Lexical retrieval in bilingual Sinhala-English and monolingual Sinhala healthy speakers and speakers with aphasia

Volume I

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Sometimes, all you need is for someone to hold your hand...

To Thaththi, Ammi, Narada, Akhaain, Akki,

Gaya, Iro and Pramo

Thank you for doing just that.

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[1] CAT: Swinburn Porter & Howard, 2004
[2] OANB, Druks & Masterson, 2000

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LIST OF ABBREVIATIONS

TESL	Teaching English as a Second Language
SLT	Speech Language Therapists
CVA	Cerebro-Vascular accident
MCA	Middle Cerebral Artery
ICH	Intra Cerebral Hemorrhage
AVM	Arterio-Venous Malformation
ISC	Immediate self-corrections
P1	Phase 1
P2	Phase 2
P3	Phase 3
LPQ	Language Proficiency Questionnaire
LEAP-Q	Language Experience and Proficiency Questionnaire
CLQT	Cognitive Linguistic Quick Test
OANB	Object Action Naming Battery
CAT	Comprehensive Aphasia Test
PS	Picture Sequences
SP	Single Picture
ML	Monolingual Sinhala speakers
BL	Bilingual Sinhala-English speakers
MLG	Monolingual Group
BLG	Bilingual Group
MLS	Monolingual Sinhala
BLS	Bilingual Sinhala
BLE	Bilingual English
PWA	Persons with Aphasia/Participants with Aphasia
ML-PwA/ MLA	Monolingual Persons with Aphasia
BL-PwA /BLA	Bilingual Persons with Aphasia
HC	Healthy Controls
MLC	Monolingual Controls
BLC	Bilingual Controls
DS	Data Sets
TW	Target Word
TL	Target Language

NTL	Non-target Language
PropAS	Proportional accuracy scores
CRn	Correctly recalled nouns
CRv	Correctly recalled verbs
Type-N	Type – nouns
Token-N	Token – nouns
TTR-N	Type Token Ratio for nouns
Type-V	Type – verbs
Token-V	Token – verbs
TTRn	Type Token Ratio for nouns
TTRv	Type Token Ratio for verb

ABSTRACT

When language breakdown subsequent to neural injury occurs, an apparent disruption of language production skills follow. This is particularly evident in the major grammatical classes of nouns and verbs. This deficit could be selective, effecting either nouns or verbs or both in asymmetrical severity, in selected language modalities or at varied linguistic complexity (i.e. naming vs. connected speech). In bilinguals, these selective disassociation may manifest in equal or varying degrees across the languages known. This is influenced by the differences in the linguistic structure of the bilinguals' languages. The need for language and culture specific assessment tool and data is therefore critical.

This three-phase cross sectional exploratory study aimed to compare word retrieval skills in monolingual and bilingual people with aphasia (PwAs) post stroke. Investigated here are specific language populations of Sri Lanka; Sinhala monolingual (ML) and Sinhala- English bilingual (BL) healthy speakers and PwAs who have not been studied to date.

In the first phase, the study adapted test tools and material published in English and develops some other stimuli anew, to gather data from healthy adults. This data was then used as a normative baseline against which 26 PwAs in the said populations were assessed in the second and third phases of the study. The subsequent data compared word production performances between and within the language conditions in the ML and BL groups, across word classes and language tasks.

Findings showed better performance in bilinguals than in the monolingual group and a comparatively higher score for Sinhala than for English in bilinguals. Word class and task effects on performance was noted. An error analysis that focused specifically on bilingual code mixing showed language and task specific trends which are discussed in the context of the linguistic profile of the Sinhala-English bilingual. Further, there was

evidence that the influence of psycho metric variables on naming performance varied across the language conditions. It is anticipated that this study would contribute towards the cross-linguistic database on aphasia in bilingual speakers and particularly towards developing an evidence-based research and clinical platform for bilingual PwAs in Sri Lanka.

CHAPTER 1: Introduction

Aphasia is an acquired language disorder resulting from a lesion to the cortical areas responsible for language, usally lateralized to the dominant hemisphere of the brain (Naeser & Palumbo, 1994). It is characterised by the impairment of language modalities that is, comprehension, expression, reading and writing in the absence of a motor, sensory and cognitive impairment leading to difficulties in communication (Hallowell & Chapey, 2008). Based on the presence or absence of impairments and language fluency as core parameters the most commonly used aphasia classifications systems differentiate between non fluent types, Broca's, transcortical motor aphasia and global aphasia and fluent aphasia types, Wernicke's, conduction, anomic, and transcortical sensory aphasias.

Stroke (cardio-vascular accident; CVA) is a major cause of aphasia (de Freitas, 2012). Approximately 21-38% of acute stroke patients are diagnosed with aphasia (Berthier, 2005; Laska, Hellblom, Murray, Kahan & Von Arbin, 2001). Throughout this thesis the term 'aphasia' will be used referring to complete or partial loss of language post single CVA.

Anomia is broadly defined as the difficulty in retrieving words which were previously readily available to the speaker (Goodglass & Wingfield, 1997). It is a frequent characteristic and a pervasive symptom of aphasia (Manasco, 2017; Herbert, Hickin, Howard, Osborne & Best, 2008), which may range from an absolute failure to a mild impairment (Goodglass & Wingfield, 1997). Such difficulties in word retrieval post brain lesion are attributed to the disruption of the sequence of cognitive processes that underlie spoken language (Rohrer et al., 2008; Laine & Martin, 2006).

The term anomia is synonymously used with word finding difficulty (WFD) although both terms fail to capture the complete range of language deficits that may be clinically observed. WFDs in speakers with aphasia (PwAs) may manifest in different aphasia syndromes and through a variety of language situations ranging through structured (e.g. picture description) to spontaneous speech (e.g. conversation) (Zingeser & Berndt, 1990). It often leads to a breakdown in conversation between the person with aphasia (PwA) and their communication partner (Wilkinson et al., 1998) consequently affecting the person's communication, social function and overall quality of life (Davidson, Howe, Worrall, Hickson & Togher, 2008; Parr, 2007).

1.1 Bilingualism and aphasia in bilingual speakers

Bilinguals are defined as those who use two or more languages or dialects in their everyday lives and is irrespective of their varied levels of proficiency and competency (Grosjean, 1994). The differences in language proficiency and competency across the bilingual's known languages are influenced by several factors including those of age at which the language is acquired, language use and exposure (Perani & Abutalebi, 2005). Despite the fact that more than half the world's population is bilingual (Grosjean, 2010; Ansaldo, Marcotte, Scherer & Raboyeau, 2008; de Bot, 1992) or polyglots (those who speak three languages or more) literature on bilingual aphasia is sparse (Roberts, Kiran, Ardila & Ramos, 2007).

In bilingual speakers, aphasia may differentially affect the languages known. Language deficits may be greater in one language than the other or may affect different modalities across the languages. Theoretically, language profiles of bilingual PwAs offer a direct window on the mechanisms of interaction between the language systems (Bialystok, Craik, Green & Gollan, 2009; Abutalebi & Green, 2008; Hyltenstam & Obler, 1989). For the PwA, language profiles allow an in-depth analysis of language competency post-stroke for each language known (Fabbro, 2001). Findings from bilingual aphasia studies contribute to developing assessment protocols, treatment methods and prognostic models for the dual language speaker (Hope et al., 2015; Altman, Goral, Levy, 2012; Faroqi-Shah & Waked, 2010; Kambanaros, 2009).

1.2 Assessment methods for WFD

Clinically and in research the assessment of WFD usually involves the use of confrontation naming tests (e.g. Herbert et al., 2008; Nickels & Howard, 1995; Kohn & Goodglass, 1985; Butterworth, Howard & Mcloughlin, 1984; Snodgrass & Vanderwart, 1980) or discourse (e.g. Vitale, 2016; Ulatowska, Allard, Reyes, Ford & Chapman, 1992; Nicholas & Brookshire, 1993). Picture naming tests are a widely used assessment method, both clinically and in research. They are advantageous as they provide a simple and quick clinical method of assessment and are a valid assessment of WFD in discourse (Herbert et al, 2008). Naming tests however, fail to represent natural everyday speech (Bastiaanse & Jonkers, 1998; Kambanaros, 2009; Peach & Reuter, 2010) and involve rigid and predetermined responses, which compromise its ecological validity.

Discourse in its simplest meaning refers to everyday talk. It requires generating a continuous stream of linguistic elements presented in a coherent manner to be able to convey a meaningful message (Wright, 2011; Ulatowska & Olness, 2004). These include a range of sample elicitation techniques including that of story narratives, picture sequence descriptions, single picture descriptions, monologues and also conversational speech (e.g. Andreetta, Cantagallo & Marini, 2012; Ulatowska, Reyes, Santos & Worle, 2011; Olness & Ulatowska, 2011; Armstrong, Ciccone, Godecke & Kok, 2011; Webster, Franklin & Howard, 2007; McNeil et al., 2007; Armstrong & Mortensen, 2006; Perkins, 1995; Nicholas & Brookshire, 1993). Despite the fact that connected speech samples closely simulate everyday functional speech, there is no agreed single method of analysis which results in further variation across studies (see Armstrong, 2000). Unlike in picture naming, the absence of a known target response and the unavailability of a processing model or a framework for analysis challenges the clinician with identifying the exact locus of breakdown (Marshall & Pound, 1997).

1.3 Adapted or translated assessment tools in aphasia

In bilingual speakers with aphasia, the assessment of all languages known to the PwA is a clinical and research pre-requisite (Paradis & Libben, 2014; Spreen and Risser, 2003). The need for comparable assessment tools for this purpose has been emphasized by the Collaboration of Aphasia Trialists (COST Action IS1208, 2013–2017), an EU funded network of aphasia researchers from 26 countries. Developing comparable assessments in multiple languages however requires that a series of methodological precautionary steps are taken to ensure that assessment findings are reliable and valid (Fabbro, 2001; Grosjean, 1998) along with linguistically equivalent tests and the use of bilingual specific norms (Lorenzen & Murray, 2008).

The Bilingual Aphasia Test (BAT; Paradis & Libben, 1987) is the only assessment commercially available for the testing of bilinguals. The lack of standardized assessments for blingual speakers with aphasia however means that clinical assessment relies on the use of translated versions of existing English assessment tools[1] and stimuli (see Caesar & Kohler, 2007). Normative data are then gathered for native speakers of languages other than English.[2]

Provided below in Table 1.1 is a brief summary of key aphasia assessments which have been translated or adapted in to different languages and cultures. Sections of some of these assessments have also been translated (for example, Monaco et. al., 2018; Adaptation of PALPA test no. 3 in to European Portugese) while the shortened forms of some tests have also been translated in to other languages.

[1]Assessments developed and standardized for native (L1) English speakers

[2]E.g. Bilingual Aphasia Test in Russian (Ivanova & Hallowell, 2009), Boston Diagnostic Aphasia test, Spanish norms (Rosselli, Ardila, Florez & Castro, 2008), Verb and Sentence Test (VAST) in Dutch (Bastiaanse, Edwards, Maas, & Rispens, 2000)

Table 1.1: A summary of aphasia assessments translated or adapted in to other languages and cultures (Adapted from Spreen & Risser, 2003, *Pg. 219* and Ivanova & Hallowell, 2013)

Assessment tool	Language in which the tool was originally developed	Languages/ cultures in to which the test has been adapted/translated[3]
Aachen Aphasia Test (AAT)	German (Huber et. al., 1983)	English (Miller et.al., 2000) Dutch (Graetz et.al., 1992), Italian (Luzzatti et. al., 1992), Thai (Prachritpukdee et.al., 1998); Portugese (Lauterbach, 2006)
Assessment of Bilingual Aphasia (BAT)	English (Paradis & Libben, 1987)	Spanish (Masson, 1993; Paradis & Ardila,1989), French (Paradis & Libben, 1993), Italian (Bologna, 1999), Chinese (Lin, 2003); Russian (Ivanova & Hallowell, 2009); Portugese (Paradis & Hub-Faria, 1989); Arabic (Paradis & El Halees, 1989)
Boston Diagnostic Aphasia Examination (BDAE)	English (Goodglass & Kaplan, 1972; 1983) Goodglass, Kaplan & Baressi (Edition 3; 2000)	Chinese (Tseng, 1993; Naeser & Chan,1980); Norwegian (Reinvang & Graves, 1975); Finnish (Laine et. al., 1993), French (Mazaux & Orgogozo, 1985), Spanish (Goodglass & Kaplan, 1979; 1986; Gracia-Albea et. al., 1986); Brazillian Portugese (Mansur et. al., 2005), French (Mazaux & Orgogozo, 1981), Hindi (Pauranik, 2010; Kacker et. al.,1991); Greek (Papathanasiou et. al., 2008)
Boston Naming Test (BNT)	English (Kaplan, Goodglass & Weintraub, 1983)	French (Lapointe, 2004; Thuillard-Colombo & Assal, 1992); Spanish (Allegri, 1997; Ponton et.a l., 1992; Taussig et. al., 1988); Dutch (Marien

[3] Some of these tests are in the process of adaptation. Some tests have population specific norms and information on psychometric propertites while others do not. Some tests have been adapted while some have been mere translations.

		et. al., 1998) Finnish (Laine et. al., 1993); Korean (Kim & Na (2004); Greek (Particacou et. al., 2007); Portugese (Miotto et. al., 2010); Swedish (Tallberg, 2005); Chinese (Tsang, 2000); Hindi (Paradis & Vaid, 1987)
Communication Abilities in Daily Living (CADL)	English (Ed. 1- Holland, 198; Ed. 2- Holland, Frattali & Fromm, 1999)	Italian (Pizzamiglio et. al., 1984; Japanese (Sasanuma, 1991) Spanish (Martin, Manning, Munoz & Montero, 1990); Hindi (Mahendra, 2004)
Object Action Naming Battery (OANB)	Picture Naming Test for speakers of English (Druks & Masterson, 2000)	Saudi Arabic (Alyahya & Druks, 2016); Brazilian Portuguese (Spezzano, Mansur & Radanovic, 2013); Spanish (Cuetos & Alija, 2003), French (Schwitter, Boyer, Méot, Bonin, & Laganaro, 2004); Dutch (Shao, Roelofs, & Meyer, 2013); Greek (Kambanaros, 2010)
Psycholinguistic Assessment of Language Processing in Aphasia (PALPA)[4]	English (Kay, Coltheart & Lesser, 1992)	Spanish (Valle & Cuetos, 1995); Dutch (Bastiaanse, Bosje & Visch-Brink, 1995) , Hebrew (Gil & Edilstein, 2001), European Portugese (Monaco et. al.,2018)
Comprehensive Aphasia Test (CAT)	English (Swinburn, Porter & Howard, 2005)	Danish (Swinburn, Porter, & Howard, 2014) and Dutch (Visch-Brink, Vandenborre, de Smet, & Mariën, 2014). Gulf Arabic (Abou El-Ella, 2013)

[4] The PALPA has been translated entirely in to some languages while sections of the test has been translated to a few other languages.

		European languages including, Basque, Catalan, Croatian, Cypriot Greek, French, (Standard Modern) Greek, Hungarian, Norwegian, Serbian, Spanish, Swedish and Turkish (Collaboration of Aphasia Trialists [COST] Action IS1208, 2013–2017 in Fyndanis et. al., 2017
Western Aphasia Battery (WAB)	English (Kertesz, 1982)	Spanish (Kertesz et. al., 1990); Hindi (Karanth, 1980) Japanese (WAB Aphasia Test Construction Committee, 1986); Hebrew Kasher et al. (1999) Zaidel et al. (2000) Kannada (Chengappa & Kumar, 2008), Telugu (Pallavi, 2010) Malayalam (Jenny, 1992); Chinese (Yiu, 1992)

1.4 Cross cultural adaptation of assessments for testing lexical retrieval

1.4.1 Emergent issues and pitfalls

The assessment of aphasia in culturally and linguistically diverse clients is possibly the greatest challenge to SLTs (Speech and Language Therapists), particularly those working in multi-cultural societies (Centeno, 2015; Kiran & Roberts, 2012). As a quick remedy to deficits in accessible resources, a widespread practice of borrowing popular commercially available assessment tools developed in another country or culture is often reported. A summary of a selection of such translated and adapted tests were provided in table 1.1 above.

Adapting the same test across different languages allows cross-linguistic comparisons (Roberts & Doucet, 2011). It nevertheless poses a number of grave challenges (see Milman, Faroqi-Shah & Corcoran, 2014) and has been discussed below.

1.4.1.1 Translation rigour

The use of assessment materials in English for speakers whose L1 is not English, the use of assessments that have not been rigorously translated from one language to the language tested may heavily compromise the ecological validity of the assessment (Paradis, 2004). Most tests translated or adapted are those originally developed for native English speakers. The adapted or translated version must measure what it is intended to measure but more importantly should reflect what is measured in the original language or cultural version (Geisinger, 1994). It is therefore necessary to ensure that the adopted test maintains roughly equal sensitivity and difficulty across all tested populations. This may require that most research employ services from a professional linguist at an assessment development stage and subsequently from a clinician with sufficient understanding of the language tested, without whose input research findings in languages less known, may be questionable (Monaco et. al., 2018; Spreen & Risser, 2003)

Paradis (2011) note that the development of the BAT was an exception to all translated tests and instead adopted the principle of equivalence in complexity. Here, the items selected across the tested languages were similar in complexity rather than being actual translations of the original stimulus and were selected to tap a similar rationale that motivated the selection of the original item. A similar approach has been described by Fyndanis et. al. (2017) where in the adaptation of the *Comprehensive Aphasia Test* (CAT; Swinburn, Howard & Porter, 2005) several identified stimuli were replaced with another of equal complexity instead of with its direct translation. This however may require sources of data for the given language such as a language corpus, which may not be readily available for all languages, including Sinhala.

The influence of the two languages on each other also affects translation rigour. Sinhala is a language that is heavily influenced by English, loan words such as bus, guitar may not have a translated version and may then need to be completely removed from or replaced in a translated bilingual assessment.

1.4.1.2 Cultural appropriateness

In all sorts of language tasks including that of picture naming, the cultural appropriateness of items is of primary concern. For example, items such as a *sleigh, skate, snow, caravan, pretzel, autumn, spring, wreath, butcher* may not be familiar across the language communities in Sri Lanka. Ball and Damico (2007) note that most clinicians in the UK may have experienced low responses on the items *bagel* and *wreath* in the Boston Naming Test. Barker- Coello (2001) also noted that New Zealander English speakers made over 60% errors on items such as *pretzel, beaver, tripod, globe, funnel* on which native *Maori* speakers performed even worse. Fyndanis et. al. (2017) note similar issues in the CAT, where some items were deemed less appropriate to the culture in to which the test was adapted. As a result they report the removal of stimuli such as '*licking the stamp'* or characters such as *'butcher', 'nun'* and also avoiding negative connotations such as '*shooting'* and '*killing*' in some cultures when adapting the CAT in to other languages.

1.4.1.3 Population specific data

The use of norms from an unrelated population is another critical factor that may inversely affect the validity of adapted tests (Paradis, 2004) and therefore it is imperative that findings be analysed against population-specific data. Quantitative and qualitative differences in performance and errors distribution have been reported not just between cultures or speakers of different languages (Barker-Collo, 2001) but also between populations of different areas (Chen, Hakkani-Tür & Tur, 2014). There can also be difference in the education levels of the population for which the test was developed and the population on which the test is to be administered. Population specific information should be available well ahead to the user before the adapted tool is applied in practice.

1.4.1.4. Psycholinguistic properties

The influence of lexical and semantic variables on picture naming tasks has been well documented in literature and has been extensively discussed in chapter 4 of this thesis. It is understandable that across two different languages, some variables may differ significantly; particularly those of name agreement, imageability and word frequency. Despite so, most translated or adapted versions of test tools are used in the absence of adequate psychometric data (Spreen & Risser, 2003). Fyndanis et. al. (2017) note that imageability and word frequency differences between stimuli across languages posed a significant challenge in adapting the CAT in to different languages. Bell and Damico (2007) also note that psycholinguistic differences in word length, frequency and regularity of spelling effected the translation of the English PALPA in to Dutch as a result of which some stimuli were necessarily replaced.

1.4.1.5 Linguistic properties

Languages largely differ in their typological properties including that of phonology, morphonsyntax, semantic and lexicon (Fyndanis et.al., 2017). Assessment materials developed for English speakers could be adapted in to languages that are closely or distantly related according to which stimuli matching between the languages could be challenging. Such challenges include balancing word length for naming and repetition tasks, matching target words and distractors and also in both word and sentence level complexity. Monaco et. al. (2018) in a process followed to adapt PALPA test no. 3 in to European Portuguese note that while linguistic criteria should be the basis on which a conversion of any aphasia test should occur, the conversion must explicitly rest on the linguistic analysis of the new target language.

Bell and Damico (2007) note that differences in morpho syntax between languages may contribute to distinct differences in particularly verb argument structure. For example, in Dutch, the single–word verb *badmintonnen* implies to play badminton. Similar issues arose in Sinhala- English translation where the single word sitting in English directly translates to */ɪŋðəʤɛnə ɪŋ'ŋəʋaː/* (sitting and waiting) in Sinhala. Sinhala also has a number of items, particularly verbs, which are phrases rather than a single-word. For example, the verb ‘threading (CAT action naming test) translates in to a phrase that describes the action */ɪŋðɪkʌtˈtətə ŋʊːɭə ðʌːnəʋaː/* (putting a thread in to the needle). Bell and Damico (2007) also point out that while English and some European languages may have ready-made sources from which researchers are able to instantly draw reliable information, researchers and clinicians adapting or translating tools in to other languages may find themselves at a disadvantage. Differences in the orthography between the two languages should also be considered if written stimuli are involved. Direct translations of stimuli are near impossible in subsections such as auditory comprehension where the target word is accompanied by a phonetic distractor. In the translation of the English CAT in to Sinhala, all such words were replaced by entirely new items. This has been explicitly discussed later in chapter 6.

1.4.2 Recommendations

To ensure rigor in assessment, particularly in bilinguals the following factors must be addressed: cultural factors including familiarity of participants with objects depicted, psycholinguistic equivalence, language factors including linguistic equilibrium between the tested languages and differences in education between the target and tested populations (Ivanova & Hallowell, 2013; Edwards & Bastiaanse, 2007, Lorenzen & Murray, 2008). Without these factors being addressed fully in test construction assessment results may be biased.

Paradis (2011) also suggests the use of the principles of equivalence in complexity and equivalence in formatting where in assessment content may differ from one tested language to the other but remains equal in terms of complexity and formatting.

Fyndanis et. al. (2017) reports the use of rating scales and online sources such as (corpora for languages) as methods for gathering information for the different languages. They note that while an exact resemblance may not be possible, the use of a common principle in the selection of stimuli across the languages may minimize the effect of differences in psycholinguistic properties.

1.5 The Sinhala language and aphasia research in Sinhala

Sinhala is the state language and the native language of over 76% of Sri Lanka's population. Sinhala possesses a number of dialects and forms (Giar, 1998). The major forms of Sinhala are classified as formal and spoken or colloquial Sinhala of which the latter is used in casual routine speech. Colloquial Sinhala is characterized by its less rule governed language structure and the presence of a significant quantity of borrowed or loaned words, particularly from English. The Sinhala language possesses a number of unique lexico-syntactic features that are different to that of English. English spoken by the bilingual Sinhala-English speaker is referred to as Sri Lankan English (SLE) and differs from that of British English. SLE is the variant of English spoken by native Sri Lankan Sinhala speakers and is influenced by the native Sinhala (Senaratne, 2012; 2009; Giar, 1998). This underlies the need for population specific data for both Sinhala monolinguals and Sinhala-English bilinguals.

Although exact statistics are not available, the numbers of Sinhala-English bilinguals have steadily grown over the years. A concurrent increase has occurred in the number of Sinhala-English bilingual PwAs referred to local clinical and rehabilitative settings, particularly in Colombo and similar urban areas. A research project by Ratnayake (2016) involved the development of an aphasia tool incorporating identified language functions in Sinhala as tasks in the tool. Its primary aim was to identify the presence of aphasia in stroke survivors. This validated assessment tool was however restricted to monolingual Sinhala speakers and is not commercially available to date. A few other unpublished undergraduate research studies have also investigated various aspects of aphasic language in the monolingual Sinhala speaking population. In spite of this, comprehensive research into the nature of aphasia in Sinhala-English bilingual PwAs has not been attempted before. The only available data comes from one undergraduate research study (Dharmaratne & Atapattu, 2014).

1.6 The current study

This study involves the development of test materials and subsequent execution of investigations of spoken language production in native Sri Lankan Sinhala monolingual (ML) and Sinhala- English bilingual (BL) non-brain damaged adults and PwAs.

The study builds on work by Marini, Andreetta, Del Tin and Carlomagno (2011); Kambanaros (2010); Herbert et al., (2008); Mayer and Murray (2003), Dell, Schwartz, Martin, Saffran and Gagnon (1997); Nicholas and Brookshire (1993) on the use of single word naming and connected speech sample methods for analysing word retrieval in bilingual speakers with aphasia.

1.6.1 Rationale for this study

At present there are no published comprehensive test materials for adult speakers of local languages or Sinhala-English bilingual speakers in Sri Lanka. There is also a severe lack of information on the linguistic structure of Sinhala. This is a significant challenge both clinically and in research. Consequently, there are no published literature or normative data on ML Sinhala and/or BL Sinhala –English healthy adult speakers or PwAs. This study is the first known comprehensive research attempt that focuses on BL Sinhala-English healthy speakers and PwAs in Sri Lanka.

1.6.2 Aims of the study

The aims of the study were as follows.

i. To develop language and culture appropriate assessment materials for use with monolingual Sinhala and bilingual Sinhala-English speakers recruited to this study. The tests battery involved *the Comprehensive Aphasia Test* (CAT; Swinburn, Porter & Howard, 2004), the *Object Action Naming Battery* (OANB; Druks & Masterson, 2000) and several newly developed material, which included a language proficiency questionnaire, case history questionnaire and new stimuli for the assessment of discourse in this study.

ii. To collect normative data using the assessments from monolingual Sinhala and bilingual Sinhala and English speakers

iii. To collect data from monolingual and bilingual speakers with aphasia

iv. To compare spoken word retrieval across languages in the monolingual and bilingual speakers and within languages in the bilingual speakers, with and without aphasia and across single word retrieval and connected speech tasks.

v. To investigate word class effects across the participant groups, language groups and across the tasks.

vi. To explore the error profiles of participants including code switching across language tasks and all participant groups.

vii. To identify significant psycholinguistic variables on naming in monolingual and bilingual speakers and within the languages of the bilingual speaker with aphasia.

viii. To contribute to the existing research evidence concerning spoken Sinhala in healthy speakers, bilingual aphasia, and aphasia in Sinhala and Sri Lankan English

1.6.3 Structure of the study

In order to address the above, a three phase cross sectional exploratory study was conducted.

Phase 1. This phase involved the selecting, translating and adapting of published English language assessment materials. Novel test stimuli were also developed.

The original standardized test tools selected here were the *Comprehensive Aphasia Test* (CAT: Swinburn et al., 2004) and the *Object Action Naming Battery* (OANB, Druks & Masterson, 2000) (See appendix 1.1 for CAT publisher permission for translation). Translation of instructions and stimuli from English to Sinhala involved a rigorous three-step translation procedure. Materials were first translated, backward translated and subsequently pilot tested. The above tests were then adapted to suit the tested populations.

Here, the CAT was used for language profiling. The main test battery involved the OANB as the picture naming test and novel stimuli were developed to elicit connected speech samples. A Naming Accuracy Score (NAS) and normative data from Sinhala and English on key psycholinguistic variables for stimuli in the OANB were established with 30 monolingual and 45 bilingual healthy adults.

Newly developed picture sequences and single picture stimuli were trialled on the same 30 monolingual and 45 bilingual speakers. Data were obtained for three language conditions, monolingual Sinhala (MLS), bilingual Sinhala (BLS) and bilingual English (BLE). This phase also involved trialling a procedure to administer the above naming and connected speech tasks and a method for analysing resulting data. The outcome of phase 1 resulted in developing a test protocol for use in phases 2 and 3 and coding systems for use with the naming and connected speech data.

This phase also involved the development of several supplementary material for use in the study. This included a novel Language Proficiency Questionnaire (LPQ) as applicable to ML Sinhala and BL Sinhala-English speakers, based on the LEAP-Q (Marian, Blumenfeld & Kaushanskaya, 2007). The LPQ was developed in both Sinhala and English and was used to gather language related information of participants recruited. A case history was also developed in English for use through all three phases of the study. This consisted of a general section applicable to all recruited participants and a separate section for only PwAs to be used when recruited in subsequent phases.

Phase 2. This phase involved a pilot phase to test the developed test protocol. The pilot phase involved a total of 12 participants comprising of three ML and three BL PwAs and three ML and three BL age, sex, education and language proficiency matched healthy non-brain damaged controls (HCs)[5] All participants completed the case history, LPQ and CAT before proceeding to complete the OANB actions and objects naming and connected speech tasks. The aim of the pilot study was to review and revise the test protocol and analysis methods prior to the study's third phase of data collection. Data were obtained for the MLS, BLS and BLE language conditions, separately for PwAs and HC groups. Based on the outcome of phase 2, amendments were made to the test protocol administration and coding systems in the naming and connected speech tasks developed in P1. The modifications primarily involved changes that were required for testing and analysing data from speakers with aphasia.

Phase 3. The amended test protocol from phase 2 was administered with 15 ML and 11 BL PwAs and 15 ML and 11 BL age, sex, education and language proficiency matched healthy non-brain damaged controls[3]. Data were gathered across the MLS, BLS and BLE language conditions for PwAs and HCs. Data from phase 3 were analysed for accuracy and errors, separately for each language task. Figure 1.1 summarizes the information above.

[5] Language proficiency was matched on the LPQ while education was matched in the number of years of education received.

Phase 1 **30 ML and 45 BL healthy speakers**

- Developemnt and standardisation of test material and initial test protocol established.

Phase 2 **Three ML and three BL PwAs and their matched HCs[3]**

- Pilot testing and amending the protocol prior to phase 3.

Phase 3 **15 ML and 11 BL PwAs and their matched HCs[3]**

- Data collection using the amended test protocol and analysis of data

Figure 1.1: Summary of the structure of this study

1.7 Implications of the study

This study is expected to contribute to the existing cross-linguistic clinical and research databases on bilingualism and aphasia.

Research Impact

This will be the first comprehensive Sinhala-English bilingual study on healthy speakers and PwAs. The meticulous details considered in developing materials and protocols for this three-phase research will provide a guideline when developing similar studies in the future. The study outcomes include preliminary data on monolingual Sinhala and bilingual Sinhala-English healthy speakers and PwAs, which can be used in further research. In a larger perspective, the findings from this study will contribute to the current understanding of word class effects in word retrieval. Findings from this study will contribute to the cross-linguistic database on single word processing, language control in bilinguals and also in language assessment methods for bilingual PwAs

Clinical Impact

Findings in P1 of this study will emphasize the need for rigorous protocols that need to follow translating or adapting foreign language tools. Presently used in clinical setups, clinicians will have access to a preliminary database for Sinhala-English healthy speakers and speakers with aphasia. It is also presumed that findings from this study will encourage clinicians, particularly those in the Sri Lankan clinical context to reflect on the commonly used methods of clinical assessment and acknowledge the need for systematic assessment protocols and population specific norms. The study outcomes will also serve as a guide for clinicians involved with monolingual Sinhala and bilingual Sinhala-English PwAs.

1.8 Structure of this thesis

This thesis has been organized in to 20 chapters as follows;

- Chapter 2. The breakdown of word retrieval in Anomia: This chapter provides an overview of WFD in aphasia post stroke, the psycholinguistic models of word retrieval, an overview of the primary types of word retrieval error as seen in healthy adults and the types of anomia
- Chapter 3. Bilingualism: This chapter discusses theory in bilingualism, outlines the issues that underlie bilingual research, details models of bilingual lexical access and selection and briefly details code mixing behaviors in healthy BLs and PwAs.
- Chapter 4. The assessment of nouns and verbs: This chapter details word class effects (for nouns and verbs) on word production, picture naming and connected speech tasks as methods of assessment for word production and related cross cultural modifications and also factors affecting word retrieval performance are discussed.

- Chapter 5. Sinhala: This chapter introduces the Sinhala language and the Sinhala-English[6] bilingual to the reader, particularly of its spoken forms and dialects. It also provides an insight to code mixing in the Sinhala-English bilingual.
- Chapter 6 through chapter 9: These include details of phase 1 in this study, which involved healthy ML and BL adults. Details on the selection, translation, adaptation and development of assessment material are provided. Findings are detailed in Chapter 9.
- Chapter 10. Methods in testing word retrieval in post stroke: This chapter outlines participant recruitment, protocol, methods and data analysis in phase 2 and phase 3 involving PwAs and healthy controls.
- Chapter 11. Participant characteristics for the Pilot & Main test phases: This chapter provides a comprehensive account of all participants recruited to phases 2 and 3.
- Chapter 12. Findings in Phase 2: This chapter presents findings from the phase 2 and details on the modifications made to procedures and protocols developed in P1, prior to phase 3.
- Chapters 13 through 19: These include all analyses performed on the phase 3 data and correlation analyses related to study data. In chapters 17 and 19, analyses and inferences of P3 are amalgamated to reflect on how they address the research questions posed at the onset of each phase of this study.
- Chapter 20: Finally, chapter 20 discusses contributions to research and clinical practice, limitations and implications for future research.

[6] Sri Lankan English (SLE) is English spoken by the Sri Lankan native Sinhala speaker and is different to that of British English

Chapter 2: The breakdown of word retrieval in anomia in aphasia

2.0 Overview

Spoken word production is the consequence of a sequence of processes namely, conceptual processes, selection and retrieval of words, syntactic programming, motor sequencing at word level, articulation and feedback monitoring of the output (Zingeser & Berndt, 1990). In fluent speech, words are retrieved at a rate of 1-3 words per second from lexicons that include tens of thousands of words (Friedmann, Biran & Dontan, 2013). PwAs present word finding difficulties (WFD) as a pervasive symptom of their aphasia. In conversation it leads to disruption of the flow of speech and subsequent communication breakdown (Herbert, et al., 2008; Perkins, Crisp & Walshaw, 1999). This chapter presents a brief outline on the breakdown of word production and its breakdown in aphasia.

2.1 Clinical manifestation of anomia in aphasia

Aphasia manifests itself in some or all components of language, that is, phonology, morphology, syntax and semantics across all modalities including, expressive language, language comprehension, reading, writing and signing (Manasco, 2017; Dronkers & Baldo, 2010; Code & Herrmann, 2003; Goodglass, Kaplan & Barresi 2001). The term anomia refers to the difficulty in retrieving, selecting and using words in verbal output (Friedmann et al., 2013; Goodglass, 1993; Garman, 1990; Benson, 1988). It is a universal symptom found in all aphasias except for in pure forms of aphasia[7] (Goodglass, 1993) and is also perhaps the most pervasive aphasia symptom of all (Goodglass & Wingfield, 1997). Anomia as a symptom differs from pure anomia, a subtype of fluent aphasia often attributed to a lesion at the left temporo-parietal-occipital junction (Takeda et al, 1999) also see chapter 2, section 2.2.).

[7] Where in the symptomology is strictly limited to a single given type of aphasia

Although relatively rare in its pure state, pure anomic aphasia is characterised by frequent WFD ranging from hesitations and pauses to circumlocutions and no responses while all other linguistic functions may remain minimally affected. (Code, 1989). When anomia occurs as a symptom, WFD may occur together with other impaired language functions and may range from severe word finding difficulties to category or [8]modality specific anomia. WFD in anomia are quite often attributed to nouns-verbs, objects-actions, although it is quite possible that naming difficulties may also involve other classes of words[9] (Raymer, 2005). WFD in other word classes are less known since content words are clinically assessed more often than others (Marshall, 2003). Throughout this thesis the term 'anomia' will refer to difficulties in verbal naming as a concomitant symptom in persons with aphasia (PwAs) post-stroke.

2.2 Neuropathology of aphasia and anomia

Aphasia typically results from lesions in the cortical areas responsible for language, that is, the perisylvian regions of the dominant hemisphere, usually the left (Dronkers & Baldo, 2010). The major cyto-architectonic landmarks for language include Broca's area (Brodmann area; BA 44), the Inferior Frontal Gyrus (IFG), the Superior Temporal Gyrus (STG), the frontal operculum, the pre motor cortex (BA 6), Wernicke's area (BA 22) the Primary auditory cortex (BA 41 & 42), the Medial Temporal Gyrus (MTG) and Heschl's gyrus (Friederici, 2011; Price et al., 2006). Also involved are the structural connectivity pathways connecting language relevant regions including the arcuate fasciculus and the two dorsal and two ventral pathways (see Kljajevic, 2014) (see Figure 2.1 below). Neural organization and the resultant cortical activation for speech

[8] E.g. WFD in categories such as animate/inanimate/colours and modality specific aphasia such as optic aphasia, tactile aphasia.

[9] E.g. pronouns, prepositions

processing is task dependent (Hickok & Poeppel, 2007; Price et al., 2006). Hence, the pattern of language deficits in aphasia may vary according to the brain regions affected.

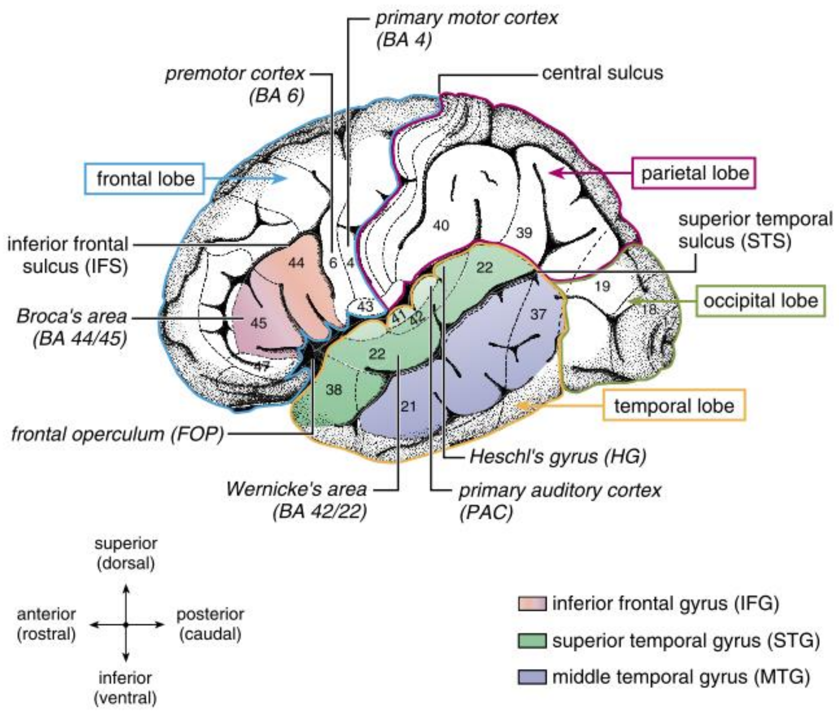


Figure 2.1: Anatomical and Cytoarchitectonic details of the left hemisphere. Reproduced with permission from, Friederici, A.D. (2011) Physiological Reviews, Vol.91 (4) Pg.1359.

Naming specifically involves most major cortical regions particularly the frontal, temporal and parietal regions (Sörös, Cornelissen, Laine, & Salmelin, 2003) and is predominantly attributed to the left hemisphere of the brain in most right-handed people (Donkers & Baldo, 2010). Conventionally, most research evidence suggests the involvement of the left posterior temporoparietal junction including the angular gyrus and the left anterior inferior temporal lobe in naming (Price, 2000). Neurophysiological studies involving those with varied manifestations of word finding deficits have associated anomia with damage to the left hemispheric angular gyrus (Dejerine, 1892, cited in; Hart & Gordon, 1990), left anterior temporal cortices (Visser, Jefferies & Ralph, 2010; Humphries, Willard, Buchsbaum & Hickok, 2001), inferior temporal gyri

(Visser, Embleton, Jefferies, Parker & Ralph, 2010) and the junction of the left inferior temporal and inferior parietal lobes (Binder, Desai, Graves & Conant, 2009) thalamus (Wahl et al., 2008) and connective white matter tissue (Baldo, Arévalo, Patterson & Dronkers, 2013).

2.3 Word retrieval errors in speech production

In the simplest explanation spoken word production involves the selection of an appropriate concept, construction of an appropriate syntactic framework, assembly of sound forms and intonation and subsequent articulation or speech production (Bock & Levelt, 1994). The seemingly effortless process involves a complex mechanism that may not be perfectly executed each time. This results in errors in single word production.

Speech errors are not confined to those with brain lesion. In healthy speakers, error analysis provides a window to understanding the architecture of the normal speech production system (Papathanasiou & Coppens, 2017; Dell et al., 1997). Speech errors occur at all levels of language involving all linguistic units (e.g. sentences, words, syllables and phonemes).

Errors are also not random in character or context (Papathanasiou & Coppens, 2017). All errors can be defined by their intrinsic (e.g. semantic, phonological) or contextual (e.g. degree of similarity between target and error) relationship with the target stimulus (Dell et al., 1997).

Table 2.1 provides a summary of the different types of spoken word errors shared by healthy speakers and speakers with aphasia as reported across several publications.

Table 2.1; Summary of speech errors in healthy speakers and speakers with aphasia

Source	Error type	Sub-type	Example
Dell et. al. (1997)	Lexical errors (verbal paraphasias)	Semantic errors	*table* → *chair*
		Formal errors	*pan* → *penny* *pan* → *van*
		Mixed errors	*sweet* → *sour*
		Unrelated error	*ball* → *rat*
	Sub lexical errors	Phonemic paraphasias	*fork* → */fokI/*
		Neologisms	*fork* → */mo/*
Source	**Error type**	**Sub-type**	**Example**
Martin & Saffran, 1992; Schwartz et. al., 2006	Mixed lexical and sub lexical level error	Complex error	*unicorn* → *(horse)* → *house* [10] (Martin & Saffran, 1992)
Levelt et. al. (1999)	Blends	Word type error Non-word type error	Red + socks →rocks Brush + comb →bromb
Dell & Martin, 2004	Syntactical errors ▪ Morpheme related errors ▪ Number agreement errors		 My mum and I already read*ed* the book You *was* amazing
Martin & Dell, 2004; Mc Neil, Pratt & Fosset, 2004; Humphreys, 2002	Anticipatory or perseverated type (spoonerisms or slips of the tongue)		my fit bit → my bit bit
Garett, 1992	Errors of word movement	Exchange errors Stranding error	They were talking Turkish → They were turking talkish (Garett, 1992) Please sit down and talk → Please talk down and sit

[10] Here, unicorn is the target word and house is the response. The target word (unicorn) first undergoes a semantic substitution (horse) followed by a formal error (house)

2.4 Models of single word production

From the earliest box and arrow models to the more recent sophisticated ones, models of word production aim to map this sequence of events in the process of lexical retrieval. This provides an understanding of how word meanings and form are retrieved from the language processing system while also providing a basic framework against which language errors can be described (Wilshire, 2008; Nickels, 2001). Modularity in language processing refers to the extent with which the different processing types are encapsulated, thereby implying that the output of each module is completely dependent on its input (Warren, 2012). Based on this, all major models of spoken word production imply that when brain damage does occur it causes disturbance within the system resulting in the segregation of these segmental components (Howard & Franklin, 1988; Dell, Martin & Schwartz, 2007).

Three major types models of spoken word production, the WEAVER ++ (Word-form Encoding by Activation and VERification) model (Levelt et al., 1999), the Interactive 2-step theory for lexical retrieval (Dell et al., 1997) and the cognitive neuropsychological model (Patterson & Shewell, 1987) are discussed here.

2.4.1 The WEAVER ++ (Word-form Encoding by Activation and VERification) Model

WEAVER++ (Indefrey & Levelt, 2004; Levelt et al., 1999; Roelofs, 1992, 1997, 2006; Roelofs, Meyer & Levelt, 1996) is a computational model developed within the theoretical framework of Levelt's model (1989) and modified to be a partially interactive version (similar to Dell et al.,1997; 1986 discussed later) (Roelofs, 1997). The model distinguishes between three strata, the conceptual stratum, lemma stratum and form stratum (Levelt, 1999). These involve the processes of preparing the concept, retrieving the lemma and encoding the word form, respectively (Roelofs, 2005). (See Figure 2.2)

Unlike Levelt's (1989) strictly feed-forward activation pattern, the WEAVER++ model (Levelt et al., 1999) is partially interactive. The model assumes that the conceptual and lemma strata share a connection that is bidirectional. The form strata however, is fully dedicated to word production and does not feedback to the lemma strata (see, Levelt, 1999; Levelt et al., 1999).

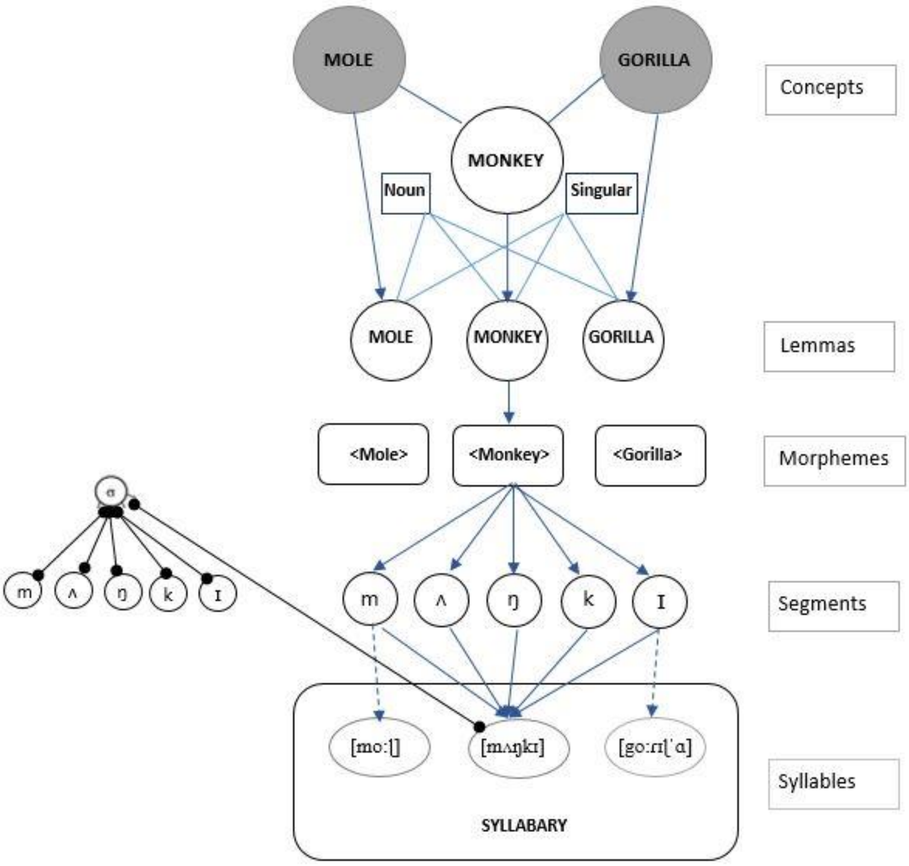


Figure 2.2: The WEAVER++ Model; Adapted Levelt, W. J. (1999). Models of word production. *Trends in Cognitive Sciences*, 3(6), *p* 227.

The word production process begins at the conceptual level representing lexical concepts. When a selected concept is flagged as the target concept, it then spreads activation to its corresponding lemma[11]. Related concepts within the semantic network may also receive activation resulting in their corresponding lemmas also being simultaneously activated. This co-activation of semantically related lemmas may influence and slow down the selection process.

The selection of a lemma is crucial and mandatory in order to initiate activation and retrieval of a phonological code (Roelofs, 2005, 1997; Levelt, 1999; Levelt et al., 1999). This selection of the lemma is fully dependent on activation levels, that is, the lemma with the highest activation is selected (Levelt et al., 1999). The selection of the lemma then makes available the syntax of the word for grammatical encoding. The process then proceeds to word form encoding.

As the first step of preparing the articulatory gestures for the selected word, the word form that is the word's phonological shape is retrieved from the mental lexicon of the speaker (Levelt et al., 1999). This is followed by a process of syllabification, which is dependent on prosodic patterns within the language spoken (Roelofs, 2005; Levelt, 1999).

Finally, based on the syllabic and prosodic structure, articulatory gestures are prepared. A core feature of the WEAVER++ model at this stage is the assumption of a 'mental syllabary' (Levelt & Wheeldon, 1994), a repository of articulatory-syllabic programs that triggers the articulatory gesture corresponding to the generated syllable. It is assumed that this plays a key role in ensuring the correct sequencing of articulatory gestures in production (e.g. that /m/ is the first sound of the word /*mʌŋki*/). The WEAVER++ model primarily addresses language errors of word retrieval in healthy speakers.

[11] A lemma entails the words syntactic and semantic properties while the lexeme entails the words morphological properties (Roelofs, Meyer and Levelt, 1998)

2.4.2 Interactive two step model of lexical retrieval (Dell, Schwartz, Martin, Saffron and Gagnon, 1997)

The interactive model (Dell et al., 1997) builds on previous theories of interactive lexical access (e.g. Dell & O'Seaghdha, 1992; Butterworth, 1989; Dell, 1986). As the name implies this model describes word retrieval in two clear steps; word retrieval and phonological retrieval. The first step is word retrieval or word access, where semantic activation spreads to its corresponding word. Secondly, the phonological access that involves the mapping of word to the phoneme node.

The interactive two-step model involves the same strata as the WEAVER++ model that is the conceptual stratum, lemma stratum and the form stratum (Levelt, 1999). Semantic features, words and phonemes are arranged within these three layers with connections between semantic features and words and words and phonemes.

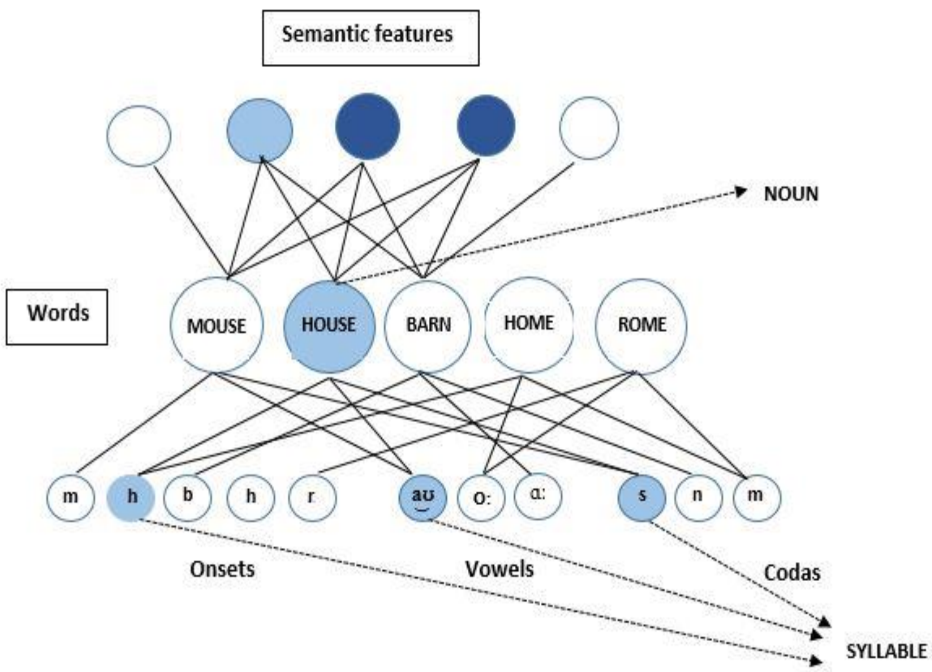


Figure 2.3: Interactive two-step model of lexical retrieval. Adapted from Dell, Schwartz, Martin, Saffron and Gagnon (1997), Lexical access in aphasic and non-aphasic speakers, *Psychological Review*, Vol. 104 (4) *p.* 805

The most significant characteristic of the IA two-step model is its activation flow. In contrast to the partially interactive WEAVER++ model, the IA model proposes a highly interactive and bi-directional flow of activation in both top-down and bottom-up directions. This allows one step to influence the other.

Word retrieval involves activation of semantic features of the selected word. Activation spreads in downward and upward directions resulting in the activation of the most appropriate word unit. The selected word then further spreads activation provoking phonological retrieval (Schwartz et.al, 2006; Dell et al., 1997). In the IA two step model, morphological representation does not form a separate layer. Instead it is denoted within the connections from word nodes to phoneme nodes (Schwartz et al., 2006). The IA model has been widely used to describe both aphasic and healthy speech errors (see Dell et al., 1997).

2.4.3 The cognitive neuropsychological model (Patterson & Shewell, 1987)

Patterson and Shewell, (1987) proposed a cognitive neuropsychological model that mapped a modular system representative of the systems involved in single word processing. The model provided an explanation for word retrieval deficits associated with spoken comprehension, naming, spontaneous word production and also deficits of reading and writing (Mitchum & Berndt, 1992).

Patterson and Shewell's (1987) model proposes word production involving three components, the cognitive system, the phonological output lexicon, and the response buffer (see, Wilshire, 2008)[12].

[12] These components have been outlined in red in the Figure 2.4 above

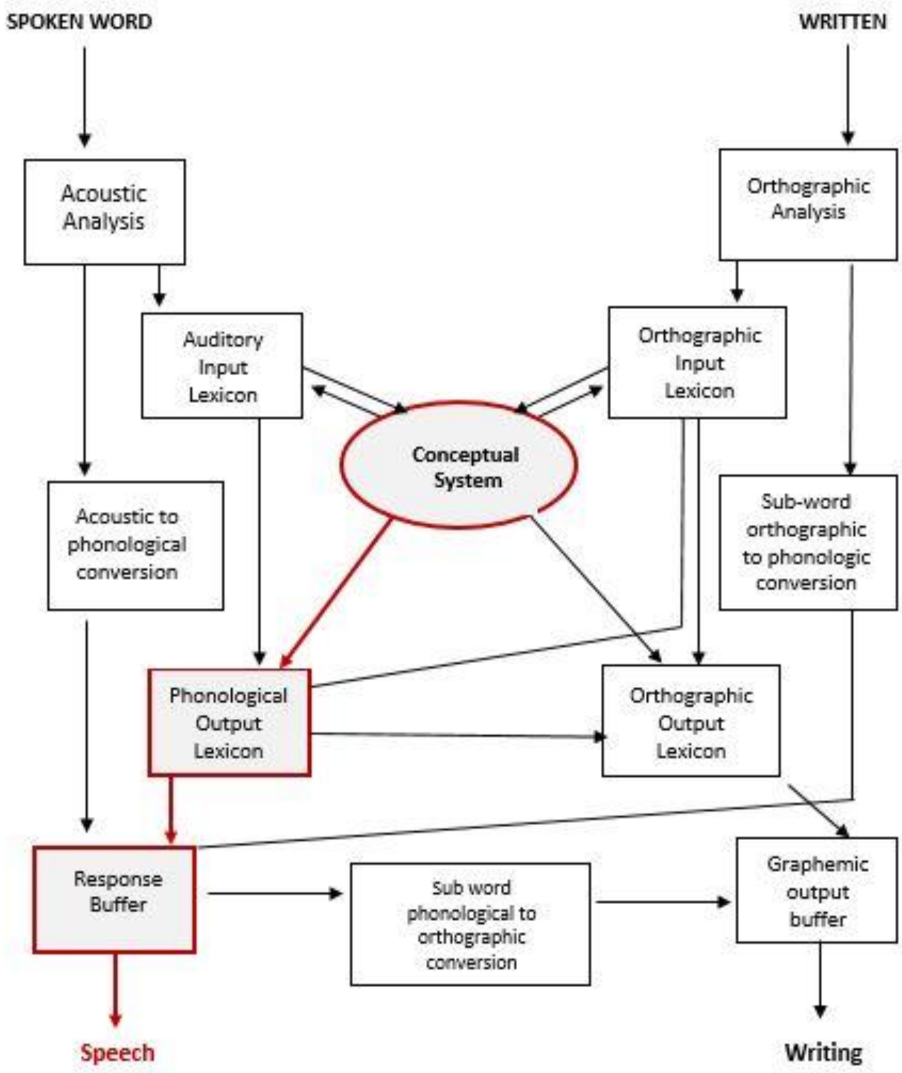


Figure 2.4: The cognitive neuropsychological model (Patterson & Shewell,1987). Adapted from Wilshire (2008) Cognitive Neuropsychological approaches to word production in Aphasia; Beyond boxes and arrows, *Aphasiology*, 22:10, *p* 1023

The process of word retrieval begins from within the cognitive system involving a central non-modality specific verbal store or a semantic lexicon (Wilshire, 2008) from which semantic information of the word is accessed. This is followed by the realization of the word's phonological form at the phonological output lexicon (POL). The POL is referred to as a conceptualized lexical store (different from the verbal semantic store) that contains information on the word's phonological form. (Patterson & Shewell, 1987;

Ellis & Young, 1988). The third component, the phonological output buffer acts as a temporary storage for planned phonological sequences until it is articulated.

A key advantage of this model is that it provides a flexible method in which selective or combinations of deficits manifested by PwAs could be explained (Foundas, Daniels & Vasterling,1998). Many psycholinguistic aphasia assessments have been based on this influential cognitive model (e.g. Psycholinguistic Assessment of Language Processing in Aphasia; PALPA: Coltheart, Kay & Lesser, 1992; Cognitive Aphasia Test; CAT: Swinburn, Porter & Howard, 2004). In therapy this has been a significant approach, which encouraged treatment that targeted the identified cognitive systems and their connections.

2.5 Types of word production errors

Errors are can be broadly classified as lexical errors and sub lexical errors.

Lexical errors also known as verbal paraphasias are errors in which one word is substituted for another (Schwartz et. al., 2006; Foygel & Dell, 2000; Dell et al., 1997). Sub-lexical errors refer to those in which a real word is derailed due to segments or syllables being added, omitted, substituted or transposed. The interactive two-step model noted lexical errors to be those that occur during the word retrieval process while sub-lexical errors are localized to the stage of phonological encoding (Schwartz et.al, 2006).

2.5.1 Lexical errors

Lexical errors can be further classified as semantic errors, formal errors, mixed errors and unrelated errors (Foygel & Dell, 2000; Dell et al., 1997).

2.5.1.1 Semantic errors

Semantic errors also known as semantic substitutions or semantic paraphasias refer to errors, which relate to the target in meaning (e.g. Dell et al., 1997) [*e.g. table→ chair*]. It is a common error type in picture naming, both in PwAs and healthy speakers (Schwartz et.al., 2006; Eysenck & Keane, 2000; Dell et al., 1997).

Levelt et al. (1999) WEAVER++ model asserts that when a target concept is flagged, the activation transfers to the corresponding lemma within the network. Here word retrieval is based on the notion that although related lemmas may also receive activation, the lemma corresponding to the target concept receives the highest activation leading to its selection. In some instances though due to insufficient activation to the target, it is possible that a related lemma is co-activated. When the co-activated lemma is one that is semantically related to the target lemma, the resulting error is one of semantic type.

Dell et al. (1997) attribute semantic errors to the fact that the target word and error response share a common conceptual-semantic node. This results in shared feature activation. For example, at the stage of lemma access, the semantically related node *chair* is activated as it shares at least one common semantic node with that of the target word, *table*. Although it is expected that the level of activation for *table* would exceed the activation level for *chair*, this may not occur leading to a semantic error. Dell et al. (1997) attribute this insufficiency in activation level to noise within the system.

2.5.1.2 Formal errors

Formal errors are those where the target word and error response are phonologically related (Schwartz et al., 2006; Dell et al., 1997). The general consensus is to classify an error as a formal error when the target word and error shares either the initial phoneme [e.g. *pan →penny*] or 50% of the phonetic structure with the target word [e.g. *pan →van*]

(Meyer, Schvaneveldt & Ruddy, 1974; also see, Goldrick, Folk & Rapp, 2010; Slowiaczek, Nusbaum & Pisoni, 1987).

Levelt's (1999) WEAVER++ model attributes phonologically related errors to the process of syllabification. The model suggests that competition amongst articulation programs at the level of the syllabary result in subsequent co-activation of syllabic structures, which in turn leads to a phonological type error (Levelt, 1999). Despite so, the WEAVER++ does not distinguish between a word and a non-word error response.

In an alternative view, the interactive model assume phonological errors occur due to the interactive bidirectional flow of activation between word and phoneme level (Foygel & Dell, 2000). As a result the errors may be provoked at either lemma access or phonological access (Dell et al., 1997). This is therefore referred to as the 'dual nature of formals (Schwartz et al., 2006). In PwAs formal errors are commonly attributed to failure in lemma access (Dell, Chang & Griffin, 1999; Dell et al., 1997).

2.5.1.3 Mixed errors

Mixed errors refer to when the error shares both a phonological and semantic relationship with the target word [e.g. *sweet →sour*] (Foygel & Dell, 2000; Eysenck & Keane, 2000). It demonstrates an additive effect of lexical and formal type errors (Schwartz et.al, 2006).

Mixed errors are not represented within the serial processing accounts such as WEAVER++ since these models presume lexical and phonological levels to be discrete and the activation between the two levels to be strictly feed forward.

Dell et al. (1997) attribute mixed errors to the level of lexical access. The bidirectional activation feature of interactive models, that is the feed forward (top-down) activation from the lexical to the phonological level and the feedback (bottom-up) activation from phonological to lexical level are crucial in explaining the mixed type effect (Dell et al., 2006; Dell et al.,1997).

Schwartz et al. (2006) note that when a competitor with both a semantic and phonological relationship to the target word receives activation via the top-down and bottom-up routes, a mixed type error occur. In healthy speakers, mixed errors have also been associated with working memory and attention levels (Garrett, 1992). As a result of the multiple involvements at different processing levels, mixed errors have been found to occur more often than others (Dell et al., 2007; Martin, Gagnon, Schwartz, Dell & Saffran, 1996).

2.5.1.4 Unrelated errors

Unrelated errors are those that have no lexical or phonological relationship with the intended target (Dell et al., 1997) [e.g. *ball* → *chair*]. Several possibilities for the occurrence of an unrelated error have been postulated.

One explanation for unrelated errors are that when a related node is erroneously activated, it provokes the subsequent activation of lemmas associated with it. This continuous trend of each previous flawed selection leading to a string of erroneous activations may ultimately result in an unrelated response type error.

Alternatively, Dell et al. (1997) attributes unrelated errors to the level of lexical access, where in the error occurs due to low activation levels or noise.

Yet another possibility is that unrelated errors occur involving both lexical and phonological access. These are also known as complex errors (see, Schwartz et al., 2006; Martin & Saffran, 1992) For example, the error response [*rat*] for target word [*ball*] could be related to the word [*bat*], which is semantically related to the target word and phonologically related to the error word (Foygel & Dell, 2000). Here, the error word may in the first instance seem unrelated although there exists a distant relationship.

