.	newspaper	kuranta
8.	flower	leblomo/ letšoba
9.	bread	borotho
10.	church	kereke
11.	glass	galase
12.	watch	sešupanako/ watchi
13.	fish	hlapi
14.	man	monna
15.	heart	pelo
16.	children/ kids	bana
17.	table	tafola
18.	tomato	tamati
19.	book	puku/ buka
20.	telephone	mogala/ motato/ phone
21.	wool	wulu
22.	butterfly	serurubele
23.	leaf	letlakala
24.	strawberries	distroperi
25.	hat	kuane/ kefa
26.	dog	mpša
27.	ice-cream	aesekhrimi

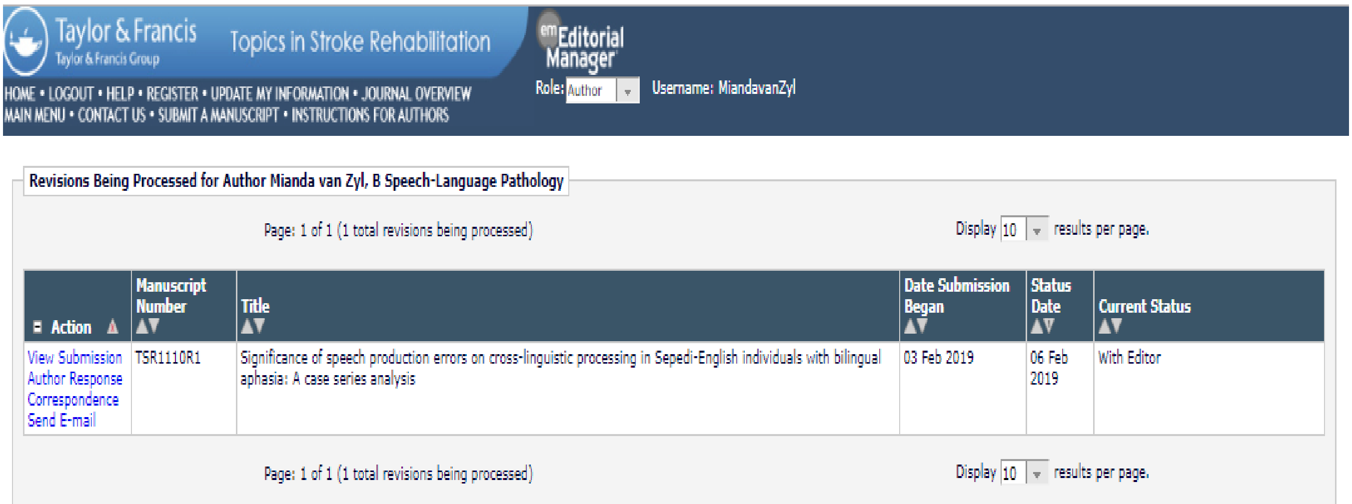
28.	horse/ donkey	pere
29.	eye	leihlo
30.	door	lebati/ monyako
31.	cat	katse
32.	window	lefastere/ mafestere
33.	computer	khomphutha
34.	soup	sopo
35.	comb	kamo
36.	pineapple	phaeneapola
37.	zip	zipi
38.	helicopter/ aeroplane	helikoptere/ sefofane
39.	star	naledi
40.	microwave/ microwave oven	maekrowaevie/micro-oven
41.	nose	nko
42.	earring	lengina
43.	house	ntlo
44.	pizza	phitsa
45.	chair	setulo

APPENDIX G – EXAMPLES OF COLOUR PICTURE CARDS

[3]

[3] Cigarette image retrieved from: https://myaccount.news.com.au/sites/heraldsun/subscribe.html?sourceCode=HSWEB_WRE170_a_GGL&mode=premium&dest=https://www.heraldsun.com.au/news/tobacco-giant-shrinking-size-of-some-cigarette-packs-as-smokers-to-be-hit-with-another-tax-rise/news-story/535e6f0188faad2317a570620e6b7b26&memtype=anonymous
Bread image retrieved from: https://us.royalquest.com/forum/index.php?/topic/1227-bread/:

APPENDIX H – PROOF OF ARTICLE RESUBMISSION



Action	Manuscript Number	Title	Date Submission Began	Status Date	Current Status
View Submission Author Response Correspondence Send E-mail	TSR1110R1	Significance of speech production errors on cross-linguistic processing in Sepedi-English individuals with bilingual aphasia: A case series analysis	03 Feb 2019	06 Feb 2019	With Editor