2.5.2 Non-lexical type errors

Non-lexical errors include phonemic paraphasias and neologisms (Foygel & Dell, 2000; Dell et al., 1997). Phonemic paraphasias are characterised by errors that are non-words, yet bears an obvious resemblance to the target word. Alternatively, neologisms are distinguished from phonemic paraphasias by the fact that here the non-word error shows little or no relationship to the target word.

The WEAVER++ (Levelt et al., 1999) does not distinguish between words and non-words. Hence, phonemic paraphasias could be viewed as mentioned before, that is errors that result from simultaneous co-activation of multiple syllabic structures, in this instance resulting in a non-word.

Dell et al. (1997) note that sub-lexical or phonemic paraphasias reflect faulty encoding of articulation resulting in failure to represent the particular phonological representation retrieved from the lexicon (also see, Foygel & Dell, 2000). This then localizes to the lexical-phonological retrieval stage.

The 'dual origin theory of aphasic phonological errors suggest that it is also possible that such errors occur during post lexical phonological processing instead. This implies that the transposition and disordering of phonemes occurred at a latter part of the word production process despite the phonological information being accurately retrieved from the lexicon (see, Schwartz, Wilshire, Gagnon & Polansky, 2004). In both cases, the error is attributed to a combination of noise and interference from co-activated words.

Dell et al. (1997) further suggests that a non-word that relates to the target is likely a result of correct lemma selection and disruption at the phonological level while a non-word that does not relate to the target is likely a result of severe disruption in phonological access or difficulties at both word and form levels of access.

2.6 Word retrieval errors in healthy speakers versus PwAs; the aphasia model (Dell et. al, 1997)

Based on the interactive two-stage theory of lexical retrieval, Dell et al. (1997) developed the aphasia model in an attempt to compare word retrieval errors in healthy speakers and PwAs. The model explains five categories of errors placed across three levels of linguistic units; semantics, words and phonemes and two bidirectional processes, lemma selection and phonological encoding.

In applying this model across healthy speakers and PwAs, Dell et al. (1997) make two key hypotheses. Firstly, they presumed that error patterns of PwAs would fall on a continuum in which one extreme corresponded to normal pattern as observed in healthy speakers and the other end to a random pattern.

The second basis on which spoken word errors in PwAs and healthy speakers were differentiated was the mechanism of error occurrence in the two groups. One such mechanism results in errors while still maintaining its activation and connections between the semantic and word level while another results in limited activation and inconsistency in connections between the semantic and word levels. The former mechanism was associated with healthy speakers resulting in more related errors (semantic, formal and mixed errors) or ‘smart errors’ (Dell et al., 1997). In contrast, the later mechanism led to more non-word or unrelated errors also known as ‘stupid errors’ (Dell et al., 1997*)*. Thus by assuming a continuity approach Dell et al., (1997) also postulates that the frequency of occurrence for ‘stupid errors’ is greater with increasing severity of aphasia and less seen in healthy speakers or in speakers with mild impairment.

2.7 Diagnosis of the types of anomia

A typical discussion of word retrieval failure should involve the three main components described by the many models of spoken word production, which are conceptual representation, lexical node selection and phonological encoding.

Discussed here, in relation to the cognitive neuropsychological model are semantic anomia, phonological access deficits and phonological encoding deficits.

2.7.1 Failure at the semantic level

A deficit at the semantic level, also known as semantic anomia, is one that is frequently associated with aphasia. In the context of the amodal approach, semantic anomia interferes with the process of identifying lexical concepts (Andreetta, Cantagallo & Marini, 2012) (see Figure 2.5 below).

There has been much debate if anomia occurs as a result of semantic degradation of the memory store or if it represents impaired access.

Thompson and Jefferies (2013) noted that in post-stroke semantic anomia, the representations within the semantic storage remains relatively intact while attentional control mechanisms which allows the person to focus on the selected semantic features is impaired. Good scores on auditory comprehension tasks demonstrate this relatively intact semantic storage. This is also a key feature that distinguishes semantic anomia in aphasia and dementia (Thompson & Jefferies, 2013).

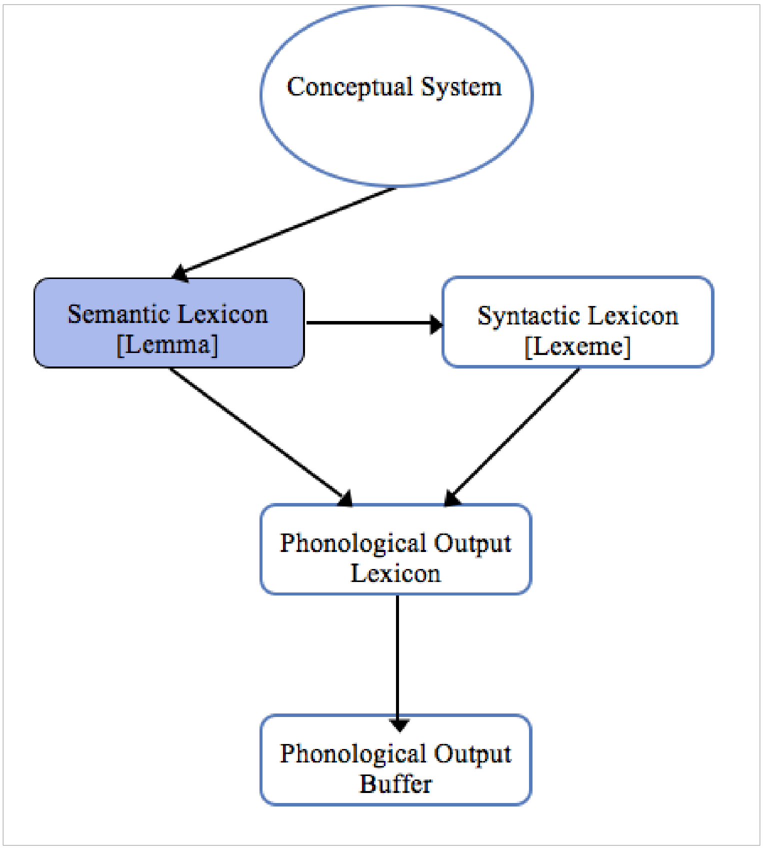


Figure 2.5: Locus of impairment when word retrieval fails at semantic level

Semantic anomia is characterized by the presence of semantic paraphasias, which may include coordinate errors, subordinate errors, superordinate errors, and associated errors (Harnish, 2015). Semantic errors made here may also show higher scores for more concrete items and familiar items than abstract items and less familiar items, respectively.

2.7.2 Failure in the connection between the semantic & phonologic output lexicons

Naming difficulties may also occur due to failures in connecting two otherwise unimpaired components of the word production process. Severed lexical phonological connections thus result in anomia. (Goodglass, 1993).

Typically, a disassociation of the link between the phonological output lexicon and semantic lexicon (see Figure 2.6 below) would relatively preserve comprehension, repetition, provide conceptual information of the target item and probably spare reading or writing of the same word that the person is unable to verbally name. The ability to comprehend words and pictures well despite failing to name manifests that although enough semantic information had been retrieved (spared lexical semantic store), sub lexical conversion of the chosen word did not occur (see, Kay & Ellis, 1987).

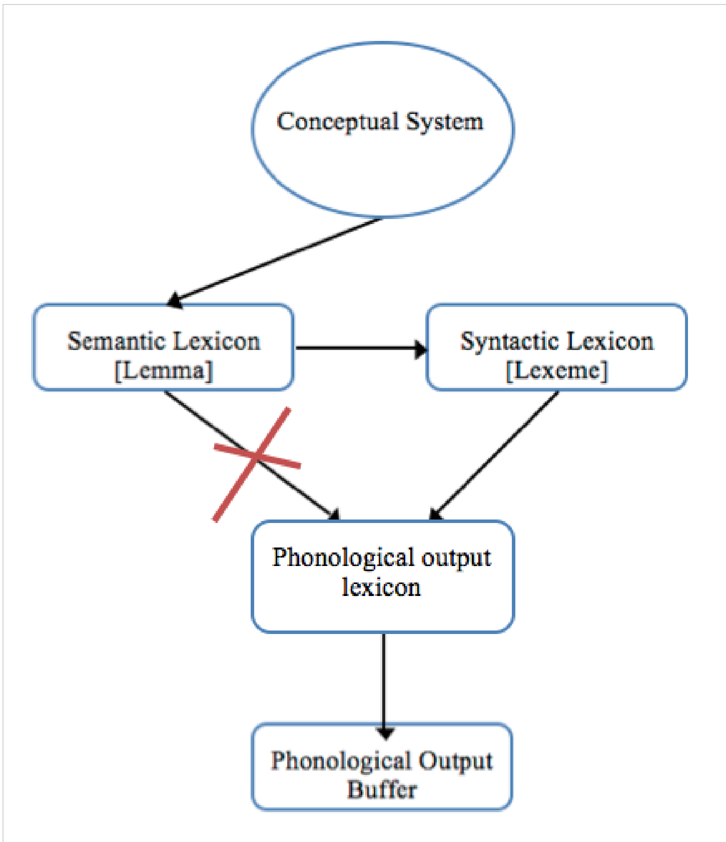


Figure 2.6: Locus of impairment when WFD occurs due to a breakdown of connection (marked here with a red cross) between the semantic and phonologic output lexicons

Clinically, an individual with this sort of disconnection would present predominantly semantic paraphaisas and relevant circumlocutions in verbal naming tasks (Friedmann et al., 2013; also see Miceli, Amitrano, Capasso & Caramazza, 1996 for a case report).

2.7.3 Failure in the phonological output buffer

The phonological buffer is thought to play a key role in single word productions including picture naming (see Shallice, Rumiati & Zadini, 2000) by sustaining activation throughout the serial processes of syllabification and phonological-to-articulatory conversion (Roelofs, 1997). Due to the later positional placement of this component, those with phonological buffer anomia will manifest an error pattern dominant with more phonological and less semantic errors, preserved comprehension, fluent and grammatically well-constructed speech but severe impairment in composing and repeating non-words and in reading. The less semantic dependency and more motor articulatory planning nature of non-words result in it being the most significant impairment of individuals with a breakdown at the buffer (Friedmann et al., 2013; Shu, Xiong, Han, Bi & Bai, 2005; Shallice et al., 2000). Individuals with breakdowns at the buffer (Figure 2.7) are also competent at self-monitoring and are able to self-correct (for case examples see, Shu et al., 2005).

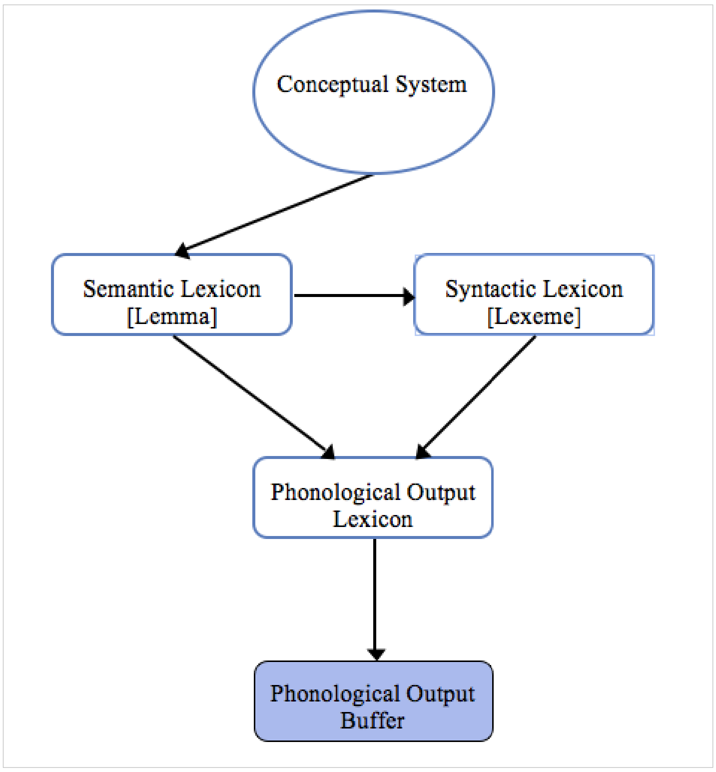


Figure 2.7: Word retrieval errors that occur due to failure at the phonological output buffer (shaded)

The phonological buffer stage is affected by word length effect; where shorter words are recalled better than longer words and the syllable and phoneme frequency effects; where less errors are seen in syllables and phonemes that are frequently used. As a result the length of the target word and the frequency of the sound combinations as they occur in the target word are key factors for anomic speakers with a deficit at the buffer (Romani, Galluzzi & Olsen, 2011).

The phonological buffer is also closely tied to the phonological short-term memory (pSTM) and therefore those with deficit at the buffer may show poor recall scores for digit spans, word spans and non-word spans (Friedmann et al., 2013).

2.8 Summary

The process of lexical retrieval is in essence a complex, multifaceted and tightly networked process, which is possibly why no one theory or approach is able to completely account for it all. Despite the theories, assumptions, criticisms and counter arguments, theoretical and empirical evidence continue to expand our understanding of what constitutes the normal process in the healthy speaker and how this process breaks down post brain lesion. This has also led to the replacement of syndrome-based approaches to assessment and diagnosis with a subsystem-based approach. Studies investigating spoken word production in healthy speakers and PwAs continue to reinforce and modify these theoretical models, which in turn allows an in-depth understanding of each individual patient in research and clinical contexts.

CHAPTER 3: Bilingualism

3.0 Overview

Bilingualism refers to the use of two languages by an individual or a group of speakers (Moradi, 2014) and is rapidly gaining more attention in the previously monolingual-dominant field of aphasia research. Increasing language contact due to reasons such as politics, religion, culture, economics, education and technology has resulted in increased number of multiple language speakers (Wei, 2000). In the modern world, bilingualism is the rule not the exception (Harris & Nelson, 1992). The increase in the number of bilinguals necessitates systematic and scientific evidence on all aspects of bilingualism in order to assist communities to develop their understanding of bilingualism for multiple areas of interest including that of education and rehabilitation.

The need to manipulate more than one language demands a unique set of language skills from the bilingual (Abutalebi & Weekes, 2014). Nevertheless, there exist pervasive similarities and differences between monolinguals and bilinguals, throughout a range of linguistic tasks and communication contexts. This is true of both the healthy and language impaired populations, children and adults.

In aphasia, the lack of awareness and sufficient research evidence of critical differences between monolingual and bilingual speakers may lead to a less than adequate analysis of language in the bilingual speaker (Bailystock & Luk, 2012). In research, this may lead to bias findings that are not valid and reliable. The consequences could be detrimental.

3.1 The bilingual and bilingualism

3.1.1 Defining the bilingual

A precise estimation of the number of bilinguals in the world is challenging given that the definition of 'bilingualism' remains disputed. Formerly, bilinguals were expected to have 'native-like control' of both languages (Bloomfield as cited in Hamers & Blanc, 2000). In contrast, Grosjean (1994) defines a bilingual as 'an individual who uses two or more languages or dialects in his or her everyday life regardless of the context of use'. Bilingualism in developmental studies often includes the reading and writing components in addition to the usual speaking and comprehension aspects of a language. For example Brice and Brice (2009, *p*.115) define bilingualism as 'the ability to speak, listen, read and/or write in more than one language with varying degrees of proficiency'.

The exact measures that constitute proficiency are uncertain. Therefore bilingualism is often viewed as a continuum where the terms 'balanced bilinguals', 'dominant bilinguals', 'recessive bilinguals' and 'semilinguals' have been used to categorize bilinguals[13] (Ng & Wigglesworth, 2007). According to Grosjean (1997) truly *balanced bilinguals* are quite rare, if they exist at all.

Weinreich (1953) suggested a typology of bilingualism based on language contact and subsequent language proficiency. He distinguished between a level of bilingual lexical representation, where information is organized according to meaning (conceptual level; represented by squares in Figure 3.1) and the word form (lexical level; represented by the circles in Figure 3.1). The proposed compound-coordinate model represents three possible configurations involving the phonological (signifier) and semantic (signified) aspects of the bilingual's dual language lexicon; coordinate, compound and subordinate models (See Figure, 3.1)

[13] **Balanced Bilingual:** Used first by Lambert & Fillenbaym, (1959). The term refers to bilinguals who are fully competent in both languages; **Dominant bilinguals:** Bilinguals who are dominant in one language than the other (subordinate language); **Recessive Bilinguals (also known as passive bilinguals);** Bilinguals who are gradually loosing competence in one known language due to less use; **Semilinguals;** Bilinguals who show limited level of proficiency in both L1 and L2, such as seen in minority children with low academic achievement. (as cited in Ng & Wigglesworth, 2007)

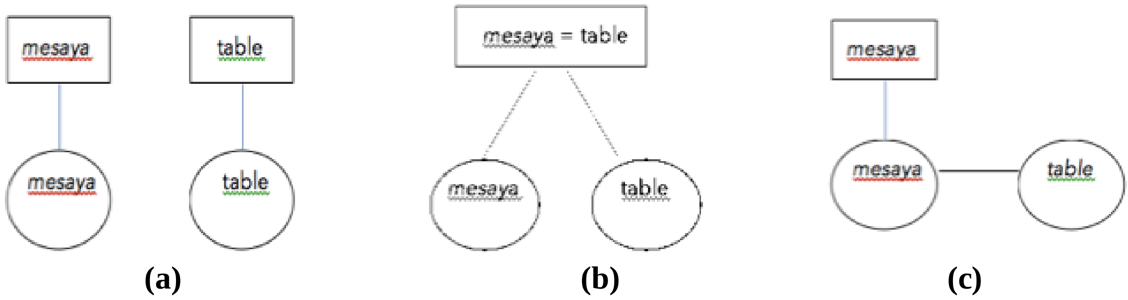


Figure 3.1: Weinreich's typology of bilinguals for the examples *table* (English) and *mesaya* (Sinhala). Adapted from R. R. Heredia, J. Altarriba (eds.), *Foundations of Bilingual Memory*, (2014) p.13

Coordinate bilingualism (3.1a) involves independence between the two languages, manifesting pure bilingualism. Compound bilinguals (3.1b) exhibit shared information between L1 and L2 at the conceptual level and independent information at the word level. Subordinate bilinguals (3.1c) have one representational system with strong links between L1 and L2, where L2 is highly dependent on L1. Weinreich (1953) suggests that with continued practice and increasing proficiency a bilingual transfers from the subordinate through to the compound stages of bilingualism and then to the coordinate stage. This is a representation of the dynamic nature of bilingualism.

3.1.2 Criteria in the classification of a bilingual

Several criteria are identified as influential in describing a bilingual. These include (a) developmental phenomena (b) linguistic competence (c) functional use of languages and (d) socio-psychological attitudes towards the languages known (Skutnabb-Kangas, 1984).

(a) <u>Developmental phenomena</u>; this includes the parameters of age of acquisition (AoA) and context in which language is acquired. Bilinguals are classified as early bilinguals or late bilinguals dependent on age at which language was acquired. Early bilinguals are those who acquire a second language during the 'critical period' of language acquisition. Discrepancies in published literature on what exact age constitutes an early learner have been noted (See, Bialystok, Craik, & Ryan, 2006; Moradi, 2014). It is assumed that early acquisition of a language allows more time for the second language (L2) to be activated and used in parallel with the first learnt language (L1) leading to increased level of proficiency (Bialystok et al., 2006). This view of bilingual language proficiency has since been challenged by critics, who suggest that the effect of habitual language use is stronger than the developmental aspects of childhood bilingualism (Pelham & Abrams, 2014).

Early bilinguals are further classified as simultaneous or successive bilinguals. Infants who are exposed to two languages at birth, also known as 'Bilingual First Language Acquisition (BFLA) or 2L1 (Meisel as cited in Cenoz & Genesee, 1998) are referred to as simultaneous bilinguals. The introduction of a second language well within the critical period of language acquisition but when a first language is already established is referred to as sequential or successive bilingualism (De Groot, 2011).

The context of language acquisition, which is formal or informal/ learnt or acquired refers to the mode in which L2 was delivered. This assesses the contextual demands through which language was delivered, a formal setup such as a classroom or an informal manner such as when spoken at home. Despite the distinct explanations, segregation of bilinguals based on the context of acquisition may be near impossible given that one may casually acquire a language at home but later decide to add some fine skills such as grammar or writing through a rigorous formal method (Bhatia & Ritchie, 2006)

(b) Language competence: Measures of language competence involve a combination of conventional and modern terminologies used to describe the proficiency of the adult bilingual. The term balanced bilingual (Pearl & Lambert, 1962) replaces the formerly used terms, ambilingual or equilingual to describe a bilingual whose proficiency in both languages is approximately equivalent (Bhatia & Ritchie, 2006). The dominant bilingual on the other hand demonstrates a significant variation between the competencies achieved in L1 versus L2.

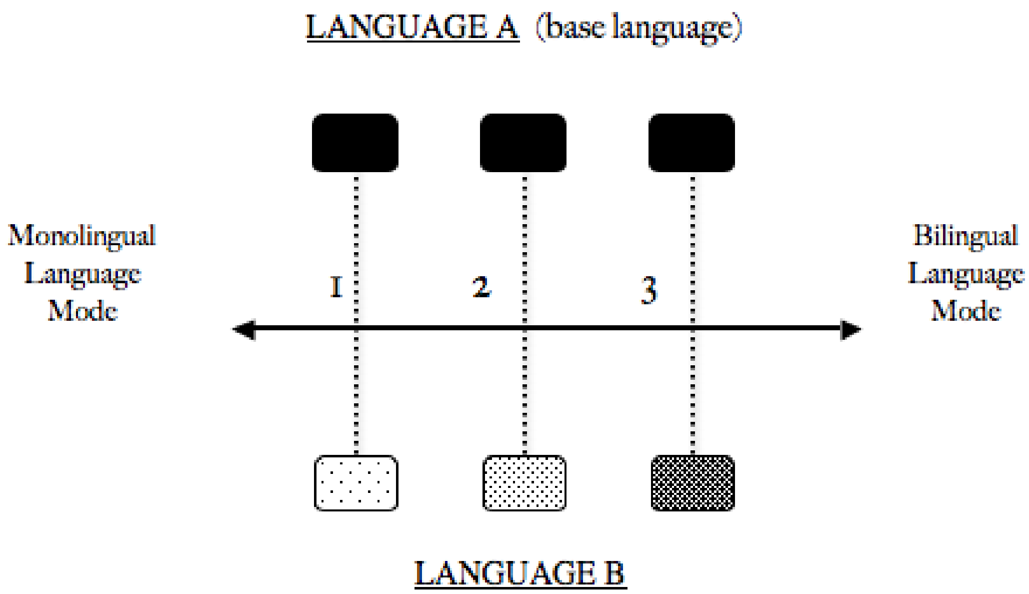
(c) Functional use of languages: Semi bilingual, used to describe the functional competence across languages identifies a bilingual who is a passive user of a language, that is, those who understand a language but are unable to speak it. Distinguishing between a receptive or passive bilingual and a productive or active bilingual is considered critical information in bilingual research and language rehabilitation practice (Faroqi-Shah, Frymark, Mullen & Wang, 2010)

(d) Psychosocial attitudes towards the languages: Bicultural and Monoculture bilinguals (Hamers & Blanc, 2000) refer to whether the two languages share a common cultural setting. For example deaf bilingual adult who speaks both British Sign Language and English in different contexts is deemed a bicultural bilingual, whereas a Norwegian-Danish bilingual speaks their different languages in similar cultural contexts and is deemed monocultural.

Elective and circumstantial bilinguals (Valdes & Figuero, 1994) differ from each other in the sense that while the former may have a choice in learning a second language, the latter may include groups of people for whom learning a L2 is compulsory for political, educational, economical or professional reasons. Though not widely used, these terminologies are critical in understanding the language profile and competency of an adult bilingual.

3.1.3 Understanding bilingualism; Grosjean's language modes (1985)

Grosjean (1985) describes 'language mode' as the state of activation of the bilingual's languages and language processing mechanisms at a given point in time. The 'language



mode', which includes spoken, written and sign forms of language resembles a situational continuum of which one end is totally monolingual and the other is completely bilingual.

Figure 3.2: Grosjean's language modes; Three hypothetical positions (1-3) and relative language activation depicted by the degree of darkness of the squares. Adapted from Grosjean, F. (1998) Studying bilinguals: Methodological and conceptual issue in Bilingualism; Language and cognition, p. 136

In his hypothetical account, Grosjean proposes that in everyday life a bilingual may find themselves at various points of this continuum corresponding to different 'modes'. While in the monolingual mode the bilinguals restrict themselves to one language though the other language is never totally deactivated (Grosjean, 1999). In the bilingual mode, both languages are active, shared and mixed although one language (base language or the language learnt first; also known as the host language or matrix language) is used more dominantly than the other.

The language mode has a significant impact on the bilinguals' languages, deciding the amount of activation for the non-target language, degree of language mix and the ease with which the languages are processed in bilingual mode. Bilingual specific language behaviours such as code switching, code mixing and borrowing occur when the host language is used to a greater extent and periodically infiltrated by the other. In the monolingual mode, the activation levels act as an inhibitor, maintaining the base language and suppressing the non-target language thereby preventing or at least limiting code switching, code mixing and borrowings (defined in Chapter 2). A bilingual's position along this continuum is dynamic, such that it is possible for a person to begin a conversation as a monolingual and with an increasing understanding of the other speaker's language proficiency levels and communication need, remain monolingual or shift in the bilingual direction of the continuum. (Also see Dunn & Fox Tree, 2012 for limitations of this account).

3.2 Bilingualism from birth to adulthood

Early research through the twentieth century viewed bilingualism as a disadvantage citing poor intellectual and scholastic performances in children of minority migrant groups (see Saer, 1923). This has since been replaced with an abundance of studies suggestive of cognitive advantages, phonological ability and meta-linguistic awareness in bilinguals (Kerrigan, Thomas, Bright & Filippi, 2017; Tytus, 2016; Dong & Xie, 2014; Kaushanskaya & Marian, 2009).

Recent research suggest that bilingual children achieve their linguistic milestones simultaneously to that of their monolingual peers (Patterson & Pearson, 2004) and even experience the spurt in vocabulary as monolingual children do though possibly at different times in each of the known languages (Pearson & Fernandez, 1994). The exact difference is neither clear nor consistent. (see, Bialystok, Luk, Peetes & Yang, 2010; Gollan, Montoya, Fennema-Notestine & Morris, 2005; Pearson, Fernandez & Oller, 1993; also see Nicholadis, 1999).

Bilingualism requires a unique set of linguistic and cognitive skills needed for being classified a competent bilingual. By the age of two years, most children are aware of their choice of language. By around the age of three years, children are able to alternate between languages in a way that is close enough to be identified as a language-switch (Chung, 2006; Serratrice, Sorace & Paoli, 2004; Yip & Matthews, 2000) while minimally violating the socio-pragmatic and grammatical rules that govern this unique, bilingual-specific language behavior (Paradis, Nicholadis & Genesee, 2000).

The level of inappropriate interference is expected to further diminish with age as the bilingual child draws on a large pool of linguistic, communicative and cognitive resources over time (Paradis, Crago, Genesee & Rice, 2003; Maneva & Genesee, 2002). Further studies investigating the development of 'doublet vocabulary', that is words learnt in both languages as translation equivalents and used appropriately in contexts has shown to be present from as early as 8 months (Pearson & Fernandez, 1994). This evidence is suggestive of the development of two distinct lexical systems in bilinguals begin at childhood itself.

Individualized findings and plentiful variations often seen in children pose a challenge when drawing firm conclusions from developmental studies (Poulin-Dubioz & Goods, 2001). Despite this, developmental data provide a unique method in predicting and understanding the adult bilingual mind.

3.3 Bilingualism; is it an advantage or disadvantage?

Bilingualism and cognition has been discussed with respect to two hypotheses; an additive effect and a subtractive effect (Cook, 1998). The additive hypothesis proposes benefits of bilingualism such as heightened creative thinking, cognitive advantages such as heightened function of executive control (Bialystock, 2009) and increased grammatical awareness as documented especially in developmental research. It has also been shown that lifelong bilingualism protects the brain against cognitive decline such as dementia (Gollan, Salmon, Montoya & Galasko, 2011; Bialystock, Craik & Freedman, 2007; Craik, Bialystok & Freedman, 2010; Bialystock, Craik, Klein & Viswanathan, 2004).

The subtractive effect of bilingualism concerns reduced vocabulary size (e.g. Gollan, Montoya & Werner, 2002) and slower lexical retrieval (e.g. Rosselli et al., 2000) in comparison to their monolingual counterparts. Studies have also reported bilinguals to exhibit slower linguistic processing (Kroll, Dussias, Bogulski & Kroff, 2012) as demonstrated across a range of linguistic tasks including comprehension (Blumenfeld & Marian, 2011), verbal fluency tasks (e.g. Luo, Luk & Baileystok, 2010; Ivanova & Costa, 2008) and naming (e.g. Gollan et al., 2005). This effect was most marked when the task required rapid lexical access and retrieval (Bialystock & Craik, 2010). These findings have been supported by electrophysiological evidence such as EEG N400 signals in eye tracking studies[14] (e.g. Friesen, Chung-Fat-Yim & Bialystok, 2016).

Slower linguistic processing is often attributed to the fact that bilinguals engage in dual language processing (Rosselli et al., 2000) and exhibit continual involvement of executive control (Ye & Zhou, 2009), which in turn creates an intrinsic hindrance in

[14] Eye tracking is a process in which the timing and patterns of eye movement is closely time locked to the spoken word. Here electroencephalographic (EEG) measures include the measurement of the well-established N400 evoked response potential (ERP)

language selection and processing (Kaushanskaya & Marian, 2007). Furthermore, what sets aside the monolingual from those who speak more than one language is that the latter needs to distribute learning time between the two languages (Oller, Pearson & Cobo-Lewis, 2007), differs in the contextual use of a given language and may vary in their choice of lexical use within the language (Bailystok et al., 2010), be challenged with the relative differences in the frequency of word usage (Allman, 2005) and importantly unlike the monolingual possesses a 'doublet vocabulary' (Pearson & Fernandez, 1994). Therefore modern focus has attempted to shift opinion suggesting that these differences be viewed not as a disadvantage but instead as changes that come with a life-long shift in language skills.

3.4 Issues in bilingual research

Studies in bilingual language vary in terms of cultures, socio-economic factors, beliefs and values and also participants of varying language proficiency and use, all of which needs to be considered when planning and executing research across two or more different languages.

3.4.1. Language proficiency

Defining and measuring bilingual proficiency is challenging. Much of the published research on bilingualism attributes language proficiency to the level of performance in L2 in particular (Newman, Tremblay, Nicholas, Neville & Ullman, 2012; Costa & Santesteban, 2004; Marian, Spivey & Hirsch, 2003; Meuter & Allaport, 1999). Individual differences in language acquisition result in distinct behavioural and cognitive-linguistic differences between the languages, especially in terms of language use (Grosjean, 1998), which in turn determines language proficiency. Neuroimaging evidence suggestive of differential cerebral activation for L1 and L2 also associates proficiency to be a stronger determiner than the age of language acquisition (Abutalebi & Green, 2007; Also see, Perani et al., 1998).

Grosjean (1998) noted that bilingual participants often with asymmetrical proficiency across the languages known might fluctuate in competence based on contextual needs. Bilinguals living in a context that requires a greater frequency of switching may require alternating between a monolingual mode (when talking to monolinguals of either language) and bilingual mode (bilinguals of the languages known). This in turn has been shown to heighten their proficiency levels across the spoken languages.

Some of the published literature fails to report sufficient language proficiency details of recruited participants and therefore deprive the reader of critical information of the bilingual's language ability (Treffers-Daller et. al., 2011; also see, Marian, Blumenfeld & Kaushanskaya, 2007)

3.4.2. Participant factors

Participant factors in bilingual studies include multiple variables such as vocabulary size, working memory capacity, verbal and nonverbal IQ, socio-economic status and level of education (Marain, 2008). Nevertheless, the relative importance placed on each of these participant factors in determining individual language proficiency has been controversial.

It is likely that bilinguals may provide clinicians and researchers with biased and conflicting reports of themselves when asked to self-rate their language proficiency and use (Marian et al., 2007). It is also known that personal attitudes and perceptions may lead the bilingual to favour one language over the other, leading to untruthful information on his or her bilingual status. Such discrepancies may occur due to the lack of the participants understanding of what constitutes bilingualism. The failure to include multiple measurements in rating participant proficiency may result in a diverse study population being recruited, subsequently leading to erroneous inferences and inappropriate recommendations (Treffers-Daller et al.,, 2011).

3.4.3. Bilinguals' language mode

The mode of language (See, section 3.1.3 for more details) is a 'true reflection' of how bilinguals process the two languages, separately or together (Grosjean, 1999). This state of activation is influenced by numerous external variables including the speaking situation, context, partners and purpose. The placement of a bilingual participant in a mode suitable for the study prior to testing is of critical importance to studies using conversational samples of bilinguals and also those investigating bilingual code mixing and switching. These require that a language mode be stated, prior to and during testing.

The control of the researcher's language is known to have a direct impact on the bilingual participant's mode. Grosjean (1998) cautioned against the use of the non-test language prior (e.g. delivery of task instructions) or during (e.g. a conversation task between participant and researcher) testing. Grosjean (1998) who reviewed his own research in the past (see Soares & Grosjean, 1984) noted that by having prior knowledge of the study and by being allowed to code switch with one of the experimenters, the bilingual participants were never confined to a monolingual mode even when the monolingual parts of the study were conducted (also see, Rosselli et al., 2000).

Most research do not report or simply do not consider at all the aspects of study design that relate to establishing a bilingual mode (e.g. the language in which task instructions were delivered, examiners choice of language). Failure to consider language mode particularly in bilingual studies may result in increased code switching (Grosjean, 1998; also see Verhoef, Roelofs & Chwilla, 2009; see review, Bobb & Wodniecka, 2013) confounding the actual research question and subsequently resulting in invalid data.

Grosjean's (1998) suggestions for establishing an extreme monolingual mode in research where monolinguals are tested include not disclosing to participants the forthcoming bilingual aspects of the study; prior to monolingual testing giving instructions in the test language; engaging participants in preliminary tasks conducted in the test language; providing participants with occasional reminders to remain on the test language; careful selection of stimuli in the test language and even using a complete monolingual of the test language if testing involves tasks such as conversations or interviews. Alternatively, establishing an actual bilingual mode may require that the participant is informed and prepared for being tested in both languages and involve a bilingual experimenter, preferably from the same community as the bilingual tested.

3.4.4 Selection of stimuli

The selection of stimuli is particularly important to bilingual studies regardless of the whether the tested languages are alike or different. It is important that the stimuli used are of equal status in both languages in order for valid comparisons to be made across languages. Factors include word length, imageability, frequency, grammatical class and phonetic composition (Obler, Zatorre, Galloway & Vaid, 1982). For example the Sinhala translation of the English word 'train' *(/koːʈʃˈɪjə/)* is not similar in word length nor do they share similar phonetic structure. The Sinhala and English languages themselves differ in their phonetic composition, such that a large number of words in Sinhala possess a CVCV phonetic form and unlike English there are few consonant clusters. Sinhala also consists of a variety of dialects, primarily, a formal (written) form and an informal (spoken) form. For example, the English word 'train' could be referred to as /*koːʈʃˈɪjə*/ in a formal form and as /*ðʊmɽɪjə*/ in an informal spoken form. The level of skill and knowledge therefore required may greatly challenge the researcher, demanding more time and expertise and even the need for developing tailor-made stimuli (Marian, 2008).

The inclusion or exclusion of cognate words, loan words, and inter-lingual homographs is of importance in bilingual studies (Roberts & Doucets, 2011). Cognates refer to words that both sound and mean the same in two languages while interlingual homographs are words that sound the same but have different meanings. Cognates are often excluded from priming studies, whereas cognates and interlingual homographs are extensively used in studies involving second language processing or word interference. In the case of Sinhala- English, both formal and informal forms of Sinhala consist of a number of words adopted from the English vocabulary (e.g. admiral, album, bus).

3.5 Language processing in the bilingual

Psycholinguistic research in bilingualism has disputed three interrelated issues concerning bilingual language:

(a) Does a bilingual hold separate memory stores for each of the languages known, or do they hold one common, language-independent store?

(b) If this memory store is unique to a language even at one linguistic level, then is access to this level language specific (language selective access) or not (language non selective access). This is particularly important to a model where at least one level of language representation is unique to each known language of the bilingual (De Groot, Delmaar & Lupker, 2000).

(c) How are the monolingual models of language processing (e.g. Levelt, 1989) applicable to bilingualism.

Recent research in BL have used a wide range of tasks such as Stroop tasks (E.g. Rosselli et al., 2002; Meuter & Allaport, 1999), exploitation of shared or distinct linguistic features such as cognates, interlingual neighbours and shared homographs as single words (E.g. Durlik, Szewczyk, Muszynski & Wodniecka, 2016; Zied et al., 2004; De Groot et al., 2000) or in sentential contexts (Poort, Warren & Rodd, 2016; Conklin & Mauner, 2005), comprehension tasks, cross language semantic and phonological priming (E.g. Kerkhofs, Dijkstra, Chwilla & De Bruijin, 2006; Dong, Gui & Macwhinney, 2005; Duyck, Diependaele, Drieghe & Brysbaert, 2004), and word recognition tasks that promote automatic processing (E.g. Blumenfeld & Marian, 2013; Mitchel, 2005; Dijkstra, Grainger & Van Heuven, 1999).

3.6 Language organization and representation

3.6.1 Shared, separated or integrated?

In essence, bilinguals have more than one lexical label of a concept, which in turn may have more than one representation in each language. The central focus on bilingualism research is on how the words in multiple languages are represented in the bilingual brain. Two main hypotheses underlie the organization of the bilingual's mental lexicon; an independence hypothesis and the interdependence hypothesis (De Bot, 1992).

The independence hypothesis proposes a distinct and separate language store for each language, such that processing in L1 does not interfere with L2 (Kroll, Van Hell, Tokowicz & Green, 2010). The interdependence hypothesis suggests the opposite, where L1 and L2 share an integrated memory store and information linguistically labeled for each known language (Mitchel, 2005). This hypothesis may however, suggest the need for control and inhibition systems. More recently Kroll and colleagues proposed an intermediate stance, suggesting a separate yet interconnected system (Kroll et al., 2010). Other theories have acknowledged the influence of the learning process on word storage and retrieval.

3.6.2 Models of bilingual lexical storage

3.6.2.1 Hierarchical models

Hierarchical models were developed on the early premise that a distinction was required between lexical representations containing word form and conceptual representations containing word meaning (Brysbaert & Duyck, 2010).

Incorporating their findings and based on previous work by Weinreich (1953) (see Figure 3.3), Potter, So, Von Eckardt and Feldman (1984) proposed two possible hypotheses to describe the associations between the bilinguals L1 and L2: the Word Association Hypothesis and the Concept Mediation Hypothesis.

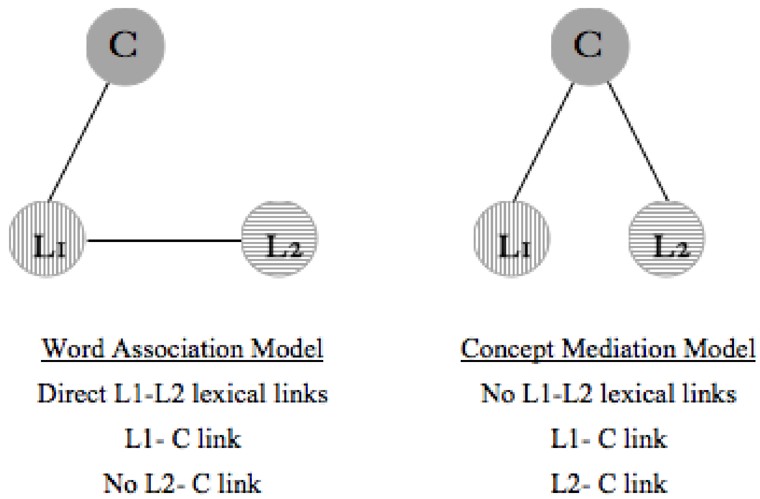


Figure 3.3: A comparison between the hierarchical models of bilingual language processing; (a) Word Association Model (Potter, So, Von Eckardt & Feldman, 1984) (b) Concept mediation model (Potter, So, Von Eckardt & Feldman, 1984); Adopted from French & Jacquet (2004) Understanding bilingual memory: models and data. *Trends in Cognitive Sciences, 8*(2), p88

The Word Association Hypothesis (Figure 3.3a), similar to that of Weinreich's sub ordinate model suggested a direct connection between the lexicons of the two languages with only L1 connected to the concepts. Access to the less proficient L2 occurs through L1 (Potter et al., 1984). This hypothesis successfully describes language processing for those with low levels of L2 proficiency (De Groot & Hoeks, 1995) such as when L2 has been learnt later through formal methods. According to this hypothesis, picture naming in L2 involves a five step procedure; (i) recognizing the image (ii) retrieving the concept (iii) retrieving the word in L1 (iv) retrieving the translation equivalent in L2 and v) producing the spoken word in L2 (Mitchel, 2005).

The Concept Mediation Hypothesis (Figure 3.3b) however proposes direct links between L1 and L2 and their corresponding concepts with access from L2 to L1 word form also occurring through access to the concept (Menenti & Indefrey, 2006). It also assumes that the same underlying, amodal conceptual system, which connects the two languages, also receives non-linguistic input from pictures (Potter et al., 1984). Here, picture naming in L2 would involve a four-step procedure; (i) recognize stimulus (for picture naming) and L1 word (for translating) (ii) retrieve the concept (iii) retrieve L2 word and (iv) produce the L2 word. Thus retrieval of a concept from a picture is at least as rapid as retrieving from a written L1 word (Potter et. al., 1984).

3.6.2.2 Revised hierarchical model (RHM; Kroll and Stewart, 1994)

Characterized by its weighted bidirectional lexical links, the Revised Hierarchical Model (RHM) assumed that L1 and L2 share conceptual representations but have separate word representations.

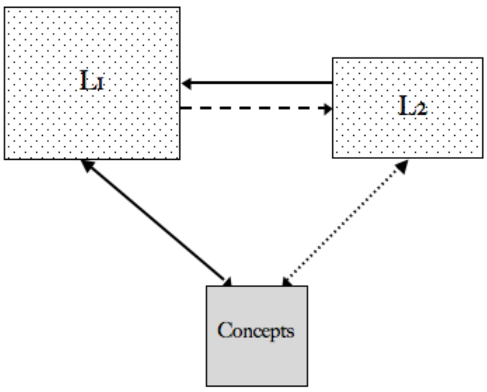


Figure 3.4: Revised Hierarchical Model (RHM; Kroll & Stewart, 1994) depicting weighted bidirectional links; Adopted from French & Jacquet (2004)

The RHM proposed that; (a) both lexical and conceptually mediated links occur between L1 and L2 (b) In the L2 to L1 direction, lexical links are stronger (c) In the L1 to L2 direction, the conceptual links are stronger (d) the relative balance between lexical and conceptual links changes with increasing proficiency; where conceptual links become stronger and concept mediation occurs with increasing proficiency in the bilingual (Menenti & Indefrey, 2006). Hierarchical models have however been criticized for their inability to account for the varying competency and proficiency levels of bilinguals (Kroll, Van Hell, Tokowicz & Green, 2010).

3.6.2.3 The subsystem hypothesis (Paradis, 1987; 2001)

Paradis (1987, 2001) proposed a range of options from separate stores through to a mixed representational system. Amongst them, the subsystem hypothesis accounts for bilingual lexical organization when near native proficiency is achieved for the bilingual's second language (De Groot, 1993). This proposes that a collection of modules (e.g. phonology, morphosyntax and lexico-semantic systems) constitute a linguistic system. In turn, each language spoken constitutes a subsystem of the larger linguistic system. Elements within the system are connected through intra-language and inter-language links, where intra language links are thought to be stronger. This allows elements from within the same language to be retrieved together. Inter language links are thought to get stronger, especially in the event of frequent code switching in normal conversations. The intra and inter language links also allow each module to be selectively activated or inhibited. This allows the person to switch between monolingual and bilingual mode, based on who the listener is.

The subsystem postulates that brain damage may result in the inhibition of specific or all modules in specific or all language systems. Thus the model is able to successfully account for language errors and all recovery patterns of bilingual aphasia.

3.7 Lexical access

In spoken production a word must be located and selected. This is referred to as lexical access. The processes of lexical access, activation and selection in the bilingual, is more complex due to the involvement of multiple languages. The bilingual may activate more than one word in more than one language (Fernandes & Brito, 2008). Thus, in addition to overcoming competition from semantical neighbours, bilinguals must also overcome competition from items in the other language (Shell, Link & Slevc, 2015). The bilingual speaker's ability to select the target language is key to this process (Kroll, Bobb & Wodenika, 2006). In order to be able to use language interchangeably and accurately one needs to identify the language to which the word belongs (language information) and use such information to either, (a) obstruct the processing of words in the non-target language or/and (b) construct a lexical output by making available language information at a latter level of processing (Ng & Wicha, 2013).

Whenever the critical notion of competition between the lexical nodes of the language in production and the nodes of the non-response language is assumed, bilingual theories on lexical access are of two types (Costa & Santesteban, 2004); Language selective access in an independent lexicon or language non-selective access in an integrated lexicon (Dijkstra & Van Heuven, 2002).

3.7.1 Language selective access

Language selective access proposes that activation is exclusive to the contextually appropriate language. In this case the preverbal message at the conceptual level carries the information concerning whether the speaker intends to use L1 or L2. The notion of language selective access is further discussed in Green's (1986) Inhibitory Control model and La Heij's (2005) model.

3.7.1.1 Models of language selective access

3.7.1.1.1 Inhibitory Control Model (ICM; Green, 1986)

Green (1986, 1998) proposed the Inhibitory Control Model (ICM); a model of multiple levels of control and selection through inhibition to explain cross-linguistic errors in bilinguals (see, Abutalebi & Green, 2008; Finkbeiner, Gollan & Caramazza, 2006; Abutalebi & Green, 2007; Green, 1998) (See Figure 3.5).

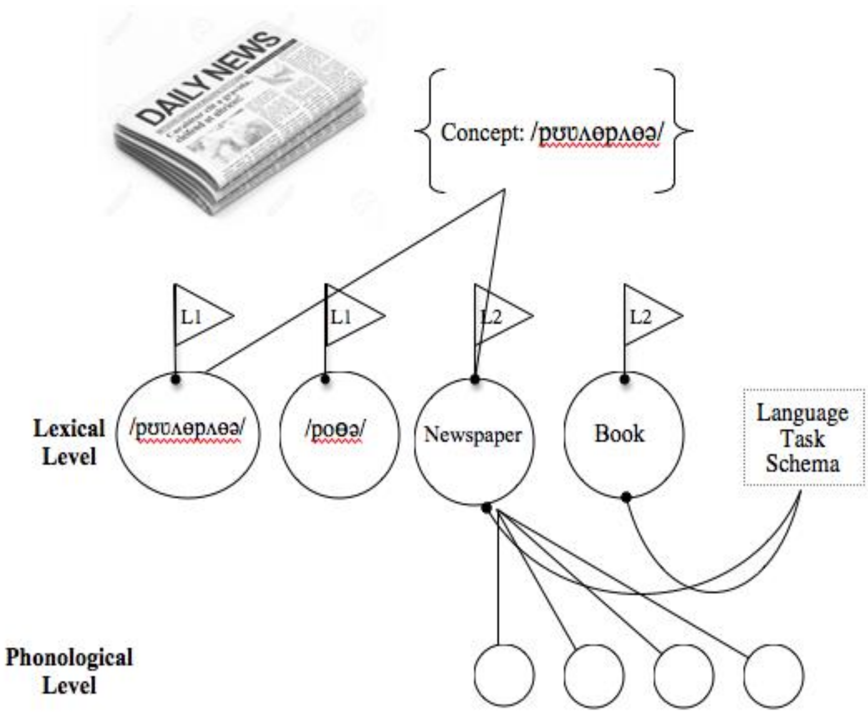


Figure 3.5: Green's (1998) Inhibitory Control Model as applicable to a Sinhala-English bilingual. Here, the selected language mode is English and therefore the Sinhala node (corresponding to the concept) and lexical competitors are inhibited. Only the selected node, in the selected language mode (that is 'newspaper' in English) is activated at phonological level. Adapted from, Finkbeiner, Gollan, T, H. & Caramazza, A. (2006). *Lexical access in bilingual speakers: What's the hard problem*. pg. 157

Green (1998) proposes three functions of the ICM; (i) a method of language control in which the output from a lexico-semantic system is the result of an inhibition of all but one language task schema (ii) word selection facilitated by the use of language tags and (iii) an inhibitor reactive behaviours at the lemma level.

Here, the concept of a 'task schema' refers to networks setup to achieve a certain task. Green (1998) argues that in repeated tasks the schemas can be adapted from memory where as in instant involuntary tasks, an added element comes into play. At the lexical level, the concepts connect to the lemma. Each lemma is made available with its specifics on its unique syntactic properties and importantly a language tag.

Between a set of language specific processes and task schemas, the ICM incorporates a control mechanism to compliment the different language modes previously proposed by Grosjean (1997) (Valenti & Scheutz, 2013).

Several features of the ICM are critical in understanding bilingual language behaviors. The ICM suggested that the semantic system remains non-selective in that it activates lexical nodes of both languages. Subsequently 'inhibition', which refers to a suppression mechanism is applied at the lemma level. This suppresses the lemmas with the wrong tags until the correct ones are selected. Inhibition is only developed and applied after the lexical nodes in the non-target language have been activated by the semantic system (Costa & Santesteban, 2004). Inhibition is independent of which stimuli it chooses to suppress and thus works to block out all competition from the target response output (May, Kane & Hasher, 1995). This inhibitory effect is proportional, such that, the more the semantic system activates lexical nodes of the non-target language, the stronger the inhibition of the same (Costa & Santesteban, 2004).

A unique feature of inhibition is that it requires time to be overcome and is therefore termed reactive. This implies that retrieving words from a language that has been inhibited will require more time as it needs to overcome the suppression (Tipper, 1985 as cited in Tipper, 2001).

This reactive, selective and proportional inhibition results in varied levels of activation, leading to three different language modes; selected, active and dormant. The language in use is referred to as selected language, languages being conferred to some kind of background role at the moment is referred to as active language and the language with no active or effective role on the speaking process but still residing in long term memory is known as dormant language. Here, the speaker needs to regulate the process in order to select one language from amongst the two languages that may be active (Fernandes & Brito, 2008). It is this mechanism of varied activation that is thought to resolve the initial conflict between the two languages (Abutalebi & Green, 2007).

The role of language proficiency and use in the cognitive control of language are disputed (Dong & Xie, 2014). Meuter and Allport (1999) in their study of 16 bilinguals measured response latencies across 'switch trials' (consecutive trials in different languages) and non-switched trials (consecutive trials in the same language). Findings indicated asymmetrical switching costs, that is a greater response time when the switch was to the less proficient L2 thus suggesting that inhibition of the proficient L1 requires more time. The asymmetry between switching costs diminish with increasing proficiency as seen in studies involving highly proficient bilinguals (e.g. Costa & Santesteban, 2004)

On the contrary, Linck, Hoshino and Kroll (2008) published findings from two studies that involved highly proficient native English speakers with a moderate proficiency of Spanish, monolingual native English speakers, Japanese-English and Spanish-English speaking bilingual adults, all late learners of L2. Findings showed bilinguals to be capable of better inhibitory control skills but refuted their hypothesis that greater language exposure and/or proficiency may result in a difference in the ability to bring about inhibitory control of a language. In fact, more proficient learners showed less inhibitory control than less proficient learners leading the authors to suggest the other critical factors related to the participants' language experience and use may enhance inhibitory skills in bilinguals (also see, Dong & Xie, 2014; Christoffels, Firk & Schiller, 2007; Costa & Santesteban, 2004). For example, the frequency with which L1 is learnt in an L2 environment or the frequency of code switching between L1 and L2. These demand that the speaker repeatedly performs transitions between the languages, enhancing the ability to cognitively detach from one language matrix and embrace that of another, while continuing to obey whatever syntactic constraints there may be.

Language inhibition was also influenced by the degree of similarity between the two known languages. Here, inhibition was found to be greater for bilinguals whose languages have greater differences such as languages with a different script (e.g. Chinese- English) rather than those with a shared script (e.g. Spanish-English) (also see, Hoshino & Kroll, 2008).

3.7.1.1.2 La Heij's (2005) model

Subsequently, La Heij's (2005) replaced the assumption of free flow of information during lexical access with the notion that an appropriate and fixed pre-verbal message is first generated. It was presumed that this pre-verbal message included information about the language non-specific concept or lexical-semantic representation that is applicable to all translation-equivalent (between the two languages of the bilingual) lexical nodes, the register and the choice of language.

The activation generated as a result of this preverbal message is disproportionate. A greater activation is directed to the target lexical node that matches complete description of the pre-verbal message, selecting it and thereafter deselecting all other unintended synonyms competing with it.

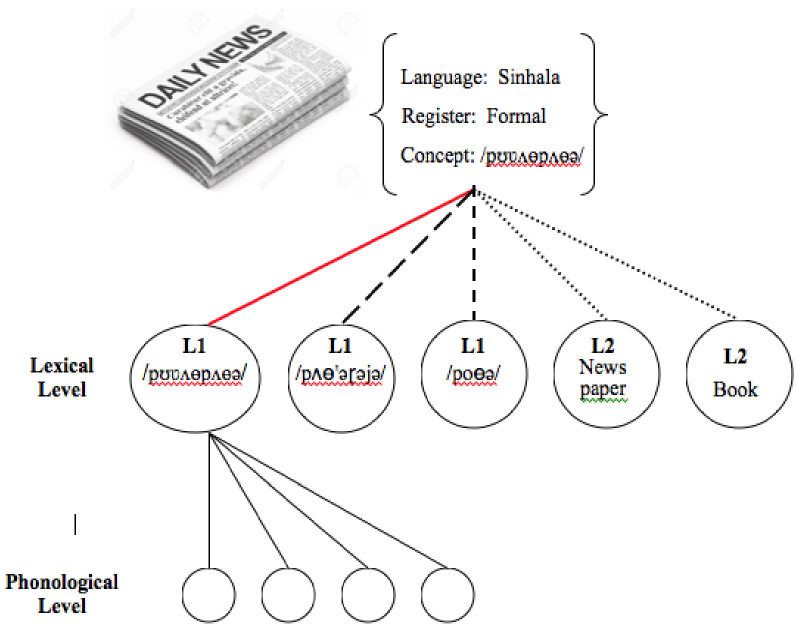


Figure 3.6(a)

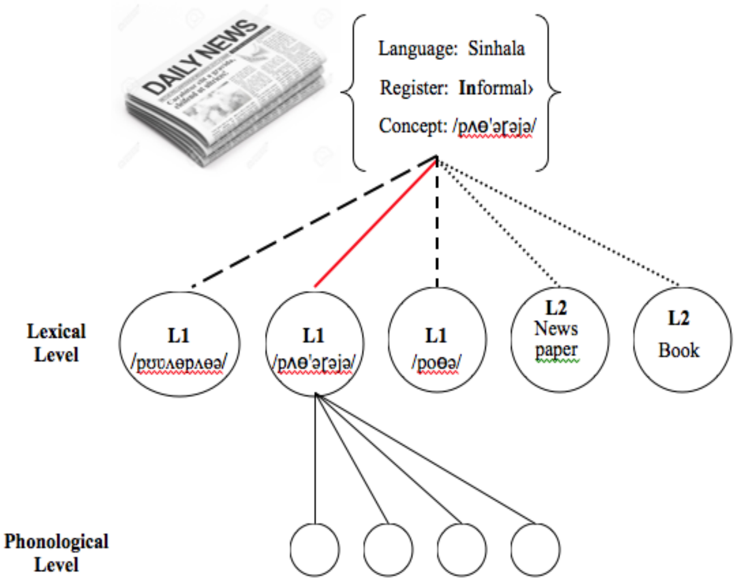


Figure 3.6(b)

Figure 3.6(a) and (b): La Heij's, 2005 as applicable to the Sinhala- English bilingual. In **3.6(a)**the selected register is formal and therefore the word, */pʊvʌθpʌθə/* (formal spoken Sinhala word for Newspaper) is activated. In **3.6 (b)** the selected register is informal and therefore the informal Sinhala word for newspaper, */pʌθ'ərəjə/*is selected. Adapted from Finkbeiner, Gollan, T, H. & Caramazza, A. (2006). *Lexical access in bilingual speakers: What's the hard problem*. pg. 157

Significant strengths of the La Heij (2005) model in terms of describing the lexical access in the bilingual include (i) depicting the semantic-lexical concept as a non-linguistic element (ii) acknowledging pre-speech knowledge such as choice of language, appreciation of communication context and partner and (iii) allows differentiation between formal (e.g. please could you come over?) and informal (e.g. Go away!) speech (see Figures 3.6(a) and (b) above).

3.7.1.2 Research evidence

Gerard and Scarborough (1989) based on bilingual performance in a lexical decision task showed slower but non-significant, lexical decision times for interlingual homographs than for non-homographs implying that the bilingual did not require access to both lexicons during language processing. That is, bilinguals were able to focus on one language tested, block off cross language interference and thereby essentially functioning as monolinguals. Despite numerous criticisms on the interpretation of the findings (e.g. See, Conklin & Mauner, 2005) several recent proposals comprehensively argue in favour of this language selective notion.

Costa and Caramazza (1999) also noted that bilingual's are capable of suppression of their languages, even of the more proficient language. Comparative data from their Catalan-English study and Spanish-English studies (Costa & Caramazza, 1999; Costa, Miozzo & Caramazza, 1999) suggest that this control on the languages prevails, regardless of how similar or dissimilar the known languages are.

Language selective models enjoyed early success but have also been criticized for their highly theoretical nature (Finkbeiner, Gollan, & Caramazza, 2006) and their inability to account for concerns associated with the changing bilingual proficiency and competency levels of a bilingual.

3.7.2 Language non-selective access

Lexical non-selectivity incorporates the notion of lexical selection after competition, possibly after both between and within language competition (Green, 1998). Further, most models that assume non-selective access are integrative, where one memory system shares a common representation system (Kroll & Sunderman, 2003). Therefore, co-activation and competition between the bilinguals' known languages is typical in non-selective access (Durlik et al., 2016).

Evidence of this cross-linguistic interference has been established specifically through picture naming studies whose evidence suggest the processing of non-target language information during a task in the target language (see Kaushanskaya & Marian, 2007; Lee & Williams, 2001).

3.7.2.1 Models of language non-selective access; the Bilingual Interactive Activation (BIA) and BIA+ models (Dijkstra and Van Heuven, 1998; Dijkstra and Van Heuven, 2002)

The BIA (Dijkstra & Van Heuven, 1998) model describes visual word recognition representations from the bilingual mental lexicon (Brysbaert & Duyck, 2010; Dijkstra & Van Heuven, 2002) in a top down language to word inhibition approach (see Figure 3.7 below). In its revised version, the BIA+ model (Dijkstra & Van Heuven (2002) included phonological and semantic information along with orthographic information and adopted a bottom up processing leading to the activation of neighboring (orthographically similar) words across both languages.

Both BIA and BIA+ models differed from the RHM such that, it proposed language non-selectivity within a shared bilingual mental lexicon and also focused on bilingual semantic memory access in language comprehension.

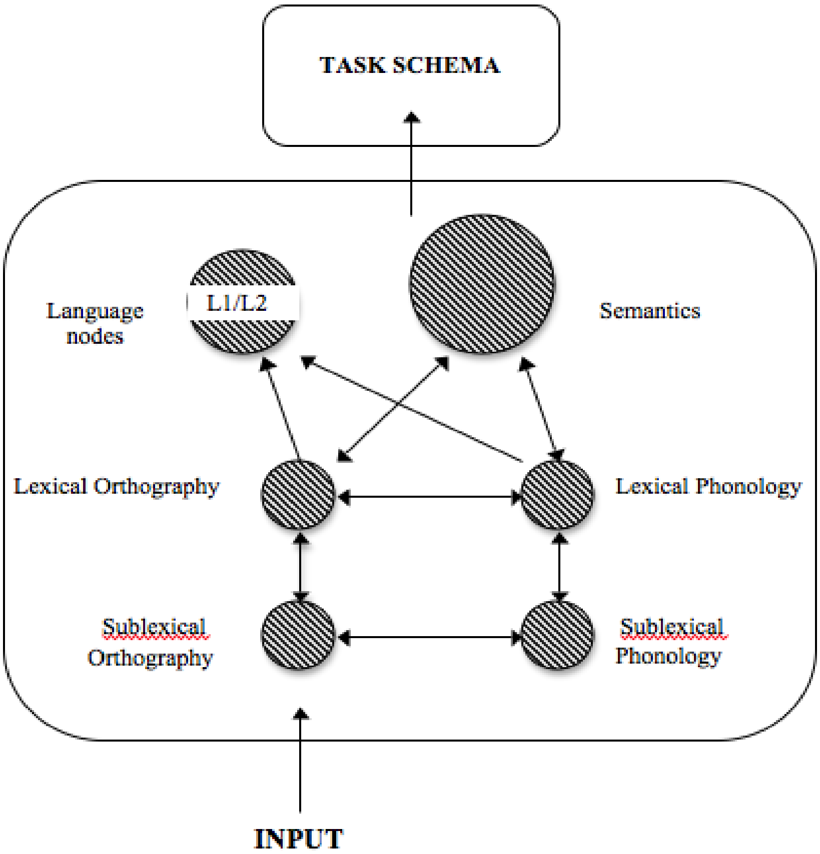


Figure 3.7: Flow chart sequencing language processing in the Bilingual Interactive Activation (BIA) model (Dijkstra, Van Heuven and Grainger, 1998; BIA+ Dijkstra, T., & Van Heuven, W., 2002) for bilingual word recognition. Adapted from Hoversten, L., and Traxler, M., (2016); *A time course analysis of interlingual homograph processing*; Evidence from eye movements *p*.348

A significant feature of the BIA model is that it consists of a shared lexical storage common to both L1 and L2 word nodes. The language nodes serve as language tags through which items are matched to their corresponding language for subsequent identification (Dijkstra et al., 1998). The activation of words in one-language results in the activation of items with the same language tag and subsequent inhibition of words with the opposite language tag (Bartolotti & Marian, 2012). Interestingly, language nodes are also able to carry over 'global lexical activation'; that is, activation from a previous trial to the next. Contrary to Green's ICM, the BIA models rely less on memory but instead relates language context to the processing level (Bartolotti & Marian, 2012).

3.7.2.2 Research evidence

Neighbourhood effects offer one way of investigating interference and hence activation of the languages. This refers to the potential capacity for phonological neighbours to inhibit or facilitate the recognition of the target word (Pugh, Rexer, Peter & Katz, 1994). The evidence is unequivocal (see, Marian & Blumenfeld, 2006; Dijkstra & Van Huven, 2002; Carreiras, Perea & Grainger, 1997) with differences attributed to the neighborhood size [15] and frequency[16].

Cognates and interlingual homophones (e.g. Zhou, Chen, Yang, & Dunlap, 2010; Conklin & Mauner, 2005; De Groot et al., 2000) have also been used to show that increased competition in the two activated languages leads to longer reaction times (See, Dijkstra & Van Heuven, 2002; also see Dijkstra, 2005 for a comprehensive review).

Priming studies[17] and repetition studies have largely supported a non-selective hypothesis in lexical access (E.g. Zhou et al., 2010; Zhao, Li, Liu, Fang & Shu, 2011; Grainger, 1998; see Neely, 1991 for a review). It is assumed that this unconscious exposure to a related or even the exact stimulus provokes early spreading of activation among the stored structures as a result of which the target word should be recalled in less time (Farells, Abrams & White, 2012).

3.8 Bilingual variant of Levelt's speaking model (De Bot 1992)

De Bot (1992) proposed a bilingual variant of Levelt's speaking model is an amalgamation of all that has been previously discussed above. Here the bilingual variant of the speaking model has a single conceptualizer, where the message is formed and

---

[15] Number of lexical units that composed the neighborhood.
[16] Influence of the frequency of the lexical units that compose the neighborhood.
[17] In semantic priming studies, the target word is preceded by a word that is semantically related or unrelated where as in phonologic priming, the preceding word is related to the target word in terms of its sound composition. In repetition studies, the exact word is presented before it is repeated slightly later as the actual target word.

refined similar to that described by Levelt (1989). In contrast to Levelt's language specific conceptualizer, De Bot (1992) argues that the conceptualizer's initial stage of large scale planning is not language specific though the subsequent levels of fine detailing could be. This allows the conceptualizer to form different pre-verbal messages for the bilinguals' two languages. In describing the bilingual's formulator, De Bot adopts the subset hypothesis (Paradis, 1987), which suggests the existence of one lexicon with two language specific sub-lexica. The formulator is supposed to be both shared and separate across the bilinguals' languages and depends on a number of factors. The most important of them are the linguistic distance between the languages and the bilingual's level of proficiency across the languages (De Bot, 1992). To justify the expanded word selection process and bilingual behaviors such as code switching when unable to retrieve a word from the language in use, De Bot's model assumes Green's (1986) proposal of different activation levels for lexical selection (i.e. selected, active and dormant). This implies that when speaking words will initially be chosen from the selected language, or from the active language and finally if necessary from the dormant language, with 'speaking time' as the manipulator. The model proposes an extended articulator; one of which the automatized syllable programs are likely correlated to language proficiency. The model also includes an extended system for the articulator where there is no systematic distinction between L1 and L2 (Marini & Fabbro, 2007). L1 is thought to be extended with the additional sounds of a newly learnt language and is represented by a common norm while sounds specific to a language, develop their own norm (also see De Bot, 1992 for foreign accent in L2).

3.9 Bilingual language behaviours

3.9.1 Language mixing and switching in healthy speakers

Code mixing specifically refers to the inter-sentential mixing of words and phrases from two language while code switching refers a switch in language due to a change in the speaking situation, topic or speaking partners (Basnight-Brown & Altarriba, 2007; Centeno, Anderson & Obler, 2007). The terminologies, code switching and code mixing have been used interchangeably in research literature. Code switching is a language behaviour that is increasingly accepted amongst most bilingual communities (Kamwangamalu, 1989). The quantity and patterns of code switching may nevertheless differ between languages (Heredia & Altarriba, 2001) and social contexts (Lee & Williams, 2001; Muysken, 2000). A review of code switching in Sri- Lankan Sinhala-English speakers is provided in Chapter 5.

Code mixing and code switching should also be distinguished from borrowing. This is critical in the frame of this language as Sinhala is a highly borrowed language.

For example, a Sinhala-English bilingual may code mix as follows; *"Mama nam ada office yanne sure ekata shortleave-ekak da:nna hithagena".* On the contrary, [*mama iskole yanne bus-eke*] uses a borrowed word (bus, for which there is no Sinhala equivalent translation]

The question of whether code switching reflects the bilingual's language proficiency (Bobb & Wodniecka, 2013) has been disputed. While some suggest greater language control by proficient bilinguals than those with asymmetrical language proficiency levels (Costa & Santesteban, 2004; Meuter & Allaport, 1999) there has also been instances where participant's less proficient L2 were readily substituted in an otherwise dominant L1 conversation (e.g. Boyd, 1993).

3.9.2 Pathological code switching in aphasia

Pathological code switching is described as a compulsive tendency to speak the language despite knowing the social inappropriateness of doing so (Fabbro, Skarp & Aglioti, 2000).

Cross-linguistic literature often reports of pathological code mixing and switching studies in the bilingual populations. For example, Chengappa, Daniel and Bhat (2004) reported a study of six bilingual Malayalam-English speakers diagnosed with aphasia post stroke. Although their findings did not reach a generalizable consensus, the authors did note that code mixing occurs at all levels (semantic, syntactic, morphological and phonological) and in all tasks, the normal and participants with aphasia only differed in frequency, with the latter group engaging in language mixing more after that before the stroke. They also noted that even in the healthy group, controls with less proficiency easily resorted to a language switch when they encountered a word block. This led them to conclude that increase in the code mixing and switching frequency for speakers with aphasia was simply a compensatory mechanism to the encountered language deficit.

Heredia and Altarriba (2001) addressed substitution L2 when WFD occurred in L1, suggesting that code switching necessarily occurs as a counterstrategy to a momentary word retrieval difficulty. When a word finding difficulty occurs in the selected language, even if it is L1, it is easier and less time consuming to switch and retrieve the word from the non-selected language, even if it is L2. This claim is also supported by study findings that shows language switches to be a less controlled, more difficult, slower and erroneous process in older bilinguals whose executive processing skills are compromised (see, Hernandez & Kohnert, 1999).

Bhat and Chengappa (2005) also noted that L2 words were used as borrowed words, even when they did not fit the criteria to be identified as a borrowed word. This led the authors to conclude that language and social context was a crucial aspect in understanding the specifics that underlie language mixing and switching.

Ansaldo, Marcotte, Centeno, Anderson and Obler (2007) report EL a right handed native Spanish-English bilingual speaker, who after a stroke showed pathological language mixing and switching. Analysis showed that a difficulty in accessing the phonological form of language A co-occurred with a difficulty in suppressing its equivalent in language B. It was thus suggested that the failure in activation flow of the target language and/or insufficient inhibition of the competing language resulted in pathological code mixing or code switching, which is then further modulated by task demands (also see, Price, Green & Von Studnitz, 1999).

3.10 Summary

Psycholinguistic research in bilingualism has expanded immensely, individually addressing bilingual language processing at each representational level (lexico-semantic and morpho-syntactic). Despite this, research in bilingual language processing is without a doubt more complex and controversial than monolingual research. Due to the presence of an additional language and subsequent competition within and between the languages, research data and findings in bilingual studies are not so straightforward and are highly vulnerable to argument.

Despite the challenges and differences, research evidence suggests that bilingual speakers and listeners are able to maximally utilize the universally shared language features to cohesively represent all the languages they know. Valid and reliable research evidence is then a timely need as it provides the researcher and clinician with a framework for developing and testing diagnostic and therapeutic resources for the bilingual speaker with aphasia.

Chapter 4: Noun and verb processing in aphasia

4.0 Overview

Some of the most robust evidence for the process of spoken word production comes from research involving the production of nouns and verbs. Research evidence on nouns and verb production has been discussed in developmental research involving healthy young children (e.g. Bassano, 2000; Jackson-Maldonado, Thal, Marchman, Bates & Gutierrez-Clellen, 1993; Piccin & Waxman, 2007) and children with specific- language impairment (e.g. Sheng & McGregor, 2010), neuropsychological and neuroimaging research that investigate neural differentiation in the cortical representation of nouns and verbs (e.g. Moseley & Pulvermuller, 2014; Tyler, Russell, Fadili & Moss, 2001; Shapiro, Moo & Caramazza, 2006), behavioral findings in healthy adult speakers showing differences in performance on nouns and verbs in a variety of tests (e.g. Shao, Roelofs & Meyer, 2012; Szekely et al., 2005; Vigliocco, Vinson, Damian & Levelt, 2002; Masterson & Druks, 1998) and research investigating category specific deficits for nouns and verbs in persons with brain lesion (e.g. Bird, Howard & Franklin, 2000; Hillis & Caramazza, 1991; Goodglass, Wingfield, Hyde & Theurkauf, 1986). Behavioral studies investigating lexical access in healthy speakers and speakers with brain lesion have tested noun and verb production across a number of experimental tasks including oral and written picture naming, naming from definition, short term word recall tasks, oral reading and sentence completion.

This chapter discusses nouns and verbs as a measure of spoken word production. It includes details on the noun-verb dissociation seen in speakers with aphasia, methods of noun-verb assessment and variables that influence picture naming as a method of noun-verb assessment.

4.1 Differences in the linguistic structure of the noun and verb

Almost all languages of the world have words that can be categorized as nouns and verbs (Laudanna &Voghera, 2002). Nouns and verbs are frequently distinguished based on their differences in their linguistic structure (Bird, Howard & Franklin, 2000; 2003). One such difference between nouns and verbs is that in the former, the underlying concept of the noun is definite, stable (concrete) and imageable. Verbs in contrast, demonstrate a shallower semantic organization, shared semantic features and more than one permissible argument structure (see, Vinson & Vigliocco, 2002). Bird, Franklin and Howard (2001) note that verbs and nouns differed in terms of sensory and functional features. Sensory features refer to word information that is heavily based on senses, particularly vision while functional features refer to information on their functional-motoric attributes. When compared nouns had more sensory features while verbs had a greater proportion of functional features. The higher sensory features in the noun implied greater semantic richness and higher imageability.

Further nouns, particularly concrete objects and some abstract nouns (e.g. facts) are more countable while verbs that most often involve actions are more transient. This directly contributes toward the higher concreteness of nouns than verbs.

Nouns and verbs also differ in terms of the relative frequency with which they occur within the language. In English, the number of nouns are greater than the number of verbs. Yet, the token frequency of some verbs such as *give, see, go* are higher than of most nouns (Matzig, Druks, Masterson &Vigliocco, 2009). The effect of frequency difference is often addressed in language acquisition studies suggesting that despite this frequency difference nouns are still acquired earlier than verbs (Goodman, Dale & Li, 2008; Bird, Howard & Franklin, 2001). This however may not be true always (see, Tardif, 1996; Choi & Gopnik, 1995; also see, Naigles & Hoff-Ginsberg, 1998)

The fact that a verb may have more than one argument structure has also been cited as a possible reason for noun-verb differences. Kim and Thompson (2000) in a study involving speakers with agrammatic aphasia showed that verbs with such multiple arguments may cause difficulties not only at sentence level but also when it involved picture naming, even though single word naming did not require the arguments to be produced.

Conceptual-semantic and grammatical complexity is a yet another key feature that differentiates between nouns and verbs. In most languages, nouns represent more stable and cohesive entities. In comparison to most nouns, verbs are associated with a larger number of parameters such as tense, aspect, number and gender (Shapiro & Caramazza, 2003). It is possible that lesser morphological complexity in nouns facilitates quicker processing resulting in faster naming latencies (Kauschke & Von-Frankenberg, 2008).

Despite the key grammatical noun-verb difference outlined above, it is important to note that these differences can largely vary both across and within languages (Laudanna & Voghera, 2002).

4.2 Spoken word production in speakers with aphasia

4.2.1 The noun-verb dissociation

Word finding difficulties (WFD), that is a person's difficulty in correctly retrieving words from the mental lexicon for specific referents (Andreetta, Cantangallo & Marini, 2012) occur as a result of disruption to the process of lexical production (Laine & Martin, 2006).

Comparisons of noun and verb processing have been a key method for investigating WFDs, particularly in speakers with brain lesions. Although a vast majority of research support the notion that verbs are more difficult to process than nouns, this finding is not unanimous.

Research in support for claims of different cognitive mechanisms and neural specificity describe a double disassociation between noun and verb production in speakers with brain injury. Here, disassociation refers to the differential impairment of two related functions. Better performance of PwAs in the production of names or nouns than verbs or action words have been reported (e.g. Kambanaros, 2010; Kim & Thompson, 2000; Bastiaanse & Jonkers, 1998). A reverse profile has been reported for some others who manifest a superior verb production in comparison to impaired nouns (e.g. Marshall, Chiat, Robson & Pring, 1996b; Zingeser & Berndt, 1990). The occurrence of both scenarios where noun retrieval is greater than verb retrieval and vice versa, it is termed a double dissociation (see, Druks, 2002; Mätzig & Druks, 2006 for review).

Double dissociation within aphasia has also been reported within single patients across different language modalities and tasks (e.g. Crepaldi, Ingignoli, Semenza & Luzzatti, 2006; Rapp & Caramazza, 2002; Bastiaanse & Jonkers, 1998; Hillis & Caramazza, 1995) and across languages in bilingual speakers (e.g. Kambanaros, 2010; Kambanaros & Van Steenbrugge, 2006)

In bilinguals, noun-verb dissociation has been reported across the languages. For example, Kambanaros (2009) in a study on a group of late bilingual Greek-English anomic PwAs noted that participants performed better on verb retrieval scores with the native (Greek) language than in the later learnt English, yet, have an equal level of impairment on noun retrieval in both the languages.

Language selective noun superiority was also reported by Poncelet, Majerus, Raman, Warginaire and Weekes (2007) who reported one Turkish-English and two German-French bilingual PwAs that showed better noun production scores in both languages and greater noun-verb dissociation for L2.

Similarly, Faroqi-Shah and Waked (2010) reported NK, a 43-year-old right-handed Arabic-French-English trilingual, whose three languages differed in the age learnt and relative proficiency and usage. When assessed NK's naming performance showed a noun-verb disassociation, that is a relative verb impairment across all language tasks.

Although a majority of findings are suggestive of noun-verb word class asymmetry, there have also been research findings that have reported the absence of a word class dissociation (see, Kambanaros, 2016).

4.2.2 Theories of noun-verb disassociation

Several viewpoints have been formulated to explain the occurrence of a double dissociation.

Firstly, studies investigating neural specialization for linguistic and conceptual knowledge have postulated distinct neurological representations for nouns and verbs. The notion of a neuroanatomical boundary that segregates between the two word classes (Caramazza & Hillis, 1991) allows the possibility of selective sparing.

For example, Shapiro and Caramazza (2003) compared their patient RC who manifested significant verb impairment with a previously reported subject JR who showed significant noun impairment. Despite the shared locus of damage at the left frontal and insular cortical areas, R.C.'s and J.R.'s neuroimaging data showed differences in the extent of lesion, particularly in terms of the other cortical structures damaged. These differences between R.C and J.R in respect to their neurological profile and behavioral observations led the authors to speculate the existence of both shared and divergent neural processing pathways for nouns and verbs. Similar findings suggestive of cortical specialization for nouns and verbs have been reported in both healthy speakers and speakers with brain lesions (e.g. Fargier & Laganaro, 2015; Lubrano, Filleron, Demonet, Jean-Francoi & Roux, 2014; Shapiro, Moo & Caramazza, 2006; Soros, Cornelissen, Laine & Salmelin, 2003; Daniele, Giustolisi, Silveri, Colosimo & Gainotti, 1994).

A second viewpoint explains these differences through the discrete models of spoken word production that use the lemma-lexeme dichotomy (Levelt, Roelofs & Mayer, 1999). In Levelt's model (1989; 1999) it is mandatory that speakers' first retrieve the lemma, which involves the word and its syntactic information followed by its morpho-phonologically encoded form, the lexeme. Although successful lemma retrieval is required for the retrieval of the lexeme, an accurately realized lexeme does not necessarily follow a successful lemma selection (also known as the tip-of-the-tongue phenomenon) (Nozari, Kittredge, Dell, & Schwartz, 2010). Verb retrieval failure is attributed to one of these stages or both. The exact locus remains controversial. Some suggest that the dissociation occurs at the level of lemma selection which is manifested through impaired syntactic properties to the verb (e.g. Crepaldi et al., 2006; Kim & Thompson, 2000). Others assume failure at the lexeme level which then would manifest as the absence of the target verb despite having successfully retrieved the noun (e.g. Rapp & Caramazza, 2002; Kambanaros, 2009).

For example, Kim and Thompson (2000) reported findings from seven agrammatic PwAs on battery of tasks that tested nouns and verbs on comprehension, naming, categorization and a grammatical judgment task[18]. Findings showed a selective deficit for verbs in the naming task, categorization task and grammatical judgment task but not in the comprehension task. Further, in the grammatical judgment task, subjects showed better performance when the complexity level of the argument structure was decreased. The authors concluded that these findings implicate difficulty in accessing the relevant verb related information and therefore indicative of failure at the lemma level.

In contrast, Rapp and Caramazza (2002) reported of a single-case KSR who showed modality specific dissociation for nouns and verbs. Here, nouns were relatively more impaired in the oral production task and verbs in the writing task. The authors

[18] Involves the judgment of grammatical accuracy as good or poor when a sentence was provided as a stimulus.

concluded that the locus of failure cannot be at the lemma level, since damage at the semantic level should ideally cause an identical dissociation across all modalities. This inference was argued by Crepaldi et. al. (2006) who noted that while it correct to not localize the failure to the lexeme level based on the differential impairment patterns across modalities, it does not imply that the observed noun-verb differences may not have been a result of the associations between the lemma and the syntactic information

An alternative perspective is that a verb- noun dissociation implies a loss of specific conceptual features, which are sensory features in nouns and functional features in verbs postulated by Bird et al. (2000; 2003). The general notion is that the higher imageability and concreteness of nouns contribute in relatively better access and retrieval (Bird et al., 2003). This is not always true. Marshall, Chiat, Robson and Pring (1996a) reported of a patient RG who demonstrated an inverse imageability effect which involved a better understanding of low imageability words and better naming performance when presented with abstract cues. RG's specific loss for visual semantic information was accompanied by a selective noun impairment (comparatively more impaired than verbs) in which concrete nouns were replaced by abstract circumlocutions, could not perform tasks such as drawing or describing objects by memory and showed to a higher number of errors on nouns in connected speech.

Despite such variations, the loss of features may lead to a mismatch between the critical semantic variables (such as imageability and concreteness) across nouns and verbs leading to one selective impairment in one word class over the other (Rapp & Caramazza, 2002). A greater number of studies, which report a superior noun performance, suggest that verbs are possibly more vulnerable to the loss of perceptual and functional features leading to a comparative deficit in production (also see, Marshall et al., 1996a; 1996b).

4.2.3 Differentiating between noun and verb, object and action

An argument arising from the semantic/functional feature loss theory is the controversial distinction between nouns/verbs and object/actions. The controversy lies in the fact that while nouns and verbs constitute a grammatical class category, objects and actions, which are almost always substituted for nouns, and verbs in picture naming tests constitute a conceptual category (Bi, Han, Shu & Caramazza, 2007). Evidence for this distinction has primarily been drawn from studies that describe verb-noun dissociations in their patients as a consequence of a selective involving conceptual variables (e.g. Marshall et al., 1996a; 1996b) and others that attribute the dissociation to deficits in grammatical processing (e.g. Shapiro & Caramazza, 2003). Others argue that conceptual organization and grammatical processing within the semantic system are strongly correlated and therefore representative of each other.

4.3 Connected speech in aphasia

Discourse refers to the way in which a language is structured above sentence level (Armstrong, 2000). Connected speech is required to combine units of information in a coherent manner and grammatically permissible manner within the spoken language in order to convey a successful message. The use of connected speech (also discourse and conversational analysis) has been greatly advocated for several reasons. Firstly, connected speech tasks involve the complex cognitive-linguistic behaviours as they occur in natural communication (Fergadiotis & Wright, 2011). Secondly, nature of language deficits within its typical contextual use captures the person’s impairment within the World Health Organization’s (2012) International Classification of Functioning Disability and Health (ICF) (Bryant, Ferguson & Spencer, 2016). Further it also allows identifying isolated impairments, difficulties and strengths that occur in a situation where a number of linguistic domains interact. Findings here may be significantly different from situations where individual domains are assessed in isolation (Marini, Andreetta, del Tin & Carlomagno, 2011).

Studies that have attempted to compare performance across naming and connected speech (e.g. Mayer & Murray, 2003; Pashek & Tompkins, 2002; Zingeser & Berndt, 1990) or investigate the relationship between naming and connected speech data (e.g. Herbert, Hickin, Howard, Osborne & Best, 2008) are few. Evidence from such studies are crucial in understanding the interaction of phonologic, syntactic and semantic factors in speech production in expanding our understanding of normal and aphasic word retrieval in relation to the models of speech production and also in providing critical evidence with regard to therapeutic techniques that aim to generalize treatment for word retrieval at single word level in to every day speech (Schwartz & Hodgson, 2002).

There are two possibilities that may occur as a result of comparing word retrieval skills in single word production tasks and connected speech.

First there is a possibility that PwAs who are accurate and intelligible at single word level may fail when tested on connected speech. This notion is supported by evidence of superior word retrieval performance in single word naming tasks than for connected speech. For example, Wilshire and McCarthy (2002) reported of a patient B.M. who was tested across a range of expression and comprehension tasks including naming, personal narratives and a story narrative. Findings showed that despite the patient's credible scores on a naming, his word recall was severely impaired (also see, Schwartz & Hodgson, 2002). Wilshire and McCarthy (2002) suggested that in the context of the competitive activation and selection process that are proposed across the models of spoken word production (e.g. Levelt, 1989; Levelt et al., 1999; Dell, 1986; Dell, Schwartz, Martin, Saffran & Gagnon, 1997), a disproportionate performance in single word naming and connected speech could be attributed to the fact that the levels of competition may vary across the tasks. That is, in naming one target name is obviously more superior to the others while connected speech may have a number of equally eligible items that are possibly conceptually related to each other. Therefore word retrieval in confrontational naming is easier as a result of the comparatively less competition that occurs.

Conversely, it can be argued that semantic facilitation that occurs with and across lexical levels (semantic, syntactic and phonologic) in connected speech may influence better word retrieval performance (Pashek & Tompkins, 2002). This has been supported with reports of patients with superior word retrieval ability in connected speech as oppose to confrontational naming tasks. For example, Pashek and Tompkins (2002) compared lexical retrieval ability for nouns and verbs across confrontational naming and a video narration task in 20 PwAs with mild aphasia. Findings showed a greater word production difficulty for confrontational naming than for the video narration task (also see, Mayer & Murray, 2003; Zingeser & Berndt, 1990 for similar findings).

In summary, the differential performance across spoken word naming and connected speech tasks has been discussed as the distinct paradigmatic and syntagmatic competition that occurs due to the differences in the context dependent linguistic (e.g. syntax, pragmatic requirements) and non-linguistic (e.g. levels of attention) demands imposed by a given task, on the process of spoken word production (Pashek & Thompson, 2002; Penn, 2000).

4.4 Assessment methods of word retrieval

4.4.1 Picture naming tests (PNTs)

The many concrete objects and pictureable actions available allow the development of pictorial stimuli, which are then used in elicitation tasks. As a result picture-naming methods are predominated in aphasia research (see Kauschke & Von-Frankenberg, 2008). Clinically, naming is a global assessment method (Szekely et al., 2005). The Boston Naming Test (BNT; Kaplan, Goodglass & Weintraub, 1983), the *Object Action Naming Battery* (OANB; Druks & Masterson, 2000), Snodgrass and Vanderwart's (1980) standardized set of 260-pictures, Philadelphia Naming Test (PNT; Roach, Schwartz, Martin, Grewal & Brecher, 1996), Action Naming Test (ANT; Obler & Albert, 1979) are a few examples of commonly used test stimuli for picture naming.

PNTs have many advantages. Firstly, they are quick and easy to administer. It usually involves a manageable scoring design and analysis method, which is particularly useful in clinical setups (Herbet et al., 2008). Test findings in PNTs are more predictable given that test administration and analysis methods also stay uniform across all contexts in which those tests are used. When developed through a sound psychometric process, PNTs have high test-retest reliability, high intercorrelations and also generate a cumulative test score that is able to reflect the deficits in word retrieval in connected speech (Herbert et al., 2008). PNTs also provide a thorough and systematic procedure that allows the assessment of the multiple cognitive process that underlie spoken word production.

There are also several drawbacks to PNTs. Firstly, there have been questions regarding their ecological validity based on evidence that PNTs are unable to reflect the actual severity of WFD in everyday (connected) speech (Helms-Estabrooks, 1997). There has been much variability across findings that have been reported by the many studies that have investigated the relationship between word retrieval ability across naming and connected speech (see, Fergadiotis & Wright, 2015; Herbert et al., 2008; Mayer & Murray, 2003; Pashek & Tompkins, 2002). Further, semantic (prototpicality, concept familiarity), lexical (age of acquisition, naming agreement, word frequency) and visual (image agreement, visual complexity) variables that influence picture naming

(Laiacona, Luzzatti, Zonca, Guarnaschelli & Capitani, 2001) differ significantly for object and action stimuli. Hence when a picture paradigm incorporates both object and action stimuli (e.g. OANB), there is a significant challenge to create large numbers of action and object stimuli which are symmetrically matched across the many dimensions (Szekely et al., 2005; Bird et al., 2003). There have been attempts to address this discrepancy such as replacing short videos or dynamic clips for actions and still images for objects. The validity of these methods have been questioned (Mayer & Murray, 2003). There are also limitations in the cross cultural adaptation of PNTs, where in stimuli, scoring and test reliability is often highly compromised when used in contexts other than the population it was intended for (Chen et. al., 2014).

4.4.2 Analysis of connected speech samples

The ability to speak spontaneously is of primary concern to PwAs and their caregivers (Cruice, Worrall, Hickson & Murison, 2003). Clinically, it provides a near-natural context in which WFD can be identified (Brookshire & Nicholas, 1997).

Connected speech samples however pose a number of methodological challenges. Firstly, connected speech also has no one framework for data gathering or data analysis.

Studies report of a wide variety of task choice, which include semi-spontaneous speech elicited by situational pictures (e.g. cookie theft) or story re-telling (e.g. Cinderella story or videos), semi spontaneous speech elicited by role playing, spontaneous speech in a conversation dialogue between the patient and a known conversation partner and spontaneous speech elicited by a conversation method such as an interview where if moderated by using open questions, the patient is able to elicit a larger quantity of uninterrupted speech than in a normal dialogue (see Linnik, Bastiaanse & Höhle, 2016; Prins & Bastiaanse, 2004 for a review). It is important to note here that not all of the aforementioned methods fulfil the requirement for a naturalistic representation of real-life speech (Prins & Bastiaanse, 2004).

There also can be subtle differences within a task such as the choice of conversation partners or the setting in which samples were obtained. For example, although both Herbert et al. (2008) and Mayer and Murray (2003) studies obtained conversational samples, the former used a home recorded conversational samples with a known conversation partner while the latter obtained conversational samples with the examiner, at a formal test setting site. In terms of analysis, some opt to rate aspects of the patient's language on restricted scales (e.g. phrase length, grammatical forms) while others incorporate methods that quantify linguistic variables (e.g. mean length of utterance, type-token ratio, percentage of function words). Analyses have also included raw scores (Pashek & Tompkins, 2002), percentage scores (e.g. Mayer & Murray, 2003) and proportion scores (e.g. Herbert et al., 2008). Consequently, incorporating connected speech measurements in clinical settings is greatly challenging (Armstrong, 2000). Significant variations in task choice and analysis methods also impede a systematic analysis of discourse by limiting the possibility of comparing findings from across studies (Prins & Bastiaanse, 2004).

4.4.3 Error analysis

Despite the unpredictable and diverse nature of language breakdown in aphasia, a thorough understanding of the nature and locus of speech errors are of paramount importance, particularly in the treatment of aphasia. Clinically, the only available information lies within the final articulated response of the speaker and requires that the clinician derive information and interpret this to identify the exact locus of breakdown (Gordon, 2007). One successful method used to obtain this critical information has been the analysis of aphasic errors relative to the models of speech processing (Kay & Ellis, 1987).

Error analyses are often reported with picture naming studies (e.g. Kittredge, Dell, Verkuilen & Schwartz, 2008; Dell et al., 1997; Cuetos, Aguado, Izura & Ellis, 2002*)* but have also been integrated in to analyses of connected speech (e.g. Marini et al., 2011).

The primary aim of conducting an error analysis is to classify and categorize error types, understand the intrinsic and contextual relationships of the error to the target in order and understand how the PwA has departed from the known population norms. (Wilshire, Coslett, Nadeau & Crosson, 2000; Dell et al., 1997). Error analyses provide a valuable insight to both the normal and impaired processes of word production together with imperative data for clinical use.

4.5 Factors influencing word retrieval in aphasia

Variables which effect picture stimuli are of three main categories; perceptual (visual complexity and image agreement), semantic (prototypicality and concept familiarity) and lexical (word frequency and name agreement) (Laiacona et al., 2001).

4.5.1 Name agreement

Name agreement (NA) or codability refers to the degree with which people agree on the name of a particular image (Bose & Schafar, 2017; Alario et al., 2004). The greater the number of alternative names, the lower the name agreement scores. NA may also vary as a property of the image where some nouns may have a single name and some others have multiple (Bose & Schafar, 2017; also see, Snodgrass &Vanderwart, 1980).

4.5.1.1 Methods of measurement

NA is measured by asking participants to either verbally say or write down the first name that comes to their mind when presented with a picture stimulus. Often, though not always response analysis is accompanied by a reaction time (RT) measurement.

4.5.1.2 Evidence in healthy adults

Numerous behavioural studies have shown that faster (less response time) and accurate picture naming occurs for stimuli with higher NA (see, Britt, Ferrera & Mirman, 2016; Ellis & Morrison, 1998; Vitkovitch & Tyrrell, 1995). Shao et al. (2012) in a study that involved 25 healthy Dutch speaking adults reported supportive electrophysiological evidence that showed longer reaction times and larger event related potential (ERP) N2 amplitudes for naming stimuli with low name agreement (also see, Cheng, Schafer & Akyurek, 2010). NA is also known to be a high stimulus dependent variable. Therefore, language and region specific data has been encouraged particularly for NA, since people across regions and countries may use different names to identify the same stimulus (see Sirois, Kremin & Cohen, 2006).

4.5.1.3 Evidence in aphasia studies

Limited studies have investigated NA in PwAs post-stroke. Laiacona et al. (2001) in a study involving 49 PwAs, assessed the effect of perceptual, lexical and semantic variables on 60 pictures across six categories. Findings reported individual differences in naming performance that was highly associated with NA, followed by word frequency.

Similarly Bose and Schafer (2017) compared naming in 50 high NA and 50 low NA stimuli between two groups of 10 speakers with aphasia and 21 matched healthy adults. Findings revealed that stimuli with a high NA had a higher accuracy score than stimuli with a low NA in both PwAs and healthy controls (also see, Nickels & Howard, 1994).

4.5.1.4 Locus of NA

Diverse theories have been postulated. In relation to the model of word recognition, Sperl (2011) suggests NA effect has its locus at lemma selection. Alternatively, Alario et. al. (2004) postulates NA to be a function that takes place between the conceptual and lexical stages. Citing evidence that show images with low NA to generate more alternative names, the authors note that an image with low NA then possibly stimulates more competitors than an image with high NA would do leading to longer response latency measurements.

4.5.2 Age of acquisition

Age of acquisition (AoA) particularly compares words learnt in early childhood, late childhood or adulthood (Izura & Ellis, 2002) and is suggestive of the age at which the word is put to significant use in language and memory tasks (Stadthagen-Gonzalez & Davis, 2006). The expected outcome is that words learnt early in life, are processed quicker and with more accuracy than words learnt later (Perez, 2007). There has also been evidence from aphasic speech data that shows that words learned early in life are more resistant to brain injury (see Brysbaert & Ellis, 2015).

4.5.2.1 Methods of measurement

Some studies employ ‘objective’ methods such as deriving norms from child naming data (Perez, 2007; Meschyan & Hernandez, 2002; Morrison & Ellis, 2000) although the validity of objective measures have been questioned (see Chalard, Bonin, Meot, Boyer & Fayol, 2003). Alternative approaches involve ‘subjective’ self-rating methods such as directly selecting predetermined age bands (Carroll & White, 1973; Gilhooly & Logie, 1980; Stadthagen-Gonzalez & Davis, 2006) or asking participants to estimate in years as to when the word was learnt and subsequently being assigned to predetermined age bands (Stadthagen-Gonzalez & Davis, 2006; Alario & Ferrand, 1999; Snodgrass & Vanderwart, 1980).

4.5.2.2 Evidence in healthy adults

Alario et al. (2004) reported of a large-scale response timed picture-naming experiment in which 388 black and white pictures were tested on 46 adults for nine variables as predictors of picture naming. Their findings suggested age of acquisition to be a clear and independent determiner of picture naming (also see Carroll & White, 1973; Meschyan & Hernandez, 2002). Studies reporting AoA as a strong predictor of picture naming have also been reported across languages other than English (e.g. Severens, Van Lommel, Ratinckx & Hartsuiker, 2005; Morrison et al., 1997). Lewis, Gerhand and Ellis (2001) however proposed that AoA and frequency together produce a cumulative effect (known as the cumulative frequency hypothesis) and are not independent predictors of response speed (also see Ellis & Lambon Ralph, 2000).

In bilingual studies, AoA ratings are differentiated between L1 and L2 citing decisive factors such as language-based differences (Chalard et al., 2003), critical period learning for L2 and level of proficiency (see, Hakuta, Bialystok & Wiley, 2003; Kohnert, Hernandez & Bates, 1998); a claim that has been supported by neuroimaging evidence suggestive of dedicated neural systems as a result of early learning (Hernandez & Li, 2007). Despite this, critics of the critical period notion suggest that the AoA effect in the bilinguals' L2 is provoked with the acquisition of the L2 word form for an already known L1 word, which in turn, regardless of age will alter old and new lexical links, even those of L1 (see Izura & Ellis, 2002).

4.5.2.3 Evidence from aphasia studies

Nickels and Howard (1995) in two related replicated studies using 130 line drawings compared objective AoA data in study 1 to the subjective AoA data in study 2. Findings showed AoA as a significant predictor in both studies. When singled out with multiple regression, AoA was shown to influence naming in only some patients (also see Cuetos, et al., 2002; Bonin, Peereman, Maladier, Meot & Chalard, 2003).

4.5.2.4 Locus of AoA

Steyvers and Tenenbaum (2005) proposed age of acquisition to be influential at the level of lemma (name) retrieval. This was based on evidence that suggested AoA to be a reliable predictor of object naming, though not of object recognition. They postulated that as the network of lexical nodes in an individual's semantic system grows, new nodes connect to existing ones as a function of their already active connections. Consequently, early-acquired nodes form the core of an existing network which then allows a greater activation of associated lemmas, less competition and a quicker production of the newly learned word (see Morrison, Ellis & Quinlan, 1992; also see, Brysbaert, Wijenendaele & De Deyne, 2000).

4.5.3 Familiarity

Concept familiarity refers to how familiar one is of the depicted stimulus (Alario et al., 2004). Familiarity plays a critical role in retrieval in terms of the effects it has on cognition and memory. The more familiar the item, the easier access to the cognitive store and so retrieval is quicker as it could be seen on short naming latencies.

In recent times, concept familiarity has replaced word frequency as a more reliable and accurate measurement (Connine, Mullennix, Shernoff & Yelen, 1990) since the latter (as seen in the Kuçera-Francis frequencies) fails to differentiate between the metaphoric and actual usage. For example, [*car*] and [*tyre*] could be both rated high frequency due to its relatedness but may differ in familiarity counts if the actual usage was to be rated (Colombo, Pasini & Balota, 2006; Gernsbacher, 1984; Snodgrass & Vanderwart, 1980).

4.5.3.1 Methods of measurement

Familiarity is usually measured on a subjective likert scale. The rater is instructed to contemplate on how familiar the item is and how much contact is made with the item shown, in their realm of experience. Snodgrass & Vanderwart (1980) noted that concept and word familiarity should be distinguished in order to ensure better rating accuracy. For example, a speaker could be familiar with the words [*house*] and [*home*] but not familiar with how they conceptually differ.

4.5.3.2 Evidence from healthy adults

Schmitter-Edgecombe, Vesneski and Jones (2000) in a study on aging and word finding tested two groups of younger and older adults on the Boston Naming Test (BNT; Kaplan, Goodglass & Weintraub, 2001) items. Findings indicated four items on which the older and younger group significantly differed (yoke, trellis, palette, and abacus), were rated as unfamiliar by the younger group and could not be named even when cued. When these items were removed the difference in naming scores between the groups and correlation of naming performance with age, which were both significant before, disappeared.

4.5.3.3 Evidence from aphasia studies

A strong correlation exists between familiarity and AoA (Dorry, 2010). Evidence suggests familiarity to be a significant predictor of naming although its influence did not remain when singled out (Cuetos et al., 2002; Nickel & Howard, 1995).

4.5.3.4 Locus of familiarity

Word familiarity plays a critical role in word recognition and is thus related to meaningfulness. High familiarity results in high threshold levels for a concept or word leading to elevated identification threshold and fast responses (Colombo et al., 2006).

Familiarity is therefore attributed to the semantic/conceptual level at which word recognition takes place.

4.5.4 Imageability

Imageability is defined as the ease with which a word gives rise to a sensory mental image (Bird et al., 2001). Nickels and Howard (1994) note imageability to be greatly associated with concreteness and together actually reflects the semantic richness (or poorness) of a stimulus, as a result of which imageability and concreteness are recognized as significant determiners of naming. Although both variables are rated on visual scales, this relationship may not quite be true always given that the later could be perceived as a tactile sensory measure by some (see Lynott & Connell, 2013; also see, Bird et al., 2001; Altarriba, Bauer & Benvenuto, 1999).

4.5.4.1 Methods of measurement

Ratings for imageability usually involve 3 point, 5 point or 7 point rating scales. High scores on the rating scale generally imply that the stimulus readily generates a visuo-sensory image and vice versa. (E.g. Crepaldi., Che, Su, & Luzzatti, 2012; Bird et al., 2001; Gilhooly & Logie, 1980)

4.5.4.2 Evidence in healthy adults

Word imageability has been cited as a reliable predictor of early learning (Ma, Golinkoff, Hirsh-Pasek, McDonough & Tardif, 2009) and a significant contributor to the noun advantage, particularly in the child lexicon (Gentner, 1982). Imageability has also shown high correlation with age of acquisition (see Bird et al., 2001; Crepaldi et al.,2012). Research in healthy adults has shown imageability to play a significant role in reading, word association and picture naming (Crepaldi et al., 2012; Strain, Patterson, & Seidenberg, 1995) although this evidence is equivocal.

Nickels and Howard (1994) asserted that in picture naming imageability is of least concern. Based on the relationship between concreteness and imageability, they noted that it is quite probable most stimuli selected for a confrontational naming test were selected because they were possibly at the high end of an imageability scale, in the first place (see Bird et al., 2001)

4.5.4.3 Evidence from aphasia studies

Differences in imageability across grammatical classes has been cited as one possible reason for noun verb disassociation seen in PwA, although there has been no definite data on how it affects word retrieval in aphasia (see, Crepaldi et al., 2006; Berndt, Haendiges, Burton & Mitchum, 2002; Bird et al,, 2001). Bird et al., (2003) tested four PwAs and healthy controls on categorical naming, lexical categorisation tasks, reading and writing of verbs and nouns. Findings showed an initial noun verb disassociation in both PwAs and healthy speakers, which disappeared when imageability was controlled. This implied that imageability was a critical factor, particularly at single word level.

Kiran and Tuchtenhagen (2005) in a study involving Spanish-English bilingual adults on a naming to definition and a semantic priming task showed that controls and PwAs accessed and named concrete words faster than abstract words, in both languages. Findings also noted that the imageability effect on naming was not affected by the language proficiency level of the bilingual speaker and the influence of imageability remained the same even for those with asymmetrical language profiles.

4.5.4.4 Locus of imageability

It is presumed that in naming, the first step of image finding and selecting is directly dependent on imageability. Based on evidence that suggests a strong relationship between imageability and the recognition/naming of words, the effect could be possibly localized to the conceptual/semantic level.

With reference to bilingual speakers, it is assumed that in the interconnected L1 and L2 systems of a bilingual speaker, highly imageable words are shared via both verbal and imagery referents while for low imageable words, sharing only occurs via the verbal system (Paivio, 1991).

4.5.5 Visual complexity

To name an object, the stimulus needs to be recognized and its phonological form accessed. The latter may be constrained by aspects of visual recognition (Humphreys, Price, & Riddoch, 1999). Visual complexity (VC) refers to the clarity with which a stimulus has been depicted and its effect on one’s ability to recognize the picture (Nickels & Howard, 1995).

4.5.5.1 Methods of measurement

VC is usually measured on subjective rating scales; often where a higher rating score corresponds to greater visual complexity (e.g. Bonin et al., 2000; Alario & Ferrand, 1999; Gilhooly & Logie, 1980). Raters usually require guidance to understand that the rating is a reflection of the intricacy of the illustration and not the complexity of the real-life item or action (Snodgrass & Vanderwart, 1980).

4.5.5.2 Evidence in healthy adults

Sirois et al., (2006) noted visual complexity to be a significant factor much like NA. The differences of VC rating across populations led the authors to conclude that VC as in NA were more population dependent that other variables such as AoA (also see, Britt et al., 2016). Although VC is assumed to effect the performance of PwAs with visual agnosia (Riddoch & Humphreys, 1987; 2016) other studies have argued that VC *per se* does not significantly influence the aphasic speaker’s ability to name (see Nickels & Howard, 1995).

4.5.5.3 Evidence in aphasia studies

Evidence of a greater impairment in structurally similar stimuli than structurally dissimilar ones has been reported in PwAs (see Humphreys et al., 1999).

Crepaldi et al. (2012) based on a study involving Chinese-speaking PwAs noted that VC specifically influences performance in picture naming but not word naming.

4.5.5.4 Locus of visual complexity

Visual complexity has an impact on the foremost process of word retrieval, that is, object recognition. In PNT tasks, an image with complex superficial characteristics takes longer recognition time and therefore longer naming latency (Snodgrass & Vanderwart, 1980). VC is thus associated at the conceptual level, precisely at the point of visual recognition.

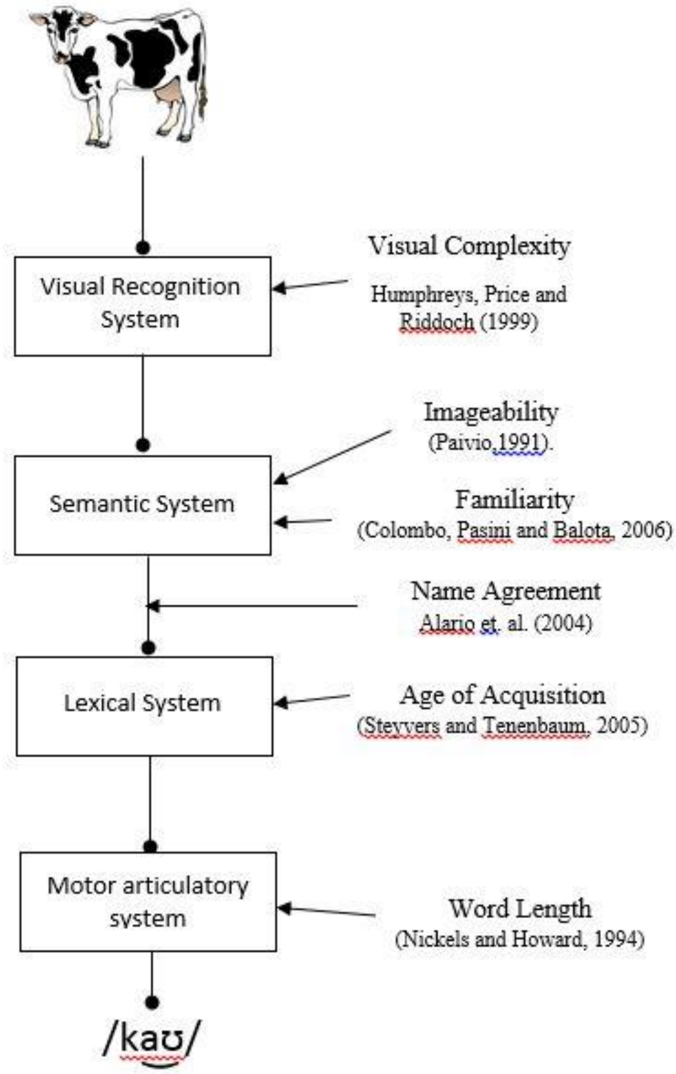


Figure 4.1: A summary of the discussion above; suggested loci for the different variables influencing picture naming. Adapted from Alario, Ferrand, Laganaro, New, Frauenfelder & Segui (2004) *Predictors of picture naming speed. Behavior Research Methods, Instruments, & Computers*, *36*(1), *p*141.

4.5.6 Specific influences on word retrieval in bilinguals

Language related variables pose the greatest challenge in bilingual research. It can therefore be expected that a common set of items, written or pictorial, could share or differ in terms of the many lexical-semantic variables across the languages tested (see Sirois et al., 2006; Sanfeliu & Fernandez, 1996).

Lemhofer et al., (2008) in a study investigated a number of variables, less often reviewed in bilingual studies. Only four selected variables are briefly discussed here as applicable to the current study.

4.5.6.1 Word length: Word length is critically sensitive to the reliability of both the input and output phonological processing networks (Papathanasiou & Coppens, 2017). The effect of word length is critical particularly when bilinguals are tested across languages as the words in the different languages are likely to be unequal E.g. *[shoe] (English) → [sapaththuwa] (Sinhala)*. It is anticipated that naming latencies are reduced for words that are shorter than those that are longer (Meyer, Roelofs & Levelt, 2003). Word length effects have been localized to the process of phonological encoding, although this may differ slightly (that is if semantic and phonologic) for word length based on the architecture of the model employed (connectionist or serial) (Nickels & Howard, 1994).

4.5.6.2 Polysemous words

Polysemous words refer to words within a language that has multiple related senses (e.g. in English, *pupil* may refer to both student and eye; *bat* as an object and as an animal. In a bilingual, the occurrence of polysemous words could be asymmetrical between the languages (Lemhofer et al., 2008). The exact effect of polysemous words in naming has been debated. Some assume polysemous words to cause interference. Others suggest that polysemous words could be facilitative in naming although the effect could be task or stimulus specific. (see Elston-Guttler & Williams, 2008).

4.5.6.3 Interlingual cognates: The numbers of cognates shared across the bilinguals' languages are thought to effect naming latencies. Cognates and homographs may facilitate or interfere performance based on the task in which it is used. In naming cognates are known to interfere (Broersma, Carter & Acheson, 2016; Marchetti, 2015; Kroll and Stewart, 1994) and are often removed from naming tests to allow an uninfluenced performance of the bilinguals naming in both languages.

4.6 Summary

Nouns and verbs are the most frequently selected measures tested in PNTs and also in discourse. Most studies report a difference between the two word classes for both PwAs and healthy speakers. This dissociation has been attributed to neurological, perceptual, semantic and lexical differences between nouns and verbs.

There are many methods of collecting data of which PNTs and connected speech samples are two methods readily used both clinically and in research. Differences reported between the methods have been attributed to context, non-linguistic demands and linguistic factors. PNTs and connected speech assessment methods may both have methodological disadvantages. Well-designed PNTs provide a rapid standardised method to assess WFD. This when combined with findings from connected speech samples, provides a holistic profile of the PwA which then reliably reflects the actual severity of impairment, in the speaker. The selection of an assessment method is not straightforward and depends profusely on the individual patient, available resources and time. No one-method fits it all.

CHAPTER 5: Sinhala and English

5.0 Overview

Sinhala /ˈsiŋɦələ/, is the common language spoken by both bilingual and monolingual populations included in the current study. Sinhala is spoken in Sri Lanka only. Large-scale migration in recent years has led to an increased number of immigrant native Sinhala speakers and particularly, Sinhala (L1) –English (L2)[19] bilingual (SEB) across the Americas and Europe, including the UK.

The primary aim of this chapter is to introduce the Sinhala language to a non-Sinhala speaker while simultaneously reflecting on the shared and distinct aspects with English.

In most cases the Sinhala- English bilingual speaks English as a second language. It is important to distinguish the non-native English as a second language speaker from the native English speaker (e.g. British native English speaker or the American native English speaker). English spoken by a native Sri Lankan as a L2 is referred to as Sri Lankan English (SLE).

[19] L1 is the first acquired/native language and L2 is a later acquired language/foreign language.

5.1. Introduction to Sinhala

5.1.1 Demographics of the Sinhala language

The Democratic Socialist Republic of Sri Lanka is a small island situated below the Indian subcontinent in the Indian Ocean (see map in Figure 5.1).

Figure 5.1: Geographical location of Sri Lanka. Reproduced with permission. Retrieved July 12, 2017 from www.globalvillage.world

Like many Asian countries, Sri Lanka consists of diverse ethnic groups. The key ethnic group is the Sinhalese, followed by the minority groups, Tamils, Malays, Moors and Burghers. Kaffirs and the aboriginal veddas form the other 1% of the population. In 2012 the Sinhalese constituted 74.9% of the total population that is 15,173,820 Sinhalese in the country's total population of 20,263,723.

Figure 5.2 below depicts the country's ethnic composition as per the 2012 national census.

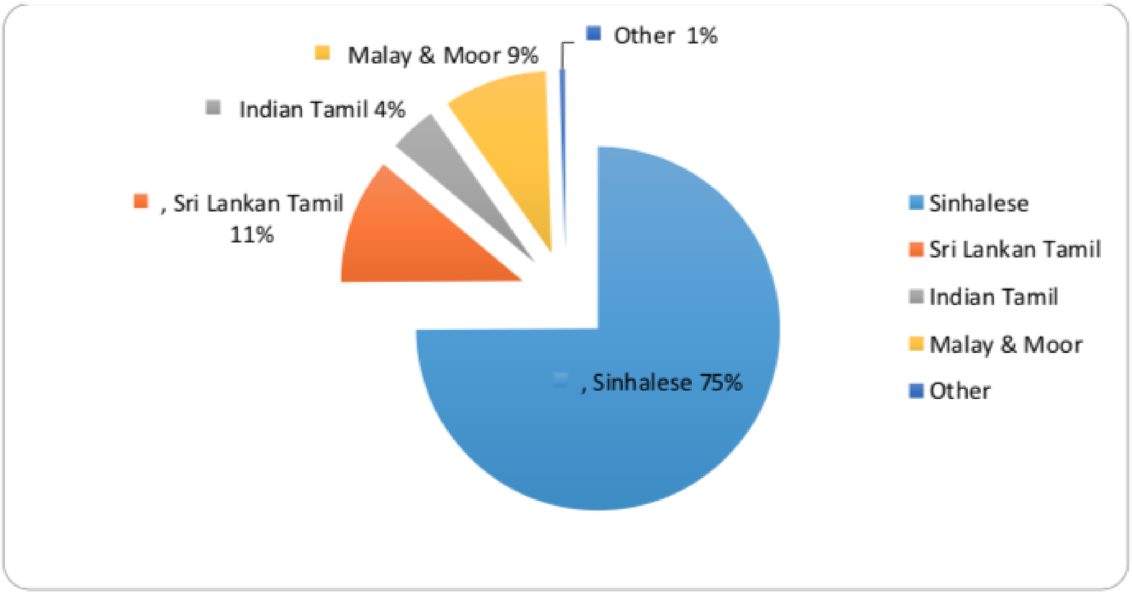


Figure 5.2: Population distribution of Sri Lanka by ethnicity (2012). Adapted from, *Department of Census and Statistics, Sri Lanka- Census year 2011, Enumeration stage February-March 2012. p.67*

The founding myth of the ethnic group Sinhalese is dated to around 543 BC when the Indian castaway Prince Vijaya and his group of bandits landed in Sri Lanka. The birth of a new language is thought to reflect an amalgamation of many Indian languages spoken by Prince Vijaya and his followers and also languages spoken by the early indigenous groups who were thought to have been already living in the island. The language that evolved and is now spoken amongst Sinhalese is known as ‘Sinhala’ and has over the years undergone numerous changes.

Since 1978 Sinhala was recognized as the administrative language of the country and also as one of the two official state languages (the other being Tamil). For those whose mother tongue is not Sinhala (e.g. Sri Lankan Tamils, Sri Lankan Moors, Sri Lankan Dutch-burghers), exposure begins from as early as pre-school in educational contexts and is used by most adult citizens at least for official purposes.

5.1.2 Linguistic roots

Sinhala is thought to belong to the *Indo Aryan* family of languages, which constitutes a larger Indo-European family consisting of languages spoken by almost a fifth of the worlds' population. India, Pakistan, Bangladesh, Nepal, Sri Lanka and the Maldives are a few countries that use Indo Aryan languages, examples of which are Urdu, Gujarati, Marathi, and Divehi. Sinhala has been closely associated Divehi, the language of the Republic of Maldives, (Hilpert, 2006; Premawardhane, 2002; Premawardhane, 2006; Seneratne, 2009) and Marathi (Gair,1998).

5.1.3 Sinhala diglossia and dialect

Ferguson (1959) was the first to put forth the concept of a diglossia which he described as a relatively stable language situation in which a very divergent, highly codified variety existed in addition to the primary dialects of a language (Hawkins, 1983). In his findings based on four selected languages, Ferguson described the existence of a high form and a low form between which differences were strictly linguistic in nature.

Diglossia in Sinhala as described by Giar (1998) involves two primary varieties: *Literary or written Sinhala* (LS) and *Spoken Sinhala* (SS) (also see, Dharmadasa, 2000). The spoken variety used for routine speech is known as *Colloquial Sinhala* (CS). LS and CS differ in terms of linguistic structure and function. Giar (1998; *p*226) defines CS as follows.

> *"It lacks literary verb agreement but has two main varieties. (A) Formal spoken Sinhala, which makes use of one of more grammatical features of literary Sinhala (other than verb agreement) with relative consistency. It characteristically makes considerable use of a formal lexicon shared with literary Sinhala. (B) Colloquial Sinhala, which is the language of ordinary conversation."*

LS is almost always used in print while CS is extensively used at all other times, including in modern media (de Silva, 1979; Hilpert, 2006). Giar (1998) refers to LS as Ferguson's high form and CS as the low form and Spoken Sinhala to be an intermediate version.

Sinhala diglossia further divides as classical Sinhala and modern Sinhala. It is quite possible that in a language sample consisting of a population with a wide age range, lexical words and syntax in either form could be produced.

A few examples extracted from the language samples of this study, are listed in table 5.1 below.

Table 5.1: Examples of words and phrases with classical and modern Sinhala

Word in English	Modern Sinhala	Classical Sinhala
Shadow	*/hɛʋənæɭ'ə/*	*/hɛ:mʌɭəjʌ/*
Cooking	*/ʊjənəʋʌ/*	*/ʋɪjənəʋʌ/*
Frying oil cakes	*/kæʋʊm bʌðɪnəʋʌ/*	*/kæʋʊm pʊt͡ʃ'ənəʋʌ/*
Worshipping	*/ʋʌð̃ɪnəʋʌ/*	*/nʌməðɪnəʋʌ/*

The many sub varieties as shown above within Sinhala can be combined in to the broader category of CS although they specifically refer to speakers of different generations, casts (*rodhiya*[20] or *govi*[21]) or geographical boundaries (up-country[22] or low-country[23] Sinhala).

Here, we only discuss the variations based on geographical boundaries as it is applicable and representative of the participants recruited to the different phases of this study.

Regional dialects are common in regions outside the capital Colombo. Dialects are seen for both words and phrases and may range from a subtle change to the phonetic

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[20] A low caste, group of gypsies who speak a different form of CS
[21] Largest and most influential caste, associated with their historical roots as commanders in agriculture.
[22] Refers to Kandy and the hill areas where traditional Sinhala words are included in their routine speaking lexicon, to date
[23] Refers to the coastal areas of the country, where the spoken Sinhala is largely the colloquial variety

composition of the standard form to a completely different one. In its broadest classification, Sinhala consists of 4 dialectal zones; the southern dialect (as seen in Galle), the highlands dialect (as seen in Kandy), the north central dialect (as seen in Anuradhapura) and the southeastern dialect (as seen in Digamadulla). Regional dialects of Sinhala have not been studied in depth, to date. Knowing this is of critical importance to linguistics-based research, in order to minimize misinterpretation of data.

Table 5.2 provides examples of regional dialects in Sinhala, of areas from which participants were recruited for this study.

Table 5.2: Examples of words and phrases with regional dialects in Sinhala

Word in English	Standard spoken form (Sinhala)	Southern dialect	Kandyan dialect
Do	*kərʌnˈə*	*kərʌnˈə*	*kaɽʌnʈ̥a*
What for	*ɲokəʈəðˈə*	*ɲʌk’kəʈæ͜ɪ*	*ɲokæː*
Did you look?	*ɓæɭʊʋaðə*	*ɓæɭʊʋa͜ɪ*	*ɓæɭʊʋaðə*
Fifteen	*pəhəɭəʋə*	*pəːɭəhə*	*pəhəɭəʋə*
Ant	*kʊ:bɪjʌ*	*hɪnˈʌː*	*kʊ:bɪjʌ*
Father	*θʌːθˈaː*	*θʌːθˈaː*	*ʌpˈʌʧˈɪ*
Curries	*ʋ͜jand͡ʒənə*	*ʋ͜jand͡ʒənə*	*maːɭʊ**
Pile	*goɗə*	*goɗə*	*kæʈɪjə*
Husking a coconut	*poɭ ɭɛɭɪ gʌhʌnəʋʌ*	*poɭ ojənəʋʌ*	*poɭ ɭɛɭɪ gʌhʌnəʋʌ*

Differences between these variants may range from a change to a phoneme or syllable to the use of a completely new word. Despite this these variants of CS usually do not affect meaning and is understood by any native Sinhala listener regardless of the listener’s adopted language form. There may be exceptions however, such as in cases of multiple mappings. For example in that marked with * in the above table, */*maːɭʊ*/ is the common term for fish in CS and SS. In Kandyan Sinhala (dialect) this refers to curries (eaten with rice) although it is simultaneously also used to refer to fish. The difference is contextually understood by another speaker of the same dialect but could be misinterpreted by a speaker of a different dialect.

5.1.4 The evolution of Sinhala

Sinhala has been influenced by several ‘donor languages’ (Premawardhena, 2002). The language reflects the influence of several Aryan-Dravidian languages, particularly *Sanskrit*, *Pali* and *Tamil* (Premawardane, 2002). Subsequently, Dutch, Portuguese and British words penetrated the local vocabulary during the periods of colonial rule and have since remained.

The acceptance of Sinhala as the State language in 1977 was perhaps the country’s most recent language revolution as a result of which the Sinhala colloquial vocabulary widened to incorporate the newly included disciplines that were previously exclusively provided in English (e.g. education, media).

5.2 Syntactic overview of Sinhala

Sinhala is left branching and is a consistent OV language[24] (Giar, 1998). In its broadest sense, the grammatical categories of modern Sinhala include nouns, verbs, gerunds, adjectives and adverbs. Additionally, the syntactic category known as *nipatha* (particles) in Sinhala does not have an exact equivalent in English grammar but instead includes conjunctions, prepositions and interjections. Sinhala is rich in inflections, particularly in verbs (Gair, 1998). The distribution of grammatical classes amongst the lexical categories may however differ across the language forms (Spoken- Written; Formal –Informal).

Table 5.3 provides an overview of the grammatical categories in Sinhala

[24] Languages where the verb follows the object

Table 5.3: Gross classification of grammatical categories in Sinhala. Adapted from Herath, Gamage and Malalasekara, n.d.)

Nama Nouns	Simple Compound Complex	Animateness Gender Number Person Case
Kriya Verbs	Finite verbs	Simple Constructed Complex constructed
	Infinite verbs	*Purva kriya* (Past participle) *Mishra Kriya* (Present participle) *Asambhavya kriya* (Conditional)
		Prayojya Kriya (Causative)
		Vidhi kriya (Imperative)
		Ashirvada kriya (blessing)
Nipatha (particles) **(Conjonctions + prépositions and interjections)**		
Krudantha	*Atheetha krudantha* (past) *Varthamana krudantha* (present)	
Nama visheshana **(Adjectives)**		
Kriya visheshana **(Adverbs)** ***Akarartha*** **(Adjectives of manner)** ***Kalathra*** **(Adjectives of time)** ***Sthanartha*** **(Adjectives of place)** **H*ethvarth*** **(Adjectives of reason)**		

5.3 Noun structure in spoken Sinhala

Na:ma pada as it is known is the functional unit in Sinhala that is equivalent to the English noun. A fundamental difference between English and Sinhala is that nouns, pronouns and adjectives in English are converged in to the single category of '*nama*' in Sinhala. This is discussed later in this section.

The simplest classification of nouns in Sinhala includes simple nouns (noun roots and nominative forms of nouns), complex nouns (nouns produced by adding a word formation affix to the noun stem)

E.g : */ɵʌnɵʊməjə/* (fibrous) ; */ɵʌnɵʊ/* + */məjə/*

[fibre] [with]

The noun structure in Sinhala is also primarily divided based on animateness, gender number, definiteness and case. (see, Brown & Ogilvie, 2009; Garland, 2006; Herath, Gamage & Malalasekara, n.d.).

A key feature in Sinhala is that adjectives and pronouns directly map in to the noun class (Hettige, 2010) and therefore based on context are sometimes considered a noun. Adjectives in CS are derived forms of nouns and are therefore not recognized as a separate entity (Renolds, 1980). Here, adjectives are combined with nouns forming what is known as compound noun and implies a meaning entirely different to its root and stem words. In Sinhala, adjectives are also able to function as postpositions, which make the differentiation morphologically challenging (Heenadeerage, 2002).

E.g.: /*kɪrɪ*/ [milk]

/*bʌθ*/ [rice]

/*kɪrɪbʌθ*/ [milk-rice; a traditional type of rice made out of coconut milk and is different to the usual rice]

5.4 Verb structure in spoken Sinhala

The verb in Sinhala as it is in English, refers to an action, state or occurrence in relation to its agent or objects and does to some extent reflect a gross grammatical classification similar to that of English.

At an elemental level of classification, the Sinhala verb in SS involves two types of verbs; simple verbs and complex constructed verbs. The simple verb in Sinhala is often constructed as a verb expressed in one word. E.g. /*ðʊvənəvʌ*/ [running], /*ɭɪjənəvʌ*/ [writing], */na:nəvʌ/* [bathing].

In contrast, the complex constructed verb includes a stem along with the main verb. In SS, the verbs */kərənəvʌ/, /ganˈnəvʌ/, /gʌhʌnəvʌ/, /ðʌnˈnəvʌ/, /ɵɪjɛnəvʌ/* and */vɛnəvʌ/* are commonly used as second constituents of a phrasal verb.

E.g. */ɪð̃ə ganˈnəvʌ/* [sitting], */nɪða: ganˈnəvʌ/* [sleeping], */otˈtʊ ða:nəvʌ/* [betting], */gætə gʌhʌnəvʌ/*[knotting], */gʌhʌ ganˈnəvʌ/*[fighting]

The preceding word here may (e.g. */rʌbʌn gʌhʌnəvʌ/;* playing the rabana, a type of traditional drums) or may not (e.g. */hɪɵʌ ganˈnəvʌ /*; decide) constitute a verb.

The use of the word preceding the second constituent is often crucial in SS as it allows the listener to distinguish between similar types.

E.g. */rʌbʌn gʌhʌnəvʌ/* [playing the rabana, a type of traditional drums] */ɭʌməjʌtə gʌhʌnəvʌ/* [hitting a child]

In the analysis of connected speech particularly in impaired language, the preceding word of a complex verb is pivotal in determining the accuracy of the retrieved word.

In Sinhala, the concept of auxiliary verbs is less defined than in English. In Sinhala, the auxiliary develops out of lexical verbs as a result of which there exists a set of verbs that can function as both a main verb and an auxiliary verb. For example;

/mamə/ /vædətə/ /jənəvʌ/
I work go (Verb)

/mamə/ /kan'nə/ /jənəvʌ/
I eat (Verb) go (Aux Verb)

Auxiliaries could also play multiple roles in Sinhala. For example, */mʌhʌnˈnə/ /pʊɭʊvʌn/* [can stitch] the auxiliary */pʊɭʊvʌn/* also functions as an obligatory tense marker and not as a verb.

Similar to that of adjectives and nouns, adverbs in Sinhala may too at times be collectively included in to the verb class. When a change of meaning occurs, the adverb and verb are collectively counted as a ‘compound verb’. Adverbs in Sinhala can be placed to modify a verb, an adjective or another adverb.

E.g. /*ʊsə*/ - *tall*

/*pʌnɪnəvaː*/ -jump

/*ʊsə pʌnɪnəvaː*/ - high jump

As in nouns, Sinhala, particularly in its spoken format employs numerous borrowed words from English for which there is no translation equivalent in LS. E.g. /type *kərənəvʌ/* [typing], /skip *kərənəvʌ*/ [skipping], /guitar -*gʌhʌnəvʌ*/ [playing the guitar]; or words which have Sinhala equivalents that are rather rarely used. E.g. *bake /kərənəvʌ*/ [baking], *hop /kərənəvʌ*/ [hopping].

<u>Variations to the verb structure across CS and LS</u>

The difference between CS and LS predominantly lies in the differences of verb structure across the two forms.

Verbs in colloquial and SS involve a simplified derivation of the literal Sinhala verb. The spoken/colloquial verb is used irrespective of person- number- gender and could be equally applied within a spoken sentence regardless of the subject. In contrast, the verb in LS exemplifies the subject in terms of person, number, gender and also in the use of cases, primarily direct and accusative (Giar 1998; Senaratne, 2009).

E.g. /*ʌmˈmʌ gɪja:/* (SS)- /*ʌmˈmʌ gɪ**ja:jə**/*(LS) ; mother went

/*θa:θθa: gɪja:/* (SS) - /*θa:θθa*: gɪ**jɛ:jə**/(LS) ; father went

/ɭʌmʌɪ *gɪja:/* (SS) - /*ɭʌmʌɪ gɪ**jo:jə***/(LS) ; children went

Sentences without a verb are common phenomenon in colloquial and spoken forms of Sinhala (Chandralal, 2010; Giar, 1998) though not ideal in formal spoken or written forms.

E.g. /*mɛnˈnə*/ /*ɵɛ:*/ /*ɛkə*/ (Meaning, 'take your cup of tea')
here (is) tea the
/*nɪðɪmʌθəɪ*/ [sleepy]
/*mʌhʌnsi*/ [tired]

The intelligibility of the connected speech is retained based on a mutual understanding between the speakers.

Colloquial spoken language also incorporates a group of quasi verbs /*nœθɪ*/ [non-existent], /*œθɪ*/ [existent], /*bœhœ*/ [cannot], /*o:nɛ*/ [want] (Giar, 1998).

Despite the ease of applicability, verbs in SS are not entirely grammatically unbound. For example the verb format of SS can be manipulated to draw a distinction between certain entities and characteristics, such as people and things.

E.g. to imply the meaning 'there'

/*ɪnnəva*/ is used for animate nouns; /*mɪnɪhɛk pa:rɛ ɪnˈnəvʌ*/
man road (on the) there

/*θɪjɛnəva*/ is used for inanimate nouns; /*kotəjʌk pa:rɛ θɪjɛnəva*/
log road (on the) there

The spoken and literal forms do share several overlapping features. For example, SS replicates the rules of LS at times such as when the noun in reference is an honorific plural. E.g. when speaking to and about clergy, regular verbs are replaced with a respectful verb is used. E.g.: /*vadɪnəva*/ (coming), /*valədɪnəva*/ (eating)

Both LS and SS places importance on the figurative distinctions between the verbs.

E.g.: The verb 'see' is expressed as /*pɛnɛnəvʌ*/ when it refers to seeing with one's eyes and /*ðəkɪnəvʌ*/ when it means to see metaphysically or with insight.

5.5 Research on the Sinhala language; the Sinmin project

The SinMin corpus project (Wijeratne, Upeksha, Lasadun & Siriwardane, 2005) initiated by the Faculty of Engineering, Moratuwa Sri Lanka is the first ever reported attempt to establish a corpus for Sinhala where statistics and linguistic details of the Sinhala language's lexical and grammatical features are made readily available. The project establishes for Sinhala, a corpus similar to that of corpora established for English Language such as the British National Corpus (BNC), American National Corpus (ANC) COCA (Corpus for contemporary American National English) and Brown corpus. It features approximately 70 million words used in both spoken and written varieties of Sinhala extracted from a wide-scale of Sinhala sources within a dynamic and regularly updated system. The SinMin corpus replaces a previously established corpus for Sinhala, the UCSC (University of Colombo School of Computing) text corpus of contemporary Sinhala, which contained only 10 million words, included a lesser range of Sinhala sources and was also not established within a dynamic system.

5.6 The Sinhala-English bilingual

A Sinhala- English bilingual (SEB) refers to a bilingual speaker who is a native speaker of the Sinhala Language and whose L2 English is acquired later. The English spoken by the SEB is referred to as Sri Lankan English (SLE). SLE differs phonologically, morphologically and syntactically from British or American English. It is best described as being closely affiliated to the syntax of Sinhala with borrowed features from English. (Senaratne, 2009). As a result the SEB differs significantly from the British English (BE) speaker (Giar, 1998).

5.6.1 Social impact

The role of English in the Sri Lankan society has steadily evolved through the years. In the colonial era, English was considered the language of the elite. Due to colonial resistance by locals native SEB were few and English words were rarely used in Sinhala. In the modern day however, English is considered one of the three official languages of the country and is heavily incorporated into the country's education policy. Linguistic borrowings from English are also frequent in Sinhala print and digital media. Being versatile with the language also results in increasing social mobility and prestige (Senaratne, 2009) and thus serves as a criterion for determining social status. Consequently, SE bilingualism has dramatically increased over the years.

5.6.2 Cross-language influence between Sinhala and Sri Lankan English

In modern Sinhala, English can perhaps be identified as the major donor language (Jayawardhane & Rewatha-Thero, 2015). The impact of English on Spoken Sinhala is visible in all areas of language (see Premawardhena, 2002 for a review).

The strong infusion of English into Sinhala has resulted in hybrid words, those which are irreplaceable in Sinhala or English. For example, words such as [*car*], [*bus*], [*tin*] have no translation equivalent in Sinhala. There is also a set of nous and verbs that have translation equivalents but are frequently substituted with a modified loan word in CS and SS by both MLs and BLs (e.g. fan, television, oven, party, hop, skip). There are also hybrid words such as */pæðʊrʊ/ /paːrtɪjə/* [*paeduru pa:tiya* [25]]. Here, the word *paduru* (mat) is in Sinhala while the word [*party*] in English is borrowed and the */jə/* suffix added. Similarly, */po:rʊvə//sɛrɪmonɪ/* [poruwa ceremony[26]] where the word

[25] A Paduru party is a Srilankan age old party trend, limited to the upper class and elite societies back in the day, Here, men clad in sarongs and women clad in wrap-ups, sing and dance to popular Sri Lankan music, baila and calypso. People sit on the 'padura' or mat, as the name suggests

[26] Poruwa ceremony is a traditional Sinhalese (Buddhist) wedding in which the ceremony takes place as the bride and groom stands on a grandly decorated wooden platform while cultural and religious rituals are performed.

poruwa (a decorated wooden platform) is in Sinhala and the English word [*ceremony*] is added to form a hybrid word.

Such hybrid words could be found in both the written and spoken forms of Sinhala.

The reverse influence of Sinhala on English is also frequently reported in the SLE speaker. Gunawardane (2008) reported that the SE bilingual struggled to distinguish the suitability of the sounds /*p*/ and /*ʃ*/. Other errors commonly known are, the substitution of the phoneme /*s*/ with palato-alveolar fricative */ʃ/*, substitution of the phoneme /*ʃ*/ with the voiceless plosive labial /*p*/, substitution of the phoneme */ʒ/* with the palato-alveolar fricative /*ʃ*/ or alveolar fricative /*s*/ and the substitution of */θ/* with the alveolar plosive /*t*/. E.g. toffee -/*topɪ*/, phone-/*po:n*/, elephant-/*ɛḻɪpənt* /, thank you – /*tæn ke‿ ʊ*/

In some instances however, such phonemic alterations may constitute another meaningful word, typically classing it as a lexical type error. E.g. seat - /*ʃɪ:t*/ [sheet], file – /*pə‿ ɪḻ* / [pile], zip- /*ʃɪp*/ [ship]. Differences between Sinhala and English in terms of word position and order also contribute to errors in SLE spoken by the SEB. For example, /*mʌmə vɪba:gəjə**tə** mʊhʊnə ðʊnˈna:*/ (I-exam-to-faced) is inaccurately said as [I face **to** examination].

Such errors were observed in this study although not many. While only phonological errors were observed in naming, both phonological and grammatical errors were noted in connected speech samples. Senaratne (2009; *p*4) suggests that such deviant responses are ‘nativized elements of English’ which are highly embraced by speakers of SLE and thus should not be considered an error (but simply as a cross-linguistic influence) unless such deviations are also seen to the speakers’ L1. Although this may be possible for the healthy speaker, it poses a challenge in the analysis of impaired language such as in aphasia.

It could also be presumed that cross linguistic influence as such would occur greater for late learners of English (particularly those who learnt in adulthood) and also for those who use English less frequently for limited purposes (see Kamalasuriya (2008). This emphasizes the need for detailed language information and a subsequent inclusion of an analogous participant sample in bilingual studies.

5.6.3 Code mixing in the Sinhala- English bilingual (SEB)

Code Mixing (CM) is a frequently manifested language behaviour by the SEB as it is by all bilingual speakers around the world. SEB speakers manifest all forms of code mixing, such as compounding, collocations, reduplications[27] within all forms Sinhala. (Senaratne, 2009; 2012)

Seneratne (2009) describes the overpowering influence of English on the linguistic structure of Sinhala in four processes adopted by the SEB in CM. Interestingly, some 'borrowed' English words have been retained, particularly in CS. Some of these words are so strongly established that a replacement in Sinhala is not available (Dissanayake, 2012). (E.g. car, bus, toffee)

In the context of research, understanding the native SEB is crucial as they significantly differ from the bilingual whose first language is English. Seneratne (2009) in a study that analysed 200 samples of SEB showed that CM was highly frequent, accepted, unconscious behaviour and was also the 'expected' code in the SEB, particularly for those in an urban bilingual setting. Based on participant interviews, the study concludes by noting that CM is a postcolonial urban linguistic identity of the SEB.

Kamalasuriya (2008) examined 70 Sinhala – English bilinguals' speech samples. Participants were categorized according to age, level of education and fluency in

[27] Compounding, Collocations and Reduplications are all linguistic processes which in this context are used by bilingual SLE speakers in code mixing. Compounding is a word formation process where compound lexemes are formed. Collocations are word formations that are habitually more often used in conversation. Reduplication refers to a morphological process where the root of the word is more or less repeated, with or without minor changes.

English. Kamalasuriya concluded that the level of fluency in English was a key determining factor where in higher fluency resulted in higher competency of code mixing and code switching between the languages.

The abundant use of borrowed and loanwords of English even by the native, functionally monolingual Sinhala speakers are increasingly common. Though competently different to the SEB, the inclusion of numerous loaned and borrowed English words in spoken Sinhala, challenges the criteria with which a Sinhala-monolingual could be distinguished from the SEB. Those who identify themselves as monolingual Sinhala speakers often engage code mixing at word level, particularly for words, which are more frequently used in English rather than its equivalent Sinhala translation. A few examples of such words are [*party*] over its Sinhala equivalent / /*ʊθsəʋəjə*/; [*shirt*] over its Sinhala equivalent /*kʌmɪsəjə*/; [*oven*] over its Sinhala equivalent /*ʋɪdʊɭɪ ʊð̃ʊnə*/. Code mixing at the sentential level however is less frequent in monolingual Sinhala speakers. This reflects the impact of the growing urban SEB community and widely embraced bilingual culture on the monolingual Sinhala speaker. Importantly, this evolution of the Sinhala monolingual speaker could greatly challenge local researchers in distinguishing the monolingual Sinhala speaker from the SEB.

5.7 Summary

Nearly 16 million Sri Lankan Sinhalese speak Sinhala as a native language. Since it is the administrative language of Sri Lanka, it is also spoken by the many minorities. As it is around the world, the Sri Lankan monolingual Sinhala speaking population is being gradually replaced by Sinhala –English bilingual speakers.

The Sinhala language is a highly variant language, implying that it has several dialects based on demography and several forms that are used across different speaking situations.

English spoken by the native Sinhala speaker is commonly referred to as Sri Lankan English (SLE) and involves several differences from English spoken by the native English speaker. These involve variations in pronunciation, grammar, sentence structure and even the choice of words. The Sinhala- English speakers also manifest intense code switching, which is almost always dominated by the English language. An understanding of the linguistic structure that underlies the Sinhala language and language behaviors of the SLE speaker will provide an insight to the analysis of outcomes observed in this study.

5.8 The thesis map

Based on the above literature review, the study rationale and aims outlined in Chapter 1, the following research questions (RQ) will be addressed within the scope of this thesis.

i. What adjustments to stimulus selection and test administration are needed to ensure task validity and reliability in translated assessments?
ii. Did word retrieval performance in Sinhala differ between the monolingual Sinhala and the bilingual Sinhala-English speakers?
iii. Did word retrieval performance differ between the two languages of the BL speaker?
iv. What specific BL behaviours were present, such as code-switching? Did it occur significantly more in terms of accuracy and frequency in any one language condition or task?
v. How did healthy controls and PwAs compare?
vi. Were there word class effects (nouns versus verbs)?
vii. Were there task effects (picture naming versus connected speech)?
viii. What was the impact of psycholinguistic variables on naming performance? Was there a relationship in performance scores across tasks?

The above research questions have been addressed through subsequent chapters. Table 5.4 below provides a map, which outlines the contents of these chapters and the research questions addressed through the findings of each.

Table 5.4: Content map for this thesis

Phase	Content	Chapter numbers	Research aims/ questions (RQs) addressed by findings
Phase 1: Development and preparation of material	Methods	Chapters 6,7 and 8	RQ (i), Selection and development of material
	Findings and interim discussion 1	Chapter 9	
Phase 2: Pilot testing of developed protocol	Methods	Chapter 10 and 11	Trialing developed material and making the required amendments
	Findings	Chapter 12	
Phase 3: Main study	Methods	Chapter 10	RQs (iii), (iv), (v), (vi) and (vii) as applicable to naming
	Amendment to phase 3 methods	Chapter 12	
	Findings in picture naming	Chapters 13 and 14	
	Findings in connected speech	Chapters 15 and 16	RQs (iii), (iv), (v), (vi) and (vii) as applicable to connected speech tasks
	Interim discussion-2	Chapter 17	Discussion of findings in chapters 13-16
	Correlation analyses and interim discussion 3	Chapter 18 and 19	RQs (ii) and (viii)
	Contributions to research, clinical practice, limitations and future directions	Chapter 20	

Chapter 6. Phase 1- Methods in developing assessment stimuli

6.0 Overview of phase 1

Phase 1 involved the selection, preparation and trialling of the language assessment materials for this study. The standardized test tools involved were the *Object Action Naming Battery* (OANB, Druks & Masterson, 2000)[28] and the *Comprehensive Aphasia Test* (CAT, Swinburn, Porter & Howard, 2004)[29]. Several novel material and supplementary materials were developed for gathering participant related information.

75 monolingual Sinhala speaking (ML) and bilingual Sinhala- English speaking (BL) healthy non-brain damaged adults were recruited to phase 1. This data was then analysed to develop psycholinguistic metrics for the adapted assessment stimuli and normative data prior to phase 2 and 3 of this study.

The aims of phase 1 were to (1) Select and adapt the tools and language assessments for testing (2) Develop a case history and Language Proficiency Questionnaire as relevant to this study (3) Translate in to Sinhala and trial the test instructions and stimuli of the CAT which is originally available in English and also formulate in Sinhala instructions for the OANB picture naming task and connected speech tasks (4) Establish population specific norms for picture naming accuracy, imageability, AoA, concept familiarity and visual complexity for the OANB stimuli in healthy monolingual Sinhala and bilingual Sinhala –English speakers (5) Identify and trial an appropriate method of analysing picture naming data (6) Develop and trial novel connected speech sample stimuli; picture sequences and single complex pictures in healthy monolingual Sinhala and bilingual Sinhala –English speakers (7) Establish population specific norms for

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[28] The OANB stimuli involve 262 object and action picture items. Subsets of these pictures have been previously used in research involving adult and child speakers of English, Persian, Spanish, Arabic, French and Brazillian-Portugese languages. Communication was made with the author of this test, Prof. J. Masterson at the University College of London who asserted that there were no copyright issues associated with using the images to test picture naming

[29] Publisher permission for translation was previously included as appendix 1.1

visual complexity in single pictures and picture sequences. (8) Identify and trial an appropriate method of connected speech analysis (9) Select a subset of OANB stimuli with high Naming Accuracy Score (NAS), one picture sequence and one single complex picture for use in phases 2 and 3 (10) Identify the variables that may affect performance in picture naming and connected speech.

This chapter details study participants, material, methods and protocols followed for only aims (1) through (3). Aims (4) and (5) involve the adaptation and development of the OANB which is detailed in chapter 7. Aims (6) through (8), which is the development of stimuli for connected speech tasks is detailed in chapter 8. Aim (9) and (10) were achieved by analysing the data and are therefore included in chapter 9; Findings in phase 1.

6.1 Selection of language profiling assessments

Existing assessments were identified which provide an overall aphasia profile and assess retrieval of nouns and verbs in isolation. A number of assessment tools were considered. The Psycholinguistic Assessment of Language Processing in Aphasia (PALPA; Kay, Lesser and Coltheart, 1992), Porch Index of Communicative Ability (PICA; Porch, 1981), WAB and The *Comprehensive Aphasia Test* - (CAT: Swinburn Porter & Howard, 2004) were considered for the purpose of profiling language skills in all PwAs and healthy controls (HCs) recruited to the second and third phases of the study. The selection of the CAT was based on the fact that the test very clearly provides language, cognition and disability perception assessments in separate sections thereby allowing the examiner to use only the language battery, which sufficed the need of this study. The CAT also has its psycholinguistic strengths were language in the PwA is assessed across the four different modalities with multiple tasks in each modality and with a limited but sufficient number of stimuli presented with increasing difficulty. The

CAT also assesses not only the impaired language skills of the PwA but also the intact ones, thereby making available a holistic profile for the patient. The Object and Action Naming Battery (OANB, Druks & Masterson, 2000) was used in this study to assess naming ability. Other tests considered included the Boston Naming Test (BNT; Kalplan, 1983) and the Birmingham Object Recognition Battery (BORB; Riddoch & Humphreys, 1993) were other tests considered. The OANB however provided a sufficient quantity of both objects and action stimuli for assessing naming.

Both selected tools were developed in English for native English speaking populations were selected and adapted.

(i) **The Comprehensive Aphasia Test** - (CAT: Swinburn Porter & Howard, 2004)

The CAT is an assessment test battery for people with acquired aphasia. It encompasses three subsections; a cognitive screening, a comprehensive language assessment and a disability questionnaire. The CAT does not adopt an aphasia syndrome classification but instead allows a systematic assessment of the patient to understand the exact loci of breakdown in lexical processing (based on Patterson & Shewell, 1987) and generate a profile of the linguistic deficits and strengths of the patient (Howard, Swinburn & Porter, 2010). The CAT has been translated in to several languages (Fyndanis et. al., 2017). The primary aim of using the CAT in the current study was to profile language skills in all PwAs and healthy controls (HCs) recruited at the second and third phases of the study. Only the language battery of the CAT was utilized and adapted for this study

(ii**) The Object and Action Naming Battery-** *(OANB, Druks & Masterson, 2000)*

The OANB assesses single word production of a large set of objects and actions. The OANB consists of 162 object and 100 action picture stimuli. The battery encompasses ratings for AoA, familiarity and imageability of the verbal labels of the pictures as known predictors of spoken word retrieval. The OANB has been previously used in studies involving adult and child speakers of Spanish (Edmonds & Donovan, 2014; Cuetos & Alija, 2003), French (Schwitter, Boyer, Meot, Bonin & Laganaro, 2004), Saudi Arabic (Alyahya & Druks, 2016), Persian (Afshordi & Kauschke, 2013) and Brazillian Portugese (Spezzano, Mansur & Radanovic, 2013). In this study, a subset of stimuli will be selected from the OANB in phase 1 and subsequently used in the picture naming task, in phase 2 and phase 3.

6.2 Development of supplementary material

6.2.1 The Language Proficiency Questionnaire (LPQ)

Self-assessed questionnaires on language acquisition and learning (Gollan et. al, 2005; Costa & Santesteban, 2004) and self-rated linguistic proficiency scales (Rossi, Gugler, Friederici & Hahne, 2006; Costa & Camarazza,1999; Roberts & Le Dorze,1997) are accepted as practical and valid in bilingual studies, even when the information requested relates to the pre-morbid language history of participants with aphasia (Ansaldo et. al., 2008). Alternative arrangements such as acceptance of proxy view on participant language proficiency rating have also been recommended (Ansaldo et. al., 2008) although there remains some controversy on the use of self-report measures, particularly that the data may be unreliable (Harris & Llorente, 2005). To minimize response bias, questionnaires employ a combination of open and closed questions and also Likert scales (E.g. Language History Questionnaire, Li, Zhang, Tsai and Puls, 2013).

6.2.1.1 The need for assessing language proficiency

There are few published language proficiency assessment tools. Most bilingual research develop their own methods (E.g. a participant interview, a language sample or conversation rated by the researcher) to obtain the relevant language information from their participants. Furthermore, most published language proficiency assessments have been developed for healthy speakers and are therefore quite complex and lengthy. Therefore an LPQ particularly suitable for PwAs needed to be developed for the study.

In this study, language proficiency information was crucial when allocating participants in to the monolingual and bilingual groups throughout all three phases. It was also needed in the second and third phase when matching the language proficiency levels of PwAs to healthy controls. There are no published tools developed in Sinhala for the assessment of language proficiency of its speakers. Therefore, the aim was to develop a concise and simple yet precise questionnaire for accumulating language proficiency details in both healthy speakers and speakers with aphasia.

6.2.1.2 Materials and methods

A novel questionnaire exploring the language function and use of the participants was developed from existing tests[30]. This is termed the Language Proficiency Questionnaire or LPQ and the full questionnaire is in Appendix 6.1.

The LPQ was initially written in English by the researcher, trialled and later translated in to Sinhala. The procedure adopted in translation is detailed in section 6.3

The following steps were taken with the aim of making this questionnaire accessible to PwAs;

(1) The questionnaire was short and quick to administer

(2) Questions were concise and written in simple English or Sinhala

(3) Questions were spaced on an A4 size paper, font Times New Roman, size 14

(4) Response methods were close ended questions, multiple choice selections or Likert scales

30 The LPQ developed here is based on the content of existing published tools including the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian, Blumenfeld and Kaushanskaya, 2007). It also draws recommendations from a language screening protocol (Roberts, Gracia, Desrochers and Hernandez, 2002) which outlines a number of criteria suitable in identifying ‘functionally unilingual’ participants.

The Language Proficiency Questionnaire (LPQ) includes the following;

(1) Five closed questions such as details of language acquisition and learning together with a comments box for any additional information the participant may want to provide (2) Two rating questions which used Likert scales for rating language proficiency and use in each language (3) A mini questionnaire of five multiple choice questions; the mini questionnaire section of the LPQ includes questions about the participants' use and preference of language for routine activities. Participants had to respond in Sinhala, English or either language to all five questions. Responses were presented in a multiple-choice format.

E.g. I prefer watching television in ______ (Sinhala/English/ Either language)

The LPQ was available in Sinhala and English. Bilingual participants were allowed to request for the Sinhala or English version of the LPQ. Participants of phase 1 and all healthy participants in phases 2 and 3 self-completed the questionnaire. Alternatively, the researcher or a caregiver of the participant with aphasia completed the questionnaire on behalf of PWAs recruited to the second and third phases of the study.

In order to minimize response bias, participants are kept oblivious to how responses on the LPQ were interpreted when allocating recruits to either language group. A similar strategy has been employed in the LEAP-Q and is expected to lessen the effect of under-rated or over rated language competence on self-rated scales.

6.2.1.3 Interpretation of the LPQ

Responses to the LPQ were interpreted as follows;

- Participants' self-reported information on the age in which language learnt and the method in learning:

  Here particular attention was given to the age and method in which English was learnt and subsequently used. It is expected that for this study, the bilingual is one who has learnt English in early childhood (<2 years) and learnt English in the home environment. Late learners of English were also considered as bilinguals providing that they reported English to be used extensively for work and/or at home. For all participants, Sinhala should be reportedly the native language.

- Participants ratings for language proficiency and use for Sinhala and English:
  Monolingual participants were expected to rate high (>3.5 on the 5-point Likert scale) for proficiency and use of Sinhala while potential participants should rate high on language use and proficiency for both Sinhala and English.

- Participants' responses to the five-question mini questionnaire:
  Potential monolinguals may respond to the questions as 'Sinhala' while bilinguals were typically expected to choose 'either language' or 'English' for at least 3 of the 5 questions in the mini-questionnaire.

6.2.2 Case history

A detailed five-section case history applicable to both healthy and aphasic speakers was prepared for use in all phases of this study (See appendix 6.2). The case history aimed to (1) confirm participant eligibility (2) gather sufficient data to permit detailed profiling of all participants. Information gathered here were as below;

<u>Section I:</u> Personal details: Included here were name, gender, date of birth, age in years completed and information on pre morbid education

<u>Section II</u>: Physical and medical details: Included here were current rehabilitation setting, information on pre morbid handedness and information on visual and auditory status

<u>Section III:</u> Neurological details: Included here were time since onset, CT findings, Stroke related signs and information on speech and cognitive status

Section IV: Information on post-morbid speech-language and communication function: Included here were verbal fluency and communication difficulties and post morbid rating of the intelligibility of speech.

Section V: Social history included here were topics of interest, information on family support and communication partners and strategies used in communication.

The case history was developed in English and was to be at all times completed by the researcher based on information obtained from the participant and/or their caregivers. The case history was translated to Sinhala in order to ensure that the exact questions were asked in both languages. This is described in section 6.3

6.3 Translations of test instructions and stimuli

6.3.1 Rationale

A participant's native language may have a direct and considerable influence on their performance (Kisser, Spencer, Wendell & Waltdstein, 2012). In countries where standardized test materials are not available, many researchers resort to translated versions of British or American test material (Carter, Lees, Murira, Gona, Neville & Newton, 2005). For a given test material to be translated with accuracy and quality, the translated version needs to be equivalent to the source, understood by those who read it (Prieto, 1992) and be guided by demographic factors pertaining to its users, such as age group, occupation, level of education, cultural differences, familiarity of testing situation (See, Carter et al, 2005). Prieto (1992) further identifies the need to incorporate linguistic concerns such as choice of vocabulary, grammatical structure, dialect choices, the degree of bilingualism of the target group and also the language attitudes of the tested population. Most often research that uses translated language tools neglect this need for high quality translations or provides either little or no information on the protocols followed in carrying out the translation. This carries the potential risk that the translated materials elicit inaccurate responses under the influence of an inaccurate translation. Given the complexity of requirements for quality and equivalent translation, it is then essential that a multi-strategy approach be utilized to ensure equivalence to the translated material (Prieto, 1992; Brislin, Conner & Thorndike, 1973).

6.3.2 Procedure in translation

The translation of English material in to Sinhala was based on the instructions provided in Van Widenfelt, Treffers, De Beurs, Siebelink and Koudijs (2005) (also see, Prieto, 1992). It further incorporated recommendations by Geisinger (1994), which proposed that participants be allowed to suggest changes and comment on the translated material.

Translations involved a three-step procedure. First, material were translated from the English to Sinhala. Then the translated material were back translated from Sinhala to English. Finally, a random selection of items from both the English and Sinhala versions were pilot tested.

Step 1: Translation

The translation of all instructions and test stimuli from English to Sinhala was carried out by a professional bilingual linguist (hereafter referred as the translator) qualified with a bachelor's degree in arts, a masters degree in linguistics, and a masters degree in teaching English as a second language (TESL). She had previously collaborated in research involving speech-language therapy and also had previous experience of translating tools and questionnaires for the same. Recruiting a translator familiar with the community and culture is thought to contribute towards improved translation quality (Van Widenfelt et. al, 2005; Prieto, 1992). It is therefore noted that the linguist recruited here also belonged to the same bilingual community (Sinhala-English speakers) featured in this study.

The translator was first familiarized with the overall objectives of the study and explicit information was delivered with regard to the aims of administering each language tool and material translated here. The translator was further instructed to (1) attempt to achieve the maximum conceptual equivalency between original test and its translated version (2) use the spoken Sinhala dialect and terminologies, avoid the use of jargon and technical terminology and maintain elementary level of language throughout translation aiming at the most common audience and (3) ensure that all information remain clear and concise, especially by avoiding long sentences (see World Health Organization guidelines, 2016).

Additional guidelines specific to this study (in Sinhala-English) were:

(i) When a target word in English had several synonyms in Sinhala, the word most commonly used in the spoken form of Sinhala should be selected ensuring also that the selected word does not represent another concept.

E.g. The target stimulus [*cat*] could be translated in to Sinhala as /*bʌləlʌ*/ or /*pʊ:sʌ*/. Here /*pʊ:sʌ*/ is the most commonly used label in spoken Sinhala and was therefore selected as the translated target.

(ii) If the target word to be translated had both an English borrowed word form, which was frequently used in spoken Sinhala and a less frequently used Sinhalese translation, the latter was used provided that it did not constitute a cognate form

E.g. The target stimulus [*radio*] is often referred to as /*rɛːdɪ͜o*/ /*ɛkə*/ in informal spoken Sinhala. This word also has a Sinhala translation, */gʊvʌn/ /vɪðʊɭɪjə*/ which was then used although it is less likely used in spoken Sinhala.

Step 2: Back translation

The researcher and one other Sinhala-English bilingual colleague who is also a qualified speech language therapist (SLT) and an academic were involved in the back-translation of the translated material. All material content translated in to Sinhala were presented in printed form. Both the researcher and the other SLT re-translated the content in to English and their responses written down on paper. Both the researcher and the SLT were asked to separately write down if any, changes that they wished to suggest in order for the translated material to be better comprehended by a lay person (e.g. substitution of one word with more familiar word).

When this was completed, the researcher and translator discussed to identify discrepancies in grammar, word usage and sentence structure essentially those leading to changes in meaning and the possibility of incorporating suggestions generated during the process of back-translation. The discussion was recorded and its outcomes were reviewed for a mutual and satisfactory agreement.

Step 3: Pilot testing the translations

The aims in pilot testing the translations were to ensure the accuracy and equivalence of translated material, clarity and ease of understanding of translated material by laypersons.

The procedure and protocol followed in pilot testing all material translated in this chapter is detailed below in section 6.7 below.

6.4 Adapting the Comprehensive Aphasia Test (CAT)

6.4.1 Translating the CAT

All instructions and stimuli for the CATs language section were translated according to the guidelines and protocols outlined in section 6.3.2.

Pilot testing of the translated CAT instructions and stimuli are detailed later in section 6.7

6.4.2 Methodological issues in adapting the CAT

When adapting the CAT, several methodological difficulties arose in matching stimulus properties across the original and translated languages. These included matching translated target words with phonological distracters provided in the original test, matching translated words with the word length of the original stimulus and also the lack of data on word frequency in Sinhala or English for the particular population tested in this study.

<u>Issues in translating target words and matching phonological distracters</u>

The tests for the comprehension of spoken and written words in the English version of the CAT include phonological distracters such as /*go:t*/ for target /*ko:t*/. These needed to be amended in the translated version. It was decided that the target word in the original version of the test be retained and the phonological distracter in the translated version be substituted with a suitable new item. Where a new item was substituted, the researcher guided a professional artist in illustrating it with close similarity to the original black and white line drawings used in the original test. In the translated version, it was not possible to match the Sinhala substitutes in the word length to that of the original. Here the word length of the target and phonological distractor were matched in word length in the Sinhala translated version as it was in the original English version of the test.

Issues in matching word length

In all cases, an exact translation of an item resulted in a difference between the word length of the translated Sinhala word and that of the original, in English. This was a common and significant issue in the repetition and naming tasks. Given that word length is a known influential variable in word production performance (a) the word length of a phonological distractor was matched to the target stimulus and (b) a Sinhala word with an equivalent word length to the original target stimulus in English was substituted in repetition tasks.

The availability of data on word frequency

Stimuli in several tasks of the English CAT also included matched sets of high frequency and low frequency words. As such information is not readily available in Sinhala, the researcher and linguist agreed on replacing words classed as high frequency with words frequently used in the routine Sinhala vocabulary and low frequency words replaced by words less commonly used by Sinhala speakers.

Though the translated Sinhala CAT did not feature the same stimuli as English version, care was taken to substitute words from the same word class as the original target. For example, where the direct translation of a target word was not used in the Sinhala CAT, a noun in the original English version was replaced only with a noun, a verb with a verb, an adjective with an adjective and so on.

Whenever permitted, the translations opted for the use of the informal form of Sinhala with the aim of preserving the naturalness of language and preventing unwarranted difficulty to participants, particularly to those with aphasia.

Any issue in translation were discussed until a satisfactory compromise was reached between the researcher and the translator.

6.5 Preparation of the Object Action Naming Battery *(OANB; Druks & Masterson, 2000)*

6.5.1 Sinhala instructions for the OANB

The 262 OANB stimuli along with its instructions were formulated in Sinhala to reflect its original English version. Translation followed the procedure outlined above in section 6.3.2. Pilot testing of the translated OANB instructions and stimuli are detailed later in section 6.7 below.

6.5.2 Specific methodological issues in using the OANB for testing in Sinhala

When the stimuli available in the original OANB assessment prepared for testing Sinhala speakers, several methodological issues arose. This required the researcher to make several decisions specific to the OANB.

<u>Issues in picture naming</u>

- The Sinhala language encompasses a large number of loan words and cognates from the English language. To avoid inadvertent priming, any stimulus that was identified as either a loan word or cognate was removed from both English and translated Sinhala lists.
- Actions in the original English version of the OANB are mostly presented in the present participle. In Sinhala however, especially in spoken and colloquial forms, a verb is often elicited as a noun+ verb compound or in its present participle tense, which constitutes a verb+ verb compound.

  E.g. */kæːmə/ /kʌnəʋʌ/*

  [food] [eating]

  Although participants were asked to respond with a single word, it was decided that a two-word response elicited for an action stimulus when tested in Sinhala would be considered as a correct response in analysis.

Issues in stimulus rating

- The action stimuli list in Sinhala was found to have one item with multiple mapping (polysemous words). The stimulus items ‘bending’ and ‘folding’ of the original English version of the test, translated to */nʌmənəvʌ/* in both instances with no other single word substitute available. It was also noted that such ambiguity could interfere during rating tasks, particularly if the participant had perceived an alternative meaning. Although presenting both the image and written word would minimize such chances of such misperception, it was not possible always (e.g. images cannot be provided in the in the imageability rating task). In order to overcome stimulus ambiguity yet retain the word, it was decided to provide participants with a verb phrase (including a related noun) only for the said item and only in the imageability task.

  For example, when the written stimulus of the above-mentioned example was presented for imageability rating, the researcher instructed as /*mɛːkə rɛðʰɪ nʌməməʊa*/*:*’ [this refers to a folding clothes]

- In the rating tasks, stimuli were presented as only written words (e.g. imageability rating) or both image and written word (e.g. age of acquisition rating). In the original English version of the test, stimuli were presented in its present participle tense (e.g. sitting). The present participle verb in Sinhala however is a verb +verb compound verb */ɪð̃əgɛnə/ /ɪnˈnəvaː/.* In order to match the one-word English stimulus, the Sinhala verb when presented as a written word was given in the present tense */ɪð̃əgʌn'əvʌ*/.

6.5.3 Stimuli selection

The Original version of the *Object Action Naming Battery* (OANB; Druks & Masterson, 2000) consists of 162 objects and 100 action picture stimuli. Following the removal of loan words and cognates, a total of 219 items remained; 125 were objects and 94 were actions. The original illustrations of the 219 selected OANB stimuli, which consisted of black and white line drawings were used in this study.

6.6 Developing and translating test instructions for connected speech tasks

Connected speech tasks for this study involved a picture sequence narration and single picture description task. The stimuli were black and white line drawings. The development of these stimuli is described in chapter 8.

The instructions for the picture sequence narration and single picture description tasks were separate. They were initially written down in English by the researcher. This was then translated in to Sinhala according to the same procedure detailed in section 6.3.2 Pilot testing of the translated connected speech task instructions and stimuli are detailed later in section 6.7 below.

6.7 Pilot testing the translated and adapted material

6.7.1 Participants

Four participants, two ML and two BL aged between 18-40 years were recruited. All participants had completed tertiary education. All recruits were native speakers of Sinhala. The bilingual speakers recruited had learnt English as a second language, either simultaneously or in early childhood (before the age of 2 years) and were functional users of both languages. Participants had no known history of neurological or psychiatric disorder, had normal or aided to normal hearing and vision and able to complete the testing.

6.7.2 Ethical considerations and informed consent

The Ethical Review Committees of the University of Sheffield, United Kingdom and the University of Kelaniya, Sri Lanka approved this phase of the study. Evidence of approval is provided in Appendix 6.3.

Participants recruited here were identified through youth groups, social groups, and work groups. The researcher provided administrators and group representatives with flyers detailing the study for distribution amongst attendees (Appendix 6.4). Interested individuals contacted the researcher directly and at times through the administrator.

All eligible participants were provided with detailed information sheets (Appendix 6.5) and those who expressed an interest in participating were then provided with an opportunity to obtain further information or clarifications. Written consent (Appendix 6.6) was obtained from all potential participants prior to commencement of testing.

6.7.3 Material

The material translated here were the CAT, LPQ, case history and instructions for the OANB and connected speech tasks. The following content from each of the above were trialled.

- CAT: Two stimuli each randomly selected from all 17 tasks of CATs language battery
- OANB: Test instructions for picture naming in Sinhala
- Picture sequence narration and picture description: Test instructions of both tasks
- LPQ: The complete questionnaire
- Case History: Complete case history.

6.7.4 Procedure

The CAT was administered as instructed in the test manual and instructions were given in the same language as tested. The two monolingual participants completed the CAT in Sinhala while the two bilingual participants completed the same in English.

One monolingual and bilingual participant each completed the LPQ and case history. The same one ML and BL also rephrased and repeated the instructions for the OANB and connected speech tasks to the researcher, as it was understood.

Participants were also allowed to report any identified errors in the use of language and suggest constructive changes to the translated and adapted tool.

6.7.5 Response recording and analysis

All responses were produced verbally, audio recorded and transcribed later by the researcher. No non-words were elicited here and therefore transcriptions were done in English orthography for testing in English and in Sinhala orthography for testing in Sinhala.

Responses were analysed separately according to the aim of each trialled test item. No response was scored. Instead all responses were scrutinized within the framework of the test item, to identify response errors suggestive of misinterpretations and/or responses suggesting erroneous translations of test instructions or stimuli. Participant suggestions on translations (specifically for the use of simple informal words) were also considered and incorporated.

6.7.6 Outcome

There were no major disagreements in translations. The few disagreements with regard to the accuracy of translated words were a result of the personal differences in the form and dialect of Sinhala spoken between the researcher and the translator. These differences were resolved through discussion. No significant changes were made.

In the pilot testing, participants scored an average of 98.5% and 98% accuracy on the trialled Sinhala and English CAT stimuli respectively. 100% accuracy was also noted when participants rephrased instructions for the OANB and connected speech tasks in both Sinhala and English.

No significant changes were made to the Sinhala translations of the LPQ and case history.

Participant suggestions were reviewed and minor concerns were discussed until the researcher and translator agreed on a final version of all six translated items.

6.8 Summary

This section involved the selection and adaptation of the CAT as a language screening test material, selection of OANB stimuli suitable for testing monolingual Sinhala and bilingual Sinhala-English speakers, developing a LPQ and case history as relevant to this study and translating all of the above material (content, instructions or both) from English to Sinhala. Particular emphasis was given within this chapter to highlight the intensive protocols followed in the selection of test material, development of supplementary material as relevant to the aims of this study and detailing the stringent criteria followed in the translating material in a bilingual study. It is anticipated that such explicit planning at the preparatory stage would contribute towards an uncompromised research outcome.

Chapter 7. Phase 1- Establishing a Naming Accuracy Score (NAS) and ratings for Age of Acquisition, Familiarity, Imageability and Visual Complexity for the OANB in Sinhala and English

7.0 Overview

This chapter outlines the protocol and methods followed in gathering normative data for the *Object Action Naming Battery* (OANB) for use with monolingual speakers of Sinhala (ML) and bilingual speakers of Sinhala-English (BL). In preparing the OANB, loan words and cognates were removed after which a total of 219 items remained; 125 were objects and 94 were actions. The aims here were as follows.

(1) To establish a NAS in Sinhala and English[31] for the OANB stimuli

(2) To collect normative data on Age of Acquisition (AoA), concept familiarity, imageability and visual complexity for the same.

The OANB test items were trialled with monolingual Sinhala speakers and bilingual Sinhala-English speakers across the three language conditions; monolingual Sinhala (MLS), bilingual Sinhala (BLS) and English (BLE) to gather NAS for all stimuli in both languages. Details of this are included below. The same participants also completed ratings for the stimuli for AoA, imageability, concept familiarity and visual complexity. Details of this follow the section on NAS.

7.1 Rationale

Naming tests are often used in cross-linguistic research on lexical retrieval. When naming tests 'travel' across countries and languages and then administered with bilingual speakers, factors of cultural appropriateness and cognate status are of increased importance (Roberts & Doucet, 2011). Quantitative and qualitative variations

[31] Refers to naming accuracy score in English for Sinhala-English bilingual speakers, whose second language is English.

in performance (Barker-Collo, 2001) and in error distribution have been reported not just between cultures or speakers of different languages but also between populations of different areas speaking same language (Chen et.al, 2014). It is therefore necessary to ensure that the adapted test maintains equal sensitivity and difficulty across the two languages of the tested populations.

7.2 Participants

75 healthy non -brain damaged adults including 30 ML and 45 BL speakers participated.

7.2.1 Inclusion and exclusion criteria

All participants were adults aged 18 year and above. There was no upper limit to age. Participants had no known history of neurological, psychiatric disorders or developmental speech and language difficulties and has normal or aided to normal hearing and vision.

In order to be recruited to the monolingual group, a participant required fulfil all of the following.

(i) Be a native speaker of Sinhala language where the language was acquired informally (ii) Predominant user of Sinhala in childhood and adulthood. (iii) Have a score of >3 for both use and proficiency on the 5-point self-rating scale of the LPQ (iv) Not be a functional user of a second language (v) Report themselves as frequent users of the Sinhala language regularly, both in childhood and adulthood. Furthermore, recruits to the monolingual test group should also (vi) Be a Sri Lankan citizen by birth with both parents being Sinhalese (native Sinhala speakers) (vii) Have lived in Sri Lanka during most of his/her life (viii) Not have lived or worked outside the country for more than five years within the last 10 years (ix) Be educated within the national education system of the country, at least during the first five years of formal education.

Those allocated to the bilingual test group should have responded to the LPQ as; (i) A self-identified Sinhala- English bilingual. (ii) Native speakers of the Sinhala language but have later learnt the English language. Here, Sinhala should be learnt first (before English) and in a natural context and English learnt later through informal acquisition and formal/academic instructions. (iii) English should have been learnt before the age of 12 years (iv) Near equal proficiency and use on both English and Sinhala languages, where both languages are rated as >3 for proficiency and use on a 5-point self-rating scale (v) Not being a functional user of a third language (vi) Self-reported regular user of both languages, Sinhala and English, with near equal frequency, during both childhood and adulthood; (vii) Be a Sri Lankan citizen by birth with at least one parent being a Sinhalese (native Sinhala speaker) (viii) Not have lived out of the country for a continuous period of ten years or more during childhood. (ix) Have been able to carry on a conversation in both languages by the age of 12 years.

7.2.2 Ethical considerations and informed consent

Ethics and informed consent here were similar to that described in section 6.7.2 of Chapter 6.

7.2.3 Participant profiling

Biographic, language proficiency and psycholinguistic information of all recruited participants were collected prior to completion of the NAS tests and the ratings of stimuli. A detailed case history was first gathered in which participants responded verbally and their responses written in-situ by the researcher. Participants then self-completed the Language Proficiency Questionnaire (LPQ) and based on their responses were grouped as ML or BL speakers. Participant characteristics are listed in table 7.1 below.

Table 7.1: Participant characteristics and LPQ scores in Phase 1

		Monolingual (n=30)	Bilinguals (n=45)
Gender	Males	17	17
	Females	13	28
Mean Age		32.56	38.37
	Males	30.06	39.06
	Females	34.07	37.46
Handedness	Right	27	36
	Left	1	8
	Ambidextrous	2	1
LPQ Proficiency (mean) scores	Sinhala	4.7	4.6
	English	2.8	4.3
LPQ usage (mean) scores	Sinhala	4.8	4.3
	English	2.1	4.0

7.3 Study design

7.3.1 Participant grouping

The 30 participants recruited to the monolingual group were subdivided in to 2 groups of 15 each. The 2 groups were identified as MLG1 and MLG2. Similarly, the 45 participants recruited to the bilingual group were also subdivided in to 3 groups of 15 each. The 3 groups were identified as BLG1, BLG2 and BLG3. No specific criteria were followed in re-grouping. Instead, participants were allocated to sub groups in the order with which they were recruited.

For example, in the BL group, the first, second and third recruits were included in to BLG1, BLG2 and BLG3 respectively, the fourth recruit included again in to BLG1, the fifth in to BLG2 and so on. The same method was followed in allocating sub groups for participants in the monolingual group.

7.3.2 Task allocation

Tasks in this section involved (a) Naming pictures (objects and actions) for establishing a NAS (b) Rating the same items for age of acquisition (AoA), imageability, concept familiarity and visual complexity.

ML participants completed testing only in Sinhala. BL participants completed testing in Sinhala, English or both; depending on the tasks allocated to them.

The following details were taken in to consideration when allocating tasks to the subgroups outlined in section 7.3.1.

<u>Avoiding response bias due to participant fatigue</u>

15 monolinguals in Sinhala and 15 bilingual participants in Sinhala and 15 bilingual participants in English, completed each task. A recruited participant would only complete a selected number of allocated tasks but not all. Since both Sinhala and English data were obtained from the bilingual group, a comparatively greater task load was to be completed by them. Therefore, the non-linguistic rating of visual complexity was only assigned to the monolingual recruits. This aimed to minimize participant fatigue.

Further, in both naming and rating tasks, the 219-stimuli tested here were administered across four lists in each language. A brief rest period of about five to ten minutes or longer if requested was provided at the end of each list.

<u>Avoiding response bias due to order effects</u>

Eight stimulus lists were generated (separately for Sinhala and English) four object lists and four action lists, which were randomly ordered. The randomized lists were first developed for English. In order to avoid semantic and phonological priming effects, each item in the auto generated lists were then manually compared with the two neighbouring items preceding and succeeding it for semantic similarities or a shared initial phoneme. Such identified items were randomly moved within and across lists.

The Sinhala lists of objects and actions were first arranged to match the initial sequence of the randomized English word lists. The lists were scrutinized for semantic and phonological relationships and the items manipulated as before. The manipulation of items within language lists resulted in different item sequences across Sinhala and English. Separate PowerPoint presentations were made for lists in English and Sinhala. The Sinhala and English stimuli lists used for testing in phase 1 are given in appendix 7.1.

Furthermore, forward and backward presentations of lists were randomly applied in testing to minimize order effect.

<u>Avoiding response bias due to familiarity effects</u>

The allocation of tasks amongst the groups and their sequence of administration were designed to take account of order and prior exposure factors. Therefore, (1) naming or imageability rating if allocated was completed first. (2) When a group was assigned both naming tasks and imageability rating, the stimulus list differed across the tasks. (3) Familiarity rating followed naming and imageability rating. If the participant was not allocated a naming or imageability rating task, then familiarity was completed first (4) Ratings for AoA and visual complexity followed subsequently in no particular order. (5) No bilingual participant was allocated the same set of stimuli in a given task for both languages.

7.3.2.1 Task allocation for naming

In the monolingual group, 15 participants in MLG1 completed the third and fourth lists of both objects and actions in Sinhala. 15 participants in the MLG2 group completed the first and second object and action lists in Sinhala.

In the bilingual group, 15 participants in BLG1 completed all 4 object lists and all 4 action lists in both Sinhala and English. There was a brief gap in between Sinhala and English testing during which the participants completed all other allocated tasks (unrelated to the OANB). Participants were made aware that the language of testing would change in the second session of naming but were oblivious to the fact that the same stimuli would be presented. The presentation order of the stimulus lists were varied between the languages.

7.3.2.2 Task allocation for rating AoA, familiarity, imageability and visual complexity

In the monolingual group, 15 participants in MLG1 rated Sinhala action and object lists, 1 and 2 for age of acquisition and visual complexity. They also rated Sinhala action and object lists 3 and 4 for imageability. Participants in the MLG2 group rated Sinhala action and object lists, 3 and 4 for age of acquisition and visual complexity. They also rated Sinhala action and object lists 1 and 2 for imageability and all 4 lists for familiarity.

In the bilingual groups, 15 participants in BLG Sinhala object and all four Sinhala action lists for age of acquisition. Participants in group BLG2 completed action and object lists 1 and 2 for rating age of acquisition in English and all action and object lists for rating imageability and concept familiarity in Sinhala. 15 participants in BLG3 completed rating for age of acquisition in action and object lists 3 and 4 and all object and action lists for both concept familiarity and imageability in English.

Table 7.2 below presents a summary of the allocation of the naming task, rating for AoA, imageability, concept familiarity and visual complexity tasks, across the tested language groups.

Table 7.2 Summary of task allocation across groups for OANB tasks

	Sinhala OANB Testing (N=219)*				**English OANB Testing (N=219)***			
	List 1	List 2	List 3	List 4	List 1	List 2	List 3	List 4
Naming task	MLG2		MLG 1		BLG 1			
	BLG1							
AoA Rating	MLG 1		MLG 2		BLG 2		BLG 3	
	BLG 1							
Frequency Rating	MLG 2				BLG 3			
	BLG 2							
Imageability Rating	MLG 2		MLG 1		BLG 3			
	BLG 2							
Visual Complexity Rating**	MLG 1		MLG 2					

* Participants in BL groups were administered the OANB in both Sinhala and English
** All 219 black and white line drawn images were rated for VC only once.

7.4 Picture naming task

This section details methods in naming the 219 OANB stimuli; 125 object items and 94 action items.

7.4.1 Materials

219 black and white line drawings from the original OANB test were used here. The drawings were scanned and presented as a PowerPoint slide on a 13” Mac Book Pro laptop.

7.4.2 Task administration

In both English and Sinhala testing and for BL and ML speakers, object and action naming were assessed separately. In order to familiarize participants with the concept of responding (naming) in one word and given the ease to do so with objects, the researcher first administered the object lists followed by the action lists.

Participants were tested individually in a quiet, spacious and well lit room. The laptop was placed on a table approximately one - two feet ahead of the participant. The researcher sat by the side of the participant.

Each stimulus was a black and white line drawing that remained visible for ten seconds. The image was removed and the next one was presented when the participant responded or if the response time had elapsed, whichever occurred first.

Participants were instructed to “Name the object/action you see on the screen as you know it, as quickly as you can and preferably in a single word.” At the inception of each stimulus list, the stimulus questions “Look at this picture. Can you name it?” for objects and “look at this picture. What is this person doing?” for actions, was used once. Instructions were delivered in the same language tested.

7.4.3 Response recording

Participants responded verbally. All responses were audio recorded using a TASCAM DR40 professional audio recorder.

Participants were asked to indicate to the researcher if the picture was unknown to them.

7.4.4 Data transcription

The researcher transcribed all recorded responses in to response sheets. All real words were transcribed in orthography. There were no non-words in this phase. English script was used for English transcriptions and Sinhala script was used for Sinhala transcriptions.

7.4.5 Data coding

The time response time window for naming was 5-seconds. Only the first response was coded unless it was immediately self-corrected by the participant (see code 2 in table 7.3 for definition of “immediate self-correction). Significantly delayed responses and self-corrections, which occur after five seconds from initial response and multiple responses are identified and coded as incorrect. Responses were considered valid only if the participants responded in the tested language.

The researcher first familiarized herself with all responses obtained in the naming tasks for both Sinhala and English and identified a broad range of response categories. The findings were then discussed by a five-member focus group discussion comprising of the researcher, three working speech language therapists (SLTs)[32] and the Sinhala-English bilingual linguist[33]. A coding system for this study was prepared based on two previously published studies by Dell et. al (1997) and Vitkovitch and Tyrell (1995). Feedback received from the focus group discussions were also included in order to further modify the coding system as applicable to the tested languages and populations.

The researcher and one other SLT from the focus group transcribed and coded all responses for the naming task. The same coding system was used to code both Sinhala and English responses. Examples in Sinhala were used as a guideline when coding responses in Sinhala.

Table 7.3 below tabulates the criteria developed for coding all responses obtained in this phase of the study.

[32] These three SLTs were involved as research assistants in this study. All three are qualified undergraduates with a four-year degree in Speech Language Therapy, clinical experience in speech therapy for persons with aphasia and previous research experience in projects related to aphasia

[33] Refers to the same bilingual linguist involved in translations of test material, previously detailed in Chapter 6

Table 7.3: Coding system developed for the analysis of naming accuracy score of OANB

Correct Responses	
1	***Target responses;*** A response that matches the target word completely; is produced within five seconds and is the first response elicited. **OR** an immediate self-correction (ISC) that included the target word in both instances. Example: **1st response:** *boy jumping* **2ndISC response**: *jumping* (Note: Here the target word, 'jumping' was elicited in both instances and therefore is coded as 1)
2	***Immediate self-corrections (ISC);*** A self-corrected response that in the second attempt, matches the target word completely, is produced within five seconds of the first response with minimal effort and with no support from the examiner.
3	***Two word phrases;*** A response that is expressed in two words where one word comprises of the target word **or** a changed form of the target word (as coded 4); is an accurate perception of the picture stimulus and does not alter the meaning of the target word.
4	***Change forms of the word;*** a response that matches the target word but includes a changed morpheme (additional or reduced bound morpheme); is an accurate perception of the picture stimulus and does not alter the meaning of the word. Also, the response does not constitute any other real word or meaning.
5	***Dialect deviations;*** is a synonym for the target word which is an acceptable reference term to the target stimulus; may or may not have a changed form (as in code 4), is derived from a different form of language, that is, informal spoken, formal spoken, informal written or formal written and which when considered alone does not constitute any other real word or meaning.
6	***Tense deviations;*** is a response that differs from the target word in term of tenses or temporal aspects of the target word but is a correct reflection of the illustrated stimulus
Incorrect Responses	
7	***Acceptable synonym with multiple meanings:*** A response that is an acceptable synonym when contextually used but may refer to one or more other real words.

8	***Delayed self-corrections;*** A self-corrected response that matches the target word but is elicited more than five seconds after the first response, shows added effort and involves the participant requesting for clarifications or information
9	***Visual Errors:*** The stimulus is misinterpreted another real word which may or may not be phonologically and/or semantically relevant to the target.
10	***Cross language responses;*** The response is a correct identification of the target stimulus but is not elicited in the language tested and/or is a structural modification of a loan word. *Responses given in Sinhala when tested in English and vice versa and modifications such as [cheese kaellak] are included here*
11	***Phonological error:*** Involves the substitution, addition, distortion or omission of speech sounds in a way that the error response can be identified as sounding like the target, an acceptable synonym/dialect deviation (as coded in 4 and 5)
12	***Non-word, Incomplete or Inappropriate responses:*** The response is a non-word *(such as [chone] for crown*), an incomplete word (such as /*θʌɭ'ɭʊ*/ for /*θʌɭ'ɭʊ kərənəva:*/ [Eng. *Pushing*]) or an inappropriate response, which is an incorrect or inappropriate reference to the stimulus.
13/a	***Singularized or pluralized target responses;*** A response that matches the target word but is different that it is a singularized or pluralized form of the target word.
13/b	***Singularized or pluralized responses (other);*** An acceptable synonym or dialect deviation of the target word, does not constitute another meaning BUT refers to the stimulus in its singularized or pluralized form.
14	***Multiple responses;*** when three or more responses including the final response were produced; even if the third response was accurate.
15	***Descriptions;*** The response is a multi-word utterance that describes the target word or explains its function, purpose or use in the stimulus picture.
17	***No response;*** Participant is silent, makes no attempt to produce a response within a given response window (five seconds) and also includes remarks involving unfamiliarity, confusion or uncertainty. (*E.g. 'Don't know', 'Is it that', 'Not so sure', 'Something like that', 'may be'.)*

7.4.6 Data analysis

In analysis, all coded responses were identified as a correct or incorrect response.

The number of correct responses for the given item calculated NAS of an item. The number of correct responses were calculated for each item, separately for each language condition, that is, MLS, BLS and BLE.

NAS were then analysed across the three language conditions; MLS, BLS and BLE, separately for actions and objects.

7.4.7 Reliability of transcription and coding

Intra-rater reliability were calculated by the researcher and the other SLT re-transcribing and re-coding randomly selected sections of data, representing 10% of all collected participant responses.

Hence, four naming transcripts from the two MLG groups and six naming transcripts each from BLS and BLE groups were randomly selected and included here. Object and action lists 1 and 2 were re-transcribed and re-coded for two ML participants and two BLS participants while object and action lists 3 and 4 were re-transcribed and re-coded for the other two ML participants and three BLS participants. In the BLE group, two participant response sheets were re-transcribed and re-coded for lists 1 and 2 while the other three involved lists 3 and 4.

Inter-rater reliability was carried out on the same transcripts by another Sinhala-English bilingual speech language therapist familiar with the study but not involved in the initial transcription and coding process.

The numbers of agreements were calculated separately for transcriptions and response coding as follows.

Reliability score = Total agreements / Total agreements + disagreements * 100

7.5 Rating for psycholinguistic variables

This section describes methods in rating the 219-OANB stimuli for (i) age of acquisition (AoA) (ii) imageability (iii) concept familiarity and (iv) visual complexity

7.5.1 Task materials

Printed booklets were provided separately for each rating task. Participants were instructed to directly note their response on printed booklets. Response booklets were separate for English and Sinhala, actions and objects. All response booklets consisted of written instructions, an illustrated example and response guideline in the same language as tested. Since rating for visual complexity was only attempted by ML group, written instructions and the illustrated example were only provided in Sinhala.

7.5.1.1 Rating for AoA

This study employed Gilhooly and Logie's (1980) 7-point Likert scale. Here, 1 indicated the age band of 0-2 years and 7 indicated the age band of 13 years and above and intermediate points were denoted with 2-year age bands. The response booklet contained a grid in which stimuli were numbered vertically and age bands indicated horizontally, providing a box per age band for each stimulus.

Using the provided response booklets, participants were expected to place a cross or tick in the box corresponding to their response.

7.5.1.2 Rating for imageability

Here, rating for imageability was carried out on a 5-point scale where a rating of 1 indicated that the stimulus was difficult to visualize and 5 indicated it to be easy to visualize. This method is similar to that reported in the development of the Snodgrass and Vanderwart (1980) picture set. When a stimulus was presented, participants were expected to circle a whole number on the 5-point rating scale that corresponded to their rating.

7.5.1.3 Rating for concept familiarity

Response booklets included a 5-point rating scale where, 1 indicated the stimulus being very unfamiliar and 5 indicated the stimulus being very familiar, similar to those used in Snodgrass and Vanderwart (1980) and Bakhtiar, Nilipour and Weekes (2013). Participants were expected to circle a whole number on the 5-point rating scale that corresponded to their response.

7.5.1.4 Rating for visual complexity

The rating scale provided here was a 5-point scale as in the Snodgrass and Vanderwart (1980) and Bakhtiar et al (2013) studies. Here, 1 indicated a simple picture, which is easy to comprehend while a rating of 5 indicated a complex picture, which is difficult to comprehend. Participants were expected to circle a whole number on the 5-point rating scale that corresponded to their response. Samples of the response scales used for rating AoA, imageability, familiarity and visual complexity are provided in appendix 7.2

7.5.2 Task administration

The stimulus was presented on the laptop screen and remained visible until the participant had written down their response on the booklet provided or indicated that they were unable to rate the item. Responses for rating tasks were not timed.

The method of stimulus presentation, that is if picture alone, written word alone or both, varied according to the requirements of the rating task. When required, the written stimulus was presented in Sinhala for testing in Sinhala and in English for testing in English. A Times New Roman font, size of 54, black, lower case font was used for English while *FmAbhaya* size 60, black, font was used for Sinhala.

Instructions were delivered in Sinhala to the monolingual group and in Sinhala or English to the bilingual group depending on the language assessed. Stimulus questions and limited support was provided to the participant in rating while ensuring no interference to participant responses in the rating of items. Participants were allowed to request for further clarifications at any point of time in testing.

Rating-task specific details for test administration are as follows.

Rating for AoA

For rating AoA, the stimulus was presented in both graphic and written form. The researcher instructed the participant to estimate the age range at which the word was acquired in the assessed language, in either written or spoken form, whichever occurred first. The participant was instructed as, “Approximate the age at which you acquired this word; in either it’s spoken or written form.”

Rating for imageability

For rating imageability, the stimulus was presented in only written form. No illustrated image was provided. The researcher instructed the participant to rate on the given 5-point scale as to how easy or difficult it was to form a visual image of the presented word. The participant was instructed as, “Can you rate how easy or difficult it is to form a mental image of this word?”

Rating for stimulus familiarity

Here, both the illustrated and written form of the stimulus were presented. The researcher instructed the participant to rate how familiar they were with the stimulus displayed. Instructions were as, “On the response sheet, rate as to how familiar you are that is how much you come into contact with or think what is shown here.”

Rating for visual complexity

This involved the presentation of the illustrated target alone. No written form was provided. Instructions were as, “Here, you would need to rate the complexity of the picture you see. What you need to rate is the drawing. Not the real item. Look at the drawing in terms of its detail and intricacy of lines used in drawing it and rate it accordingly."

7.5.3 Data

The data obtained here involved 15 individual participant ratings for AoA, imageability and concept familiarity per object and action stimulus from each language group. An exception was for the rating of visual complexity where only 15 participants recruited to the ML group rated each item. For example, the object item [sheep] was rated for AoA, imageability and familiarity by 15 ML participants in Sinhala and 15 BL participants in Sinhala and 15 BL participants in English and by only 15 ML participants for visual complexity.

7.5.4 Data Analysis

The psycholinguistic data gathered for the 219 OANB items were analysed across the three language conditions; MLS, BLS and BLE, separately for actions and objects.

7.6 Outcome

The aim was to identify pictures, which had a high accuracy score across all three language conditions. This subset of stimuli would then go forward to be used in phases 2 and 3.

Naming accuracy data for each picture was computed and only those items reaching a set accuracy criterion were selected. This set of pictures and their target words also included psycholinguistic data, that is age of acquisition, imageability, concept familiarity and visual complexity generated from the rating tasks and details of those follow in chapter 9.

Chapter 8. Phase 1- Development of stimuli for eliciting connected speech

8.0 Overview

The same 75 healthy monolingual (ML) and bilingual (BL) adults who participated in the naming and rating of the *Object Action Naming Battery* participated here.

Five single pictures and five picture sequences were developed and trialled across the three language conditions; ML Sinhala (MLS), BL Sinhala (BLS) and BL English (BLE). Responses were analysed with the aim of selecting the stimuli that were most reliable, elicited a rich language sample while also providing the most comparable data across the three language conditions tested. The procedure and methods in the analysis of data are detailed in section 8.5. The same participants also rated all stimuli for visual complexity.

8.1 Rationale

Stimuli commonly used to elicit connected speech samples such as the cookie theft picture (Boston Diagnostic Aphasia Examination; BDAE, Goodglass & Kaplan, 1983), the picnic picture (Western Aphasia Battery; WAB, Kertz,1982), the cat rescue story (Nicholas & Brookshire, 1993) and Cinderella story (Grimes, 2005) or certain elements within them are culturally less familiar outside the US and Europe. For example, it is not common in the Sri Lankan context to call the fire department to rescue a cat, neither is a ‘cookie jar’ a common kitchen item. Language related factors may also influence performance [34](Olness, Ulatowska, Wertz, Thompson & Auther, 2002). The development and pre-trialling of appropriate novel stimuli on healthy adults is one method used to maximize reliability and validity of the stimuli used (see Mayer & Murray, 2003).

[34] E.g. Cookies are generally referred to as biscuits in Sri Lanka

When connected speech tasks involve illustrated stimuli (e.g. picture description tasks), properties of the stimulus are known to have an influence on the accuracy of interpretation and on response latency. Hence, visual complexity is identified as an essential property of line-drawn pictures or scenes in terms of recognition and retrieval of multiple names necessary to describe the scene (Szekely & Bates, 2000).

8.2 Generation of picture stimuli

The same focus group involved in section 7.4.5 participated in identifying and developing five sets of six-step picture sequences for the PS task (Appendix 8.1). Each sequence featured a series of six pictures depicting a gradually developing event.
Similarly, five single pictures each describing a single event were developed for the SP task (Appendix 8.2). Both PS and SP stimuli were black and white line drawings. All stimuli involved culturally appropriate items and scenarios. A professional artist drew the pictures according to specifications and requirements outlined by the researcher.

8.3 Participants

The 75 healthy adult participants including 30 monolingual Sinhala speakers and 45 bilingual Sinhala-English speakers recruited in Section 7.2 took part. The inclusion-exclusion criteria, allocation of participants by language status into BL and ML groups, ethical considerations and informed consent and participant profiling is similar to that described in section 7.2.1 and 7.2.3

8.4 Study design and protocol

8.4.1 Participant grouping

The same subgroups of participants as detailed in section 7.3.1 of chapter 7 remained.

8.4.2 Task allocation

Tasks here included picture sequence narration, single picture description and rating all stimuli for visual complexity. As in the OANB tasks, participant subgroups were not required to complete all of the above tasks but only those allocated to them. ML participants completed testing only in Sinhala. When allocated a task (PS, SP or rating) however, the participant viewed all five stimuli in the task.

BL participants completed testing in Sinhala, English or both depending on the tasks allocated to them.

<u>Avoiding response bias due to participant fatigue and stimulus familiarity</u>

15 monolinguals in Sinhala and 15 bilingual participants in Sinhala and English, completed each of the PS and SP tasks. Tasks were allocated and sequenced in order to minimize participant fatigue and stimulus familiarity. The BL groups were not allocated the same task in both Sinhala and English.

When a ML participant was allocated both a verbal elicitation and stimulus rating task of the same stimulus material (SP or PS), the description or narration task preceded the rating task. This aimed to minimize response bias due to stimulus familiarity.

As in naming, visual complexity was only assigned to the 15 monolingual participants.

8.4.2.1 Task allocation for PS and SP tasks

15 participants assigned to MLG1 completed the SP task and MLG2 completed the PS task in Sinhala.

In the bilingual groups, group BLG1 completed the SP task in Sinhala and PS in English. 15 participants in BLG2 completed the SP task in English while those assigned to BLG3 completed PS task in Sinhala.

8.4.2.2 Task allocation for rating PS and SP stimuli for visual complexity

MLG1 rated all PS and SP stimuli for visual complexity.

Table 8.1 below presents a summary of the allocation of story narration, picture description and visual complexity rating tasks across the test groups.

Table 8.1 Summary of task allocation across groups for connected speech tasks

Task		Sinhala Testing	English Testing
PS Task (n =5)		MLG2	BLG1
		BLG3	
SP Task (n=5)		MLG1	BLG2
		BLG1	
Visual Complexity Rating ***	PS stimuli	MLG1	
	SP stimuli	MLG1	

* Participants in BL groups described pictures/narrated sequence in Sinhala for Sinhala testing and in English for the English testing
** VC was only rated once by an ML subgroup

8.5 Connected speech tasks

8.5.1 Materials

Five six-picture sequences and five single pictures were used as stimuli for the SP and PS task, respectively. The drawings were scanned and presented as a PowerPoint slide on a 13” Mac Book Pro laptop screen.

8.5.2 Task administration

Each participant was tested individually in a quiet room. The laptop was placed on a table approximately one - two feet ahead of the participant. The researcher sat by the side of the participant. Each participant viewed all five sets of picture sequences, single pictures or both, whichever was allocated. Each stimulus was presented individually and sequentially. Participants were allowed a 60-second time period to respond for each stimulus. The stimulus remained visible throughout the 60-second response window. If the participant was unresponsive for more than 20 seconds at any given point, a stimulus question, “Is there anything else you could tell me?” was used. The stimulus was removed and replaced with the next if (i) the response time of 60 seconds elapsed without the participant initiating a monologue (ii) if after the use of the stimulus question the participant continued to be unresponsive for 20 seconds, (iii) if the participant indicated that they had nothing further to say, whichever occurred earlier. The investigator provided participants with instructions prior to the commencement of the task. All participants were instructed to respond in the same language as tested.

Prior to the presentation of the first sequence, participants were instructed as follows. “I will now present six pictures to you. They are all sequentially numbered and together will form a story. Follow each picture and describe each one in the laid out sequence to narrate the complete story to me.” For each subsequent stimulus, participants were instructed as, “This is the next story sequence. Do the same as before”. Prior to the presentation of the first single picture, participants were instructed as follows. “I will now show you a picture. Tell me everything you see in it.”

8.5.3 Response recording

Participants responded to both SP and PS tasks verbally. All responses were audio recorded using a TASCAM DR40 professional audio recorder.

8.5.4 Data transcription

All recorded data from SP and PS tasks were later transcribed verbatim by the researcher and two other SLTs (same persons described in section 7.4.5 of chapter 7). Speech samples in Sinhala were written in Sinhala script and those in English were written in English script. No non-words occurred in this phase.

8.5.5 Data analysis

The responses were analysed separately for SP and PS and also separately across each language condition.

8.5.5.1 Analysis of PS data

The analysis of PS data followed a two-step procedure.

Step 1: Analysis for accuracy

By scoring accuracy in the first instance the researcher aimed (1) to ensure that the selected stimulus is one that was well interpreted by healthy adults and (2) to narrow down the number of stimuli on which required further statistical analysis[35]

Response accuracy was measured by using a 'Story completeness score'. The 'story completeness score' was adapted from Le, Coelho, Mozeiko and Grafman (2011), in a study that aimed to measure the goodness of elicited story narratives. Le et. al. (2011) combined a story grammar score and a story completeness score as a measure of story 'goodness' in patients with Traumatic Brain Injury (TBI). Based on the aims of this study only the story completeness score was adapted here.

The story completeness score is a measurement of accuracy for story narration tasks. The score indicates how accurately each picture in the sequence was interpreted and provides the examiner with an ultimate story accuracy score for a given sequence. According to Le et. al. (2011), the first step in the process is for the examiner to identify a 'core piece of information' in each picture of the 6-step picture sequence.

A 'core piece of information' is described as the most prominent event illustrated in a given picture. Consequently, the PS trialed in this study will generate six key pieces of information. Here, each core piece of information was allocated five marks if accurately

[35] Further statistical analysis involved the measures of lexical diversity and is detailed in step 2 of the analysis process.

produced and correctly placed in sequence, within the story. A ceiling score of 30 marks could be obtained for each PS that is accurately and sequentially narrated.

A single mean story completeness score (averaged from the MLS, BLS and BLE language conditions) was obtained for each stimulus. The two stimuli with the highest story completeness score were selected for further analysis (step 2).

Step 2: Analysis for lexical diversity

The selected stimuli were further analyzed for lexical diversity across the three tested language conditions; MLS, BLS and BLE.

The measurement of lexical diversity involved the following nine variables: Total words, correct nouns, type nouns (Type-N), token nouns (Token-N), Type Token Ratio for nouns (TTR-N), correct verbs, type verbs (Type-V), token verbs (Token-V) and Type Token Ratio for verbs (TTR-V). Protocols followed in each of these measurements are detailed below.

i. Total words

Included in this count were nouns, verbs, prepositions, adverbs, adjectives, conjunctions, numerals, question words ('Wh' words) and negations. Also included were loan words (words that have no equivalent in Sinhala), which almost always occurred in Sinhala.

Not included in the count were incomplete words, non-words and words in other (non-tested) languages.

ii. Correct Nouns and Correct Verbs

The count for correct nouns included common nouns, collective nouns, abstract nouns and concrete nouns. Only nouns and verbs that were relevant and appropriate in the description of the given stimulus were counted.

Not included here were proper nouns. The count for correct verbs included main verbs and linking verbs but *did not* include auxiliary verbs and modal verbs.

The choice of which nouns and verbs to include or not here depended on the differences between the languages. Included were the types that were indisputably shared by both languages. This was crucial in order to make sure that the data were representative of participant performance and not bias due to language characteristics.

When counting 'correctly recalled nouns/verbs' an immediately repeated noun or verb was counted once unless the second repetition added new information or changed meaning within the sentence. Consecutive reiterations of the same word or words with a shared lemma (such as in changed forms of a word) were considered a 'repetition'.

iii. Token-N and Token-V

The token count includes the total number of relevant and/or irrelevant nouns (Token-N) and verbs (Token-V) produced in a sample. The types of nouns and verbs included in the token count were similar to that in CR counts. That is, nouns excluded proper nouns and verbs excluded auxiliary and modal verbs. In token counts however, words are recounted even if it was previous elicited in the same or in a morphologically related form.

iv. Type-N and Type-V

A count of the frequency of the different nouns (Type-N) or different verbs (Type-V) regardless of its relevance to the stimulus, that occurred within the elicited language sample.

v. **TTR-N and TTR-V**

Type-Token ratio for nouns and verbs were calculated as,

- TTR-N = Number of noun types for nouns / Number of tokens for nouns
- TTR-V = Number of noun types for verbs/ Number of tokens for verbs

The calculating TTR in Sinhala required a few changes from that of English due to language related factors. Thus in Sinhala, the following were counted as one unit.

i. Phrasal verbs in both Sinhala (e.g. */ɽʌɓʌn gʌʄʌnəʋʌ/ /ontʃiɭɪ pʌðʰɪnəʋʌ/ /kəɽəgɛnə jʌnəʋʌ/)*
ii. Compound nouns which frequently occurred in Sinhala (e.g. */ʌm'ʌ kɛnɛk/*, */ʌ:tʃ'ɪ kɛnɛk/ /bæɭʊm bo:ɭɛ:/, /ɽʌbʌn pʌðʰə/*

   Note: If a number was specified such as */ʌm'ʌɭə: ðɛn'ɛk/ (two mothers)* it was considered as two separate TTR units/noun types.
iii. Inflections of nouns (e.g. */pɪɽɪmɪ ɭʌməjɛk/ /gæɦænʊ ɭʌməjɛk/*) in Sinhala (E.g. *eaten, called)* & Sinhala (e.g. */kʌð'ðʰɪ/*, */ʋʌ:diʋɛɭʌ/*)
iv. Spondee words often used in spoken Sinhala (e.g. */kæʋɪɭɪ pɛʋɪɭɪ/ /æðʊm pæɭəðʊm/*)
v. Adverbial conjunctions and transitional words (e.g. */ɪ:tə pʌs'ɛ/ /ɪ:tə ʌməθəɽəʋə/)*
vi. Words such as ice-cream-*/ɛkʌk/*, cake-*/ɛkʌk/*, van-*/ɛkʌk/* where a loan word with no Sinhala translation (e.g. ice-cream, cake, van) is accompanied by the suffix /*ɛkʌk*/.

8.5.5.2 Analysis of SP data

Responses for SP task were analysed similar to that of PS task with the exception of the 'story completeness score' that was replaced with an accuracy score. The criteria used to measure accuracy of a single picture were developed based on previously used measures of main concept production (Nicholas & Brookshire, 1995) also reported by Doyle, Goda and Spencer (1995) in a study that measured communicative informativeness and efficiency of PwAs in structured conversations. Nicholas and

Brookshire (1995) define main concepts as the skeletal framework that outlines the core information. In their study scoring was performed as a two-step process in which a first pair of SLTs identified main concepts and a second pair, rated them in transcribed speech samples. In the current study, the researcher and one other SLT evaluated each individual response script to identify the number of main concepts elicited and as to how many of them were relevant to the corresponding stimulus. Based on this an accuracy score was calculated for each tested participant as follows;

$$\text{Accuracy score} = \frac{\text{Number of accurate/relevant main concepts}}{\text{Total number main concepts included in the sample}}$$

Similar to the analysis in PS, mean accuracy scores (averaged from the MLS, BLS and BLE language conditions) were calculated for the five SP stimuli separately. The two stimuli with the highest accuracy score were selected for analysis of lexical diversity. Specifications of all lexical diversity measurements are similar to PS (see step 2 in 8.5.5.1)

8.5.6 Stimulus selection

The five PS and SP stimuli were narrowed down to two stimuli each based on the mean story completeness score (PS) and mean accuracy score (SP), respectively. The two PS stimuli with the highest story completeness score and the two SP stimuli with the highest accuracy score were then analysed across the nine lexical diversity measurements listed above (section 8.5.5.1). One PS stimulus and one SP stimulus with the most comparable data across the three language conditions were selected for phases 2 and 3.

8.5.7 Reliability of transcription and coding

Intra-rater reliability were calculated by the researcher and the other two SLT re-transcribing and re-analysing randomly selected sections of data, representing 10% of all collected participant responses.

Hence, four transcripts from the MLS language condition and six transcripts each from the BLS and BLE language conditions were randomly selected and included here. PS data were re-transcribed and re-analysed for two ML participants and two BLS participants while SP data were re-transcribed and re-analysed for the other two ML participants and three BLS participants.

In the BLE language condition, two participant response sheets were re-transcribed and re-analysed for PS responses and the remaining three for SP responses. Inter-rater reliability was carried out on the same transcripts by another Sinhala-English bilingual speech language therapist familiar with the study but not involved in the initial transcription and coding process. The numbers of agreements were calculated separately for transcriptions and response coding as follows.

Reliability score = Total agreements / Total agreements + disagreements * 100

8.6 Rating PS and SP stimuli for visual complexity

8.6.1 Task materials

A booklet including 5 point rating scales for visual complexity similar to that used to rate naming stimuli was used to rate each SP and PS, individually (Appendix 8.3). The booklets were separate for SP and PS. All response booklets consisted of written instructions and an illustrated example in the relevant language tested. Participants were expected to circle a whole number that corresponded to their response on the 5-point Likert scale.

8.6.2 Task administration

Participants allocated the rating tasks were instructed, “In here, you would need to rate the complexity of the picture you see. What you need to rate is the drawing that is how difficult or easy it is for you to understand the drawn picture. Not the real scenario. Look at the drawing in terms of its detail and intricacy of lines used in creating it and rate it accordingly." The rating scale provided here was a 5-point scale as in the Snodgrass and Vanderwart (1980) and Bakhtiar et.al. (2013) studies. Here, 1 indicated a simple picture, which is easy to comprehend while a rating of 5 indicated a complex picture, which is difficult to comprehend. Participants were expected to circle a whole number on the 5-point rating scale that corresponded to their response.

No time limit was placed on this. A stimulus was replaced only when the participant had indicated that they had completed rating for the given stimulus. Participants were allowed to rate a given stimulus just once. In this instance, participants were also allowed to comment on their response or provide verbal feedback to the researcher.

8.6.3 Data

The responses of the 15 ML participants who rated each PS and SP stimulus consisted of numerical values from the rating scales. These data for visual complexity were averaged and a value obtained for each PS and SP stimulus or set of stimuli.

8.6.4 Data analysis

Visual complexity ratings were averaged across the 15 participants for each PS and SP stimulus (visual complexity ratings for individual stimuli are provided in chapter 9). For both PS and SP stimuli, the mean visual complexity score was not a criterion for selection. It was nevertheless important that the selected picture or set of pictures was rated low in visual complexity; a stimulus that is easy to comprehend, interpret and unambiguous.

8.7 Outcome

The aim was to identify one PS and one SP stimulus that was most accurately interpreted, elicited a rich language sample and also provided the most comparable data across the three language conditions tested. The selected stimuli would then go forward to be used in phases 2 and 3.

Data were gathered in two steps. Accuracy measurements were obtained in the first instance based on which the selection of stimuli were narrowed down to two PS and SP stimuli each. Mean differences and absolute differences were computed across nine variables of lexical diversity for each individual stimulus. Based on this, one SP and one PS stimulus was selected. The selected stimuli also included data on visual complexity generated from the rating task. Details of those follow in chapter 9.

Chapter 9. Findings in Phase 1

9.0 Overview

The aim of this analysis is to select the following for testing in phases 2 and 3.

(a) OANB stimuli with 80% NAS together with their psycholinguistic data

(b) One picture sequence narration together with its visual complexity rating scores

(c) One single picture together with its visual complexity rating scores.

Section 9.1 presents findings for OANB naming accuracy testing from across the ML Sinhala (MLS), BL Sinhala (BLS) and BL English (BLE) language conditions and the subsequent selection of naming stimuli for phase 2 and phase 3. Sections 9.2 and 9.3 detail findings in the data analysis for selecting a picture sequence and single picture stimulus, respectively.

9.1 Reliability findings

Four MLS, six BLS and six BLE were included in reliability analysis. Reliability values were individually calculated for each participant initially and then averaged.

A 100% reliability score was obtained for both inter and intra rater data transcriptions in naming, PS and SP tasks. An average of 99.1% and 99.4% was obtained in intra-rater reliability testing for objects and actions respectively. An average of 99.8% and 99.9% was obtained in inter-rater reliability testing for objects and actions respectively. An average of 98.6% and 97.7% was obtained for intra-rater reliability testing for nouns and verbs respectively in the PS task. Inter-rater reliability was 99.3% and 99.1% for nouns and verbs in the same task. In the SP task intra-rater reliability was 99.5% and 99.2% respectively for nouns and verbs while inter-rater reliability was 99.6% for nouns and 99.8% for verbs.

9.2 Adapting the Object Action Naming Battery (OANB)

9.2.1 Selection of stimuli based on Name Accuracy Score (NAS)

The Name Accuracy Score (NAS) was tested for 219 stimuli selected from the original 262-item OANB. This included 125 object names and 94 action names. All responses were allocated a code based on the coding system described in table 6.3. Codes 1 through 6 were accurate while codes 7 through 17 were scored as inaccurate. In order to be selected, a stimulus was required to secure the specified percentage accuracy criterion in all language lists; MLS, BLS and BLE.

Given that 15 participants named each stimulus in any tested language, the following was noted that when 14 out of the 15 participants named an item correctly, a NAS of 93.3% was obtained. When 13 out of the 15 participants named an item correctly, a NAS of 86. 67% was obtained. When 12 out of the 15 participants named an item correctly, a NAS score of 80 % was obtained. When 11 out of 15 participants named an item correctly, a NAS score of 73.3 % was obtained.

Tabulated in table 9.1 and 9.2 below are the cumulative values of test items achieving each level of NAS and this number of items as a percentage of the total items presented, separately in each of the ML Sinhala, BL Sinhala and BL English lists for objects and actions respectively.

Table 9.1; Cumulative value and percentage NAS, across language conditions for object stimuli (n=125)

NAS (%)	MLS (n=15)		BLS (n=15)		BLE (n=15)	
		(%) value		(%) value		(%) value
100	37	29.6	49	39.2	64	51.2
93.3	60	48.0	66	52.8	84	67.2
86.67	69	55.2	77	61.6	102	81.6
80	94	75.2	79	63.2	107	85.6
73.3	97	77.6	88	70.4	113	90.4

Table 9.2: Cumulative value and percentage NAS across language conditions for action stimuli (n=94)

Percentage correctly named (%)	**MLS**	**(%) value**	**BLS**	**(%) value**	**BLE**	**(%) Value**
100	19	20.2	31	32.98	34	36.17
93.3	29	30.86	44	46.81	44	46.81
86.67	37	39.36	53	56.38	58	61.70
80	47	50.0	59	62.77	67	71.28
73.3	55	58.5	65	69.15	75	79.79

When a 93.3% NAS was adopted, 47 objects and 21 actions remained for use in the main test battery. When an 86.67% NAS score was adopted, 63 objects and 30 actions remained for use in the main test battery. When an 80% NAS was adopted, 69 objects and 38 actions remained for use in the main test battery. When a 73.3% NAS was adopted, 74 objects and 43 actions remained for use in the main test battery.

Individual NAS for the all tested object and action items (with values of % agreement for each language condition for each item) across the MLS, BLS and BLE language conditions are given in appendix 9.1.

Since a substantial number of stimuli were required for testing in phase 2 and phase 3, an 80% or higher level of naming agreement in all language conditions, that is, MLS, BLS and BLE determined as criterion for a stimulus to be included in the naming test. Hence, a total of 107 OANB items, that is, 38 action stimuli and 69 object stimuli were selected for inclusion in the adapted version of the OANB.

9.2.2 Analysis of data for object stimuli

Of the 125 object stimuli only the ratings for the 69 object stimuli, which achieved an 80%, or above NAS in all three language contexts were included in further statistical analysis.

The NAS data and the data concerning psycholinguistic variables were computed for the 69 object stimuli across the three language conditions and then compared. NA, AoA, imageability, familiarity and visual complexity rating scores for the selected 69 object items across the MLS, BLS and BLE language conditions are given in appendix 9.2.

9.2.2.1 Rating objects for Age of Acquisition, familiarity and imageability

AoA, imageability and familiarity ratings for the selected object stimuli (n=69) by participants in the MLS language condition (n=15), BLS language condition (n=15) and BLE language condition (n=15) were first subjected to a measurement of internal consistency. As determined by a Cronbach alpha, the following findings (table 9.3) were obtained.

Table 9.3; Cronbach Alpha scores for the selected object items (n=69)

	ML-S	**B-LS**	**BL-E**
Age of Acquisition	.959	.956	.975
Imageability	.650	.941	.965
Familiarity	.984	.861	.930

The high Cronbach alpha values for AoA, imageability and familiarity scores obtained in all tested language conditions suggests good levels of internal consistency within the data. Therefore, all rated items and participants here were eligible to be subjected to further statistical analysis.

Table 9.4 below lists the descriptive statistics for objects in each language condition across the variables tested here; NAS, AoA, familiarity, imageability and visual complexity.

Table 9.4: Descriptive statistics for naming and rating of selected object stimuli (n=69)

Objects (N=69)	Monolingual Sinhala n=15	Bilingual Sinhala n=15	Bilingual English n=15
Naming Accuracy Score			
Mean	95.48	97.29	96.13
SD	5.58	4.33	5.98
Minimum-Maximum	80.00-100.00	86.70- 100.00	80.00-100.00
Median	100.00	100.00	100.00
IQ Range	6.70	6.70	6.70
Age Of Acquisition			
Mean	2.65	2.39	3.09
SD	0.74	0.72	0.90
Minimum-Maximum	1.50-5.10	1.30-4.50	1.50- 5.50
Median	2.5	2.3	2.9
IQ Range	1.00	1.05	1.15
Imageability			
Mean	4.97	4.86	4.84
SD	0.08	0.17	0.17
Minimum-Maximum	4.50- 5.00	4.10- 5.00	4.00- 5.00
Median	5.00	4.90	4.90
IQ Range	0.00	0.10	0.10
Familiarity			
Mean	4.70	4.92	4.85
SD	0.20	0.12	0.20
Minimum-Maximum	4.30-5.00	4.40- 5.00	4.10- 5.00
Median	4.7	5.00	4.90
IQ Range	0.40	0.10	0.20
Visual Complexity		Language Independent Variable	
Mean		4.92	
SD		0.17	
Minimum-Maximum		3.90-5.00	
Median		5.00	
IQ Range		0.10	

Figure 9.1 – 9.4 depicts box plots indicating language conditions that is, MLS, BLS and BLE NAS, ratings for AoA, stimulus familiarity and imageability for selected stimuli.

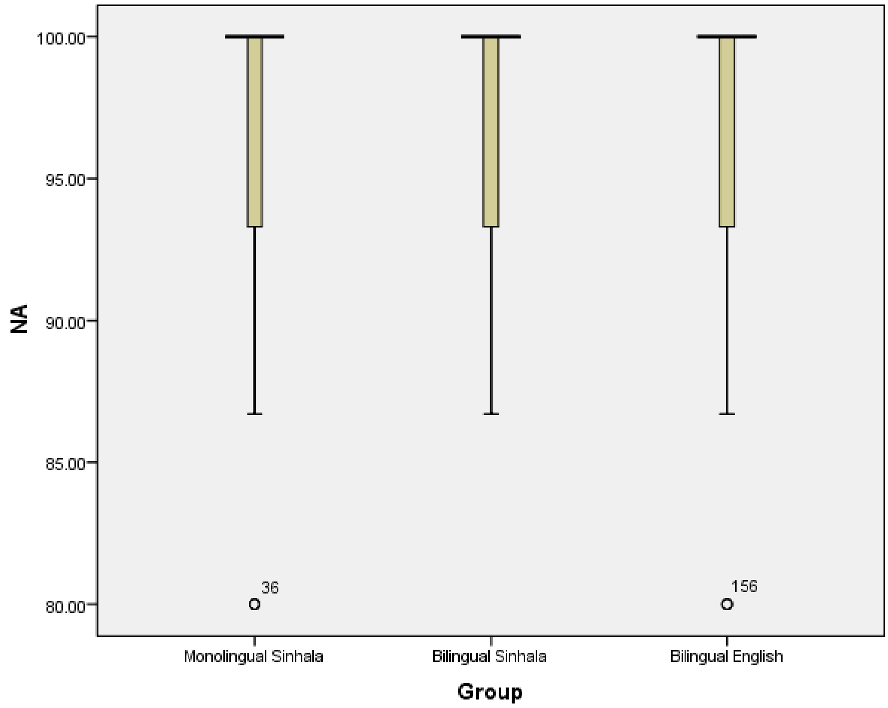

Figure 9.1: Box plot representing the distribution of responses in NAS for the selected object items across language conditions

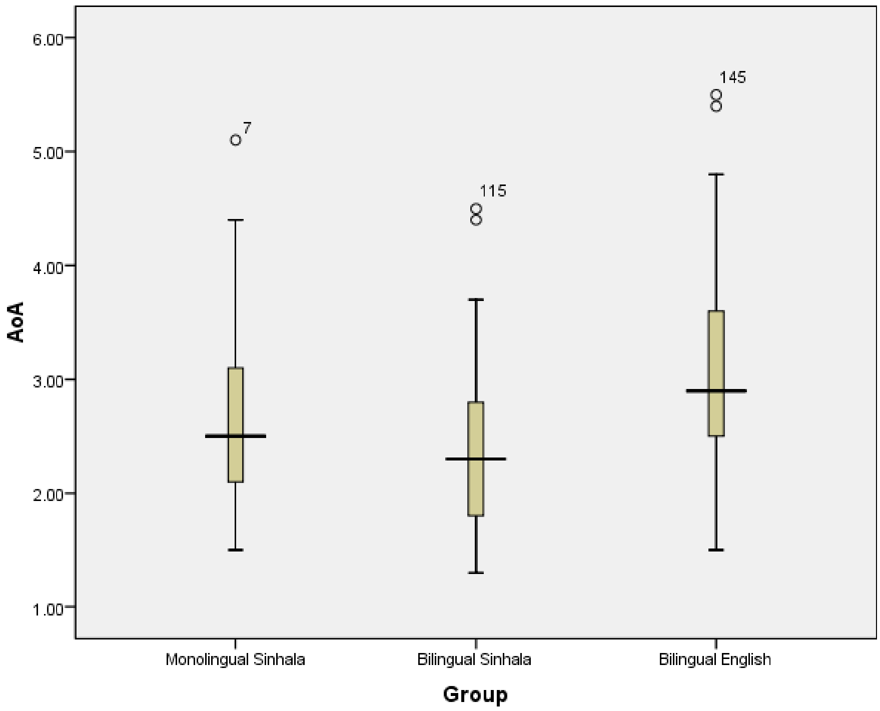

Figure 9.2: Box plot representing the distribution of responses in AoA ratings for the selected object items across language conditions

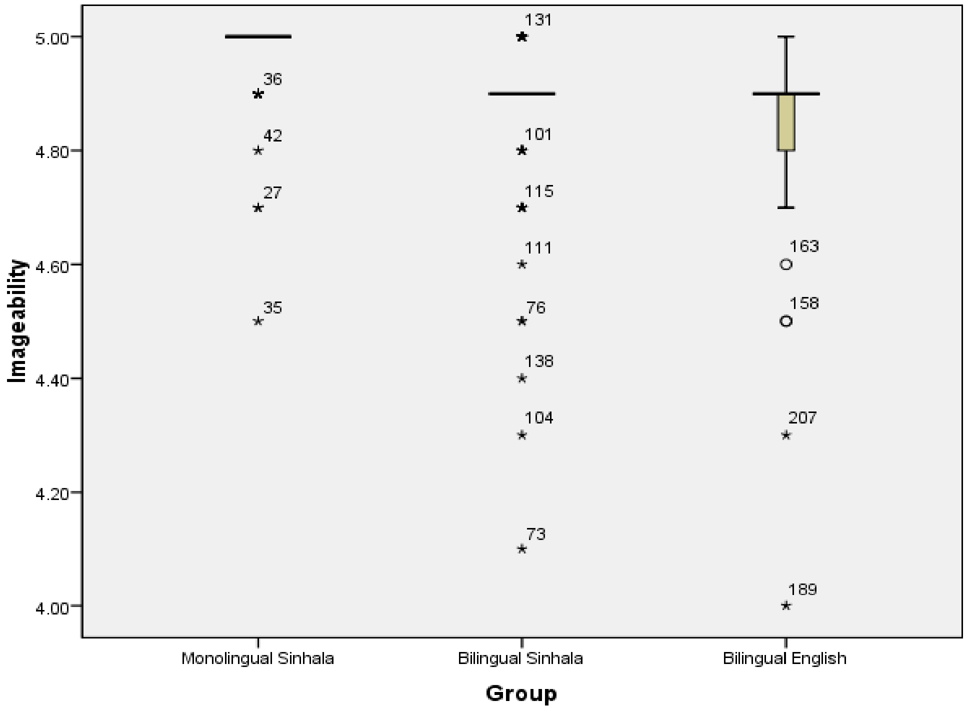

Figure 9.3: Box plot representing the distribution of responses in imageability ratings for the selected object items across the language conditions.

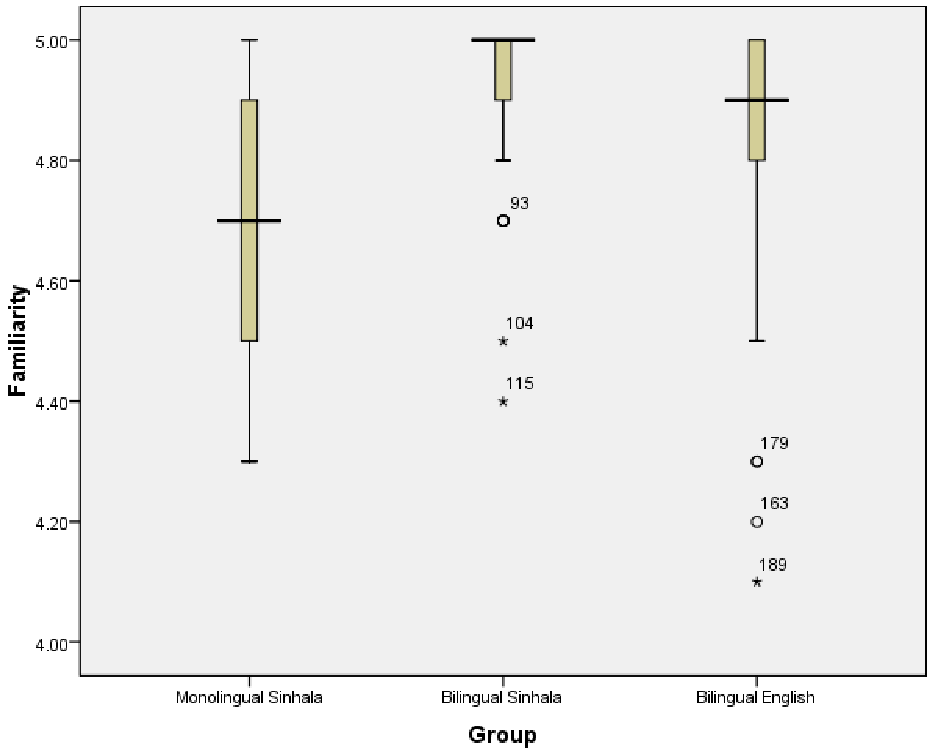

Figure 9.4: Box plot representing the distribution of responses in familiarity ratings for the selected object items across the language conditions.

Selection of statistical tests

In order to select an appropriate statistical test, Levene's test was performed to check for variances in NAS, AoA, imageability and concept familiarity data in the first instance. Levene's statistic was significant for NAS (p=0.015), imageability (p=0.000) and concept familiarity (p=0.000).

Hence, considering the data of the BLE language condition as a repeated measure, the non-parametric alternatives, that is the Friedman test of differences and Wilcoxon rank tests were used in further analysing the data.

When pair wise analyses were conducted on a group of three datasets, that is MLS-BLS, BLS-BLE and MLS-BLE, Bonferroni correction was applied which set the significance value of p at 0.025 (=0.05/2).

Non-parametric tests of significance and Post hoc analysis

There was no difference between the language conditions for NAS $\chi^2(2)$ 4.362, p=.113.

A statistically highly significant difference between the language conditions were observed on ratings for Age of Acquisition $\chi^2(2)$ 44.015, p=.000, stimulus familiarity $\chi2(2)$ 72.143, p=.000, and stimulus imageability $\chi^2(2)$ 70.995, p=.000.

Post hoc analysis with Wilcoxon rank tests was performed. In the ratings for Age of Acquisition, the median (IQR) scores were 2.5 (2.1-3.1) for the monolingual Sinhala (MLS), 2.3 (1.8-2.9) for the bilingual Sinhala (BLS) and 2.9 (2.5-3.7) for the bilingual English (BLE) language condition. Their differences were statistically highly significant between all three language conditions; the MLS -BLE (Z= -4.673, p=.000), the BLS -BLE (Z= -4.343, p=.000) and the MLS-BLS (Z=-6.310, p=.000)

In rating for stimulus familiarity, the median (Inter Quartile range/ IQR) scores for the MLS, BLS and BLE language conditions were 4.7 (4.5-4.9), 5.0 (4.9-5.0) and 4.9 (4.8-5.0) respectively. Here too, a highly significant difference was indicated between all three language conditions; the MLS - BLS (*Z*=-6.552, *p*=.000), the BLS-BLE (*Z*=-5.193, *p*=.000) and the MLS -BLE (*Z*=-3.560, *p*=.000).

In imageability, the MLS, BLS and BLE language conditions obtained mean (IQR) scores of 5.0 (5.0-5.0), 4.9 (4.9-5.0) and 4.9 (4.8-4.9) respectively. A Wilcoxon rank test to compare between the language conditions showed the differences between MLS - BLS language conditions (*Z*=-6.193, *p*=.000) and the MLS -BLE language conditions (*Z*=-5.989, *p*=.000) to be statistically highly significant. The difference between the BLS and BLE language conditions was not statistically significant (*Z*=-0.720, *p*=.472) at a p<0.025 level of significance.

9.2.2.2 Rating objects for visual complexity

Only the ML group (n=15) undertook the rating task for visual complexity (M=4.93, SD=0.12) and therefore was not included in further statistical analysis.

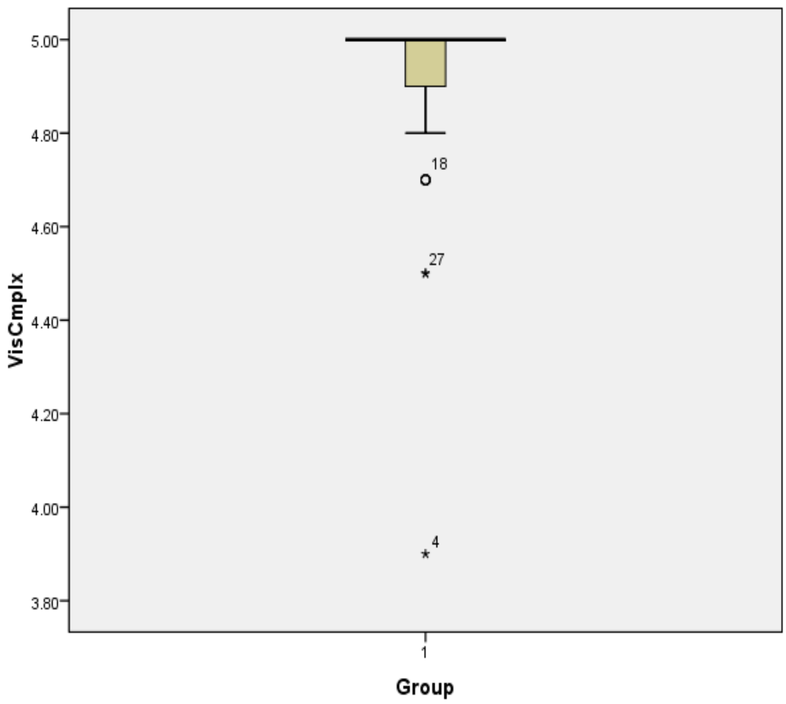

Figure 9.5: Box plot representing the distribution of responses in visual complexity rating for the selected object items in the MLS group

9.2.2.3 Summary for object stimuli

Findings for object items across the MLS, BLS and BLE language conditions are summarized in table 9.5 below.

Table 9.5: Summary of findings for object items (n=69) across the language conditions

Variable	Language conditions	Statistic	
		Chi Square	Post hoc Significance
NAS †	MLS-BLS	$\chi^2(2)$ 4.362, p=.113	-
	MLS-BLE		
	BLS-BLE		
AoA	MLS-BLS	$\chi^2(2)$ 44.015, p=.000	.000**
	MLS-BLE		.000**
	BLS-BLE		.000**
Familiarity	MLS-BLS	$\chi2(2)72.143$, p=.000	.000**
	MLS-BLE		.000**
	BLS-BLE		.000**
Imageability	MLS-BLS	$\chi^2(2)$ 70.995, p=.000	.000**
	MLS-BLE		.000**
	BLS-BLE		.472

† Post hoc comparisons were not performed since chi square finding was not statistically significant.
* Significant at $p \leq 0.025$, ** Significant at $p \leq 0.001$

9.2.3 Analysis of data for action stimuli

94 items from the original OANB action stimuli were initially tested.

Only those 38 selected action stimuli, which achieved an 80% or above NAS across all participant language conditions were included for further statistical analysis.

The NAS data and the data concerning psycholinguistic variables were computed for the 38 action stimuli across the three language conditions and then compared.

NAS, AoA, Imageability, familiarity and visual complexity rating scores for the selected 38 action items across the MLS, BLS and BLE language conditions are given in appendix 9.3

9.2.3.1 Rating actions for age of acquisition, familiarity and imageability

Here too, a measure of internal consistency was performed on the MLS (n=15), BLS (n=15) and BLE (n=15) participant responses to the selected action stimuli (n=38). The following Cronbach Alpha values were obtained (See table 9.6)

Table 9.6: Cronbach Alpha scores for the selected action items (n=38)

	MLS	BLS	BLE
Age of Acquisition	.938	.945	.947
Imageability	.172	.731	.962
Familiarity	.990	.900	.939

High Cronbach Alpha values were obtained across all factors and participant language conditions with the exception of imageability in the MLS language condition. A re-evaluation of data indicated two rogue responses by participants MLG 2/7 and MLG 2/12. For both the above participants, the exceptionally low ratings on two separate stimuli were a one off occurrence. Such low ratings were not repeated in the same or other tasks completed by the same participants. Therefore, it was decided to retain both the item and the participant for further statistical analysis.

Table 9.7 below lists the descriptive statistics for each language condition across NAS and other rated factors.

Table 9.7: Descriptive statistics for naming and rating in selected action stimuli (n=38)

Actions (n=38)	Monolingual Sinhala (n=15)	Bilingual Sinhala (n=15)	Bilingual English (n=15)
NAS			
Mean	93.68	96.14	95.27
SD	6.92	5.93	6.17
Minimum-Maximum	80.00-100.00	80.00-100.00	80.00-100.00
Median	93.30	100.00	100.00
IQ Range	13.30	6.70	13.30
Age Of Acquisition			
Mean	2.81	2.68	3.43.
SD	0.82	0.76	0.99
Minimum-Maximum	1.70-5.10	1.50-4.30	1.90- 5.70
Median	2.56	2.45	3.35
IQ Range	0.98	0.80	1.62
Imageability			
Mean	4.96	4.93	4.83
SD	0.08	0.10	0.15
Minimum-Maximum	4.70 -5.00	4.70- 5.00	4.30- 5.00
Median	5.00	5.00	4.90
IQ Range	0.10	0.10	0.12
Familiarity			
Mean	4.83	4.89	4.81
SD	0.10	0.15	0.22
Minimum-Maximum	4.50- 4.90	4.50- 5.00	4.10-5.00
Median	4.90	5.00	4.90
IQ Range	0.10	0.10	0.30
Visual Complexity		Language Independent Variable	
Mean		4.93	
SD		0.12	
Minimum-Maximum		4.40-5.00	
Median		5.00	
IQ Range		0.10	

Figure 9.6 – 9.9 depicts box plots indicating participant language condition that is, MLS, BLS and BLE NAS, ratings for AoA, stimulus familiarity and imageability respectively, for the selected action stimuli.

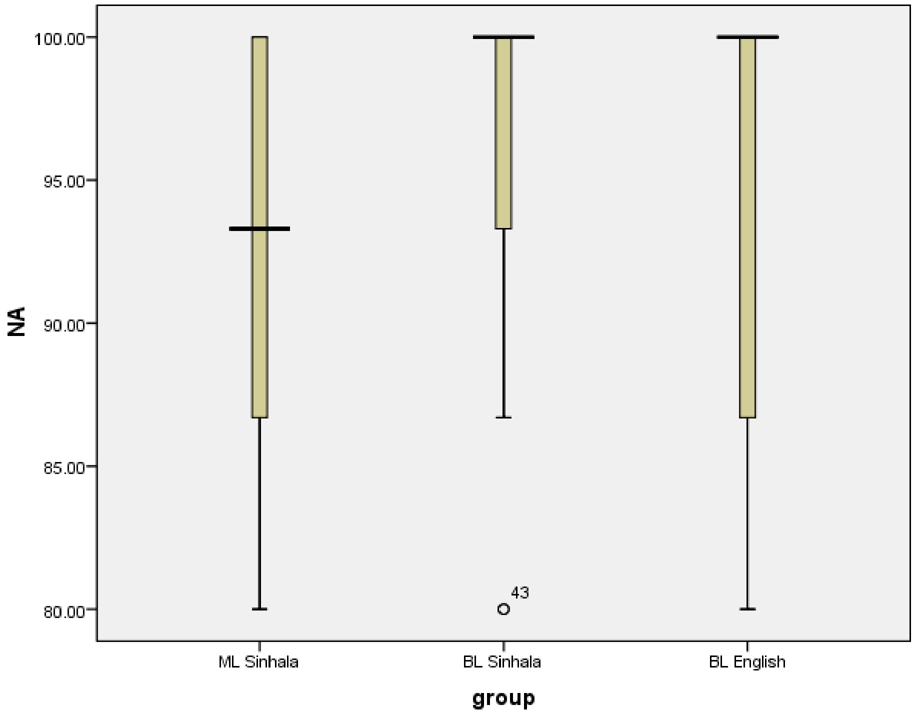

Figure 9.6: Box plot representing the distribution of responses in NAS for the selected action items across language conditions.

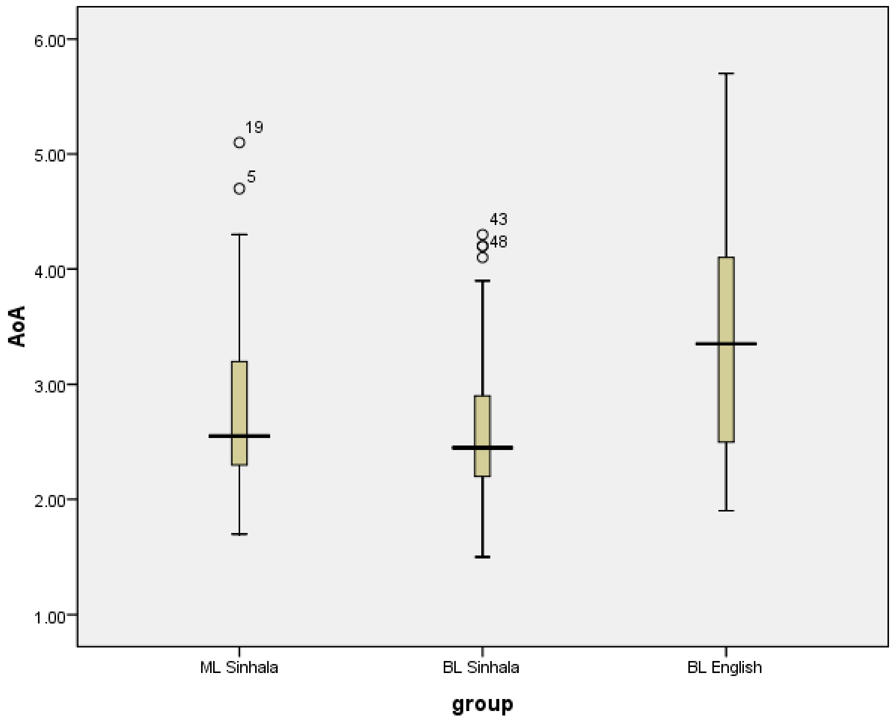

Figure 9.7: Box plot representing the distribution of responses in AoA rating for the selected action items across the language conditions.

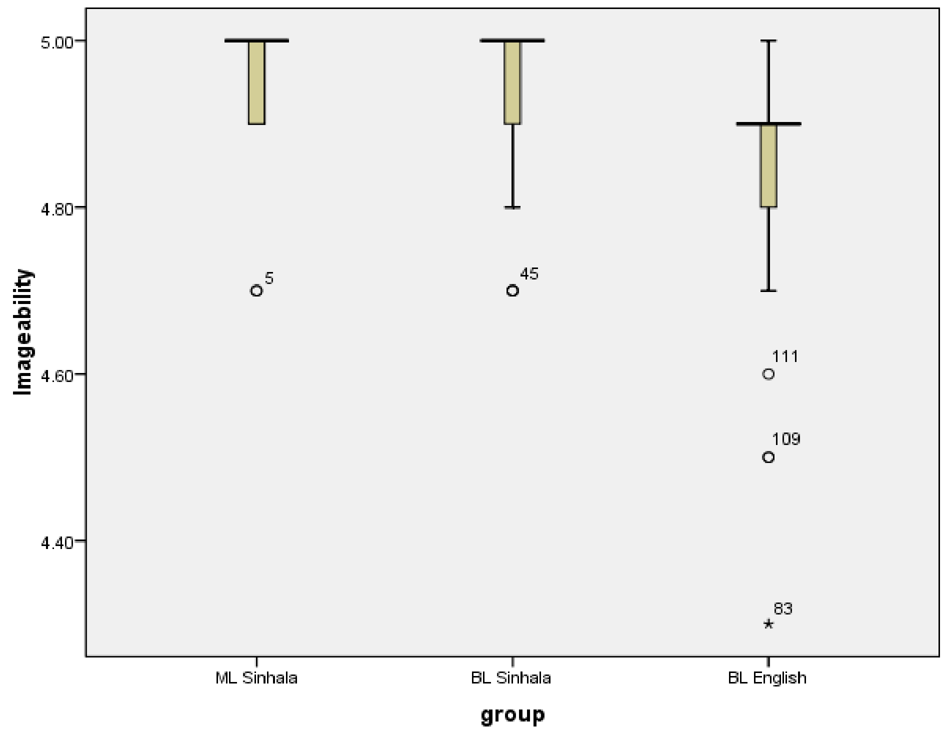

Figure 9.8: Box plot representing the distribution of responses in stimulus imageability rating for the selected action items across the language conditions.

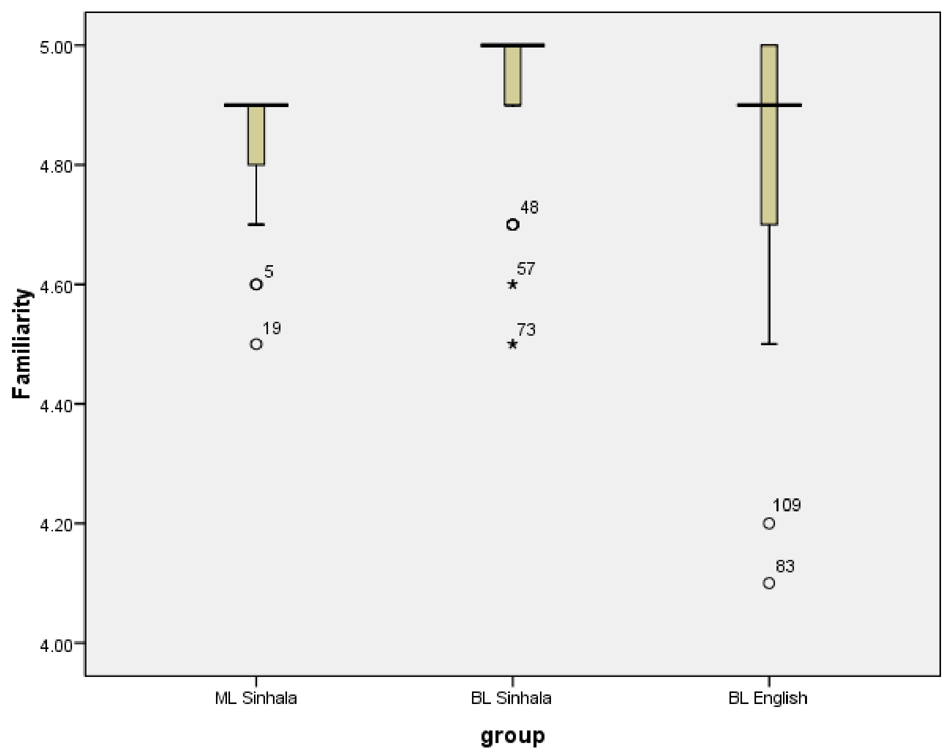

Figure 9.9: Box plot representing the distribution of responses in familiarity rating for the selected action items across the language conditions.

Selection of statistical tests

Similar to that of objects, Levene's test was performed to check for variances in NAS, AoA, imageability and concept familiarity data for the selected action items in the first instance. Here, Levene's statistic was significant for imageability (p=0.002) and concept familiarity (p=0.002).

As before, considering the data of the BLE language condition as a repeated measure, the non-parametric alternatives, the Friedman test of differences and Wilcoxon rank tests were used for further statistical analysis.

Here too, a Bonferroni correction was applied which set the significance value of p at 0.025 (=0.05/2).

Non-parametric tests of significance and Post hoc analysis

There was no difference between the language conditions for NAS $\chi^2(2)$ 3.843, p=.146.

A statistically significant difference between the language conditions was observed on rating for Age of Acquisition $\chi^2(2)$ 31.285, p=.000, Stimulus familiarity $\chi^2(2)$ 21.529, p=.000, and Stimulus imageability $\chi^2(2)$ 33.459, p=.000.

Post hoc analysis with Wilcoxon rank tests was performed with a Bonferroni correction applied and the significance level set at $p \leq 0.025$.

In rating for Age of Acquisition, the median (Inter Quartile range/ IQR) scores for the MLS, BLS and BLE language conditions were 2.6 (2.3-3.3), 2.5 (2.2-3.0) and 3.4 (2.5-4.1) respectively. There were highly significant differences between the MLS and BLE language conditions (Z= -3.648, p=.000) and the BLS and BLE language conditions (Z= -4.184, p=.000). There was no statistically significant difference between the MLS and BLS language conditions (Z=-2.029, p=.043)

When rating for stimulus familiarity, the median (IQR) scores were 4.9 (4.8-4.9) for the MLS, 5.0 (4.9-5.0) for the BLS and 4.9 (4.7-5.0) for the BLE language conditions. A comparison of responses within the language conditions indicated highly significant differences only between the MLS and BLS (Z=-3.502, p=.000) and the BLS-BLE language conditions (Z=-2.955, p=.003). Findings were not statistically significant at $p \leq 0.025$ level of significance between the MLS and BLE language conditions (Z=-0.458, p=.647).

In imageability, the MLS, BLS and BLE language conditions obtained mean (IQR) scores of 5.0 (4.9-5.0), 5.0 (4.9-5.0) and 4.9 (4.8-4.9) respectively. A Wilcoxon rank test to compare between the language conditions showed highly significant differences between the MLS and BLE (Z=-4.189, p=.000) and the BLS and BLE (Z=-4.293, p=.000). No significant difference was observed between the MLS and BLS language conditions (Z=-1.516, p=.130).

9.2.3.2 Rating actions for visual complexity

Only the ML group (n=15) undertook the rating task for visual complexity (M=4.93, SD=0.12) and therefore was not included in further statistical analysis.

Figure 8.10 below depicts the visual complexity scores for the selected object stimuli as rated by the ML response group.

Figure 9.10: Box plot representing the distribution of responses in visual complexity rating for the selected action items in the MLS language condition

9.2.3.3 Summary for action stimuli

Findings for action items across the MLS, BLS and BLE language conditions are summarized in table 9.8 below.

Table 9.8: Summary of findings for action items (n=38) across the language conditions

Variable	Group	Statistic	
		Chi Square	Post hoc Significance
NAS†	MLS-BLS	$\chi^2(2)$ 3.843, p=.146	-
	MLS-BLE		
	BLS-BLE		
AoA	MLS-BLS	$\chi^2(2)$ 31.285, p=.000	.043*
	MLS-BLE		.000**
	BLS-BLE		.000**
Familiarity	MLS-BLS	$\chi^2(2)$ 21.529, p=.000,	.000**
	MLS-BLE		.647
	BLS-BLE		.003*
Imageability	MLS-BLS	$\chi^2(2)$ 33.459, p=.000.	.130
	MLS-BLE		.000**
	BLS-BLE		.000**

† Post hoc comparisons were not performed since chi square finding was not statistically significant.
* Significant at p≤0.025, ** Significant at p≤ 0.001

9.3 Developing stimuli for the PS task

9.3.1 Selection of a picture sequence stimulus

The aim was to select a picture sequence that was culturally appropriate and that was potentially able to generate a rich connected speech sample for analysis in all language conditions. In the first instance, the two picture sequences with the highest story completeness score were selected (see, section 8.5.6)

Table 9.9 provides the mean and overall mean score for story completeness for the five PS stimuli trialed across the three language conditions, MLS, BLS and BLE.

Table 9.9: Analysis data for the selection of a picture sequence stimulus

Measurement		PS1	PS2	PS3	PS4	PS5
Story completeness score	**Mean**	**81.7**	**85.2**	**85.0**	**81.5**	**82.3**
	MLS	85.0	82.2	87.2	92.2	73.1
	BLS	82.2	84.4	86.7	76.7	88.9
	BLE	77.8	88.9	81.1	75.5	85.0
Visual Complexity Score	MLS	**5.0**	**4.7**	**4.8**	**4.8**	**4.5**

* The shaded columns represent data for the two stimuli for further analysis

Based on the story completeness scores, sequences PS2 and PS3 were selected for further analysis.

The two selected PS stimuli were further analysed to determine which sequence elicited similar data on lexical diversity measurement across the three tested language conditions. The measurement of lexical diversity involved the following nine variables: total words, correct nouns, type nouns (Type-N), token nouns (Token-N), TTR nouns (TTR-N), correct verbs, type verbs (Type-V), token verbs (Token-V) and TTR verbs (TTR-V)

Computing absolute and mean differences

The absolute difference and mean difference between the conditions for each variable was computed as follows.

In each of the nine variables, absolute differences, which is the difference in group means for the MLS-BLS, MLS-BLE and BLS-BLE pairs were computed. These three absolute difference values were then averaged to calculate a mean difference value. The equation below summates the above.

$$\textbf{Mean difference for var. X} = \frac{\text{Absolute differences of (MLS-BLS)+(BLS-BLE)+(BLE-MLS)}}{3}$$

Mean and absolute difference calculations for all nine variables above are given in appendix 9.4

Table 9.10 presents a summary of the absolute difference and the mean difference of the MLS, BLS and BLE language condition scores across the nine variables considered in measuring lexical diversity.

Table 9.10: Absolute differences and mean difference for the nine variables across language conditions

Variable	**PS2**	**PS3***
Total words	16.89	12.89
Noun and verb counts:		
Correct nouns	2.13	0.58
Correct verbs	1.65	1.96
Type-N	1.33	2.80
Token-N	1.69	1.69
TTR-N	0.07	0.15
Type-V	1.69	2.22
Token-V	2.05	2.49
TTR-V	0.03	0.03
Mean Difference of Noun and verb counts	3.06	2.76

* The shaded column represents data for the selected stimulus, PS3

9.3.2 Findings: Selection of PS3

The mean differences for variables involving the noun and verb count showed sequence PS3 to have the most comparable data across the three test language conditions. Picture sequence (PS3) was therefore selected for use in the 2nd and 3rd phases of this study (See appendix, 8.1; stimulus PS3).

Individual scores for all measurements of lexical diversity for the selected stimulus (PS3) are given in appendix 9.5.

Table 9.11 summarizes the data for the selected picture sequence PS3.

Table 9.11: Summary of the selected stimulus PS3 for the PS task

Measurement		Mean Score
Story completeness score		85.0
Visual Complexity Score		4.8
Total words elicited across the language conditions		12.89
Measurements of lexical diversity		
Noun counts	Type-N	2.80
	Token-N	1.69
	TTR-N	0.15
Verb counts	Type-V	2.22
	Token-V	2.49
	TTR-V	0.03
Total Variable Score (Mean)		2.76

9.4 Developing stimuli for the SP task

9.4.1 Selection of a single picture stimulus

The aim was to select one SP that was most culturally appropriate and was potentially able to generate a rich connected speech sample for analysis. The selection process was similar to that followed in the selection of a picture sequence. The selection was narrowed down to two single pictures in the first instance based on their accuracy scores.

Table 9.12 provides the mean accuracy scores for the five SP stimuli trialed across the MLS, BLS and BLE language conditions.

Table 9.12: Analysis data for the selection of a single picture stimulus

Measurement		**SP1**	**SP2**	**SP3**	**SP4**	**SP5**
Accuracy score (%)	**Mean**	100%	94.3%	96.7%	90%	100%
	MLS	100	98	97	83	100
	BLS	100	93	97	90	100
	BLE	100	92	96	97	100
Visual Complexity Score	MLS	5	4.7	4.9	4.7	4.7

* The shaded columns represent data for the two stimuli selected for further analysis

SP1 and SP5 (shaded in table 9.12 above) both of which had a 100% accuracy score were selected for further analysis.

The selected two single pictures (shaded in table 9.12 above) were further analysed for lexical diversity across the three tested language conditions. The measurements of lexical diversity included were the same as for PS. The absolute difference and mean difference between the conditions for each variable across the language conditions were calculated as done for PS (see section 9.2.1 above). Mean and absolute difference calculations for all nine variables above are given in appendix 9.6.

Table 9.13 presents a summary of the absolute differences and mean differences of the MLS, BLS and BLE group scores across all nine variables considered in measuring lexical diversity for SP1 and SP5.

Table 9.13: Absolute differences and mean difference for the nine variables across language conditions

Variables	SP1	SP5
Total words	14.98	22.31
Noun and Verb counts		
Correct nouns	2.40	3.55
Correct verbs	1.24	1.91
Type-N	2.18	2.80
Toke-N	2.40	3.20
TTR-N	0.05	0.08
Type-V	1.02	1.82
Token-V	1.20	1.96
TTR-V	0.05	0.01
Mean Difference of Noun and verb counts	2.83	4.18

* The shaded column represents data for the selected stimulus, SP1

9.4.2 Findings: Selection of SP1

The mean differences for variables involving the noun and verb count showed SP1 (shaded in table 9.13 above) to have the most comparable data across the three tested language conditions and were therefore included in the test protocol of phases 2 and 3 (See appendix, 8.2; SP1).

Individual scores for all measurements of lexical diversity for the selected stimulus (SP1) are given in appendix 9.7.

Table 9.14 summarizes the characteristic measurement data for the selected stimulus.

Table 9.14: Summary of the selected stimulus SP1 for the SP task

Measurement		Score/ value
Story completeness score		100
Visual Complexity Score		5
Total word elicited across the language conditions		14.98
Measurements of lexical diversity		
Noun counts	Type-N	2.18
	Token-N	2.40
	TTR-N	0.05
Verb counts	Type-V	1.02
	Token-V	1.20
	TTR-V	0.05
Total Variable Score (Mean)		2.83

9.5 Summary

This chapter presents findings from the analysis of data gathered by trialling the adapted and newly developed language instruments and stimuli on healthy ML and BL adults.

Based on the findings here 69 object items and 38 action items from the OANB, stimulus PS3 for the PS task and stimulus SP1 for the SP task were selected for use in phases 2 and 3. Details are as follows (see table 9.15).

Table 9.15: Summary of outcomes in phase 1

	Area Assessed	Material/ Test Instrument	Process carried out in phase 1	Items selected for use in Phases 2 and 3
1.	Demographic data	Case history	Developed for this study	Complete case history
2.	Language Proficiency Rating	LPQ	Developed based on the LHQ and LEAP-Q and trialed	Complete LPQ
3.	Language profiling	Comprehensive Aphasia Test (CAT)	Adapted, translated in to Sinhala and trialed	Complete CAT
4.	Picture naming	Object Action Naming Battery (OANB) (n=262)	Translated in to Sinhala and a subset of items trialled. 219 items (125 object and 94 action stimuli) were selected.	69 Object stimuli 38 Action stimuli
5.	Sequence Narration	-	Developed and trailed 5 new picture sequences	1 picture sequence 'kite story'
6.	Picture description	-	Developed and trailed 5 new single pictures	1 single picture 'Sinhala-Tamil New Year[36]

9.6 Interim Discussion 1: Adaptation and development of assessments in phase 1

9.6.1 Overview

The first phase of this study investigated responses of healthy adults in the retrieval of nouns and verbs on tasks assessing confrontational naming and connected speech in two specific populations of Sri Lanka that have not been studied before, monolingual Sinhala speakers (ML) and bilingual Sinhala-English speakers (BL). There are no published language and culture specific test materials in Sri Lanka. Hence, the first phase involved the preparation and development of assessment material to suit the

[36] The picture was that of the Sinhala- Tamil New Year festival, a Sri Lankan festival typically celebrated in the month of April marking the end of harvest/spring

linguistic and cultural needs of the population tested. The prepared test battery consisted of the *Object Action Naming Battery* (OANB; Druks & Masterson, 2000), the *Comprehensive Aphasia Test* (CAT; Swinburn, Porter & Howard, 2004) and their translated and adapted Sinhala version and also newly developed stimuli for picture sequence narration (PS task) and single picture description (SP task). The developed test battery was then trialled on 30 ML and 45 BL healthy speakers recruited to phase 1. Multiple analyses were performed across the ML Sinhala (MLS), BL Sinhala (BLS) and BL English (BLE) language conditions prior to being used in subsequent phases

9.6.2 Findings from the translation and preparation of test materials for testing in Sinhala

Translation and adaptation of published test material is a common practice in speech therapy (Ivanova & Hallowell, 2013). It is known that the actual objective of a test evaluation is achieved only when the process entails a thoughtful and rigorous process in identifying the cultural and linguistic factors affecting speakers of the target language (Milman et. al., 2014; Geisinger, 1994)

Significant issues identified when translating and adapting the CAT involved difficulty in matching phonological distractors and target words in the translated version, issues in illustrating newly added stimuli, issues in matching word length such as in repetition or naming tasks in where word length is a critical factor, lack of available data in Sinhala for word frequency, age of acquisition, imageability, high dependency on the researcher/ linguists judgment when matching and manipulating translated components for grammatical parameters such as morphological complexity, animacy, active/passive contrasts, adjectival and prepositional phrases and difficulties in finding replacements in Sinhala when multiple psycholinguistic variables (e.g. word length and word frequency) were involved. As a result the translated version lacked the rigour with which psycholinguistic variables were controlled in the construction of the original version of the CAT (See, Howard, Swinburn & Porter, 2010 for details on the construction of the CAT).

Despite being a picture-naming test, selection of a subset of stimuli for testing ML and BL participants in this study involved several other challenges. These include the occurrence of loan words and inter-lingual cognates, the presence of test items that constitute polysemous words in Sinhala and also challenges in establishing uniformity for naming accuracy score between the two languages, particularly due to the differences between the languages[37].

Some but not all of these issues have been identified and reported (Ivanova & Hallowell, 2013; Carter et. al., 2005; Prieto, 1992; Brislin et. al., 1973) although there has been little guidance to clinicians how these issues can be addressed or how such changes should be reported in research[38]. This results in numerous issues that range from mere literal translations of English assessments to published research findings derived from faulty tools (Ivanova & Hallowell, 2013). Chapter 6 of this study provides details on how all translation and adaptation issues relevant to this study were addressed.

9.6.3 Development of a coding system

A related outcome of this study was the development of two separate coding systems, initially for healthy speakers and later for speakers with aphasia. The development of this coding system[39] was crucial–as it included a number of language specific modifications identified to be specific for ML Sinhala and BL Sinhala- English speakers. The aim was to provide a guideline for coding and thereby maintaining

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[37] For example, verbs in English are a single word while verbs in Sinhala are often two words.

[38] See Ivanova and Hallowell (2013) as an example of a publication that provides researchers with guideline on ways to handle translations and adaptations of English test material.

[39] The coding systems were developed based on previous work by Dell et. al. (1997) and Vitkovitch and Tyrell (1995).

uniformity when coding responses by healthy speakers. It was also the basis on which subsequent coding systems for PwA data analysis was developed.

For example, responses to OANB items in Sinhala included verbs expressed as two word phrases (e.g. Sitting in Sinhala is /*vʌːdɪ vɛnəvaː*/, acceptable synonyms (e.g. */vʌːdɪ vɛnəvaː/* [sitting] is also referred to as /*ɪnðə gʌn'nəvaː*/ in colloquial Sinhala), dialectal deviations from the spoken Sinhala norm (e.g. the commonly used Sinhala term for shadow is /*hɛvənæḷ'ḷə*/ but was instead referred to as /*hɛmʌḷajaː*/ by speakers recruited from Kandy), tense deviations particularly in verbs (e.g. /*vʌːdɪ vɛnəvaː*/ [sitting] is also said as /*vʌːdɪ vɛḷaː ɪn'nəvaː*/ [seated], words with multiple synonyms as it occurs across the three different forms of Sinhala (e.g. house is referred to as /*gɛðərə*/ in colloquial and spoken forms and as /*nɪvəsə*/ in a formal form[40]). The coding system identified the above variations as an accurate response.

Conversely, examples of responses which were considered incorrect included synonyms with multiple meanings (e.g. /*nʌmənəvaː*/ used to imply both bending and folding), the use of the more frequent loan word when a Sinhala translation equivalent was available (e.g. In Sinhala, [*cheese*] is referred to as /*kɛd͡ʒʊ*/ although the frequently used word in spoken Sinhala is its loaned hybrid form /*t͡ʃɪːs*/ /*kæːḷ'ḷʌk*/). Based on the above, the coding system was further modified in phase 2 to suite speakers with aphasia. The modified coding system allowed a separate coding for language, which allowed the identification of code-switching behavior.

9.6.4 Matching sets of object and action naming stimuli

Stimuli for the picture-naming test in this study was were selected from 262-item OANB. Following the removal of interlingual cognates and loan words only 214-items, 125 objects and 94 actions remained and were named and rated in phase 1. Given the

[40] Both words do not have multiple mappings and were therefore in phase 1 was coded as accurate response within the sub-code, an acceptable synonym with no multiple meaning.

limited number of items available for further testing, it was not possible to obtain sufficient number of items if naming accuracy score and all other psycholinguistic variables were to be matched.

NAS has been shown to be an independent and robust predictor of naming performance (Vitkovitch & Tyrrell, 1995) in healthy speakers and speakers with aphasia (Alario et. al., 2004; Bose & Schafer, 2017). Therefore a decision was made to use naming accuracy score as the measurement of test item selection for this study. In the context of this study, it was noted that naming accuracy score was most likely to be a significant issue in Sinhala due to the fact that the many forms of Sinhala (literal, spoken and colloquial Sinhala) resulted in a greater number of different names for many OANB items.

This led to visible differences between the sets in terms of psycholinguistic variables across the language conditions in both objects and actions.

For object items on the OANB, the BLS language condition showed a lower AoA and higher frequency than the BLE and MLS language condition. For action items, there was a clear pattern with BLS ratings showing higher imageability, higher frequency and lower AoA that the BLE and MLS language conditions. This placed the BLS group at a higher performance advantage and implied that the stimuli selected would potentially be easier in the BLS language conditions to name than the other language conditions.

Findings in the subsequent phases need to be viewed in the light of these differences.

Chapter 10: Methods of assessing word retrieval in people with aphasia and healthy controls

10.0 Overview of phases 2 and 3

Using materials selected, prepared and developed in phase 1 of this study, phase 2 aimed to (1) Trial the developed material on monolingual (ML) and bilingual (BL) participants with aphasia (PwAs) and healthy controls (HCs), (2) Identify necessary changes to the assessment methods and test protocols prior to the main study (3) Identify practical considerations and necessary amendments to the developed protocol prior to the main study, (4) Familiarize with the novel data anticipated in this phase of the study, particularly data of PWAs and also (5) Identify the best methods for data analysis in the main study.

Phase 2 involved three ML PwAs, three BL PwAs and matched healthy controls. Phase 3 involved 15 ML PwAs and 11 BL PwAs and matched healthy controls. Each participant was required to (i) complete the language profiling test (CAT) (ii) name all 69 objects and 38 actions (iii) narrate one picture sequence and (iv) describe one single picture. This chapter details the methods followed for the above in phase 2 and phase 3.

Based on findings and observations from phase 2, amendments to the methods and testing protocol were identified and incorporated into the methods and protocols of phase 3. Details of these amendments and modifications are in chapter 12. The modified methods were then used in phase 3.

10.1 Ethical considerations and informed consent

10.1.1 Ethical approval

Ethical approval for phases 2 and 3 was obtained from the Department of Human Communication Sciences Research Ethics Committee at the University of Sheffield, United Kingdom and the Faculty of Medicine, University of Kelaniya, Sri Lanka. Evidence of ethical approval is provided in Appendix 10.1

10.1.2 Participant recruitment

PwAs were recruited through licensed Speech Language Therapists (SLT) based at government and private hospitals, teaching hospitals, rehabilitation hospitals and clinics in Sri Lanka. A one-page screening tool (Appendix 10.2) was provided to assist staff in identifying suitable participants. Initial contact was made by the SLT who then provided the patient and their caregiver with information sheets. Contact details of those who consented to the study were then passed on to the researcher. The accessible information guidelines (Herbert, Haw, Brown, Gregory & Brumfitt, 2012) were followed when developing the information sheets (Appendix 10.3 a & b) and consent forms (Appendix 10.4) for PwAs. For participants with aphasia a separate information sheet was also provided to the participant's caregiver/family (Appendix 10.5).

Healthy controls recruited to the study were expected to match an already recruited PwA in terms of age, gender, education and language proficiency. Recruitment was made through known contacts and senior citizen groups (Appendix 10.6 for flyer). An identified healthy participant was first contacted directly by the researcher or by a group administrator and provided with an information sheet (Appendix 10.7).

All information sheets and consent forms were initially developed in English and later translated in to Sinhala by a professional linguist. The translated versions were scrutinized by the researcher to ensure simple vocabulary, unambiguous meaning and to ensure that no information was deleted during translation. Information sheets and consent forms were provided in any either language requested by potential participants, regardless of the test group to which they were recruited.

Participants were provided with an opportunity to ask questions and/or request for further clarifications. Those who were willing to participate then provided written consent (see Appendix 10.8 for consent sheet for controls).

10.2 Participants

PwAs and HCs were recruited to either a monolingual or bilingual group. 12 participants that is, the first three ML PwAs and three BL PwAs to complete testing were recruited to phase 2 along with their matched HC. Another 15 ML PwAs, 11 BL PwAs and their matched healthy controls were recruited to phase 3. Participants were residents from the Colombo, Gampaha and Kandy districts. No recruitments were made from the Northern and Eastern areas where the population largely consists of Tamil speakers.

10.2.1 Eligibility criteria

10.2.1.1 Participants with aphasia and matched healthy controls

<u>Participants with Aphasia</u>

Participants with Aphasia recruited for this phase of the study met all of the following criteria. (i) Male or female volunteers above the age of 18 years but with no upper limit on age (ii) Experienced a single Cerebro-vascular accident (CVA) (iii) With a subsequent diagnosis of aphasia from a SLT (iv) Medical records confirming the medical and communication diagnosis (v) Absence of widespread brain atrophy, cognitive and psychiatric difficulties (vi) At least six months post stroke at the time of recruitment (vii) Retains sufficient expressive language to enable completion of tasks (viii) Speech intelligibility must not be significantly compromised by motor difficulties such as apraxia of speech or dysarthria (ix) Sufficient auditory verbal comprehension to understand test instructions and provide informed consent via an accessible aphasia consent form (x) Presence of anomia as diagnosed by a SLT (xi) Completed a minimum of eight formal years of education as per the Sri Lankan Education System (xii) Normal or aided to normal hearing and vision.

Participants were excluded if they reported, (i) Multiple strokes or Traumatic Brain Injury (TBI) following a stroke (ii) A history of neurological problems, psychiatric disorders, developmental speech and language difficulties, learning difficulties, visual and/or auditory impairment and intractable substance abuse (iii) Current use of medication that may alter their mental state or alertness (iv) Inadequate physical capacity for participation and/or evident significant fluctuations in mood or behaviour.

Healthy controls

Healthy controls were selected to match the group of PwA in terms of age, gender, level of formal education and language proficiency level. A matched control was allocated to each PwA recruited for the study. A potential control participant was excluded if they presented with, (i) Speech and language difficulties or cognitive or physical disabilities that may interrupt with communication were reported or observed (ii) Reduced speech intelligibility (iii) A history of neurological problems, psychiatric disorders, developmental speech and language difficulties, learning difficulties, visual and/or auditory impairment and intractable substance abuse were present (iv) Unable to cooperate due to inadequate physical capacity for participation and/or evident impairments in mood and personality (v) Difficulties in vision and hearing, even when aided.

10.2.1.2 Criteria for grouping as monolingual or bilingual

Monolingual participant groups

Participants recruited to the PwA and control monolingual participant groups met all of the following criteria. (i) Native speakers of Sinhala where the language was acquired informally (ii) Identified as a monolingual by the participant him/herself, or caregiver in the case of some of the PwA (iii) Predominant users of Sinhala in childhood and (for PwA) pre-stroke adulthood, able to engage in conversation in Sinhala by the age of 12 years (iv) A self or caregiver reported score of >3 for both use and proficiency of Sinhala, on the 5-point self-rating scale of the Language Proficiency Questionnaire (LPQ) (v) A self or caregiver reported score of <2 for both use and proficiency of English, on the 5-point self-rating scale of the Language Proficiency Questionnaire (LPQ) (vi) Educated in Sinhala that is, received education with Sinhala used as the language of instruction (vii) No functional use of a second language.

Bilingual participant groups

Those allocated to the PwA and control bilingual participant group were, (i) Self-identified Sinhala- English bilingual, where English was acquired before the age of 12 years (ii) Native speakers of the Sinhala language with English later learnt as a second language (iii) Self-reported regular user of both languages, Sinhala and English with near equal frequency, during both childhood and pre-stroke adulthood, with the ability to carry out a conversation in both languages by the age of 12 years (iv) Self or caregiver reported near equal proficiency and use of both English and Sinhala languages pre-morbidly, where both languages are rated >3 for proficiency and use on a 5-point rating scale

(v) Educated either in Sinhala (see above) or in in both Sinhala and English but with no one language more dominant than the other (vi) No functional use of a third language.

All participants were (vii) Sri Lankan citizen by birth with both parents being Sinhalese (native Sinhala speakers) (viii) Not lived or worked abroad for a continuous period of 10 years.

10.2.2 Participant screening and profiling

Demographic, language proficiency and psycholinguistic information of all participants recruited to phase 2 and 3 were profiled prior to administering the main tests. A detailed case history was first administered to all participants and their responses written in-situ by the researcher. Participants then completed the Language Proficiency Questionnaire (LPQ) and based on their responses were grouped as ML or BL speakers. For PwAs, caregivers were allowed to assist with completing the LPQ while the case history was verbally administered by the researcher to all PwAs and HCs.

All participants HC and PWA then completed the *Comprehensive Aphasia Test* (CAT; Swinburn, Porter and Howard, 2004). The CAT was administered in Sinhala for ML participants. For BL participants the CAT was administered in both Sinhala and English, on two separate days.

An overview of the areas assessed by the CAT is provided in appendix 10.9

A detailed account of participant characteristics including their demographic, medical (for PwAs), language proficiency and CAT scores of those recruited to both phases 2 and 3 of this study are provided in Chapter 11.

10.3 Materials

10.3.1 Language profiling

Language profiling was carried out using the *Comprehensive Aphasia Test* (CAT; Swinburn et. al, 2004). As a result of translation and adaptation, there were differences between the items of the Sinhala and English versions of the CAT (see 5.3). Details of administration are provided in section 10.2.2 above.

10.3.2 Picture naming task

The picture naming tasks involved the 69 objects and 38 action pictures from the *Object Action Naming Battery*, for which 80% NAS had been achieved (Chapter 9; also see appendices 9.2 and 9.3). The stimuli were the same black and white line drawings as in the original test. No changes were made to the original drawings of the selected OANB stimuli. The object and action lists were prepared by randomly ordering the stimuli using Microsoft Excel's randomization function. The randomized lists were then manually checked for semantic and phonological relatedness and rearranged with at least three stimuli intervening between semantic or phonological relatives. This aimed to prevent priming effects. As a result, the stimulus order of the Sinhala and English word lists differed from each other.

10.3.3 Connected speech tasks

10.3.3.1 Picture sequence narration (PS task)

The six picture sequence materials developed and selected from those trialed in phase 1 were used to elicit a connected speech sample (see Appendix 8.1; PS3).

10.3.3.2 Single picture description (SP task)

The stimulus picture developed and selected in phase 1 was used to gather single picture description data (see Appendix 8.2; SP1).

10.4 Study Design

Phase 2 and 3 involved cross sectional studies examining spoken word production in two language groups, BL and ML and two populations, PwAs and HC. Data were collected across three language conditions, ML Sinhala (MLS), BL Sinhala (BLS) and BL English (BLE). The BL Sinhala and English data were collected from the same participants, hence the study involves a mixed design with between group factor for

Sinhala (BL vs. ML) and within group factor comparing Sinhala-English and object (noun)-action (verb), within the same group of speakers.

Avoiding response bias due to order effects

In order to minimize order effects, a forward and backward presentation order was implemented only for stimuli in the naming task. The order of presentation was assigned to participants randomly. Both object and action stimulus lists were presented in the same order assigned to the participant. For example, if the object list in Sinhala was presented in forward order, then the action stimulus list was also presented in the forward order.

For BL participants, the order of presentation in Sinhala was different to that of English. For example, if Sinhala naming was tested in forward presentation order, then English was presented in reversed order and vice versa.

In phase 2 naming in Sinhala, seven out of the 12 participants received stimuli in a forward presentation order while the remaining five received in reversed order. When testing in English forward order was presented to three participants while the others received stimuli in reversed order.

In phase 3, when testing naming in Sinhala 30 out of 52 participants received stimuli in a forward presentation and 22 in reverse order. Stimuli presentation order in English for BL speakers were forward for 11 and reversed for nine participants.

Avoiding response bias due to familiarity effects

BL participants were allowed to select the order of language for conducting testing. Sinhala and English testing were carried out on different days. In order to minimize stimulus familiarity and practice effects, a minimum period of seven days was maintained between testing in Sinhala and English.

ML and BL PwAs and HC were tested on a single protocol. For BL participants however, the order of tasks in the language first tested was reversed when testing in the other. The test protocol for ML PwAs and HCs are given in appendix 10.10

The test environment and procedure remained constant across Sinhala and English test sessions.

10.5 Testing procedure

All participants recruited were visited at their home or live-in institutions.

The complete test protocol (see appendix 10.10) was administered to each individual across several days and multiple sessions. A maximum of two sessions, each lasting one-hour was conducted each day. The number of assessment sessions completed ranged from four to eight sessions for monolingual PwAs and from eight to ten sessions for bilingual PwAs. The testing for monolingual and bilingual controls ranged from two to four sessions. In order to minimize participant fatigue, participants took a 15-minute break between sessions on the same day or longer if requested. Further breaks were between tasks if the participant was tired or if the participant requested this.

Participants were tested individually in a well-lit, spacious and quiet room. All stimuli were presented as a PowerPoint slide on a 13” MacBook pro laptop, which was placed on a table approximately one - two feet ahead of the participant. The researcher was seated to the side of the participant. Stimuli were changed using a remote control slide changer to minimize distraction to the participant.

In order to ensure that the participant understood the task instructions practice trials were provided for each task. In both naming and connected speech testing, instructions were provided in the same language as tested and were delivered to the participant once, at the onset of each task. Instructions were repeated if the participant did not respond, responded inaccurately or asked for repetition. Stimulus questions were used once within a task, when a participant remained silent for a significant amount of time.

10.5.1 Picture naming task

10.5.1.1 Instructions

In the picture-naming task, participants were instructed as follows. *"In this task, you will see a picture displayed on the laptop screen before you. You are expected to name it, preferably in a single word".* Stimulus questions used in between a test *"Look at this picture. Can you name it?"* for objects and *"look at this picture. What is this person doing?"* for action words.

10.5.1.2 Practice trial

All participants were presented with one practice slide prior to actual testing. In both Sinhala and English naming tests the practice item for object testing was a '*toothbrush*' (/*ðʌθ ɓʊɽʊsʊvə*/) while the trial item for action testing was '*sweeping*' (/*ʌɵʊɠa:nəvʌ*/). Responses to the practice items were not timed or scored. There was no presentation time window for the trial item. The researcher provided cues, support and feedback to maximize the participant's understanding of the test task.

10.5.1.3 Test administration

Object and Action stimuli and Sinhala and English testing were included as separate PowerPoint presentations. Stimuli of all lists were presented individually, one item at a time. The black and white line drawings were displayed on the PowerPoint slide against a white background. The image size on each slide was set at 27cm x 27cm and positioned to the center of the slide.

The stimulus remained visible until the participant responded, indicated that they could not recall the word, or 60-seconds had elapsed, whichever occurred first. After the initial response, the stimulus remained visible for an additional five seconds before the next item was presented. This time was allowed for immediate self-corrections, if any. No phonemic or semantic cues were presented. Self-corrections were noted. No immediate feedback was given until the complete response time (60-seconds) had elapsed.

10.5.2 Connected speech tasks

10.5.2.1 Instructions

Instructions for sequence narration and picture description were as follows.

Sequence Narration

"*I will now present to you six pictures. They are numbered and placed in the correct order. What you need to do is to follow these numbers and describe picture by picture to narrate the complete story you see here."*

When required, participants were prompted as, *"Look at this picture. Tell me what you think is happening here?"*

Picture Description

"I will now show you a picture. Tell me everything you see in it."

When required, participants were prompted as, *"Is there anything else about this picture that you could tell me?"* was used.

Instructions and prompts were given in the same language tested.

10.5.2.2 Practice trial

As in naming testing, here too a practice item preceded the actual test stimuli. The practice stimulus for the sequence narration task was the 'wet paint sequence' (See Appendix 8.1; PS5) and the picture of a paddy field (see Appendix 8.2; SP3) for the picture description task. The participant attempted the practice item as per instructions given and with maximum support and feedback from the researcher. The response for the practice stimulus was not timed, recorded or scored.

10.5.2.3 Test administration

A stimulus when presented remained visible on the screen for 90-seconds. A verbal prompt was given when the participant had not responded for 30-seconds or indicated severe difficulty in completing the task. If the participant didn’t respond, the prompt was repeated at the 60-second time mark. The stimulus was removed if 90-seconds elapsed with no response despite having been prompted verbally or when the participant had indicated to have completed his response, whichever occurred first. Responses longer than 90-seconds were not interrupted. Participants were not given immediate feedback on the accuracy of their response.

10.6 Response recording

All spoken responses in the CAT were recorded in-situ by the examiner in the response booklet. For CAT tasks that required pointing, the researcher noted down the given response in the response booklet simultaneously. Responses for tasks that involved a verbal response were recorded using a Tuscam DR40 professional voice recorder.

Responses for the naming and connected speech tasks were audio-recorded using the same voice recorder. The researcher maintained written notes for each participant, noting down any information that was useful in coding, e.g. a delay in response due to reasons other difficulty in naming such as an unanticipated disturbance, a sneeze or the participant looking away.

10.7 Data analysis

Responses of each test group, that is, BL and ML, HC and PwA were analysed separately. The researcher and two BL SLTs transcribed all audio-recorded responses. All real words were transcribed orthographically. Responses in English were transcribed using English script while responses in Sinhala were transcribed in Sinhala script. Non-words, distorted words and/or unintelligible words were transcribed in IPA.

10.7.1 Response coding for picture naming

All responses were coded by the researcher and one other BL SLT (who was previously involved with coding responses for naming in phase 1). Each response was allocated a single code. The code was later identified as a correct or incorrect response. Only the first response was coded unless it was immediately self-corrected by the participant (see code 2 in table 7.3in chapter 7 for definition of immediate self-correction).

All responses, which the above dyad failed to agree upon, were then discussed by a six-member focus group. The group included the researcher and four BL speech and language therapists with knowledge and professional experience in aphasia and the Sinhala-English bilingual linguist who participated in the translations involved in phase 1 of this study (see section 7.4.5 in chapter 7).

10.7.1.1 Phase 2

All English and Sinhala responses in phase 2 were coded by the researcher using the coding system from phase 1(see table 7.3 in chapter 7). All responses were coded for type of error and for the language of production so that both aspects of spoken production were captured. Correct responses were only those elicited in the tested language. Based on findings in phase 2, the coding system developed for healthy speakers in phase 1 was further modified to include additional language errors specific to speakers with aphasia. The amended version of the coding system was then trialed in phase 2 and subsequently used in phase 3.

10.7.1.2 Phase 3

Responses in phase 3 were coded according to the amended coded system developed and trialed during the analysis of phase 2 responses. The amended coding system is provided in chapter 12; findings in phase 2.

10.7.2 Response coding for connected speech

All responses were coded by the researcher and one other BL SLT (who was previously involved with analyzing connected speech samples in phase 1).

10.7.2.1 Phase 2

Eight out of the nine measures of lexical diversity used to analyse PS and SP responses in phase 1 were obtained for the PS and SP responses of each participant across the tested language conditions. The measurement of total words was excluded for analysis in this phase. The eight measurement of nouns and verbs included correct nouns, type nouns (Type-N), token nouns (Token-N), Type Token Ratio for nouns (TTR-N), correct verbs, type verbs (Type-V), token verbs (Token-V) and Type Token Ratio for verbs (TTR-V) (for details of each measurement see step 2 in section 7.8.1).

Based on findings in phase 2, further categories were added to include language errors specific to speakers with aphasia. The amended language measures were then subsequently trialed prior to being used in phase 3.

10.7.2.2 Phase 3

Responses in phase 3 were analysed based on the amended measurements developed after the analysis of phase 2 responses. These amendments made prior to the analysis connected speech in phase 3 and is detailed in chapter 12; findings in phase 1.

10.8 Reliability coding

Intra and Inter rater reliability were calculated by re-transcribing and re-coding randomly selected sections of data, representing 10% of all collected participant responses.

Hence in phase 2, one PwA and one HC participant transcript from each language condition were randomly selected for reliability testing for naming, PS task and SP task. The transcripts chosen for each of the three tasks were of three different participants.

In phase 3, this included a random selection of two PwA and two HC participant transcripts from each language conditions. Again, the transcripts chosen for each of the three tasks were of three different participants.

In all cases, the entire transcript of each selected participant was subjected to a reliability check.

Re-coding for inter-rater reliability was carried out by another Sinhala-English bilingual speech language therapist familiar with the study but not involved in the initial round of transcription and coding. The numbers of agreements were calculated separately for transcriptions and response coding in naming, PS and SP tasks was as follows.

Reliability score = Total agreements / Total agreements + disagreements * 100

Chapter 11: Participant characteristics for phase 2 and phase 3

11.0 Overview

This chapter describes the Participants with Aphasia (PwAs) and healthy controls (HC) recruited to phase 2 (pilot phase) and phase 3 (main phase) of this study. PwAs and HCs were recruited into two language groups; a monolingual Sinhala speaking (ML) group and a bilingual Sinhala-English (BL) group. BL speakers recruited to this study were native Sinhala speakers who spoke English as a second language. The criteria followed in recruitment are detailed in section 10.2 of chapter 10.

A total of six PwAs were recruited to Phase 2. Participants were residents from the Colombo, Gampaha and Kandy districts.

The chapter consists of five sections. Section 11.1 and 11.2 presents details of the PwAs and HCs recruited to Phase 2. Section 11.3 and 11.4 presents details of all PwAs and HC recruited to Phase 3. Each of the above sections presents background information, language information and findings from the language-profiling test for participants of the respective group. Section 11.5 presents findings of statistical comparisons for identifying differences in participant characteristics across the groups in phase 3.

11.1 Participant characteristics of PwAs in phase 2

11.1.1 Background information

Tables 11.1 and 11.2 summarize the background information of participants recruited to the ML and BL PwA groups, respectively.

Table 11.1: Background information of PwAs recruited to the ML group in phase 2

Pt. ID number	Age	Sex	Education (in years)	Occupation status prior to stroke	Lesion	Time since onset (Months)	Pre morbid Handedness
ML/A/01	71	F	13	Unemployed	L/MCA Infarction	360	Right
ML/A/02	58	M	13	Retired	L/MCA Infarction	15	Right
ML/A/15	66	M	13	Businessman	L/Parietal infarction	35	Right

Table 11.2: Background information of PwAs recruited to the BL group in phase 2

Pt. ID number	Age	Sex	Education (in years)	Occupation prior to stroke	Lesion	Time since onset (Months)	Pre morbid Handedness
BL/A/03	78	M	17	Retired	L/Parietal and MCA Infarction	152	Right
BL/A/06	60	M	17	Supervisor	L/MCA Infarction	07	Right
BL/A/09	47	M	17	Public Officer	L/Parietal Infarction	15	Right

All but one participant recruited to phase 2, in both language groups, were male. All participants except one in the bilingual group were above the age of 50 years. The mean age of participants in the bilingual group was 65 years (SD= 6.56; Range= 58-71) and 61.67 years in the monolingual group (SD= 15.57; Range= 47-78). Participants of the BL group (mean=17; SD=0) had a higher education level *(in years)* than the ML group (mean=13; SD=0). All recruits here were right handed.

In the monolingual PwA group, two participants had recent onsets (<36 months) while the female participant (ML/A/01) had suffered a single stroke approximately 30 years ago (mean *in months*= 136.67; SD=193.67; Range= 15-360). Similarly in the bilingual group, one recruit (BL/A/03) had completed over 12.5 years post onset, at the time of participation (mean *in months*= 58; SD=81.50; Range=7-152). Despite their lengthy time since of onset, both participants, at the time of testing demonstrated visible language deficits, including that of anomia. Only one participant (BL/A/09) in the bilingual group was in active employment at the time of testing.

11.1.2 Language information

Table 11.3 presents the mean language proficiency and language use scores for participants recruited to the ML and BL PwA groups.

Table 11.3: Summary of LPQ scores for PwAs recruited to phase 2.

Group	Sinhala		English	
	Use	Proficiency	Use	Proficiency
Monolingual group (n=3)	5	4.67		
Bilingual group (n=3)	3.67	4	3.67	4

Note: LPQ scores for PwA represent their pre-stroke language use and proficiency

Table 11.4 and table 11.5 summarise the Sinhala and English language histories of BL-PwAs.

Table 11.4: Sinhala language histories of BL PwAs in phase 2

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for Sinhala	(ii) Self-rated use score for Sinhala	(iii) Method of Sinhala Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years Sinhala used	(vi) Sinhala use at home/ family communities	(vii) Sinhala use for education/ employment purposes	(viii) Post morbid use of Sinhala
BL/A/03	04	03	I	C <2 years	SIM	78	F	VF	VF
BL/A/06	05	04	I	C <2 years	SEQ (SbE)	60	F	VF	VF
BL/A/09	04	04	I	C <2 years	SEQ (SbE)	47	VF	VF	VF

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM), Sinhala before English (SbE)*
Response key for (vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

Table 11.5: English language histories of BL PwAs in phase 2

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for English	(ii) Self-rated use score for English	(iii) Method of English Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years English used	(vi) English use at home/ family communities	(vii) English use for education/ employment purposes	(viii) Post morbid use of English
BL/A/03	4	3	I	C <2 years	SIM	78	VF	F	F
BL/A/06	4	4	I & F	C >2 years	SEQ(SbE)	30	F	F	F
BL/A/09	3	3	F	LA	SEQ(SbE)	23	O	F	F

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM), Sinhala before English (SbE)*
Response key for(vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

11.1.3 Language profiling

The CAT provided individual language profiles of each participant. The Sinhala version of the CAT was administered to ML participants. BL participants completed the CAT in both Sinhala and English.

Table 11.6 provides the median and range across CAT tasks for monolingual and bilingual PwA groups in phase 2.

See Appendix 11.1(a) for individual CAT task scores of PwA in phase 2

Table 11.6 Median and range of CAT task scores for the ML and BL PwAs in phase 2

		Comprehension of spoken words	Comprehension of spoken sentences	Comprehension of written words	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non-words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken Picture Description	Reading words	Reading complex words	Reading function words	Reading non-words
ML PwA	Med	26	23	20	9	2.5	26	6	8	6	6	22	6	5	28	0	4	2
	Range	24-27	18-24	19-24	8-14	2.5-5	22-28	5-6	8-10	6-8	6-8	15-28	0-6	0-5	20-34	0-2	0-6	0-5
BL PwA Sinhala	Med	27	26	25	22	4	28	6	10	8	6	23	6	(-13)	36	5	6	3
	Range	26-28	21-29	24-28	12-25	3.5-4	28-32	0	9-10	6-14	6-14	21-28	5-10	(-18.5) -33	33-41	0-6	0	0-9
BL PwA English	Med	24	24	15	22	3	29	4	10	6	6	18	2	(-1)	36	4	6	6
	Range	21-30	23-28	9-26	13-26	2.5-3.5	24-32	4-6	4-10	4-10	0-8	14-38	2-4	(-3)-7	27-45	2-4	4-6	6-10

11.2 Participant characteristics of healthy controls, in phase 2

Three healthy non-brain damaged adults were recruited as controls to each of the ML and BL groups.

Participants were recruited from the Colombo, Gampaha, Galle and Kandy districts.

11.2.1 Background information

HCs were matched to their corresponding PwA in terms of age, gender, education and importantly language proficiency as determined by the LPQ.

Table 11.7 and table 11.8 below summarize the background information of the control participants recruited to the monolingual and bilingual groups, respectively.

Table 11.7: Background information of HCs recruited to the ML group, in Phase 2

Participant ID number	Age	Sex	Education (in years)	Occupation status	Premorbid Handedness
ML/C/01	70	F	13	Unemployed	Right
ML/C/02	58	M	13	Manager	Right
ML/C/15	63	M	13	Retired	Right

Table 11.8: Background information of HCs recruited to the BL group, in Phase 2

Participant ID number	Age	Sex	Education (in years)	Occupation status	Premorbid Handedness
BL/C/03	79	M	17	Retired	Right
BL/C/06	57	M	17	Retired	Right
BL/C/09	46	M	17	Technical Officer	Right

Gender representation and handedness of the control group matched that of the PwA groups. Mean age of participants was 63.67 years for the ML condition and 60.7 years for the BL language condition. Only two healthy recruits, one from each language condition were in active employment at the time of testing.

11.2.2 Language information

Similar to that of the PwA group, HCs rated their language proficiency and use in the LPQ.

Table 11.9 presents the mean language proficiency and language use scores for participants recruited to the monolingual and bilingual healthy control groups in phase 2 of this study.

Table 11.9: Summary of LPQ scores for healthy controls recruited to phase 2

Group	Sinhala		English	
	Use	Proficiency	Use	Proficiency
Monolingual group (n=3)	5	5		
Bilingual group (n=3)	4.67	4.67	4.33	4.5

Note: LPQ scores for PwA represent their pre-stroke language use and proficiency

Table 11.10 and 11.11 summarizes the Sinhala and English language histories of BL HCs recruited to phase 2 of this study.

Table 11.10: Sinhala language histories of BL HCs in phase 2

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for Sinhala	(ii) Self-rated use score for Sinhala	(iii) Method of Sinhala Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years Sinhala used	(vi) Sinhala use at home/ family communities	(vii) Sinhala use for education/ employment purposes	(viii) Post morbid use of Sinhala
BL/C/03	5	5	I	C<2 yrs	SIM	79	VF	VF	N/A
BL/C/06	5	5	I	C<2 yrs	SEQ (SbE)	57	F	VF	N/A
BL/C/09	4	4	F	C<2 yrs	SEQ (SbE)	46	VF	VF	N/A

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM), Sinhala before English (SbE)*
Response key for (vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

Table 11.11: English language histories of BL HCs in phase 2

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for English	(ii) Self-rated use score for English	(iii) Method of English Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years English used	(vi) English use at home/ family communities	(vii) English use for education/ employment purposes	(viii) Post morbid use of English
BL/C/03	4.5	4	I	C<2 yrs	SIM	79	O	F	N/A
BL/C/06	5	5	I	C<2 yrs	SEQ (SbE)	57	VF	VF	N/A
BL/C/09	4	4	F	LA	SEQ (SbE)	28	O	F	N/A

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM), Sinhala before English (SbE)*
Response key for(vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

11.2.3 Language profiling

The CAT was administered to all HCs recruited to phase 2. BLs completed the CAT in both languages; Sinhala and English.

Table 11.12 provides the median and range across CAT tasks for ML and BL HC groups recruited to phase 2.

See Appendix 11.1(b) for individual CAT task scores of HCs in phase 2.

Table 11.12: Median and range of CAT task scores for the ML and BL HC groups in phase 2

		Comprehension of spoken words	Comprehension of spoken sentences	Comprehension of written words	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non-words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken Picture Description	Reading words	Reading complex words	Reading function words	Reading non-words
ML HCs	Median	28	28	26	28	4	32	6	10	12	12	43	8	31	48	6	6	10
	Range	28-30	26-28	23-30	23-30	0	0	0	5-10	10-12	0	38-44	7-10	27-37	0	0	0	0
BL HCS	Median	29	26	27	27	4	32	6	10	14	10	43	10	41	48	6	6	10
Sinhala	Range	26-30	24-29	26-30	24-29	0	0	0	0	0	10-12	40-46	8-10	39-43	32-48	0	0	9-10
BL HCs	Median	26	27	28	27	4	32	6	10	14	12	42	10	39	48	6	6	10
English	Range	19-27	26-27	20-29	25-29	0	31-32	0	8-10	12-14	0	31-46	8-10	29-43	46-48	0	0	0

11.3 Participant characteristics of PwAs in phase 3

Twenty-six participants diagnosed with aphasia post single Cerebro Vascular Accident (CVA) were recruited to this phase. Participants were residents of the Colombo, Gampaha and Kandy districts.

11.3.1 Background information

Participants were allocated to a ML or BL language conditions (See 11.2.2 for language details). Hence, 15 PwAs were recruited to the ML language condition and 11 participants to the BL language condition. Tables 11.13 and 11.14 summarize the background information for PwAs in the main phase recruited into the ML language condition and BL language condition, respectively.

Table 11.13: Background information of PwAs recruited to the ML group in phase 3

Participant ID number	Age	Sex	Education (in years)	Occupation status prior to stroke	Lesion	Time since onset (Months)	Pre-morbid Handedness
ML/A/04	46	F	15	Teacher	L/MCA Aneurysm	09	Right
ML/A/05	52	F	13	Unemployed	R/MCA Infarction	60	Left
ML/A/07	55	M	08	Labour	L/CVA Infarction	17	Right
ML/A/11	64	M	11	Retired	L/MCA Infarction	84	Right
ML/A/12	47	F	13	Unemployed	L/Occipital Infarction	11	Right
ML/A/14	71	M	13	Retired	L/Hemorrhagic Infarction	70	Right
ML/A/17	60	M	11	Minor staff worker	L/ Parietal Infarction	116	Right
ML/A/18	47	M	13	Public servant	L/ICH Infarction	12	Right
ML/A/19	46	M	08	Self employed	Lacunar Infarction in the IC	24	Right
ML/A/21	56	F	11	Unemployed	L/ICH Infarction	16	Right
ML/A/06	24	F	13	Unemployed	L/Temporo-Parietal Infarction	70	Right
ML/A/08	30	M	11	Mechanic	L/Parietal Lobe AVM	13	Right
MLA/13	36	F	15	Manager	L/ Frontal Ischemic Stoke	09	Right
ML/A/16	34	M	11	Minor staff worker	L/MCA Infarction	17	Right
BL/05/ML	32	F	15	Allied health staff	AVM & Large Venous Aneurism	56	Right
Mean	46.7		12.1			38.9	
SD	13.464		2.22			34.14	
Range	24-71		8-15			9-116	

Table 11.14: Background information of PwAs recruited to the BL group in phase 3

Participant ID number	Age	Sex	Education (in years)	Occupation prior to stroke	Lesion	Time since onset (Months)	Pre-morbid Handedness
BL/A/04	80	F	17	Retired	L/Deep Parietal Infarction	82	Right
BL/A/08	53	M	17	Manager	L/MCA Infarction	12	Right
BL/A/10	41	M	17	Manager	L/MCA Territory Infarction	29	Right
BL/A/11	72	M	17	Director	L/CVA Temporo-Parietal Infarction	114	Right
BL/A/13	68	M	17	Manager	Sub-acute Infarction of the L/MCA	222	Right
BL/A/15	46	M	13	Bank Officer	L/MCA Infarction	07	Right
BL/A/01	30	F	17	Academic	L/MCA Territory	17	Right
BL/A/02	35	M	17	Business	L/AVM	11	Right
BL/A/07	35	M	17	Manager	L/MCA Infarction	101	Right
BLA/14	36	M	17	Manager	L/Thalamic & Internal Capsular ICH	17	Right
BLA/16	31	M	20	Academic	L/Parietal ICH	31	Right
Mean	47.9		16.9			58.5	
SD	17.81		1.58			66.57	
Range	30-80		13-20			7-222	

Mean, SD and range for age, education and time since onset of stroke have been presented in each table above. One participant (ML/A/05) presented an aphasia following lesion to the right hemisphere was included since the patient was pre morbidly left-handed and diagnosed with aphasia post stroke. All other recruits were pre morbidly right handed.

At the time of testing all participants recruited to both groups were physically mobile and were independent functional communicators. Five participants in the BL group were in employment, three participants had retired prior to the stroke and three others reported to be unemployed since the onset of stroke. In contrast, all 15 participants of the ML group were unemployed and reported being unable to reintegrate in to employment, post stroke.

In contrast to the 13 out of the 15 ML recruits receiving long-term and frequent speech therapy, only four participants of the BL group had enrolled in a speech rehabilitation program. While all participants in the BL group and 12 participants of the ML group were tested in home-based settings; two ML participants were tested in an outpatient setting and one ML participant in an institutional setting.

11.3.2 Language information

Based on their response to the LPQ, participants were allocated to language groups. Table 11.15 presents the mean language proficiency and use scores in Sinhala for ML PwAs and in both Sinhala and English for BL PwAs.

Table 11.15: Summary of LPQ scores for PwA recruited to phase 3.

Group	Sinhala		English	
	Use	Proficiency	Use	Proficiency
Monolingual group (n=15)	5	4.4		
Bilingual group (n=11)	4.18	4.36	4.09	4.18

Note: LPQ scores for PwA represent their pre-stroke language use and proficiency

Responses to questions on the LPQ revealed several variations amongst the bilingual participants. Five (BL/A/02, BL/A/04, BL/A/07, BL/A/10, BL/A/11) participants were reportedly from dominant English speaking family backgrounds reported to have acquired English in early childhood (<2 years) and had frequently spoken English at home, with family, during schooling times and at work places. One participant (BL/A/08) reported to have learnt English in late childhood (>2 years), be frequent speaker of English especially in employment but reported an almost equal use of Sinhala and English with his spouse and family with whom he spends the most time post stroke. For the above six participants, English was learnt through both family and formal methods such as school with no one environment having a greater impact on their English development than the other.

Five other participants (BL/A/01, BL/A/13, BL/A/14, BL/A/15, BL/A/16) also fluent speakers of English reported to have learnt English in their adolescence largely through formal methods of language learning. They also noted that English was rarely spoken at home with their non-English speaking family members but claimed to have used English extensively in their education and employment environments.

Table 11.16 and 11.17 summarizes the Sinhala and English language histories of the BL PwAs recruited to phase 3 of this study.

Table 11.16: Sinhala language histories of BL PwAs in phase 3

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		Pre-morbid						Post-morbid
	(i) Self-rated proficiency score for Sinhala	(ii) Self-rated use score for Sinhala	(iii) Method of Sinhala Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years Sinhala used	(vi) Sinhala use at home/ family communities	(vii) Sinhala use for education/ employment purposes	(viii) Post morbid use of Sinhala
BL/A/01	5	4	I	C<2 yrs	SEQ(SbE)	30	VF	F	VF
BL/A/02	4	4	I	C<2 yrs	SEQ(SbE)	35	VF	VF	VF
BL/A/04	4	3	I	C<2 yrs	SIM	80	F	F	F
BL/A/07	4	4	I	C<2 yrs	SIM	35	F	O	F
BL/A/08	5	5	I	C<2 yrs	SEQ(SbE)	53	VF	F	VF
BL/A/10	4	4	I	C<2 yrs	SIM	41	F	O	F
BL/A/11	5	5	I	C<2 yrs	SEQ(SbE)	72	VF	VF	VF
BL/A/13	5	5	I	C<2 yrs	SEQ(SbE)	68	VF	VF	VF
BL/A/14	4	4	I	C<2 yrs	SEQ(SbE)	36	VF	VF	VF
BL/A/15	4	4	I	C<2 yrs	SEQ(SbE)	46	VF	VF	VF
BL/A/16	4	4	I	C<2 yrs	SEQ(SbE)	31	VF	VF	VF

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM) , Sinhala before English (SbE)*
Response key for(vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

Table 11.17: English Language histories of BL PwAs in phase 3

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		Pre-morbid						Post-morbid
	(i) Self-rated proficiency score for English	(ii) Self rated use score for English	(iii) Method of English Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years English used	(vi) English use at home/ family communities	(vii) English use for education/ employment purposes	(viii) Post morbid use of English
BL/A/01	4	4	F	LA	SEQ(SbE)	13	R	VF	F
BL/A/02	5	4	I & F	C <2 years	SIM	33	F	F	F
BL/A/04	5	5	I & F	C <2 years	SIM	80	VF	VF	VF
BL/A/07	5	5	I & F	C <2 years	SIM	35	VF	VF	VF
BL/A/08	4	4	I & F	C >2 years	SEQ(SbE)	36	O	F	O
BL/A/10	5	5	I & F	C <2 years	SIM	41	VF	VF	VF
BL/A/11	5	5	I & F	C <2 years	SEQ(SbE)	72	VF	VF	VF
BL/A/13	4	3.5	F	LA	SEQ(SbE)	48	R	F	F
BL/A/14	4	4	F	LA	SEQ(SbE)	16	R	F	O
BL/A/15	4	3.5	F	LA	SEQ(SbE)	28	R	F	O
BL/A/16	4	4	F	LA	SEQ(SbE)	15	R	VF	F

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*
Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM)*
Response key for (vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

11.3.3 Language profiling

All participants also completed the CAT. As before, monolinguals completed the CAT only in Sinhala while bilinguals completed in both Sinhala and English.

Table 11.18 provides the median and range across CAT tasks for monolingual and bilingual PwAs in phase 3.

See Appendix 11.2 (a) for individual CAT task scores of PwAs recruited to phase 3.

Table 11.18: Median and range CAT task scores for PwA groups in phase 3

		Comprehension of spoken words	Comprehension of spoken sentences	Comprehension of written words	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non-words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken Picture Description	Reading words	Reading complex words	Reading function words	Reading non-words
ML PWA	Med	28	26	20	19	3	26	4	7	6	6	27	6	2.5	36	3	4	4
	Range	21-30	4-29	9-28	0-28	1-4	16-32	0-6	0-10	4-12	0-12	3-40	0-8	(-20)-27	0-46	0-6	0-6	0-10
BL PWA Sinhala	Med	28	24	23	26	4	32	6	10	8	2	24	7	2	48	6	6	5
	Range	8-30	16-30	14-31	14-31	3-4	23-32	0-6	3-10	3-12	4-14	1-48	0-10	(-6)-50	14-34	0-6	0-6	0-9
BL PWA English	Med	25	26	21	22	3.5	30	6	10	10	8	30	6	19	41	5	6	6
	Range	13-30	24-30	6-27	12-27	1-4	25-32	2-6	2-10	6-18	0-14	16-34	2-8	(-9)-32	32-43	0-6	0	0-10

11.4 Participant characteristics of healthy controls in phase 3

A total of 26 healthy non-brain damaged adults were recruited to the ML or BL group as controls. Each control was matched to their corresponding PwA in terms of age, gender, education and importantly language proficiency and use as measured on the LPQ. Recruited healthy participants were residents of the Colombo, Gampaha, Galle and Kandy districts.

11.4.1 Background information

Similar to their corresponding PwA groups, the ML control group included 15 healthy participants and the BL control group included 11.

Tables 11.19 and 11.20 below summarize the background information for healthy participants in the monolingual and bilingual groups of phase 3, respectively.

Table 11.19: Background information of HCs recruited to the ML group in Phase 3

Participant	Age	Sex	Education (in years)	Occupation	Handedness
ML/C/04	49	F	16	Unemployed	Right
ML/C/05	52	F	13	Unemployed	Left
ML/C/07	54	M	09	Public servant	Right
ML/C/11	68	M	09	Retired	Right
ML/C/12	48	F	13	Unemployed	Right
ML/C/14	70	M	15	Retired military officer	Right
ML/C/17	63	M	09	Retired	Right
ML/C/18	46	M	13	Businessman	Right
ML/C/19	47	M	09	Clerical staff	Right
ML/C/21	56	F	10	Self-employed	Ambidextrous
ML/C/06	26	F	12	Unemployed	Right
ML/C/08	28	M	12	Supervisor	Right
ML/C/13	33	F	17	Public servant	Right
ML/C/16	36	M	10	Business	Right
BL/05/ML	34	F	17	Travel and tourism	Right
Mean	47.3		12.1		
SD	13.82		3.1		
Range	26-70		9-17		

Table 11.20: Background information of HCs recruited to the BL group in phase 3

Participant	Age	Sex	Education (in years)	Occupation	Handedness
BL/C/04	83	F	17	Retired	Right
BL/C/08	54	M	20	Academic	Right
BL/C/10	42	M	17	Accountant	Right
BL/C/11	69	M	17	Retired	Right
BL/C/13	67	M	17	Retired	Right
BL/C/15	47	M	17	Journalist	Right
BL/C/01	31	F	17	Engineer	Right
BL/C/02	34	M	17	Businessman	Right
BL/C/07	32	M	17	Pharmaceuticals	Right
BLC/14	36	M	17	Manager	Right
BLC/16	28	M	17	Health care provider	Right
Mean	47.6		17.27		
SD	18.39		0.9		
Range	28-83		17-20		

Mean, SD and range for age and education have been presented in each table above.

In contrast to the two ML PwAs who reported to have had primary level education (≤ 11 years of education), the control ML group reported eight participants with primary level education (≤ 11 years of education). At the time of testing, eight participants from the ML and eight participants from the BL groups were in active employment.

Importantly, to match the corresponding PwA, the participant recruited as ML/C/05 was left handed while one other control reported herself as ambidextrous.

11.4.2 Language information

Recruited controls were matched as closely as possible to their corresponding PwAs, primarily according to their responses to the self-rated English proficiency and use scales (i and ii in table 11.17) and to the years of English use (v in table 11.17).

Table 11.21 and 11.22 below summarizes the English language histories of matched bilingual healthy controls recruited to phase 3.

Table 11.21: Sinhala language histories of BL HC in phase 3

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for Sinhala	(ii) Self-rated use score for Sinhala	(iii) Method of Sinhala Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years Sinhala used	(vi) Sinhala use at home/ family communities	(vii) Sinhala use for education/ employment purposes	(viii) Post morbid use of Sinhala
BL/C/01	4	5	I	EA	SEQ(SbE)	31	F	F	N/A
BL/C/02	5	4	I	EA	SEQ(SbE)	33	F	F	N/A
BL/C/04	5	5	I	C<2yrs	SIM	82	O	O	N/A
BL/C/07	4	5	I	C<2yrs	SIM	32	O	O	N/A
BL/C/08	5	5	I	C<2yrs	SIM	54	F	O	N/A
BL/C/10	4	4	I	C<2yrs	SIM	38	O	O	N/A
BL/C/11	5	5	I	EA	SEQ(SbE)	68	F	F	N/A
BL/C/13	4	4	I	EA	SEQ(SbE)	67	F	F	N/A
BL/C/14	4	4	I	EA	SEQ(SbE)	36	F	O	N/A
BL/C/15	5	5	I	LA	SEQ(SbE)	47	O	F	N/A
BL/C/16	4	4	I	LA	SEQ(SbE)	28	F	O	N/A

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*

Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*
Response key for (v): *Sequential (SEQ), Simultaneous (SIM)*
Response key for (vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

In (v) the actual chronological age of the participant is noted for those who reported to have been exposed to English since birth/ < than 2 years. For others, participants approximated the number of years they had used English

Table 11.22: English language histories of BL HCs in phase 3

Participant ID	Self-Rating scale and tester agreement		Open-ended Questions relevant to the LPQ						
	Pre-morbid		**Pre-morbid**						**Post-morbid**
	(i) Self-rated proficiency score for English	(ii) Self-rated use score for English	(iii) Method of English Language Acquisition	(iv) Age period of bilingualism	(v) Type of language acquisition	(v) Years English used	(vi) English use at home/ family communities	(vii) English use for education/ employment purposes	(viii) Post morbid use of English
BL/C/01	4	4	I & F	C<2yrs	SEQ(SbE)	31	O	F	N/A
BL/C/02	4	4	I & F	C>2yrs	SEQ(SbE)	29	F	F	N/A
BL/C/04	5	5	I	C<2yrs	SIM	82	VF	VF	N/A
BL/C/07	5	5	I	C<2yrs	SIM	32	VF	VF	N/A
BL/C/08	4	4	I & F	C<2yrs	SIM	54	F	VF	N/A
BL/C/10	5	5	I	C<2yrs	SIM	38	VF	VF	N/A
BL/C/11	4	4	I & F	C>2yrs	SEQ(SbE)	65	O	F	N/A
BL/C/13	4	4	I	C<2yrs	SIM	67	O	F	N/A
BL/C/14	4	4	I & F	C>2yrs	SEQ(SbE)	30	O	F	N/A
BL/C/15	4	4	I & F	C>2yrs	SEQ(SbE)	40	F	F	N/A
BL/C/16	4	4	F	C>2yrs	SEQ(SbE)	20	O	F	N/A

NOTE: Response key for (iii): *Informal (I) such as family 7 social community, Formal (F) such as school, special classes, training etc.*

Response key for (iv): *Childhood<2 years (C<2 years), Childhood >2 years (C>2 years), Early Adolescence (EA), Late Adolescence (LA), Adulthood (A)*

Response key for (v): *Sequential (SEQ), Simultaneous (SIM)*

Response key for (vi), (vii) & (viii): *Very Frequently (VF), Frequently (F), Occasionally (O), Rarely (R), Never (N)*

In (v) the actual chronological age of the participant is noted for those who reported to have been exposed to English since birth/ < than 2 years. For others, participants approximated the number of years they had used English

11.4.3 Language profiling

Participants also completed the CAT. As in phase 2, monolinguals completed the CAT only in Sinhala while bilinguals completed in both Sinhala and English. Table 10.23 provides the median and range across CAT tasks for monolingual and bilingual matched healthy control groups recruited to phase 3.

See Appendix 11.2 (b) for individual CAT task scores of HCs in phase 3.

Table 11.23: Median and range of CAT task scores for the ML and BL control groups in phase 3

		Comprehension of spoken words	Comprehension of spoken sentences	Comprehension of written words	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non-words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken Picture Description	Reading words	Reading complex words	Reading function words	Reading non-words
ML HCs	Med	30	30	30	30	4	32	6	10	12	12	44	9	34	48	6	6	10
	Range	28-30	23-32	22-32	24-32	3.5-4	0	0	0	10-14	10-13	41-48	6-10	12-66	8-48	4-6	0	0
BL HCs Sinhala	Med	30	31	30	30	4	32	6	10	14	12	46	10	38	48	6	6	10
	Range	28-30	27-32	27-32	26-32	0	0	0	0	8-14	10-12	40-48	0	33-57	0	0	0	6-10
BL HCs English	Med	24	28	28	28	4	32	6	10	14	12	44	10	40	48	6	6	10
	Range	27-30	25-32	25-30	26-32	0	30-32	0	6-10	8-14	0	38-48	8-10	36-43	36-48	4-6	0	8-10

11.5 Comparison of participant variables in Phase 3

ML and BL PwA and HC groups were compared across the six variables; age, education, time since onset of stroke[41], CAT scores (for three selected tasks, i.e. comprehension of single words, object naming and action naming) and LPQ scores The aim was to identify differences between the language conditions in the above variables, if any.

11.5.1 Descriptive statistics for the selected variables

Tables 11.24-11.28 below presents a comparison of the descriptive statistics across the participant groups in the above variables

Table 11.24: Comparison across groups for age of participants

	n	Mean	SD	Minimum	Maximum
ML PwA	15	46.67	13.46	24	71
ML Controls	15	47.33	13.82	26	70
BL PwA	11	47.91	17.81	30	80
BL Controls	11	47.55	18.39	28	83

Table 11.25: Comparison across groups for level of education (in years)

	n	Mean	SD	Minimum	Maximum
ML PwA	15	12.07	2.22	8	15
ML Controls	15	12.27	2.94	9	17
BL PwA	11	16.91	1.58	13	20
BL Controls	11	17.27	0.91	17	20

[41] Only applicable to PwA groups

Table 11.26: Comparison across PwA groups for time since onset of stroke (in months)

	n	Mean	SD	Minimum	Maximum
ML PwA	15	38.93	34.14	9	116
ML Controls	15				
BL PwA	11	57.55	67.05	7	222
BL Controls	11				

Table 11.27: Comparison across groups for LPQ use and proficiency scores

		Sinhala				English			
	n	M	SD	Min	Max	M	SD	Min	Max
Language proficiency scores									
MLS PwA	15	4.4	0.51	4	5				
MLS HC	15	4.87	0.35	4	5				
BL PwA	11	4.36	0.50	4	5	4.46	0.52	4	5
BL HC	11	4.46	0.52	4	5	4.27	0.47	4	5
Language use scores									
MLS PwA	15	5.00	-	5	5				
MLS HC	15	4.93	0.26	4	5				
BL PwA	11	4.18	0.60	3	5	4.27	0.61	3.5	5
BL HC	11	4.55	0.52	4	5	4.27	0.47	4	5

Table 11.28: Comparison across groups for CAT scores*

		CSW				NO				NA			
	n	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
MLS PwA	15	26.47	2.70	21	30	22.67	11.78	3	40	4.20	2.81	0	8
MLS HC	15	29.47	0.92	28	30	43.93	2.46	41	48	8.60	1.50	6	10
BLS PwA	15	25.45	6.76	8	30	29.36	14.58	1	48	6.09	3.53	0	10
BLS HC	11	29.36	0.92	28	30	45.82	2.60	40	48	10.00	-	10	10
BLE PwA	11	23.64	5.35	13	30	27.73	6.31	16	34	5.64	2.66	2	8
BLE HC	11	29.09	1.04	27	30	43.73	2.45	38	48	9.64	0.67	8	10

* Comprehension of single words (CSW), Naming objects (NO), Naming actions (NA)

11.5.2 Tests for normality and homogeneity of variance

Prior to statistical analysis, the Shapiro-Wilk test was used to test normality and homogeneity of variance for accuracy scores across the groups for all selected variables.

Findings are presented in table 11.29 and 11.30 for PwA groups and control groups, respectively.

Table 11. 29: Shapiro-Wilk findings across variables for PwA groups

Variable		Participant group	Shapiro- Wilk		
			Statistic	**df**	**Sig**
Age		ML PwA	.974	15	.909
		BL PwA	.863	11	.063
Education		ML PwA	.889	15	.064
		BL PwA	**.617**	**11**	**.000*******
TSO		**ML PwA**	**.820**	**15**	**.007****
		BL PwA	**.760**	**11**	**.003****
CAT	**CSW**	ML PwA	.899	15	.092
		BL PwA/Sinhala	**.711**	**11**	**.001****
		BL PwA/English	.893	11	.152
	NO	**ML PwA**	**.865**	**15**	**.028***
		BL PwA/Sinhala	.923	11	.341
		BL PwA/English	**.838**	**11**	**.029***
	NA	**ML PwA**	**.840**	**15**	**.013***
		BL PwA/Sinhala	.878	11	.099
		BL PwA/English	**.780**	**11**	**.005****
LPQ	**Proficiency**	**ML PwA**	**.630**	**15**	**.000*******
		BL PwA/Sinhala	**.625**	**11**	**.000*******
		BL PwA/English	**.649**	**11**	**.000*******
	Use	ML PwA+			
		BL PwA/Sinhala	**.774**	**11**	**.004****
		BL PwA/English	**.791**	**11**	**.007****

+ Shapiro-Wilk for ML PwA is not computed since participants' scores are constant.

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 11. 30: Shapiro-Wilk findings across variables for HC groups

Variable		Participant group	Shapiro- Wilk		
			Statistic	df	Sig
Age		ML HC	.956	15	.622
		BL HC	.892	11	.149
Education		ML HC	.886	15	.058
		BL HC	**.345**	**11**	**.000*** **
CAT	**CSW**	**ML HC**	**.561**	**15**	**.000*** **
		BL HC/Sinhala	**.662**	**11**	**.000*** **
		BL HC/English	**.829**	**11**	**.023***
	NO	ML HC	.905	15	.114
		BL HC/Sinhala	**.822**	**11**	**.018***
		BL HC/English	.876	11	.092
	NA	**ML HC**	**.802**	**15**	**.004****
		BL HC/Sinhala			
		BL HC/English	**.619**	**11**	**.000*** **
LPQ	**Proficiency**	**ML HC**	**.413**	**15**	**.000*** **
		BL HC/Sinhala	**.649**	**11**	**.000*** **
		BL HC/English	**.572**	**11**	**.000*** **
	Use	**ML HC**	**.284**	**15**	**.000*** **
		BL HC/Sinhala	**.649**	**11**	**.000*** **
		BL HC/English	**.572**	**11**	**.000*** **

+ Shapiro-Wilk for BL HC/Sin is not computed since participants' scores are constant.
Note: *p≤0.05; **p≤0.01; ***p≤0.001

11.5.3 Selection of statistical tests

Since all participant groups had at least one non-normally distributed data set in one or more of the selected variables, non-parametric statistical tests were used. Here, the Mann Whitney U test was used for independent sample comparisons and the Wilcoxon sign rank test for analysis of repeated measures. The planned pairwise analyses involved grouping according to the variable investigated. Table 11.31 below lists the pairwise comparisons made across the six selected variables.

In variables which multiple pairwise comparisons occurred (i.e. age, education, LPQ proficiency and use score), a Bonferroni correction of 0.025 (p= 0.05/2) was applied.

Table 11.31: Pairwise comparisons across the groups for participant variables

<table>
<tr><th colspan="2">Variable tested</th><th>Pairs analysed</th></tr>
<tr><td colspan="2">Age *</td><td rowspan="2">(i) ML PwA- BL PwA
(ii) ML HC- BL HC
(iii) ML PwA- ML HC
(iv) BL PwA- BL HC</td></tr>
<tr><td colspan="2">Education *</td></tr>
<tr><td colspan="2">TSO</td><td>(i) ML PwA- BL PwA</td></tr>
<tr><td colspan="2">CAT

(CSW, NO & NA)</td><td>(i) CSW Sinhala ML PwA- CSW Sinhala BL PwA
(ii) NO Sinhala ML PwA- NO Sinhala BL PwA
(iii) NA Sinhala ML PwA- NA Sinhala BL PwA

(iv) CSW Sinhala BL PwA- CSW English BL PwA
(v) NO Sinhala BL PwA- NO English BL PwA
(vi) NA Sinhala BL PwA- NA English BL PwA

(vii) CSW Sinhala ML HC- CSW Sinhala BL HC
(viii) NO Sinhala ML HC- NO Sinhala BL HC
(ix) NA Sinhala ML HC- NA Sinhala BL HC

(x) CSW Sinhala BL HC- CSW English BL HC
(xi) NO Sinhala BL HC- NO English BL HC
(xii) NA Sinhala BL HC- NA English BL HC</td></tr>
<tr><td rowspan="4">LPQ *</td><td>Proficiency score for Sinhala</td><td>(i) ML PwA- BL PwA
(ii) ML PwA- ML HC
(iii) BL PwA- BL HC</td></tr>
<tr><td>Proficiency score for English</td><td>(iv) BL PwA- BL HC</td></tr>
<tr><td>Use score for Sinhala</td><td>(v) ML PwA- BL PwA
(vi) ML PwA- ML HC
(vii) BL PwA- BL HC</td></tr>
<tr><td>Use score for English</td><td>(viii) BL PwA- BL HC</td></tr>
</table>

* Bonferroni correction applied.

11.5.4 Findings

11.5.4.1 Between group comparisons for PwAs

Table 11.32: Comparisons between ML and BL PwA

Variable		ML median	BL median	Statistic U statistic (r)	P value
Age		47.00	41.00	81.00 (-.02)	.938
Education		13.00	17.00	5.50 (-.81)	.000***
Time since Onset		17.00	21.00	72.00 (-.11)	.585
Language proficiency (Sinhala)		4.00	4.00	79.50 (-.04)	.854
Language use (Sinhala) †		5.00	4.00	22.50 (-.76)	0.000***
CAT	CSW	28.00	28.00	69.50 (-.13)	.492
	NO	27.00	24.00	66.00 (-.17)	.391
	NA	6.00	7.00	50.00 (-.33)	.088

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025

† ML language use (M=5.00;SD=0.00) BL language use (M=4.18; SD=.603)

11.5.4.2 Within group comparisons for PwAs

Table 11.33: Comparisons between Sinhala and English CAT scores in the BL PwA group

Variable		BLS median	BLE median	Statistic Z value	P value
CAT	CSW	28.00	25.00	-1.021	.307
	NO	24.00	30.00	-.866	.386
	NA	7.00	6.00	-.310	.757

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025

11.5.4.3 Between group comparisons for HCs

Table 11.34: Comparisons between ML and BL HCs

Variable		ML median	BL median	Statistic U statistic (r)	P value
Age		48.00	42.00	77.50 (-0.05)	.795
Education		12.00	17.00	10.00 (-.78)	.000**
Time since Onset					
Language proficiency (Sinhala)		5.00	4.00	48.50 (-.43)	.270
Language use (Sinhala) †		5.00	5.00	50.50 (-.45)	.023*
CAT	CSW	30.00	30.00	76.50 (-.08)	.699
	NO	44.00	46.00	48.50 (-0.35)	.073
	NA ††	9.00	10.00	38.50 (-.55)	.005**

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025
† ML language use (M=4.93; SD=0.258) BL language use (M=4.55; SD=.522)
†† ML NA score (M=8.60; SD=1.50) BL NA score (M=10; SD= 0.00)

11.5.4.4 Within group comparisons for HCs

Table 11.35: Comparisons between Sinhala and English CAT scores in the BL HC group

Variable		BLS mean or median	BLE mean or median	Statistic	P value
CAT	CSW	30.00	29.00	-1.134	.257
	NO	46.00	44.00	-1.906	.057
	NA	10.00	10.00	-1.633	.102

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025

11.5.4.5 Comparisons between ML and BL PwAs and HCs

Table 11.36: Comparisons between ML PwAs and HCs

Variable	PwA mean or median	HC mean or median	Statistic	P value
Age	47.00	48.00	108.00 (-.034)	0.852
Education	13.00	12.00	112.00 (-3.83)	0.983
Language proficiency (Sinhala)	4.00	5.00	60.00 (-.48)	0.009**
Language use (Sinhala)	5.00	5.00	105.00 (-.18)	0.317

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025

Table 11.37: Comparisons between BL PwAs and HCs

Variable		PwA mean or median	HC mean or median	Statistic	P value
Age		41.00	42.00	59.00 (-.02)	.921
Education		17.00	17.00	55.50 (-.12)	.582
Language proficiency	Sinhala	4.00	4.00	55.00 (-.09)	.672
	English	4.00	4.00	49.50 (-.18)	.386
Language use	Sinhala	4.00	5.00	41.50 (-.30)	.155
	English	4.00	4.00	58.00 (-.04)	.851

Key: U (r) values are reported for Mann Whitney U tests and Z value for Wilcoxon
***p≤0.001; **p≤0.01; *p≤0.025

11.6 Summary

This chapter presents biographic details, self-reported language information, language and cognitive profiles for all participants recruited to phases 2 and 3. For participants in phase 3, comparisons were made across six selected variables namely, age, education, time since the onset of stroke, CAT scores for object and action naming and single word comprehension and language proficiency and use scores. Findings were as follows.

- **Age and Level of education:** In both ML and BL groups PwA and their corresponding HCs did not differ in age and education levels.

  When ML and BL groups were compared, the BL PwAs and HCs had a statistically significantly higher education level (as measured in years) than their corresponding ML groups.

- **TSO:** PwA participants across the ML and BL groups did not differ in their time since the onset of stroke.
- **CAT:** The ML and BL PWA groups did not differ across their CAT scores in Sinhala. When ML and BL HC groups were compared the CAT scores were significantly higher for the BL HC group in only the naming task.

In both BL PwA and HC groups, Sinhala and English CAT scores did not significantly differ across any selected task.

- **Language Proficiency:** The ML and BL PwA or the ML and BL HC groups did not significantly differ in their Sinhala proficiency scores.

  The ML PwA and HC groups differed significantly in their Sinhala proficiency rating scores although in both groups, the minimum and maximum scores for Sinhala proficiency (as rated on a 5-point Likert scale) was 4 and 5 respectively.

  Proficiency scores for English also did not differ between the BL PwA and BL HC groups.

  Language Use: When rating scores for Sinhala use was compared, both BL PwA and BL HC groups showed a lower Sinhala use score than their corresponding ML groups.

  When PwA and HC groups were compared no group differed in their Sinhala or English language use scores.

Chapter 12: Findings in Phase 2

12.0 Overview

This chapter presents the analysis of naming and connected speech data in phase 2. Section 12.1 provides modifications made to the general protocol of the study. Sections 12.2 through 12.4 present the data, methodological and data coding issues and details of the amendments for the naming, PS and SP tasks respectively. Details on transcription and coding reliability for all tasks follow.

12.1 Reliability findings

One MLS, one BLS and one BLE PwA and HC each were included in reliability analysis. Reliability values were individually calculated for each participant (see section in chapter 10) and averaged for all six participants above.

A 100% reliability score was obtained for both intra and inter-rater data transcriptions in naming, PS and SP tasks. An average of 100% and 99.6% intra-rater reliability scores were obtained for object and action coding respectively. Inter-rater agreement for both object and action naming were 100%. In the PS task, an average of 98.97% and 96.98% intra-rater reliability were obtained for nouns and verb respectively. Inter-rater reliability for the same were 99.3% and 99.1% respectively. Intra-ratter reliability for nouns and verbs of the SP task were 99.9% and 99.0% respectively. Inter-rater reliability for the same was 100% for both nouns and verbs.

12.2 General modifications to test administration and protocol in phase 3

Based on observations made in phase 2, the following modifications were made to the methods and test protocol of phase 3 to ensure maximum participant involvement and performance.

i. In phase 2 participants requested for assistance particularly if they repeatedly failed to respond. A few times, an anxious caregiver would interrupt to provide a cue.

   In phase 3 caregivers if they chose to remain by the participant during testing were strictly warned to not interrupt testing or cue the participant in any way. While phonemic cues and semantic cues were allowed in the CAT as per protocol, only the tester was allowed to present such cues based on test guidelines (the caregiver was nt allowed to support or cue). No cueing or prompting was allowed in naming and discourse tasks.

ii. In phase 2 a naming item was removed and the next one presented once the 5-second response time window elapsed. Participants, particularly PwAs showed anxiety due to the strict limitations placed on the response time in the naming task. This subsequently affected their performance on the remainder of the task.

   Hence, in phase 3 the stimulus was retained on the screen for 30-seconds. In response transcription, coding and scoring however, the tester only considered responses within the first 5-sconds as in phase 1.

iii. In phase 1 the first response within the 5-second coding time window was coded. In phase 2, PwAs demonstrated effortful starts when responding and misarticulations due to concomitant weakness in oral musculature, which were then self-realised and self-corrected. In order to accommodate language errors that arise from concomitant conditions other than aphasia, the last response during the 5-second response time window was coded.

iv. In phase 2, some participants were persistent on receiving regular feedback. Therefore participants in phase 3 were prepared in advance by informing them that feedback would not be provided except for the practice trial[42].

[42] The researcher deflected from this with one participant that showed to be demotivated, due to repeated failure. Nevertheless, no feedback was provided within the 5-second time window and no response that received feedback were counted as correct.

v. In phase two one participant with aphasia used several word recalling strategies such as writing or gesturing prior to attempting a verbal response.

   In phase 3, participants were instructed that responses needed to be quick and were timed. If a participant still chose to use a self-cueing strategy to achieve a correct response, the researcher allowed this although the response was coded as correct only if it was verbally elicited within the 5-second response window.

vi. Frequent language switching behaviour was seen in one bilingual PwA in phase 2.

   When this occurred in phase 3 the researcher briefly interrupted testing to re-instruct the participant. The error stimulus was not re-attempted. Instead testing was reassumed by presenting the next stimulus in line.

12.3 Picture naming task

12.3.1 Phase 2 data for naming accuracy

Tables 12.1and 12.2 presents the individual participant scores of those in phase 2 for object and action naming, respectively.

Table 12.1: Individual scores of PwAs for object naming in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct (AS)	42 (1)	30 (1)	17	13 (3)	22	18 (2)	16	59 (1)	44
Total Lexical errors	3	4	21	0 (1)	12	7 (3)	8	5	5
Total non-lexical responses	7 (2)	89	2 (3)	2	2 (1)	0 (2)	2 (2)	1	4 (1)
Total other responses	8 (6)	26	26	50	32	36 (1)	41	3	15
Lexical errors									
Semantic errors	0	2	12	0	10	4 (1)	4	5	3
Formal errors	2	1	0	0	0	1	3	0	1
Mixed errors	0	0	0	0	0	0	0	0	0
Unrelated errors	1	1	9	0	2	2 (2)	1	0	1
Non-lexical errors									
Phonologically related errors	7 (2)	8	0	1	2	0	2 (1)	1	4
Non-related errors	0	0	2 (3)	0	0 (1)	0 (2)	0 (1)	0	0 (1)
Phonologically and semantically related errors	0	0	0	1	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	3	2	0	1	0	0
D/circumlocutions	0	0	1	1	2	1	1	0	0
No response	14	26	25	46	28	35	39	3	15
Miscellaneous	0	0	0	0	0	0 (1)	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in the non-target language (NTL), if any, are in parentheses, within the category in which it occurred.

Table 12.2: Individual scores of HCs for object naming in phase 2

	Controls								
	ML			BL					
	MLC/01	MLC/02	MLC/15	BLC/03		BLC/06		BLC/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct (AS)	56	58	66	58	51	68 (1)	64	68	58
Total Lexical errors	6	9	3	8	7	0	5	0	2
Total non-lexical responses	1	0	0	0	1 (1)	0	0	0	8
Total other responses	6	2	0	3	9	0	0	1	1
Lexical errors									
Semantic errors	6	6	2	6	4	0	5	0	0
Formal errors	0	0	0	0	0	0	0	0	1
Mixed errors	0	0	0	0	1	0	0	0	1
Unrelated errors	0	3	1	2	2	0	0	0	0
Non-lexical errors									
Phonologically related errors	0	0	0	0	1	0	0	0	0
Non-related errors	1	0	0	0	0 (1)	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	1	2
D/circumlocutions	1	1	0	1	0	0	0	0	3
No response	5	1	0	2	9	0	0	0	1
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in the non-target language (NTL), if any, are in parentheses, within the category in which it occurred.

Table 12.3: Individual scores of PwAs for action naming in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct (AS)	13 (3)	8	8	11 (2)	19	10 (2)	5	32	18
Total Lexical errors	5 (2)	6	5 (1)	7	2	7	3	3	1
Total non-lexical responses	0	1 (1)	0	1(1)	3	0	0	0	3
Total other responses	14	22	24	16	14	19	30	3	16
Lexical errors									
Semantic errors	3 (2)	5	3 (1)	6	2	4	1	3	0
Formal errors	0	0	1	0	0	1	0	0	0
Mixed errors	0	0	0	0	0	0	1	0	1
Unrelated errors	2	1	1	1	0	2	1	0	0
Non-lexical errors									
Phonologically related errors	0	0	0	0	1	0	0	0	3
Non-related errors	0	0 (1)	0	1 (1)	1	0	0	0	0
Phonologically and semantically related errors	0	1	0	0	1	0	0	0	0
Other Errors									
R/circumlocutions	0	1	1	3	1	1	0	0	0
D/circumlocutions	0	0	1	2	0	1	0	0	0
No response	11	20	21	11	14	17	30	3	16
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	3	1	1	0	0	0	0	0	0

* Responses here are given in the target language. Responses in the non-target language (NTL), if any, are in parentheses, within the category in which it occurred.

Table 12.4: Individual scores of HCs for action naming in phase 2

	Controls								
	ML			BL					
	MLC/01	**MLC/02**	**MLC/15**	**BLC/03**		**BLC/06**		**BLC/09**	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	29 (1)	31	37	29 (1)	28	37	37	38	29
Total Lexical errors	5	4	1	4	4	1	1	0	6
Total non-lexical responses	0	0	0	1	0	0	0	0	1
Total other responses	3	3	0	3	6	0	0	0	2
Lexical errors									
Semantic errors	3	4	1	4	4	1	1	0	3
Formal errors	0	0	0	0	0	0	0	0	2
Mixed errors	0	0	0	0	0	0	0	0	1
Unrelated errors	2	0	0	0	0	0	0	0	0
Non-lexical errors									
Phonologically related errors	0	0	0	0	0	0	0	0	1
Non-related errors	0	0	0	1	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	1	0	0	1	2	0	0	0	0
D/circumlocutions	0	1	0	1	3	0	0	0	0
No response	2	1	0	1	1	0	0	0	2
Miscellaneous	0	1	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in the non-target language (NTL), if any, are in parentheses, within the category in which it occurred.

12.3.2 Amendments to stimuli and protocol in naming

No changes were required to the stimuli in English testing. In Sinhala, pilot testing revealed two instances where phonologically similar words were approximate positioned in the translated Sinhala version of the stimulus list. In one instance, the use of a wrong stimulus picture (the image of a 'foot' was used to elicit the target word 'leg'). These were corrected prior to testing in phase 3.

12.3.3 Amendments to data recording, transcription and coding in naming

The coding system based on previous work by Dell et al. and Vitkovitch and Tyrell (1995) was developed for coding responses in phase 1. Phase 1 however involved only healthy adults and did not involve aphasic errors. The inclusion of PwAs in the phase 2 allowed the researcher to identify new response codes, which were then incorporated in to the existing coding system. Language errors specific to PwAs were added across three separate categories: Lexical errors, non-lexical errors and other errors. These categories were further divided to include error subtypes (see table 12.1; modified coding system for phase 3).

Yet another key revision to the modified coding system involved the introduction of language of response in coding. This was based on the observation that pilot phase participants, particularly PwAs, produced frequent language switches not seen in phase 1. The aim here was to acknowledge the probability of pathological code switching, mixing and borrowings occurring particularly with bilingual PwAs in phase 3. Coding for language also allowed the researcher to distinguish responses that were incorrect from responses that were correct but elicited in the non-tested language. A sub code for language was used to categorize each real word response as either a response in the target language or a response in the non-target language. Non-lexical errors were coded for language only if it clearly approximated the tested or non-tested language. Non-lexical responses, which did not approximate either language, were coded separately[43]. Failures to respond (no response) were not assigned a language code.

A population-specific finding was the presence of mispronunciations not caused by aphasia but produced by both HC and PwA. Instead they were identified as errors made by speakers of English as a second language as evidence of the influence of their L1 (Sinhala) on the later learnt L2 (English); for example, /*æɲɭɔp ɛkə*/ for the target English word, *'envelope'*. Here the mispronunciation of the English word 'envelope' is observed in bilingual Sinhala-English speakers, especially late bilinguals though not all. Such errors were not coded as incorrect and were differentiated from errors made by PwAs. Such errors were first identified in the early interaction with participants. Although the research was familiar with such mispronunciations in bilingual English speakers, the decision made here, that is whether to perceive it as a mispronounced word or an error were agreed upon by the same focus group detailed in section 10.7.1.

Following the initial round of coding and subsequent focus group discussions, the criteria below in addition to those developed following phase 1 were proposed as response coding in phase 3[*].

i. The coded response was the last response in the 5-second response time window.
ii. In order to be coded, an elicitation counted as a response should be, at least, of a CV or VC structure.
iii. Response coding was carried out separate to that of coding for response language.

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[43] When a coder was in doubt, language coding for the particular non-lexical error was discussed between both coders. In the case of disagreement, it was further discussed with the focus group prior to being assigned a code.
[*] All criteria were developed for phase 3 based on observations made in phase 2, except for (x) and (xi)

iv. All responses that were lexical or assumed to be related to the target, such as in the case of related non-lexical errors, were coded as a target language or non-target language response according to the language in which testing was conducted.

v. False starts *[s-s-s- spoon]*, filled pauses *[um..ahh…]*, reference words used without meaning *[this one…um..]* were not coded.

vi. Running commentary such as *'Wait a minute. I'm thinking'* were not coded. Those that described the picture, such as, '*This I know. We use it every morning to heat water'* (*Kettle)*, were considered as a circumlocution.

vii. Where a participant immediately self-corrected, the self-corrected response was coded providing that it was within the 5-second response time window.

viii. Where a participant said a word but immediately realized the word was incorrect, the first word recalled was still considered to be the first response of the participant.

E.g.; *[This is not a spoon]* (Response 1)

If however, the participant was then able to immediately recall the correct response within the 5-second response time, the second response was scored while also being identified as a successful self-correction

E.g.: *[This is not a spoon]* (Response 1) - *[it's a fork]* (Response 2/ Scored response)

If the incorrectly recalled but self-denied word was the only response within the 5-second response window, it was scored as the response

E.g. *"Not spoon..* (pause)". Fork (scored response)

ix. Mispronunciations in English, those commonly seen in bilingual Sinhala- English speakers (where English is learnt as a second language) were not coded as errors, if only the mispronounced word did not constitute another real word in English. (E.g. */ɪskʊ:ḷ/* for */skʊ:ḷ/)*

x. Participants were typically expected to respond in a one-word response. If however, the participant responded with multiple words, an accurate score was given only if the target word was included within the response and if other words accompanying it did not change the meaning of the target word.

   Examples:

   Flower- *[This is a flower]* was scored as correct. *[a daffodil]* was scored as a subordinate lexical error.

   Envelope- The response, *[envelope and a letter]* was produced within the 5-second response window. Therefore, the last response that is *[letter]* was coded.

   Beard- Since in the response, *[Bearded man]*, the beard acts as an adjective used to describe *[man]*, it was scored as incorrect and coded accordingly.

xi. Throughout the coding process, language specific characteristics such as the use of multiple synonyms, dialects and geographical differences in language use (*/ɦɛ:mʌḷəjə:/* for */ɦɛvənæḷ'ə/*, */gæ:ɽəp'ʊvə/* and */gæ:ɽʊp'ʊvə/*), minor linguistic changes to words through different forms of language (E.g.; */va:ḷɛ/* for target word, */vaɦaḷɛ/*) changes to tenses (E.g.; */ĩðəgɛnə ɪn'əvʌ/* for */ĩðəgʌn'əvʌ/*) were considered when determining the combination of codes for responses in Sinhala. Omissions of morphological markers were frequently seen in English. (e.g. *[sit]* for *[sitting]*; *[rain]* for *[raining])*.

Based on the above observations the coding system of phase 1 was modified as below. The modified coding system is presented in table 12.5

Table 12.5: Modified coding system for scoring naming responses in phase 2 and 3

1. Correct Responses		
	Subcode	
	1	***Correct responses;*** A response that matches the target word (TW) completely; is the final response produced within the five-second-response window. A correct response may also include; ***A changed form of the word;*** a response that matches the target word but includes a changed morpheme (additional or reduced bound morpheme); is an accurate perception of the picture stimulus and does not alter the meaning of the word. Also, the response does not constitute any other real word or meaning. *E.g.: /ɱʌɭʌ/ (flower, in Sinhala) → /ɱʌɭʌk/ (the addition of /k/ at the end, specifically implying that it is one flower)* */gʌhʌ/ → /gʌhʌk/*
	2	***Acceptable synonyms/ Dialectal deviations;*** is a synonym for the target word which is an acceptable reference term to the target stimulus; may or may not have a changed form, is derived from a different form of language, that is, informal spoken, formal spoken, informal written or formal written and which when considered alone does not constitute any other real word or meaning. E.g.: */ɦɛʋəɲæɭˈə/ → /ɦɛːɱʌɭəjʌ/*
	3	***Singularized or pluralized target responses;*** A response that matches the target word **or** a changed form of the target word but is the singularized or pluralized form of the target word. E.g.: */kɛsɛɭ/ → /kɛsɛɭ gɛɗijə/* ; Roots → Root
	4	***Tense deviations;*** is a response that differs from the target word in term of tenses or temporal aspects of the target word but is a correct reflection of the illustrated stimulus E.g.: */ʋəːdɪʋɛɲəʋʌ/ → /ʋəːdɪʋɛɭəː/ /ɪɲˈəʋʌ/* (Sitting in Sinhala; present tense (TW) and present continuous tense.

<table>
<tr><td colspan="3">0. Incorrect Responses</td></tr>
<tr><td colspan="3">1. Lexical Errors
A response that is different from the TW but is a real word. Lexical errors can be categorised as the following;</td></tr>
<tr><td></td><td>1</td><td>Semantic Errors
A response that is different from the TW, is a real word and bears a semantic relationship to the correct response.
E.g.: Car → bus</td></tr>
<tr><td></td><td>2</td><td>SE of Superordinate type
A response that bears a semantic resemblance to the TW but can also be identified as one that refers to a superior order or category within the TW’s system of classification
E.g.: bread → food</td></tr>
<tr><td></td><td>3</td><td>SE of Subordinate type
A response that bears a semantic resemblance to the TW but can also be identified as a specific lexical item within the TWs generic system of classification
E.g.: Flower → Daffodil</td></tr>
<tr><td></td><td>4</td><td>SE of Associated type
A response that bears a semantic resemblance to the TW but can also be identified to have a structural or functional association to the TW E.g.: Car → transport</td></tr>
<tr><td></td><td>5</td><td>SE with a visual relationship
A response that holds a semantic relationship to the TW but can also be identified as bearing a strong visual resemblance, leading to a visual misinterpretation.
E.g.: opening (the door) → closing (the door)</td></tr>
<tr><td>6</td><td colspan="2">Formal Errors
A response that differs from the TW, is a real word and reflects a phonological relationship to the correct response. At all times, a phonological relationship required that the TW and response ‘lemma’ share at least 50% of the phonemes and/or present a shared initial phoneme.
E.g.: pear → bear</td></tr>
</table>

7	***Mixed Errors*** A response that differs from the TW, is a real word and bears both a semantic and phonological relationship to the correct response. E.g.: */kœʈˈəjə/* (pillow) → */ɱɛʈˈəjə/* (mattress)	
8	***Unrelated word (lexical category)*** A single word response that has no semantic or phonologic relationship to the target word E.g.: *Ladder/ pillow, a thing/ pencil*	
2. Non-Lexical Errors A response that is different from the TW but is a not a real word.		
	1	***Phonologically related errors*** This includes response that differs from the TW and is a non-word, and bears a phonological resemblance to the TW (or an acceptable synonym, changed form, dialectal deviation or tense deviation) that is, where the TW and response shares at least 50% of the phonemes and/or present a shared initial phoneme. E.g.: *Bat → /bæp/*
	2	***Non-related errors*** This includes response that is a non-word, and bears no relationship to the TW. E.g.: *Bat → /gʌk/*
	3	***Mixed Error*** A response that is recognized and strongly believed to be a semantic error with a superimposed phonological error resulting in a non-word E.g.: *Letter→ /ænɭo:p/ (for 'envelope')*
3. Other Errors		
	1	***Circumlocution*** Involves when a participants provided running commentary including semantic relevant information on a stimulus instead of a response. E.g.: *"Ahh this one i know.. it was at home too.. we have one."*

	2	***Deviant Circumlocution*** Irrelevant and inappropriate circumlocutions used to describe the target. E.g.: *Dangerous one in the house/horse*
	3	***No Response*** The following two types are coded as no response and the type indicated in the comments section. **TOT;** Participant recalls one or more features of the target word, including initial sound, stress pattern and/or words with similar sound or meaning also including remarks such *as 'I know the word/it's at the tip of my tongue'* or similar. **OR** Participant is silent, makes no attempt to produce a response within a given response window (five seconds) and also includes remarks involving unfamiliarity, confusion or uncertainty (*Such as, 'Don't know', 'Is it that', 'Not so sure', 'Something like that', 'may be'.)*
	4	***Miscellaneous*** Includes all responses, which cannot be categorised in to any of the above codes, including that of correct responses given in the non-tested language. E.g.: frog → */bʌkə/ /bʌkə/ ;*cooking → *[ranjith]* (name of his household cook)

Coding for Cross language responses (1; Target language, 2; Other language)

Coding for Cross language responses; The response is a correct identification of the target stimulus but is not elicited in the language tested and/or is a structural modification of a loan word. *Responses given in Sinhala when tested in English and vice versa and modifications (of loan words) such as [cheese kaellak] are included here*

Coding:	0	Non-target language
	1	Target language
	2	Non-Lexical error -Language cannot be decided

<table>
<tr><td colspan="3">Coding for Immediate self-corrections (ISC)</td></tr>
<tr><td colspan="3">Immediate self-corrections (ISC);
A self-corrected response that immediately follows an otherwise incorrect response. To be considered as a ISC, the correction, the must immediately follow an incorrect response, be a ‘correct response’, be produced within five seconds of the first response with minimal effort and with no support from the examiner.
Example: Jumping/ → 1st response: Bumping
2nd ISC response: no..no.. jumping</td></tr>
<tr><td rowspan="2">Coding:</td><td>0</td><td>No self-correction</td></tr>
<tr><td>1</td><td>Self-corrected response</td></tr>
</table>

12.4 PS task

12.4.1 Pilot data for the PS task

Analysis of the narrative speech data aimed to reflect the ability to retrieve nouns and verbs in a way that is most comparable with object and action word retrieval in naming. In order to do so, the CR and TTR scores for nouns and verbs elicited in the target language were calculated separately on the phase 2 PS data (tables 12.6 and 12.7). Tables 12.8 through 12.11 present individual accuracy and error scores for nouns and verbs, separately for PwAs and HC.

Table 12.6: CR and TTR scores for nouns and verbs in target language for PwAs in the PS task

	Nouns									Verbs								
	Monolingual Sinhala			**Bilingual Sinhala**			**Bilingual English**			**Monolingual Sinhala**			**Bilingual Sinhala**			**Bilingual English**		
	MLA/01	MLA/02	MLA/15	BLA/03	BLA/06	BLA/09	BLA/03	BLA/06	BLA/09	MLA/01	MLA/02	MLA/15	BLA/03	BLA/06	BLA/09	BLA/03	BLA/06	BLA/09
Correctly recalled (CR)	6	3	3	15	7	12	26	11	15	9	5	11	23	17	14	15	11	4
Types	4	3	16	10	6	8	11	8	9	9	7	16	33	23	13	19	17	6
Tokens	7	4	17	20	10	12	28	14	22	9	8	20	42	28	16	27	20	8
Type-Token Ratio	0.57	0.75	0.94	0.50	0.60	0.67	0.39	0.57	0.41	1.00	0.88	0.80	0.79	0.82	0.81	0.70	0.85	0.75

Table 12.7: CR and TTR scores for nouns and verbs in target language for HCs in the PS task

	Nouns									Verbs								
	Monolingual Sinhala			**Bilingual Sinhala**			**Bilingual English**			**Monolingual Sinhala**			**Bilingual Sinhala**			**Bilingual English**		
	MLC/01	MLC/02	MLC/15	BLC/03	BLC/06	BLC/09	BLC/03	BLC/06	BLC/09	MLC/01	MLC/02	MLC/15	BLC/03	BLC/06	BLC/09	BLC/03	BLC/06	BLC/09
Correctly recalled (CR)	12	11	8	8	11	18	5	11	8	14	13	11	14	14	20	13	11	9
Types	8	8	8	7	9	11	4	8	6	13	12	11	12	13	15	8	10	9
Tokens	12	12	8	10	11	18	5	13	10	14	13	11	17	14	20	15	12	9
Type-Token Ratio	0.67	0.67	1.00	0.70	0.82	0.61	0.80	0.62	0.60	0.93	0.92	1.00	0.71	0.93	0.75	0.53	0.83	1.00

Table 12.8: Individual scores of PwAs for nouns elicited in the PS task in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	6	3	2	15 (3)	22	7 (2)	11	12 (1)	15
Total lexical errors	1	1	15	5	2	4	3	0	7
Total non-lexical errors	7	2	0	0	0	0	0	2	0
Total other errors	1	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	7	5	1	3	2	0	1
Formal errors	0	0	0	0	0	0	0	0	0
Mixed errors	1	0	2	0	0	0	0	0	0
Unrelated errors	0	1	6	0	1	1	1	0	6
Non-lexical errors									
Phonologically related errors	7	2	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	2	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	1	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.9: Individual scores of HCs for nouns elicited in the PS task in phase 2

	Controls								
	ML			BL					
	MLC/01	MLC/02	MLC/15	BLC/03		BLC/06		BLC/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	12	11	8	8	5	11	11	18	8
Total Lexical errors	0	1	0	2	0	0	2	0	2
Total non-lexical errors	0	1	0	0	0	0	0	0	0
Total other errors	0	0	0	0	1	0	0	0	0
Lexical errors									
Semantic errors	0	0	0	0	0	0	1	0	0
Formal errors	0	0	0	0	0	0	0	0	0
Mixed errors	0	0	0	0	0	0	0	0	0
Unrelated errors	0	1	0	2	0	0	1	0	2
Non-lexical errors									
Phonologically related errors	0	1	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	1	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.10: Individual scores of PwAs for verbs elicited in the PS task in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	9	5	11	23	15 (1)	17	11	14	4
Total Lexical errors	0	3	9	19	12	11	9	2	4
Total non-lexical errors	0	2	0	1	0	1	0	0	0
Total other errors	0	0	1	1	0	2	0	0	0
Lexical errors									
Semantic errors	0	0	3	4	3	4	2	0	3
Formal errors	0	0	1	0	2	0	0	0	0
Mixed errors	0	1	0	4	0	1	0	0	0
Unrelated errors	0	2	5	11	7	6	7	2	1
Non-lexical errors									
Phonologically related errors	0	1	0	1	0	0	0	0	0
Non-related errors	0	1	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	1	0	0	0
Other Errors									
R/circumlocutions	0	0	0	1	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	2	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	1	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.11: Individual scores of HCs for verbs elicited in the PS task, in phase 2

	Controls								
	ML			BL					
	MLC/01	MLC/02	MLC/15	BLC/03		BLC/06		BLC/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	14	13	11	14	13	14	11	20	6
Total Lexical errors	0	0	0	3	2	0	1	0	3
Total non-lexical errors	0	0	0	0	1	0	0	0	0
Total other errors	0	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	0	0	0	0	0	0	2
Formal errors	0	0	0	0	0	0	0	0	0
Mixed errors	0	0	0	1	0	0	0	0	0
Unrelated errors	0	0	0	2	2	0	1	0	1
Non-lexical errors									
Phonologically related errors	0	0	0	0	1	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

12.4.2 Amendments to data coding

Phase 1 did not involve an error analysis. In this phase, all inaccurate responses[44] were further classified as lexical, non-lexical and other errors together with their error sub types, similar to that of naming.

12.4.3 Amendments to data analysis

Eight out of the nine measurements for lexical diversity developed for phase 1 were used to analyse speech samples of participants in phase 2. These measurements were correct nouns (CR-n), type nouns (Type-N), token nouns (Token-N), Type Token Ratio for nouns (TTR-N), correct verbs (CR-v), type verbs (Type-V), token verbs (Token-V) and Type Token Ratio for verbs (TTR-V).

Details of what constitutes the above measurements were similar to that in phase 1 and was previously detailed in section 8.5.5.1 of chapter 8.

Here, CR scores (CRn and CRv) were used as a measurement of accuracy in word retrieval.

TTR scores (TTRn and TTRv) were representative of the overall word (noun and verb) production of an individual but did not distinguish between accurate and inaccurate responses.

Hence both CR and TTR scores were selected to analyse data for connected speech.

[44] As in phase 1, an elicited noun or verb that was related to the given stimulus was considered to be 'accurate'

12.5 SP task

12.5.1 Pilot data for the SP task

Similar to the analysis of PS data, SP data too aimed to reflect the ability to retrieve nouns and verbs in a way that is most comparable with object and action word retrieval in naming. As before, CR and TTR scores for nouns and verbs elicited in the target language were calculated separately on the phase 2 PS data (tables 12.12 and 12.13). Tables 12.14 through 12.17 present individual accuracy and error scores for nouns and verbs, separately for PwAs and HC.

Table 12.12: CR and TTR scores for nouns and verbs in target language for PwAs in the SP task.

	Nouns									Verbs								
	Monolingual Sinhala			Bilingual Sinhala			Bilingual English			Monolingual Sinhala			Bilingual Sinhala			Bilingual English		
	MLA/01	MLA/02	MLA/15	BLA/03	BLA/06	BLA/09	BLA/03	BLA/06	BLA/09	MLA/01	MLA/02	MLA/15	BLA/03	BLA/06	BLA/09	BLA/03	BLA/06	BLA/09
Correctly recalled (CR)	6	3	3	15	7	12	26	11	15	9	5	11	23	17	14	15	11	4
Types	4	3	16	10	6	8	11	8	9	9	7	16	33	23	13	19	17	6
Tokens	7	4	17	20	10	12	28	14	22	9	8	20	42	28	16	27	20	8
Type-Token Ratio	0.57	0.75	0.94	0.50	0.60	0.67	0.39	0.57	0.41	1.00	0.88	0.80	0.79	0.82	0.81	0.70	0.85	0.75

Table 12.13: CR and TTR scores for nouns and verbs in the target language for HCs in SP task.

	Nouns									Verbs								
	Monolingual Sinhala			Bilingual Sinhala			Bilingual English			Monolingual Sinhala			Bilingual Sinhala			Bilingual English		
	MLC/01	MLC/02	MLC/15	BLC/03	BLC/06	BLC/09	BLC/03	BLC/06	BLC/09	MLC/01	MLC/02	MLC/15	BLC/03	BLC/06	BLC/09	BLC/03	BLC/06	BLC/09
Correctly recalled (CR)	12	11	8	8	11	18	5	11	8	14	13	11	14	14	20	13	11	9
Types	8	8	8	7	9	11	4	8	6	13	12	11	12	13	15	8	10	9
Tokens	12	12	8	10	11	18	5	13	10	14	13	11	17	14	20	15	12	9
Type-Token Ratio	0.67	0.67	1.00	0.70	0.82	0.61	0.80	0.62	0.60	0.93	0.92	1.00	0.71	0.93	0.75	0.53	0.83	1.00

Table 12.14: Individual scores of PwAs for nouns elicited in the SP task in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	5	4	6	5 (2)	14 (2)	14	10	14	11 (1)
Total Lexical errors	3	1	20	4 (1)	10	8	9	2	2
Total non-lexical errors	0	0	0	0	0 (1)	0	0	0	0
Total other errors	0	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	6	0	2	0	1	0	0
Formal errors	1	0	0	1	0	0	0	0	0
Mixed errors	0	0	0	3 (1)	1	0	0	0	0
Unrelated errors	2	1	14	0	7	8	8	2	2
Non-lexical errors									
Phonologically related errors	0	0	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0 (1)	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.15: Individual scores of HCs for nouns elicited in the SP task in phase 2

	Controls								
	ML			BL					
	MLC/01	MLC/02	MLC/15	BLC/03		BLC/06		BLC/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	12	12	13	10	8	6	8	12	9 (1)
Total Lexical errors	0	1	0	2	4	0	1	0	1 (1)
Total non-lexical errors	0	0	0	0	0	0	0	0	0
Total other errors	0	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	0	0	1	0	1	0	0
Formal errors	0	0	0	0	0	0	0	0	0
Mixed errors	0	0	0	0	0	0	0	0	0
Unrelated errors	0	1	0	2	3	0	0	0	1 (1)
Non-lexical errors									
Phonologically related errors	0	0	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.16: Individual scores of PwAs for verbs elicited in the SP task in phase 2

	PWA								
	ML			BL					
	MLA/01	MLA/02	MLA/15	BLA/03		BLA/06		BLA/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	4	4	5	4	5 (7)	7	4	7	5
Total Lexical errors	3	1	16	8	9 (3)	4	5	0	2
Total non-lexical errors	0	0	0	0	0	0	0	0	0
Total other errors	0	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	6	0	1 (1)	0	1	0	1
Formal errors	0	0	0	0	3 (1)	0	2	0	0
Mixed errors	0	0	0	0	0	0	0	0	0
Unrelated errors	3	1	10	8	5 (1)	4	2	0	0
Non-lexical errors									
Phonologically related errors	0	0	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

Table 12.17: Individual scores of HCs for verbs elicited in the SP task in phase 2

	Controls								
	ML			BL					
	MLC/01	MLC/02	MLC/15	BLC/03		BLC/06		BLC/09	
	Sinhala			Sinhala	English	Sinhala	English	Sinhala	English
Correct	7	9	8	9	6	4	3	7	5
Total Lexical errors	0	0	0	0	0	0	0	0	1
Total non-lexical errors	0	0	0	0	0	0	0	0	0
Total other errors	0	0	0	0	0	0	0	0	0
Lexical errors									
Semantic errors	0	0	0	0	0	0	0	0	0
Formal errors	0	0	0	0	0	0	0	0	0
Mixed errors	0	0	0	0	0	0	0	0	0
Unrelated errors	0	0	0	0	0	0	0	0	1
Non-lexical errors									
Phonologically related errors	0	0	0	0	0	0	0	0	0
Non-related errors	0	0	0	0	0	0	0	0	0
Phonologically and semantically related errors	0	0	0	0	0	0	0	0	0
Other Errors									
R/circumlocutions	0	0	0	0	0	0	0	0	0
D/circumlocutions	0	0	0	0	0	0	0	0	0
No response	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0
Language specific errors	0	0	0	0	0	0	0	0	0

* Responses here are given in the target language. Responses in NTL, if any, have been indicated within brackets ( ), within the category in which it occurred.

12.5.2 Amendments to data transcription, coding and analysis

An error classification similar to that of PS data (see section 12.4.1) was performed on SP data.

In phase 2, SP language samples included a high quantity of loan words and borrowed words from English. Only the following however were excluded from the counts for language switches (responses in NTL).

- In monolingual and bilingual narrative speech samples elicited in Sinhala, loan words for which there are no Sinhala translations such as for cake and van, were classified as words in the target language.
- In English testing for BLs culture specific words, especially those frequently used along with English text (E.g. */ʌʅʊθ ʌvʊʅʊð ˈðə/ for New Year, /kævʊm/)* were allowed and not coded as a language switch[45].

The above did not occur for the in the PS task stimulus.

12.6 Summary

Phase 2 identified specific amendments that were indicated in order to ensure that phase 3 data collection was valid and reliable. Amendments were made primarily in test methods and response coding. These are summarized throughout sections above and integrated into the amended phase 3 protocol shown in appendix 10.10.

The subsequent chapters present findings for data obtained in phase 3.

[45] Such culture specific words did not occur in naming OANB stimuli. Regardless, such questionable words if any, were removed when the OANB stimuli were adapted in the initial preparation stage (see chapter 6).

Chapter 13: Analysis of naming data in Phase 3

13.0 Overview

This chapter presents the analysis of picture naming accuracy data in the monolingual Sinhala (MLS) and bilingual Sinhala (BLS) and bilingual English (BLE) language conditions for PwA and HC participants recruited to phase 3. Only accurate responses elicited in the target language for the picture-naming task were included for analyses in this chapter.

The datasets from naming in Phase 3 are coded as outlined in table 13.1 below.

Table 13.1: Grouping of data sets

Data set number	**1**	**2**	**3**	**4**	**5**	**6**
	Controls ML Sinhala *Objects*	***Controls*** BL Sinhala *Objects*	***Controls*** BL English *Objects*	***PwAs*** ML Sinhala *Objects*	***PwAs*** BL Sinhala *Objects*	***PwAs*** BL English *Objects*

Data set number	**7**	**8**	**9**	**10**	**11**	**12**
	Controls ML Sinhala *Actions*	***Controls*** BL Sinhala *Actions*	***Controls*** BL English *Actions*	***PwAs*** ML Sinhala *Actions*	***PwAs*** BL Sinhala *Actions*	***PwAs*** BL English *Actions*

Note: The bilingual groups provide repeat measures for Sinhala and English (BLS and BLE) testing; i.e. the same participants were tested in both languages hence datasets 2 and 3 were from same participants and similarly for other BL data.

Analyses addressed the following questions.

i. Were there differences between the ML and BL groups, in Sinhala?[46]

A comparison was made here between the accuracy scores of the monolingual groups and bilingual groups in Sinhala for object and action naming separately. The aim here was to identify if scores in Sinhala differed between the ML and BL language conditions. Individual scores for all ML participants and naming scores in Sinhala for all BL participants were included in the following pair-wise comparison; (i) MLS PwA- BLS PwA (ii) MLS control- BLS control

ii. **Were there differences between the BLs' two languages, Sinhala and English?**

Comparisons were made across the languages tested in the BL language conditions. The aim here was to identify if performance differed across Sinhala (BLS) and English (BLE) in the BL group for object and action naming separately.

iii. Were there differences between the PwAs and HCs?

A comparison was made between the accuracy scores of the PwA and HC groups separately for the MLS, BLS and BLE language conditions and separately for action and object naming. Individual scores in each language condition were included in the following pair-wise comparison; (iii) MLS Control- MLS PwA and (iv) BLS Control- BLS PwA (iii) BLE Control- BLE PwA

iv. Were there differences between object and action naming within the language conditions?

Comparisons were made between the accuracy scores for objects and action naming in a given language across the groups and within Sinhala and English for BLs. The aim here was to identify if performance differed between object naming and action naming in a given language condition.

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[46] Analyses presented here are only ML PwA-BL PwA and ML HC-BL HC comparisons. The PwA-HC comparisons have been included in (iii) through out chapters 13,14,15 and 16.

Questions (i) through (iii) above involved separate analyses for object and action naming scores. The PwA-HC comparisons for question (i) have been included in question (iii). Question (iv) involved a comparison between the object and action naming scores.

13.1 Reliability findings

Two ML, two BL Sinhala and two BL English participants from the PwA and HCs groups were included in reliability analysis. Reliability values were individually calculated for each participant (see section in chapter 10) and averaged for all 12 participants above.

A 100% reliability score was obtained for both inter and intra rater analyses for transcriptions. Intra-rater reliability was an average of 98.7% for object coding and 99.3% for action coding. Inter-rater reliability was 99.8% for object and 99.0% for action coding.

13.2 Descriptive statistics for naming accuracy

The naming data analysed here was obtained from four groups, monolingual and bilingual PwA and HC groups across three language conditions, MLS, BLS and BLE.

All participants named 69 object stimuli and 38 action stimuli. The ML groups named all test items once while the BL groups completed the naming tasks in both Sinhala and English. Individual participant (accuracy and error) scores are provided in appendix 13.1.

Tables 13.2 and 13.3 present the descriptive statistics for accuracy scores across the test groups for naming in objects and actions.

Table 13.2: Descriptive statistics for HCs*

		Object naming (n=69)			Action naming (n=38)		
		MLS Controls (n=15)	BLS Controls (n=11)	BLE Controls (n=11)	MLS Controls (n=15)	BLS Controls (n=11)	BLE Controls (n=11)
Accuracy score	**Mean**	0.94	0.94	0.92	0.90	0.98	0.90
	Std. Dev.	0.06	0.06	0.06	0.10	0.04	0.07
	Minimum	0.78	0.84	0.81	0.68	0.87	0.79
	Maximum	1.00	1.00	1.00	1.00	1.00	1.00

Table 13.3: Descriptive statistics for PwAs*

		Object naming (n=69)			Action naming (n=38)		
		MLS PwA (n=15)	BLS PwA (n=11)	BLE PwA (n=11)	MLS PwA (n=15)	BLS PwA (n=11)	BLE PwA (n=11)
Accuracy score	**Mean**	0.48	0.57	0.59	0.43	0.53	0.56
	Std. Dev.	0.28	0.30	0.24	0.27	0.28	0.21
	Minimum	0.07	0.19	0.07	0.00	0.11	0.21
	Maximum	0.94	0.97	0.81	0.79	0.89	0.87

* The tables above provide proportion scores to allow comparison between objects and actions.

Figures 13.1 and 13.2 presents the mean proportion accuracy scores and standard deviations (error bars; +/- 2SD) across the language conditions for naming objects and actions for PwAs and HCs respectively.

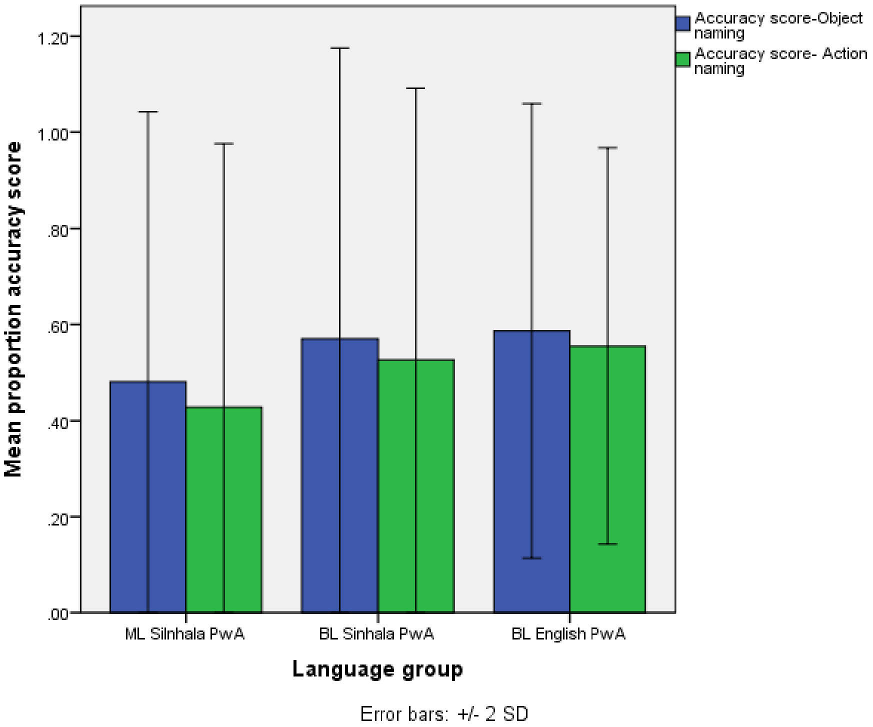

Figure 13.1: Bar charts depicting the proportion accuracy score for object and action naming across the language conditions in the PwA group

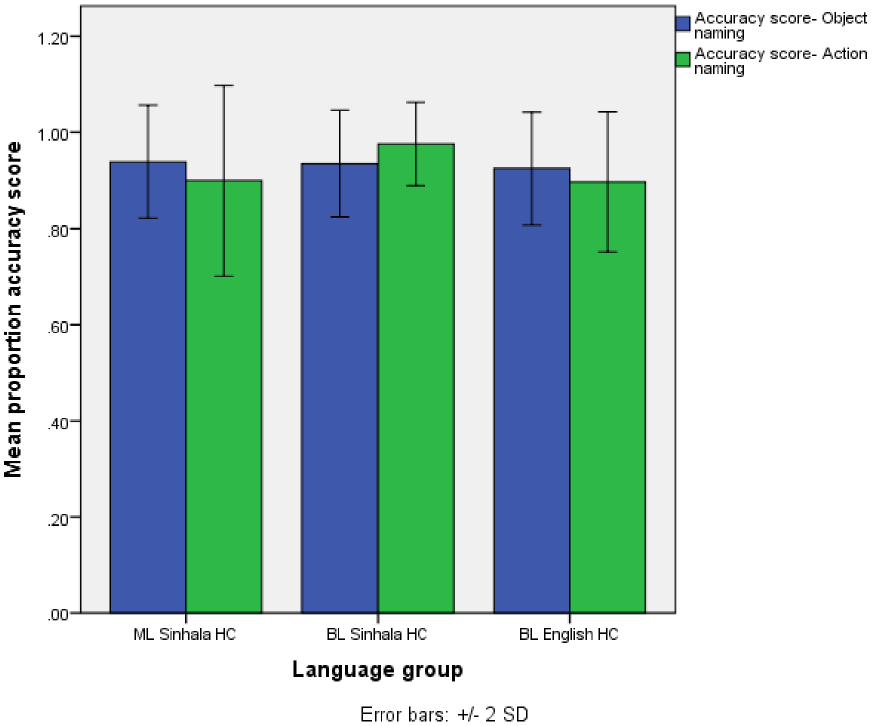

Figure 13.2: Bar charts depicting the proportion accuracy score for object and action naming across the language conditions in the HC group

13.3 Tests for normality and homogeneity of variance

Prior to statistical analysis, the Shapiro-Wilk test was used to test normality and homogeneity of variance for accuracy scores across all groups. Findings are presented in tables 13.4 and 13.5 for PwA groups and control groups, respectively.

Nine datasets met the criteria for normally distributed samples as shown by non-significant results on the Shapiro-Wilk test. Three data sets yielded significant values and any analysis involving these sets therefore involved non-parametric tests. These sets were BL PwAs for object naming in English (DS 6), ML controls for object naming (DS 1), and BL controls for action naming in Sinhala (DS 8).

Table 13.4: Shapiro-Wilk findings for PwAs

	Object naming			**Action naming**		
	Statistic	df.	Sig.	Statistic	df.	Sig.
MLS PwA	.937	15	.348	.918	15	.183
BLS PwA	.879	11	.101	.914	11	.271
BLE PwA	**.845**	**11**	**.003****	.957	11	.611

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 13.5: Shapiro-Wilk findings for HCs

	Object naming			**Action naming**		
	Statistic	df.	Sig.	Statistic	df.	Sig.
MLS HCs	**.806**	**15**	**.004****	.894	15	.074
BLS HCs	.921	11	.330	**.644**	**11**	**.000*****
BLE HCs	.947	11	.611	.939	11	.514

Note: *p≤0.05; **p≤0.01; ***p≤0.001

The Q-Q plots depicting the distribution of accuracy scores for object and action naming in Sinhala and English across the BL and ML PwA and control groups are provided in Appendix 13. 2.

13.4 Selection of statistical tests

Since all planned comparisons involved here involved at least one subset whose data were non-parametric data, two-factor ANOVA could not be performed across the groups. Variables including language status (BL vs. ML), language tested (in BL only, Sinhala vs. English), stimulus (objects vs. actions) and group comparisons between PwA and controls were examined independently therefore by use of two-way statistical comparisons. Statistical analysis involved planned pair-wise comparison of data sets based on the predetermined research questions. Non-parametric alternatives, the Mann Whitney U and Wilcoxon sign rank test for matched pairs were used for analysing independent group and repeated measures (within group), respectively.

The number of comparisons made in each of the analyses questions outlined in section 13.0 differed and the Bonferroni correction was applied accordingly. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In the following sections 13.5 through 13.7, statistical significance has been reported for pairwise analyses.

13.5 Object naming

This section involves analyses based on object naming scores across the MLS, BLS and BLE language conditions.

13.5.1 Between group comparisons in Sinhala

Figure 13.3 below shows the distribution of raw accuracy scores for object naming in the BLS and MLS language conditions of the PwA and HC groups. The graph represents the median, minimum–maximum scores and the interquartile range for the monolingual and bilingual PwA and control groups, separately.

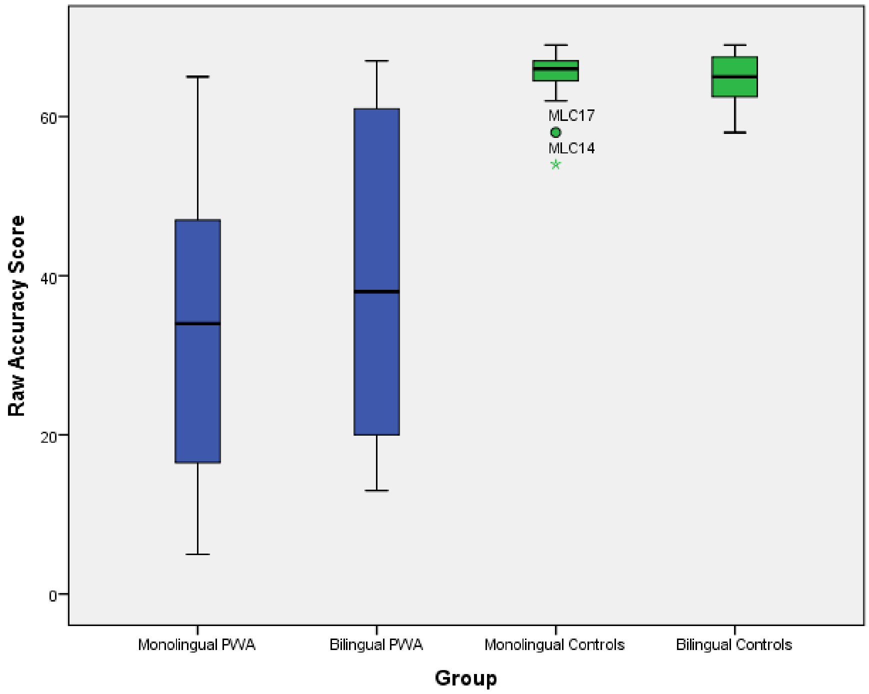

Figure 13.3: Box plot depicting raw accuracy scores for object naming in Sinhala in the MLS and BLS PwA and HC groups

Mann-Whitney U tests were performed on the above data.

The analyses in section 13.5.1 above revealed no significant difference in object naming between MLS and BLS PwA or between MLS and BLS HC groups. Data are shown in table 13.6.

Table 13.6: Comparisons in ML and BL Sinhala object naming scores

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r value	
MLS PwA	34.00	BLS PwA	38.00	70.00	.13	0.516
MLS HCs	66.00	BLS HCs	65.00	77.50	.05	0.794

Note: $*p \leq 0.025$; $**p \leq 0.001$

13.5.2 Within group comparisons between the languages

Figure 13.4 below shows the median, minimum –maximum scores and the interquartile range of the raw accuracy scores for object naming in English and Sinhala for the bilingual PwA and control groups.

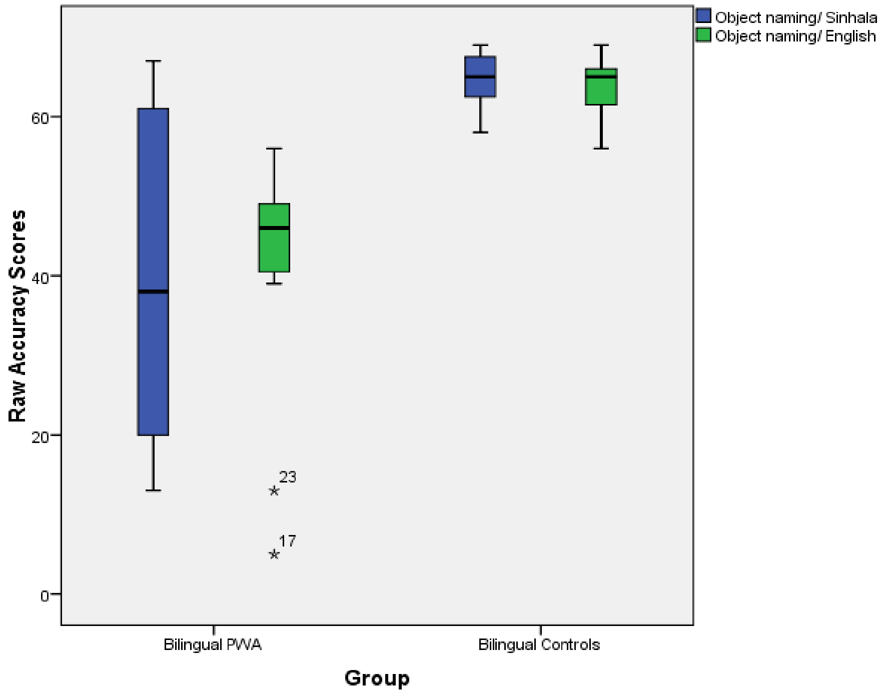

Figure 13.4: Box plot depicting raw accuracy scores for object naming in English and Sinhala, in the BL PwA and HC groups

Wilcoxon Sign Rank tests for repeated measurements were performed.

The analyses in section 13.5.2 above revealed no significant difference between object naming scores in Sinhala and English for both the BL PwA and HC groups. Data are shown in table 13.7.

Table 13.7: Comparisons in BL object naming scores in Sinhala and English

Condition 1	Med	Condition 2	Med	Z statistic	Sig. at <0.008
BLS PwA	38.00	BLE PwA	46.00	-.267	.789
BLS HCs	65.00	BLE HCs	65.00	-.931	.352

Note: *p≤0.025; **p≤0.001

13.5.3 Comparisons between PwAs and HCs

Mann-Whitney U tests were performed on the above data.

The analyses in section 13.5.3 above revealed highly significant differences between the PwA and HC groups in the MLS, BLS and BLE language conditions. As expected HCs were significantly higher than PwAs. Data are shown in table 13.8.

Table 13.8: Comparisons in PwA-HC object naming scores across the language conditions

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r value	
MLS PwA	34.00	MLS HCs	66.00	7.50	.80	.000**
BLS PwA	38.00	BLS HCs	65.00	16.00	.62	.003*
BLE PwA	46.00	BLE HCs	65.00	50.00	-.84	.000**

Note: $*p \leq 0.017$; $**p \leq 0.001$

13.6 Action Naming

This section involves analyses based on action naming scores across the MLS, BLS and BLE language conditions.

13.6.1 Between group comparisons in Sinhala

Figure 13.5 below shows the median, minimum –maximum scores and the interquartile range of the raw accuracy scores for action naming in Sinhala for the BL and ML PwA and control groups.

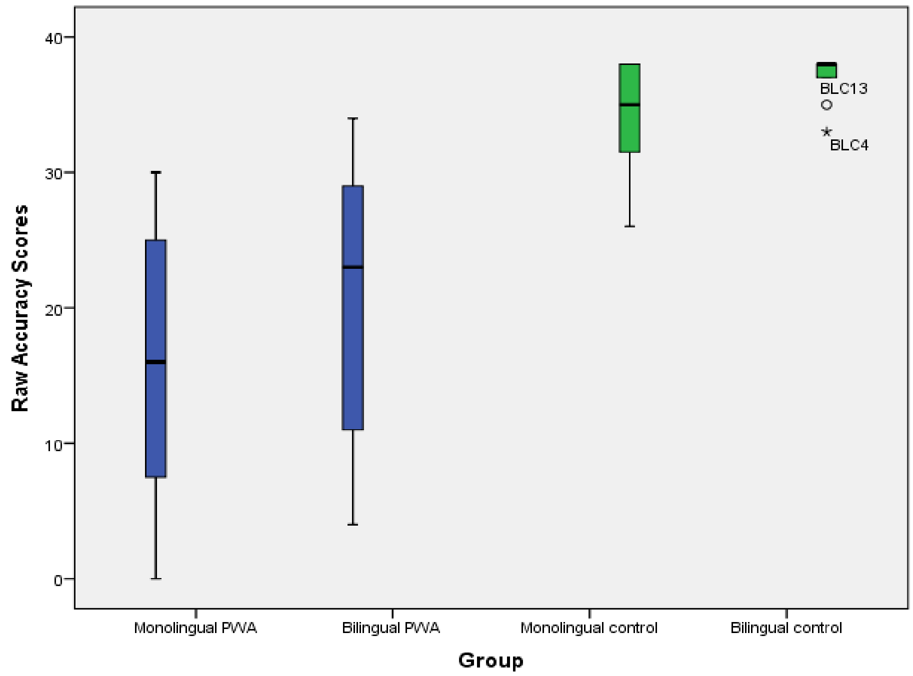

Figure 13.5: Box plot depicting raw accuracy scores for action naming in Sinhala in the MLS and BLS PwA and HC groups

Mann-Whitney U tests were performed for between the group comparisons.

The analyses in section 13.6.1 above revealed no difference in action naming between MLS and BLS PwA or HC groups. Data are shown in table 13.9.

Table 13.9: Comparisons in ML and BL Sinhala action naming scores

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r value	
MLS PwA	16.00	BLS PwA	23.00	63.50	-.19	.323
MLS HCs	35.00	BLS HCs	38.00	44.50	-.41	.038

Note: *p≤0.025; **p≤0.001

13.6.2 Within group comparisons between the languages

Figure 13.6 below shows the median, minimum–maximum scores and the interquartile range of the raw accuracy scores for action naming in Sinhala and English for the BL control and PwA groups.

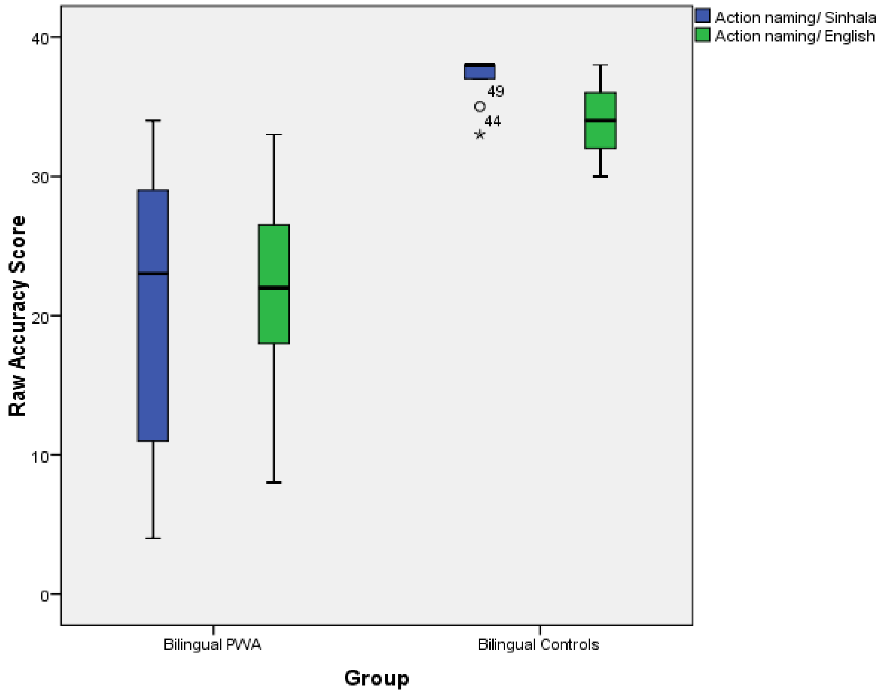

Figure 13.6: Box plot depicting raw accuracy scores for action naming in English and Sinhala, in the BL PwA and HC groups

A one-sample Wilcoxon Sign Rank tests for repeated measurements were performed.

The analyses in section 13.6.2 above revealed a significant difference between action naming scores in Sinhala and English in only the BL HC group.

Data are shown in table 13.10.

Table 13.10: Comparisons in BL action naming scores in Sinhala and English

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLS PwA	23.00	BLE PwA	22.00	-.255	.799
BLS HCs	38.00	BLE HCs	34.00	-2.530	.011*

Note: *p≤0.025; **p≤0.001

13.6.3 Comparisons between PwAs and HCs

Mann-Whitney U tests were performed on the above data.

The analyses in section 13.6.3 above revealed highly significant differences between the PwA and HC groups in the MLS, BLS and BLE language conditions. Accuracy scores were significantly higher for HCs than PwAs. Data are shown in table 13.11.

Table 13.11: Comparisons in PwA-HC action naming scores across the language conditions

Condition 1	**Med**	**Condition 2**	**Med**	**Statistic**		**Sig. at <0.008**
				U value	**r value**	
MLS PwA	16.00	MLS HCs	35.00	5.00	-.82	.000**
BLS PwA	23.00	BLS HCs	38.00	1.00	-.85	.000**
BLE PwA	22.00	BLE HCs	34.00	4.50	-.78	.000**

Note: *p≤0.017; **p≤0.001

13.7 Within group comparisons of accuracy in naming objects and actions

This section involves pairwise analyses across object and action naming scores, separately for each language condition.

Since the number of object stimuli and action stimuli were not equal proportional accuracy scores [PropAS] were calculated for each participant prior to analysis. The PropAS for objects and actions were calculated by dividing an individual score by the number of items, 69 for objects and 38 for actions.

Proportional scores for objects and actions were then compared using one-sample Wilcoxon Sign Rank tests for repeated samples.

13.7.1 Naming in Sinhala for MLS PwAs and HCs

Figure 13.7 below shows the median, minimum –maximum scores and the interquartile range of Proportion accuracy scores (PropAS) for object naming and action naming in Sinhala, for the ML control and PwA groups.

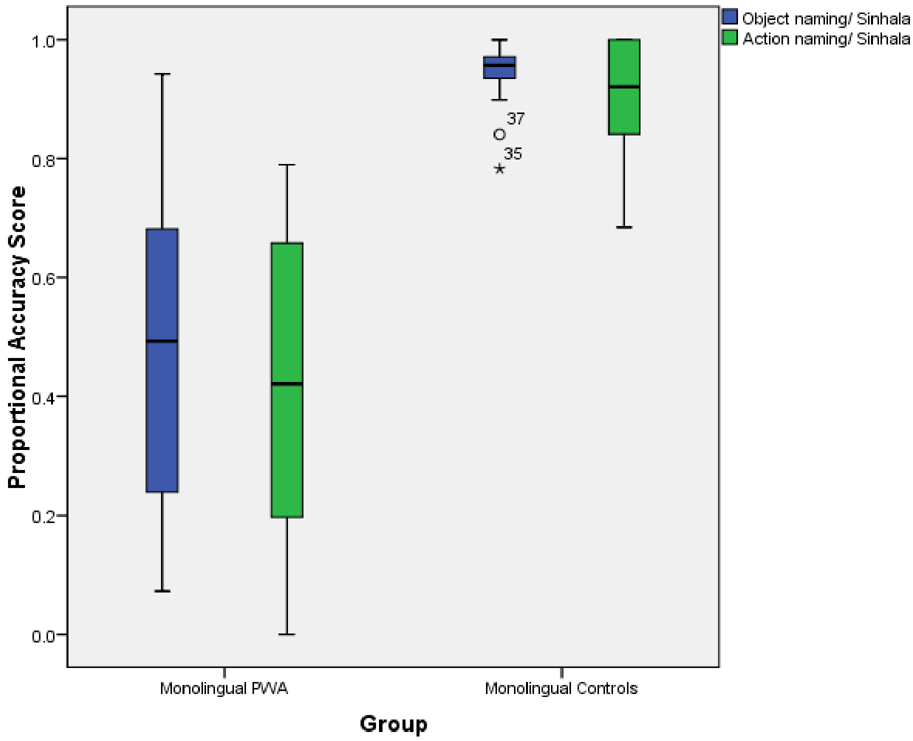

Figure 13.7: Box plot depicting proportion accuracy scores (PropAS) for object and action naming in Sinhala, in the MLS PwA and HC groups

The analyses in section 13.7.1 above revealed no significant difference between scores for object naming and action naming in both PwA and HC groups.

Data are shown in table 13.12.

Table 13.12: Comparisons in MLS object and action naming scores

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
MLS PwA Objects	.49	MLS PwA Actions	.42	-1.761	.078
MLS HC Objects	.96	MLS HC Actions	.92	-2.274	.023

Note: *p≤0.008; **p≤0.001

13.7.2 Naming in Sinhala for BLS PwAs and HCs

Figure 13.8 below shows the median, minimum–maximum scores and the interquartile range of PropAS for object naming and action naming in Sinhala for the BL control and PwA groups.

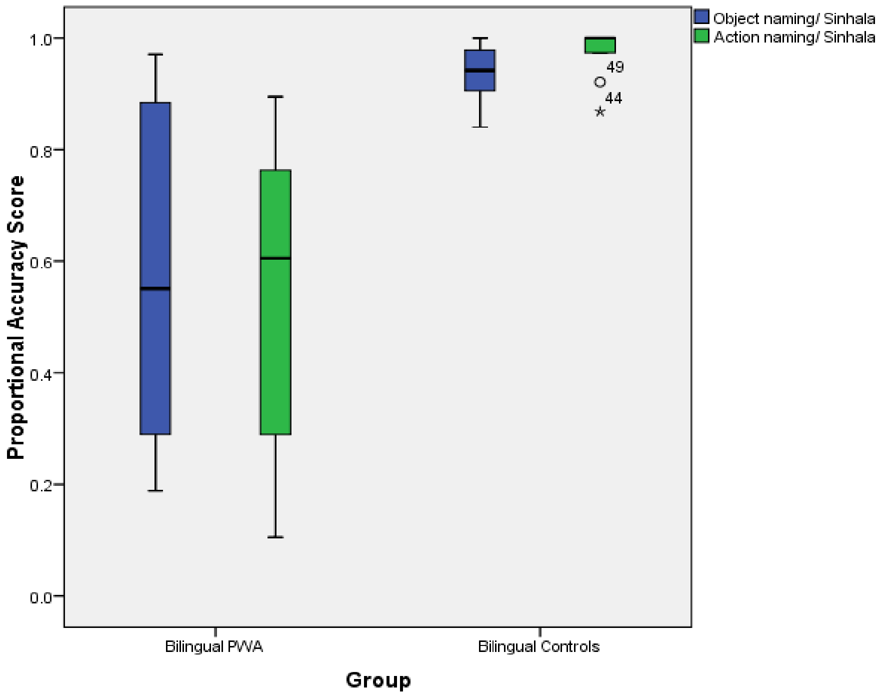

Figure 13.8: Box plot depicting proportion accuracy scores (PropAS) for object and action naming in Sinhala, in the BLS PwA and HC groups

The analyses in section 13.7.2 above revealed no significant difference in Sinhala object naming and action naming scores in both the BLS PwA and BLS HC groups. Data are shown in table 13.13.

Table 13.13: Comparisons in BLS object and action naming scores in Sinhala

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLS PwA Objects	.55	BLS PwA Actions	.61	-1.423	.155
BLS HC Objects	.94	BLS HC Actions	1.00	-2.431	.015

Note: *p≤0.008; **p≤0.001

13.7.3 Naming in English for BLE PwAs and HCs

Figure 13.9 below shows the median, minimum–maximum scores and the interquartile range of PropAS for object naming and action naming in English for the BL PwA and control groups.

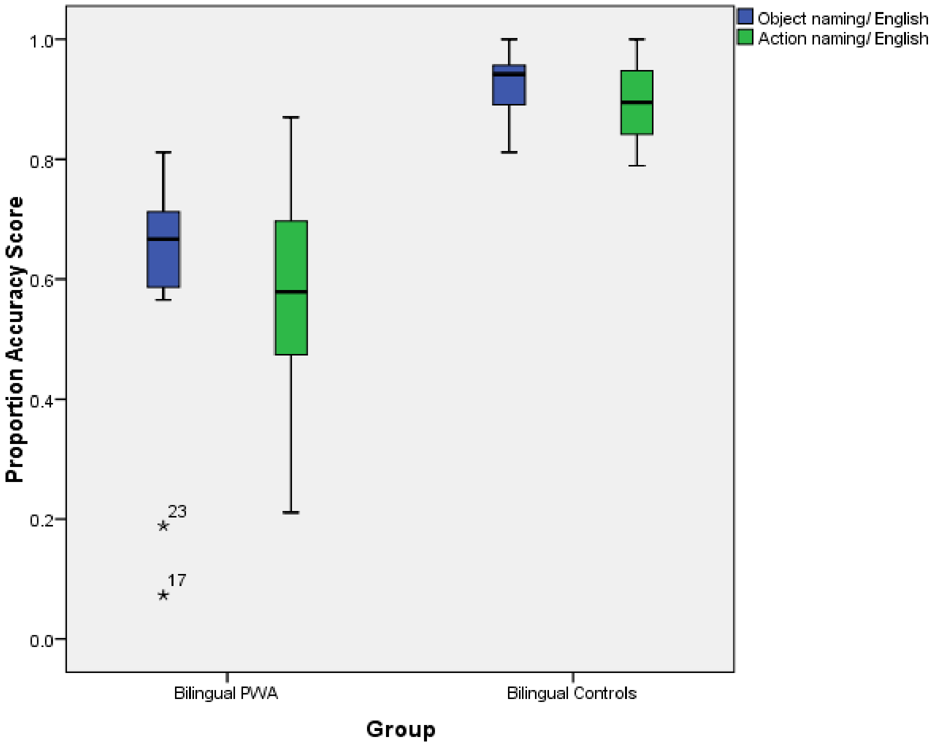

Figure 13.9: Box plot depicting proportion accuracy scores (PropAS) for object and action naming in English for the BLE PwA and HC groups

The analyses in section 13.7.3 above revealed no significant difference between object naming and action naming scores in English, in both the BL PwA and BL HC groups. Data are shown in table 13.14.

Table 13.14: Comparisons in BLE object and action naming scores in English

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLE PwA Objects	.67	BLE PwA Actions	.58	-.800	.424
BLE HC Objects	.94	BLE HC Actions	.89	-1.988	.047

Note: *p≤0.008; **p≤0.001

13.8 Summary

13.8.1 Comparisons in Sinhala across ML and BL

When medians were compared, the BLS group had higher scores than MLS in PwAs for object naming and in both PwAs and HCs for action naming. Findings here revealed no difference between ML and BL PwA or between ML and BL HC groups for object and action naming in Sinhala. Findings are summarized in table 13.15.

Table 13.15: Summary: Comparisons in ML and BL Sinhala naming scores

Condition 1	Median	Condition 2	Median	Significance at p<0.008
Object naming				
MLS PwA	34.00	BLS PwA	38.00	.516
MLS HCs	66.00	BLS HCs	65.00	.794
Action naming				
MLS PwA	16.00	BLS PwA	23.00	.323
MLS HCs	35.00	BLS HCs	38.00	.038

Note: $*p \leq 0.025$; $**p \leq 0.001$

13.8.2 Comparisons in BL Sinhala versus English scores

For object naming, BLE scores were higher in the PwA group. For action naming, BLS scores were higher in both PwA and HC groups. The difference was significant only in the BLS-BLE comparison in the HC group for action naming.

Findings are summarized in table 13.16.

Table 13.16: Summary: Comparisons in BL Sinhala and English naming scores

Condition 1	Median	Condition 2	Median	Significance at p<0.008
Object naming				
BLS PwA	38.00	BLE PwA	46.00	.799
BLS HCs	65.00	BLE HCs	65.00	.352
Action naming				
BLS PwA	23.00	BLE PwA	22.00	.610
BLS HCs	38.00	BLE HCs	34.00	.011

Note: $*p \leq 0.025$; $**p \leq 0.001$

13.8.3 Comparisons between PwAs and HCs

PwA-HCs comparisons across language conditions showed a significantly higher score for HCs than PwAs in both object and action naming.

Findings are summarized in table 13.17

Table 13.17: Summary: Comparisons in PwA-HC group naming scores

Condition 1	Median	Condition 2	Median	Significance at p<0.008
Object naming				
MLS PwA	34.00	MLS HCs	66.00	.000**
BLS PwA	38.00	BLS HCs	65.00	.003*
BLE PwA	46.00	BLE HCs	65.00	.000**
Action naming				
MLS PwA	16.00	MLS HCs	35.00	.000**
BLS PwA	23.00	BLS HCs	38.00	.000**
BLE PwA	22.00	BLE HCs	34.00	.000**

Note: *p≤0.017; **p≤0.001

13.8.4 Comparisons of object and action naming scores within groups

When medians were compared, a higher object naming score was noted in the MLS and BLE language conditions and a higher action naming score in the BLS language condition. Pairwise comparisons showed no statistically significant difference in any test language condition. Findings are summarized in table 13.18.

Table 13.18: Summary: Comparisons in object and action naming scores within language conditions

Condition 1	Median	Condition 2	Median	Significance at p<0.008
MLS PwA Objects	0.49	MLS PwA Actions	0.42	.078
MLS HCs Objects	0.96	MLS HCs Actions	0.92	.023
BLS PwA Objects	0.55	BLS PwA Actions	0.61	.155
BLS HCs Objects	0.94	BLS HCs Actions	1.00	.015
BLE PwA Objects	0.67	BLE PwA Actions	0.58	.424
BLE HCs Objects	0.94	BLE HCs Actions	0.89	.047

Note: *p≤0.008; **p≤0.001

Chapter 14: Error analysis for picture naming

14.0 Overview

Responses that were not the target word in the target language (TL) were all coded as errors in accordance with the amended coding system[47] (table 12.1 in Chapter 12).

All responses were also coded as to whether they were in the target language (TL) or non-target language (NTL). Errors were then categorized as lexical, non-lexical and other types. Below is a brief description of all the response categories included here.

- Accurate responses (accuracy score; AS): This includes correct responses in TL only.
- Lexical errors (LE): Includes all responses that are incorrect but constitute a real word, including semantic, phonological and mixed errors. Responses here were in either Sinhala or English (TL or NTL).
- Non-lexical errors (NLE): Includes all responses that are incorrect and do not constitute a real word in either of the languages.

  Non-lexical responses were of three types; (i) NLEs that approximated the TL, (ii) NLEs that approximated the NTL and (iii) NLEs which does not approximate the TL or NTL.

  In the error analyses, NLEs of type (i) and (iii) were categorized separately while those of type (ii) were included in the NTL count.
- Other Errors: Includes errors that cannot be categorized as LE or NLE. These are, relevant circumlocutions, deviant circumlocutions, no responses and miscellaneous errors[48].

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[47] The coding system was developed based on Dell, Schwartz, Martin, Saffran and Gagnon (1997) and Vitkovitch & Tyrell (1995) and further modified throughout this study. (see tables 6.3 in Chapter 6; Development of the OANB and 12.1 in Chapter 12; Findings of phase 2)

[48] Examples from this study for miscellaneous errors include, frog→ [makes a croaking sound], cooking→ [ranjith] (name of the participant's chef)

Analyses here addressed the same questions outlined in section 13.0 and involved the same pairwise comparisons for comparing response types.

Similar to chapter 13, Questions (i) through (iii) above involved separate analyses for object and action response types. The PwA-HC comparisons for question (i) have been included in question (iii). Question (iv) involved a comparison between the object and action response types.

14.1 Descriptive statistics for error data

Tables 14.1 and 14.2 present descriptive statistics for accuracy scores and error categories across the three language conditions MLS, BLS and BLE in PwAs for object and action naming respectively. Tables 14.3 and 14.4 present descriptive statistics for accuracy scores and error categories across the three language conditions MLS, BLS and BLE in HCs for object and action naming respectively. Figures 14.1 and 14.2 depict the distribution of accurate responses and errors in TL and NTL across the MLS, BLS and BLE PwA groups for object and action naming respectively.

Table 14.1: Descriptive statistics for response types across categories for naming objects in PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	0.48	0.01	0.12	0.00	0.07	0.00	0.31	-
	SD	(0.28)	(0.01)	(0.09)	(0.01)	(0.06)	(0.01)	(0.28)	
	Min-Max	0.07-0.94	0.00-0.04	0.00-0.32	0.00-0.01	0.00-0.19	0.00-0.01	0.01-0.81	
BLS	Mean	0.57	0.05	0.06	0.01	0.05	0.01	0.25	0.00
	SD	(0.30)	(0.07)	(0.06)	(0.01)	(0.07)	(0.01)	(0.24)	0.00
	Min-Max	0.19-0.97	0.00-0.20	0.00-0.19	0.00-0.03	0.00-0.20	0.00-0.03	0.00-0.68	0.00-0.01
BLE	Mean	0.59	0.01	0.08	0.01	0.06	0.00	0.26	0.01
	SD	(0.24)	(0.01)	(0.03)	(0.02)	(0.07)	0.00	(0.26)	(0.01)
	Min-Max	0.07-0.81	0.00-0.03	0.03-0.14	0.00-0.04	0.00-0.23	0.00-0.01	0.03-0.90	0.00-0.04

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

Table 14.2: Descriptive statistics for response types across categories for naming actions in PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	0.43	0.01	0.19	0.00	0.04	0.00	0.33	-
	SD Min-Max	(0.27) 0.00-0.79	(0.01) 0.00-0.03	(0.11) 0.03-0.39	(0.01) 0.00-0.03	(0.06) 0.00-0.21	(0.01) 0.00-0.03	(0.28) 0.03-0.92	
BLS	Mean	0.53	0.07	0.08	0.00	0.02	-	0.30	-
	SD Min-Max	(0.28) 0.11-0.89	(0.09) 0.00-0.26	(0.05) 0.00-0.16	(0.01) 0.00-0.03	(0.04) 0.00-0.11		(0.25) 0.05-0.75	
BLE	Mean	0.56	0.01	0.10	-	0.04	-	0.29	0.00
	SD Min-Max	(0.21) 0.21-0.87	(0.03) 0.00-0.08	(0.09) 0.00-0.29		(0.06) 0.00-0.18		(0.21) 0.05-0.74	(0.01) 0.00-0.03

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

Table 14. 3: Descriptive statistics for response types across categories for naming objects in HCs*

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	0.94	0.00	0.04	0.00	0.00	-	0.02	0.00
	SD	(0.06)	(0.01)	(0.03)	(0.00)	(0.01)		(0.02)	0.00
	Min-Max	0.78-1.00	0.00-0.01	0.00-0.13	0.00-0.01	0.00-0.01		0.00-0.07	0.00-0.01
BLS	Mean	0.94	0.01	0.04	0.00	0.00	-	0.01	0.00
	SD	(0.06)	(0.03)	(0.03)	(0.01)	(0.01)		(0.01)	(0.01)
	Min-Max	0.84-1.00	0.00-0.09	0.00-0.10	0.00-0.03	0.00-0.03		0.00-0.04	0.00-0.03
BLE	Mean	0.92	0.00	0.05	-	0.00	-	0.02	-
	SD	(0.06)	(0.01)	(0.03)		(0.01)		(0.02)	
	Min-Max	0.81-1.00	0.00-0.03	0.00-0.12		0.00-0.03		0.00-0.06	

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

* Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

Table 14. 4: Descriptive statistics for response types across categories for naming actions in HCs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	**NTL**	**TL**	**NTL**	**TL**	**NTL**	**TL**	**NTL**
MLS	Mean	0.90	0.01	0.06	-	-	-	0.02	0.01
	SD	(0.10)	(0.02)	(0.07)				(0.03)	(0.01)
	Min-Max	0.68-1.00	0.00-0.08	0.00-0.21				0.00-0.08	0.00-0.05
BLS	Mean	0.98	0.00	0.01	0.00	-	-	0.00	-
	SD	(0.04)	(0.01)	(0.03)	(0.01)			(0.01)	
	Min-Max	0.87-1.00	0.00-0.03	0.00-0.11	0.00-0.03			0.00-0.03	
BLE	Mean	0.90	0.00	0.04	-	0.02	-	0.04	-
	SD	(0.07)	(0.01)	(0.03)		(0.03)		(0.05)	
	Min-Max	0.79-1.00	0.00-0.03	0.00-0.08		0.00- 0.11		0.00-0.13	

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

14.2 Selection of statistical tests

The aim was to identify whether response types differed across the language conditions and between word classes (objects vs. actions). Data included were all correct or incorrect naming responses in TL or NTL for the MLS, BLS and BLE language conditions. Although both Sinhala and English data were elicited by the same BL participant group in analysis data were considered from separate language conditions.

Chi-square test of independence were used in analysis. Since all comparisons made here involved categorical data, raw scores were used to compute the contingency tables for the Chi Square analysis. Two way statistical comparisons were made in order to allow comparisons across language conditions (BLS and MLS), languages in the BL group (BLS vs. BLE) and stimuli (objects vs. actions).

In order to do so, data were categorized in to a total of five categories. These were (i) accurate responses in TL, (ii) lexical errors (LE) in TL, (iii) non-lexical errors (NLE)[49], (iv)other errors (OE) in TL and (v) total number of responses in NTL.

In some comparisons the accuracy counts were extremely high and so the distribution of data did not satisfy test conditions for a chi square analysis. In such cases data were collapsed in to three categories; accurate responses in TL, error responses in TL (sum of LE, NLE and OE) and responses in NTL. A dagger symbol (†) has been used to indicate comparisons this was the case.

In some cases the collapsed data did not assume chi square test conditions. Hence no statistical tests were performed on the data. In such cases it has been indicated (in both text and summary tables) with a double dagger symbol (††)

[49] Refer section 14.0 for categorization of NLE

As in chapter 13, the Bonferroni correction was applied according to the comparisons made in each section. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In the following sections 14.3 through 14.5, statistical significance has been reported for pairwise analyses.

14.3 Object naming

Responses across the language conditions were compared. The aim was to identify differences in response types within the language conditions for object naming. Tables 14.5 and 14.6 show the contingency tables prepared for Chi Square tests.

Table 14.5: Contingency table for PwAs across language conditions for object naming

Objects (n=69)	**Responses in TL, *n (%)***				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	498 (48.12)	122 (11.79)	77 (7.44)	325 (31.40)	13 (1.26)	1035
BLS (n=11)	433 (57.05)	43 (5.67)	41 (5.40)	188 (24.77)	54 (7.11)	759
BLE (n=11)	445 (58.63)	60 (7.91)	43 (5.67)	195 (25.69)	16 (2.11)	759

* Percentage in each category is indicated in parentheses

Table 14.6: Contingency table for the HCs across language conditions for object naming

Objects (n=69)	**Responses in TL, *n (%)***				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	972 (93.91)	38 (3.67)	2 (0.19)	19 (1.84)	4 (0.39)	1035
BLS (n=11)	710 (93.54)	27 (3.56)	3 (0.40)	7 (0.92)	12 (1.58)	759
BLE (n=11)	702 (92.49)	35 (4.61)	2 (0.26)	17 (2.24)	3 (0.40)	759

* Percentage in each category is indicated in parentheses

Chi Square tests of independence were performed on the above data.

14.3.1 Between group comparisons in Sinhala

Analyses in section 14.3.1 revealed a significant difference between the MLS and BLS PwA groups for response types in object naming. No difference was noted between the MLS and BLS HC groups.

Data are shown in table 14.7.

Table 14.7: Comparisons in ML and BL response types for object naming in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA	4	74.32	.000**
MLS HC	BLS HC	4	10.19	.037

Note: $*p \leq 0.025$; $**p \leq 0.001$

14.3.2 Within group comparisons between the languages

Analyses in section 14.3.2 revealed a significant difference between the English and Sinhala response types in the BL PwA group but not in the BL HC group.

Data are shown in table 14.8.

Table 14.8: Comparisons in BL Sinhala and English response types for object naming

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	4	23.77	.000**
BLS HCs	BLE HCs	4	10.44	.028

Note: $*p \leq 0.025$; $**p \leq 0.001$

14.3.3 Comparisons between the PwAs and HCs

As expected the difference in response types between the PwA and corresponding HC group in all three language conditions were statistically highly significant.

Data are shown in table 14.9.

Table 14.9: Comparisons in PwA -HC response types for object naming across the language conditions

Condition 1	Condition 2	Chi Square statistics		
		df	**Test statistic**	**Significance at p<0.008**
MLS PwA	MLS HCs	4	545.11	.000**
BLS PwA	BLS HCs	4	298.34	.000**
BLE PwA	BLE HCs	4	259.00	.000**

Note: *p≤0.017; **p≤0.001

14.4 Action Naming

Responses across the language conditions were compared. The aim was to identify differences in response types within the language conditions for action naming.

Individual raw scores were used to compute the following contingency tables separately for the PwA group (table 14.10) and the healthy controls (table 14.11).

Table 14.10: Contingency table for the PwAs across the language conditions for action naming

Actions (n=38)	**Responses in TL, *n (%)***				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	244 (42.81)	109 (19.12)	24 (4.21)	188 (32.98)	5 (0.88)	570
BLS (n=11)	220 (52.63)	32 (7.66)	9 (2.15)	127 (30.38)	30 (7.18)	418
BLE (n=11)	232 (55.50)	41 (9.81)	17 (4.07)	120 (28.71)	8 (1.91)	418

* Percentage in each category is indicated in parentheses

Table 14.11: Contingency table for HCs across the language conditions for action naming

Actions (n=38)	**Responses in TL, *n (%)***				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	513 (90.0)	35 (6.14)	0	11 (1.93)	11 (1.93)	570
BLS (n=11)	408 (97.61)	6 (1.44)	0	2 (0.48)	2 (0.48)	418
BLE (n=11)	375 (89.71)	17 (4.07)	7 (1.67)	18 (4.31)	1 (0.24)	418

* Percentage in each category is indicated in parentheses

Chi Square tests of independence were performed on the above data.

14.4.1 Between group comparisons in Sinhala

Analyses in section 14.4.1 revealed a significant difference between the MLS and BLS PwA and HC groups for response types in action naming.

Data are shown in table 14.12.

Table 14.12: Comparisons in ML and BL response types for action naming in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA	4	57.76	.000**
MLS HC	BLS HC	3	22.08	.000**

Note: $*p \leq 0.025$; $**p \leq 0.001$

14.4.2 Within group comparisons between the languages

Analyses in section 14.4.2 revealed a significant difference between the English and Sinhala response types in the BL PwA group.

A Chi square analysis could not be performed for the BL HC group.

Data are shown in table 14.13.

Table 14.13: Comparisons in BL Sinhala and English response types for action naming

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	4	16.82	.002*
BLS HCs	BLE HCs			††

Note: $*p \leq 0.025$; $**p \leq 0.001$

†† Chi Square analysis could not be performed.

14.4.3 Comparisons between the PwAs and HCs

As expected the difference in response types between the PwA and corresponding HC group in all three language conditions were statistically highly significant.

Data are shown in table 14.14.

Table 14.14: Comparisons in PwA-HC response types for action naming across the language conditions

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	MLS HCs	4	317.30	.000**
BLS PwA	BLS HCs	4	228.69	.000**
BLE PwA	BLE HCs	4	128.62	.000**

Note: *$p \leq 0.017$; **$p \leq 0.001$

14.5 Within group comparisons in naming objects and actions

Comparisons were made across the accuracy scores, error scores and language switches, within language conditions, groups and for BL within each language.

14.5.1 Comparisons in Sinhala for MLS PwAs and HCs

The analyses in section 14.5.1 revealed a statistically highly significant difference between response types for object naming and action naming in both the PwA and HC† group comparisons. Data are shown in table 14.15.

Table 14.15: Object-action comparisons in MLS for response types in the naming task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA Objects	MLS PwA Actions	4	22.83	.000**
MLS HCs Objects	MLS HCs Actions	4	13.13	.001 †

Note: *$p \leq 0.008$; **$p \leq 0.001$
† Chi Square analysis performed on collapsed data.

14.5.2 Comparisons in Sinhala for BLS PwAs and HCs

The analyses in section 14.5.2 revealed no statistically significant difference between response types for object naming and action naming in the BLS PwA or BLS HC group†.

Data are shown in table 14.16.

Table 14.16: Object-action comparisons in BLS for response types in the naming task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA Objects	BLS PwA Actions	4	12.50	.014
BLS HCs Objects	BLS HCs Actions	2	9.40	.009 †

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.

14.5.3 Comparisons in English for BLE PwAs and HCs

The analyses in section 14.5.3 revealed no statistically significant difference between response types for object naming and action naming in the BLE PwA group. A chi square test could not be performed on the BLE HC data.

Findings are shown in table 14.17.

Table 14.17: Object-action comparisons in BLE for response types in the naming task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLE PwA Objects	BLE PwA Actions	4	3.91	.418
BLE HCs Objects	BLE HCs Actions			††

Note: *p≤0.008; **p≤0.001
†† Chi Square analysis could not be performed.

14.6 Summary

This chapter presents findings based on a chi square analyses conducted for response types across the language conditions MLS, BLS and BLE for object and action naming separately. In order to do so, individual responses elicited in both TL and NTL in PwA and HC groups were included in the analyses.

14.6.1 Comparisons in Sinhala across ML and BL

In the PwA group NTL was higher in the BLS language condition for both objects and actions. In the HC group, NTL was higher in the BLS language condition for objects and the MLS language condition for actions.

Response types significantly differed for both actions and objects in PwA and for only actions in HCs.

Findings are summarized in table 14.18

Table 14.18: Summary: Comparison of ML and BL response types

Condition 1	Condition 2	Significance level
Object naming		
MLS PwA Objects	BLS PwA Objects	.000**
MLS HCs Objects	BLS HCs Objects	.037
Action naming		
MLS PwA Actions	BLS PwA Actions	.000**
MLS HCs Actions	BLS HCs Actions	.000**

Note: *p≤0.025; **p≤0.001

14.6.2 Comparisons in BL Sinhala versus English scores

In both PwA and HC groups, NTL was higher in the BLS condition for both objects and actions.

Response types significantly differed between the BLS and BLE language conditions in the PwA group for objects and actions and in the HC group, only for objects.

BL HC data could not be statistically analysed. ††

Findings are summarized in table 14.19

Table 14.19: Summary: Comparison of BL Sinhala and English response types

Condition 1	Condition 2	Significance level
Object naming		
PwA BL (S) Objects	PwA BL (E) Objects	.000**
Controls BL (S) Objects	Controls BL (E) Objects	.000**
Action naming		
PwA BL (S) Actions	PwA BL (E) Actions	.002**
Controls BL (S) Actions	Controls BL (E) Actions	††

Note: *p≤0.025; **p≤0.001

†† Chi Square analysis could not be performed.

14.6.3 Comparisons between PwAs and HCs

PwA-HCs comparisons across language conditions showed a significant difference between response types for PwAs and HCs.

Findings are summarized 14.20

Table 14.20: Summary: Comparison of PwA-HC response types

Condition 1	Condition 2	Significance level
Object naming		
MLS PwA Objects	MLS HCs Objects	.000**
BLS PwA Objects	BLS HCs Objects	.003*
BLE PwA Objects	BLE HCs Objects	.000**
Action naming		
MLS PwA Actions	MLS HCs Actions	.000**
BLS PwA Actions	BLS HCs Actions	.000**
BLE PwA Actions	BLE HCs Actions	.000**

Note: *p≤0.017; **p≤0.001

14.6.4 Comparisons across objects and actions within groups

With the exception of the MLS HC group, more NTL responses were elicited for object naming than for actions across all language conditions in both PwA and HC groups.

When response types for object and action naming were compared within groups, the difference was significant only in the MLS PwA and MLS HC† groups. For the MLS HC group significance was obtained on collapsed data. BLE HC group response data could not be analysed. †† Findings are summarized in table 14. 21

Table 14.21: Summary: Comparison of response types within language conditions for object and action naming

Condition 1	Condition 2	Significance level
MLS PwA Objects	MLS PwA Actions	.000*
MLS HCs Objects	MLS HCs Actions	.001* †
BLS PwA Objects	BLS PwA Actions	.014
BLS HCs Objects	BLS HCs Actions	.009 †
BLE PwA Objects	BLE PwA Actions	.418
BLE HCs Objects	BLE HCs Actions	††

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.
†† Chi Square analysis could not be performed.

Chapter 15: Analysis of connected speech data in phase 3

15.0 Overview

This chapter presents the analysis of data from the picture sequence narration (PS) and single picture description task (SP). The data groups for the connected speech tasks were similar to that of chapter 13 (see table 13.1).

Analyses here in chapter 15 addressed the same questions outlined in section 13.0 and involved the same pairwise comparisons for noun scores and verb scores of the three language conditions, MLS, BLS and BLE. The analyses were separate for the PS (section I) and SP tasks (section II).

For the analysis questions i) through (iii) outlined in section 13.0 separate analyses were performed for noun and verb scores. Similar to chapters 13 and 14 before, the PwA-HC comparisons for question (i) have been included in question (iii). Question (iv) involved a comparison between the noun and verb scores within each language condition.

Analysis here involved two measures; correctly recalled (CR) scores as a measure of word accuracy and Type-Token Ratios (TTR) as a measure of word production, separately for nouns (CRn/ TTRn) and verbs (CRv/ TTRv) (see section, 8.5.5.1).

Only CR and TTR responses elicited in the TL were included in the analyses for this chapter. Nouns and verbs elicited in the NTL, even if accurate were included in the error analysis. Details of the error analysis for connected speech tasks follow in chapter 16.

15.1 Reliability findings

Two ML, two BL Sinhala and two BL English participants from the PwA and HC groups were included in reliability analysis. Reliability values were individually calculated for (i) transcription, (ii) CR (noun and verb) counts, (iii) TTR (noun and verb counts) and (iv) error counts. One transcript from each language condition was re-analysed in all of the above-mention aspects for PS data and the other for SP data. Reliability scores were calculated separately for the language conditions and averaged.

For PS tasks, a 100% reliability score was obtained for both inter and intra rater analyses for transcriptions. Intra-rater reliability was an average of 98.9% for CRn and 99.0% for CRv coding. Inter-rater reliability was 100% for both CRn and CRv coding. Intra-rater reliability score for TTRn and TTRv counts were 99.6% and 99.1% respectively. Inter-rater reliability was 100% for both TTRn and TTRv coding. Intra-rater and Inter-rater reliability was 100% for error coding.

For SP tasks, a 100% reliability score was obtained for both inter and intra rater analyses for transcriptions. Intra rater reliability was an average of 99.9% for CRn and 98.9% for CRv coding. Inter-rater reliability was 100% for both CRn and CRv coding. Intra-rater reliability and inter-rater reliability was 100% for both TTRn and TTRv coding. Intra-rater and Inter-rater reliability was also 100% for error coding.

SECTION I

15.2 Analysis of PS data

15.2.1 Descriptive statistics

Individual CR (CRn and CRv) and TTR (TTRn and TTRv) scores for ML and BL PwA and HC participants for the PS task are provided in appendix 15.1.

Tables 15.2 and 15.3 present the descriptive statistics across the language conditions for CR scores, type count, token count and TTR for nouns and verbs separately.

Table 15.1: Descriptive statistics for HCs in PS task

		Nouns			Verbs		
		MLS Controls (n=15)	**BLS Controls** (n=11)	**BLE Controls** (n=11)	**MLS Controls** (n=15)	**BLS Controls** (n=11)	**BLE Controls** (n=11)
Correctly recalled scores	Mean	13.27	15.82	18.00	12.93	11.82	13.36
	Std. Dev.	4.79	6.11	5.31	5.11	7.35	2.77
	Minimum	7	8	11	7	0	9
	Maximum	22	27	28	25	24	18
Type token ratio	Mean	0.73	0.81	0.53	0.94	0.96	0.81
	Std. Dev.	0.12	0.10	0.10	0.07	0.05	0.11
	Minimum	0.44	0.64	0.39	0.82	0.86	0.64
	Maximum	0.93	1	0.65	1	1	1

Table 15.2: Descriptive statistics for PwA in PS task

		Nouns			Verbs		
		MLS PwA (n=15)	**BLS PwA** (n=11)	**BLE PwA** (n=11)	**MLS PwA** (n=15)	**BLS PwA** (n=11)	**BLE PwA** (n=11)
Correctly recalled scores	Mean	6.67	10.00	9.00	8.53	12.45	5.73
	Std. Dev.	4.84	4.20	5.25	4.41	6.47	2.15
	Minimum	0	5	3	3	3	2
	Maximum	16	15	20	17	21	9
Type token ratio	Mean	0.78	0.76	0.62	0.78	0.79	0.81
	Std. Dev.	0.17	0.20	0.25	0.23	0.14	0.11
	Minimum	0.5	0.33	0.23	0.30	0.52	0.67
	Maximum	1	1	1	1	1	1

Figures 15.1 and Figure 15.2 present the mean scores for accurately recalled nouns and verbs and standard deviations (error bars; +/- 2SD) across the PwA and HC language conditions, in the PS and SP tasks, respectively.

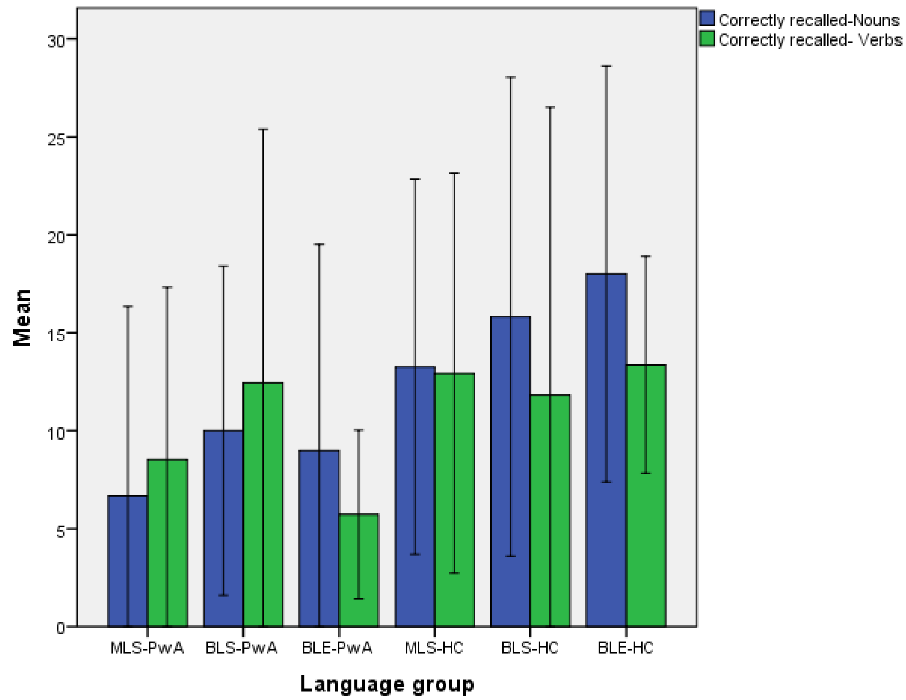

Figure 15.1: Bar charts depicting correctly recalled nouns (CRn) and verb (CRv) scores across the language conditions in the PwA and HC groups for the PS task

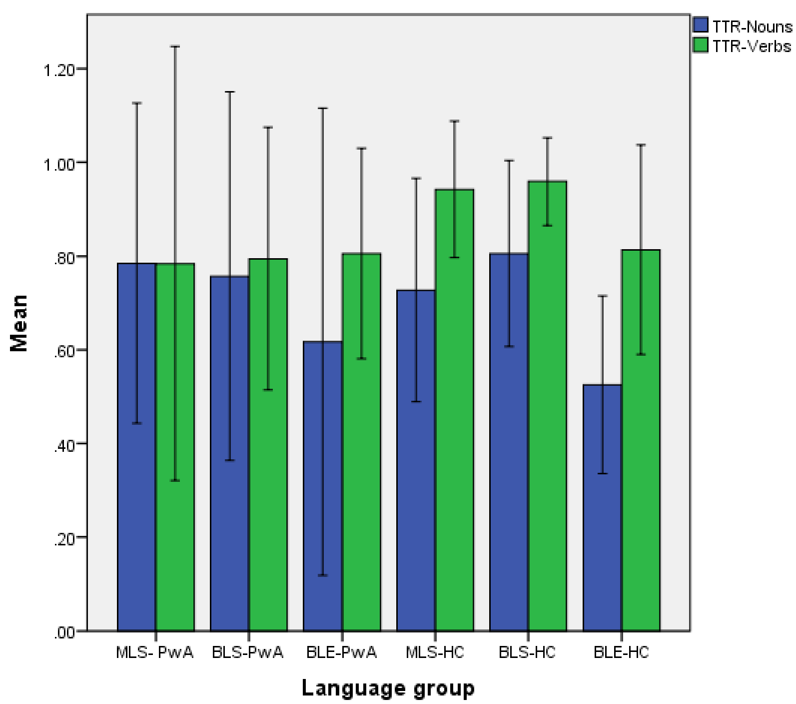

Figure 15.2: Bar charts depicting the type-token ratio for nouns (TTRn) and verbs (TTRv) scores across the language conditions in the PwA and HC groups for the PS task

15.2.2 Tests for normality and homogeneity of variance

Prior to analysis, Shapiro-Wilk test for normality and homogeneity of variance was performed on all data sets for all four measurements. Findings are presented in tables 15.3 and 15.4 for all language conditions in the PwA and HC groups across each measurement.

Table 15.3: Shapiro-Wilk findings for correctly recalled (CR) scores in PS

	n	**Noun**			**Verb**		
		Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
MLS PwA	15	.952	15	.555	.935	15	.325
BLS PwA	11	.854	11	.048	.907	11	.224
BLE PwA	11	.944	11	.563	.912	11	.256
MLS HCs	15	.933	15	.299	.908	15	.127
BLS HCs	11	.872	11	.083	.945	11	.583
BLE HCs	11	.952	11	.675	.865	11	.068

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 15.4: Shapiro-Wilk findings for type token ratio (TTR) scores in PS

	n	Noun			Verb		
		Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
MLS PwA	15	.923	15	.217	**.863**	**15**	**.027***
BLS PwA	11	.817	11	.016	**.391**	**11**	**.000*****
BLE PwA	11	.955	11	.714	**.519**	**11**	**.000*****
MLS HCs	15	.960	15	.698	**.766**	**15**	**.001*****
BLS HCs	11	.983	11	.980	**.830**	**11**	**.023***
BLE HCs	11	.913	11	.264	.955	11	.707

Note: *p≤0.05; **p≤0.01; ***p≤0.001

The Q-Q plots depicting the distribution of nouns and verbs for picture sequence narration in Sinhala and English across the BL and ML PwA and control groups are provided in Appendix 15.2

15.2.3 Selection of statistical tests

Analyses here were based on two measurements the number of correctly recalled (CR) nouns and verbs and also Type Token Ratio (TTR) separately for nouns and verbs.
Individual raw scores were used throughout this analysis.

As shown in table 15.3 comparisons involving the CR scores were normally distributed. Hence, an independent t-samples test for between the group comparisons and paired samples t-tests for repeated measures were used for all pairwise comparisons involving CR scores

In contrast, planned comparisons for TTR involved at least one non-parametric data set. Hence, for pairwise comparisons involving TTR the non-parametric alternatives, Mann Whitney U and Wilcoxon sign rank test for matched pairs were used for analysing across independent groups and their matched pairs, respectively.

As in chapter 13, the Bonferroni correction was applied according to the comparisons made in each section. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In part I of this chapter, sections 15.2.4 through 15.2.9 report statistical significance for pairwise analyses in the PS task.

15.2.4 Analysis of CR data for nouns

This section involves analyses based on CR scores for nouns, across the MLS, BLS and BLE language conditions.

15.2.4.1 Between group comparisons in Sinhala

Figure 15.3 below shows the distribution of CR scores for nouns in Sinhala for the ML and BL, PwA and HC groups. The graph represents the median, minimum–maximum scores and the interquartile range for the monolingual and bilingual PwA and control groups, separately.

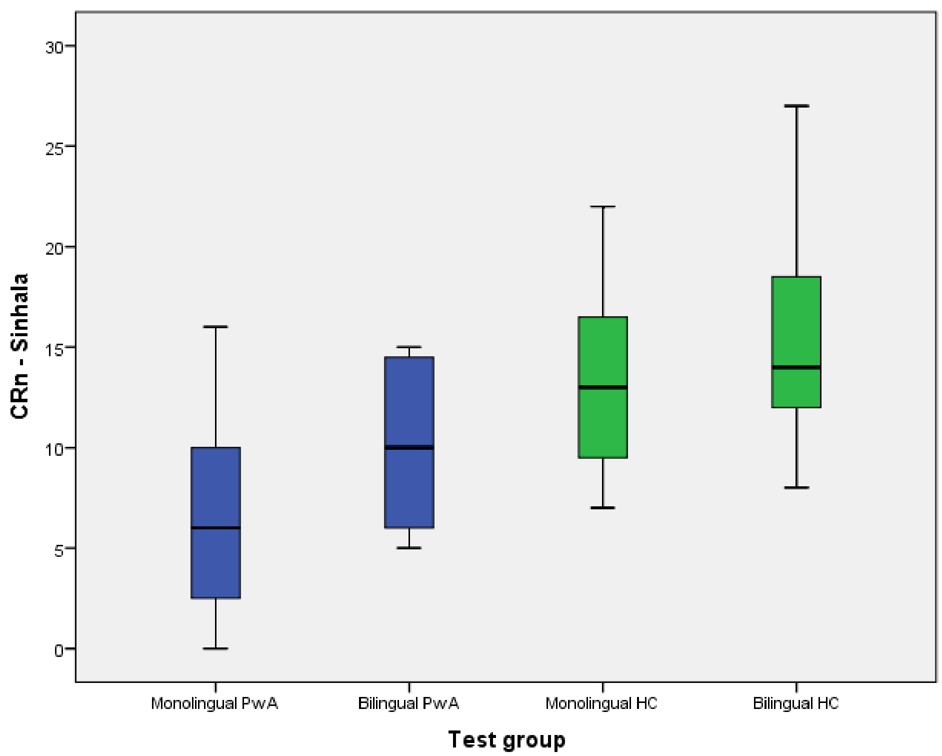

Figure 15.3: Box plot depicting CRn scores in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.2.4.1 above revealed no difference in the CR scores for nouns in Sinhala, between ML and BL PwA or between ML and BL HC groups.

Data are shown in table 15.5.

Table 15.5: Comparisons in ML and BL CRn scores in Sinhala

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
MLS PwA	6.67	BLS PwA	10.00	-1.834	24	.079
MLS HC	13.27	BLS HC	15.82	-1.195	24	.244

Note: *p≤0.025; **p≤0.001

15.2.4.2 Within group comparisons between the languages

Figure 15.4 below shows the median, minimum –maximum scores and the interquartile range of the CR scores for nouns in English and Sinhala for the bilingual PwA and control groups.

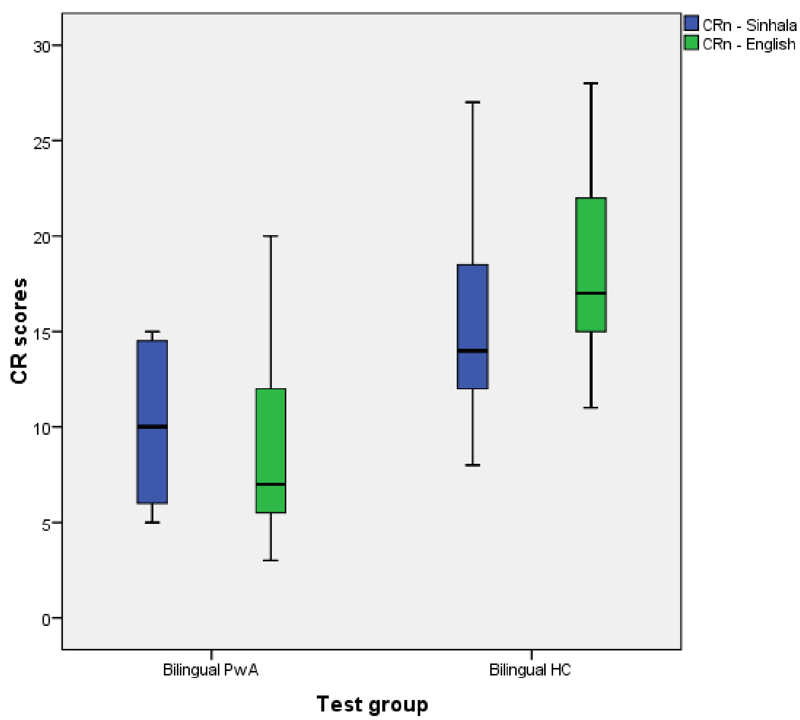

Figure 15.4: Box plot indicating CRn scores in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.2.4.2 above revealed no difference between Sinhala and English CRn scores in the BL PwA and HC groups. Data are shown in table 15.6.

Table 15.6: Comparisons in BL Sinhala and English CRn scores

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
BLS PwA	10.00	BLE PwA	9.00	.544	10	.599
BLS HCs	15.82	BLE HCs	18.00	-.899	10	.390

Note: *p≤0.025; **p≤0.001

15.2.4.3 Comparisons between PwAs and HCs

As expected, the analyses in section 15.2.4.3 above revealed that the CRn scores for HCs were significantly higher than their corresponding PwAs. The difference was statistically significant only in the MLS and BLS language conditions.

Data are shown in table 15.7.

Table 15.7: Comparisons in PwA-HC CRn scores across the language conditions

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
MLS PwA	6.67	MLS HCs	13.27	-3.76	28	.001**
BLS PwA	10.00	BLS HCs	15.82	-2.603	20	.017*
BLE PwA	9.09	BLE HCs	14.18	-2.331	20	.030

Note: *p≤0.017; **p≤0.001

15.2.5 Analysis of CR data for verbs

This section involves analyses based on CR scores for verbs across the MLS, BLS and BLE language conditions.

15.2.5.1 Between the group comparisons in Sinhala

Similar to that of nouns, a comparison was made between the groups for the accuracy in verb recall in the PS task. CRv scores of all individual participants were included to perform a pairwise comparison noted in section 15.2.4.1 above.

Figure 15.5 below shows the median, minimum –maximum scores and the interquartile range of the CR scores for verbs in Sinhala for the BL and ML PwA and control groups.

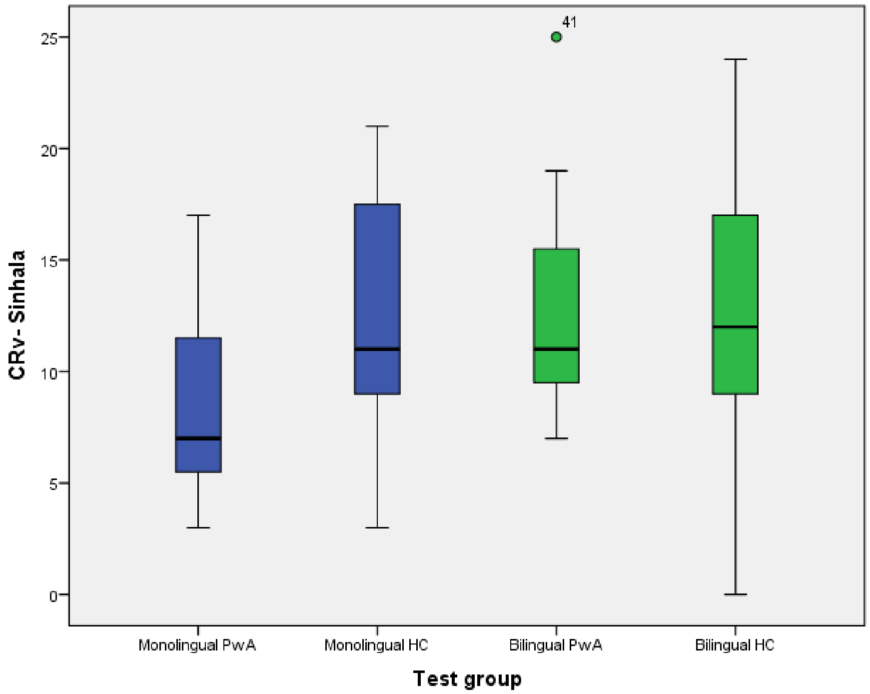

Figure 15.5: Box plot depicting CRv scores in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.2.5.1 above revealed no difference in the CR scores for verbs in Sinhala between ML and BL PwA or between ML and BL HC groups. Data are shown in table 15.8.

Table 15.8: Comparisons in ML and BL CRv scores in Sinhala

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
MLS PwA	8.53	BLS PwA	12.45	-1.842	24	.780
MLS HC	12.93	BLS HC	11.82	.458	24	.651

Note: *p≤0.025; **p≤0.001

15.2.5.2 Within group comparisons between the languages

Figure 15.6 below shows the median, minimum–maximum scores and the interquartile range of the CR scores for verbs in Sinhala and English for BL control and PwA groups.

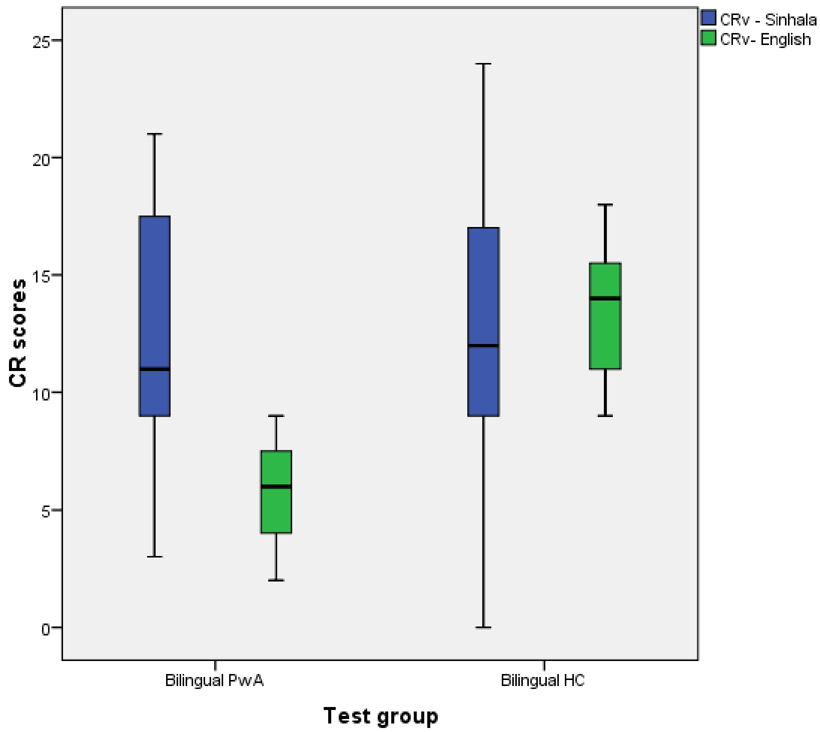

Figure 15.6: Box plot indicating CRv scores in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.2.5.2 above revealed a significant difference between Sinhala and English CRv scores only in the BL PwA groups.

Data are shown in table 15.9.

Table 15.9: Comparisons in the BL Sinhala and English CRv scores

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
BLS PwA	12.45	BLE PwA	5.73	2.87	10	.017*
BLS HCs	11.82	BLE HCs	13.36	-.606	10	.558

Note: *p≤0.025; **p≤0.001

15.2.5.3 Comparisons between PwAs and HCs

As expected, CRv scores were higher in the MLS and BLE HC. In the BLS group however, PwA CRv scores showed to be higher than the HC scores. The difference was marginally significant only for the MLS language condition. See data in table 15.10.

Table 15.10: Comparisons in PwA-HC CRv scores across the language conditions

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
MLS PwA	8.53	MLS HCs	12.93	-2.527	28	.017*
BLS PwA	12.45	BLS HCs	11.82	.216	20	.831
BLE PwA	5.00	BLE HCs	7.73	-1.910	20	.071

Note: *p≤0.017; **p≤0.001

15.2.6 Within group comparisons of CR scores for nouns and verbs

This section involves pairwise analyses across the CR noun and verb scores, separately for each language condition in the PS task.

15.2.6.1 CR scores in Sinhala for MLS PwAs and HCs

Figure 15.7 below shows the median, minimum –maximum scores and the interquartile range of the noun and verb CR scores in Sinhala for the ML control and PwA groups.

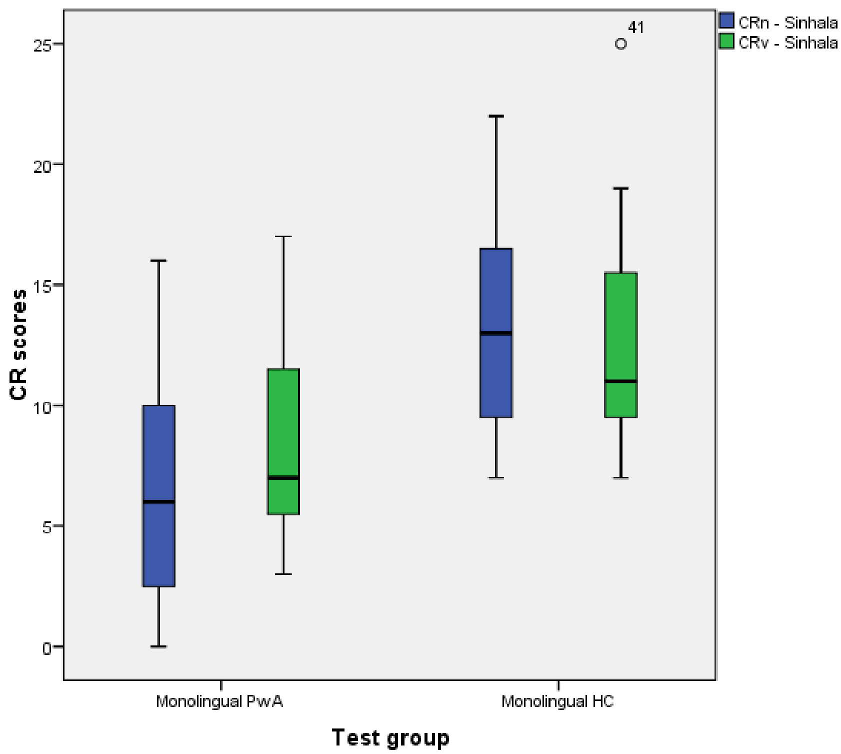

Figure 15.7: Box plot depicting CRn and CRv scores in Sinhala in the MLS PwA and HC groups

The analyses in section 15.2.6.1 above revealed no significant difference between CRn and CRv scores in both ML PwA and HC groups. Data are shown in table 15.11.

Table 15.11: Comparisons in the MLS CRn and CRv scores

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
MLS PwA - CRn	6.67	MLS PwA - CRv	8.53	-1.147	14	.270
MLS HCs - CRn	13.27	MLS HCs - CRv	12.93	.435	14	.670

Note: $*p \leq 0.008$; $**p \leq 0.001$

15.2.6.2 CR scores in Sinhala for BLS PwAs and HCs

Figure 15.8 below shows the median, minimum–maximum scores and the interquartile range of noun and verb CR scores in Sinhala for the BL control and PwA groups.

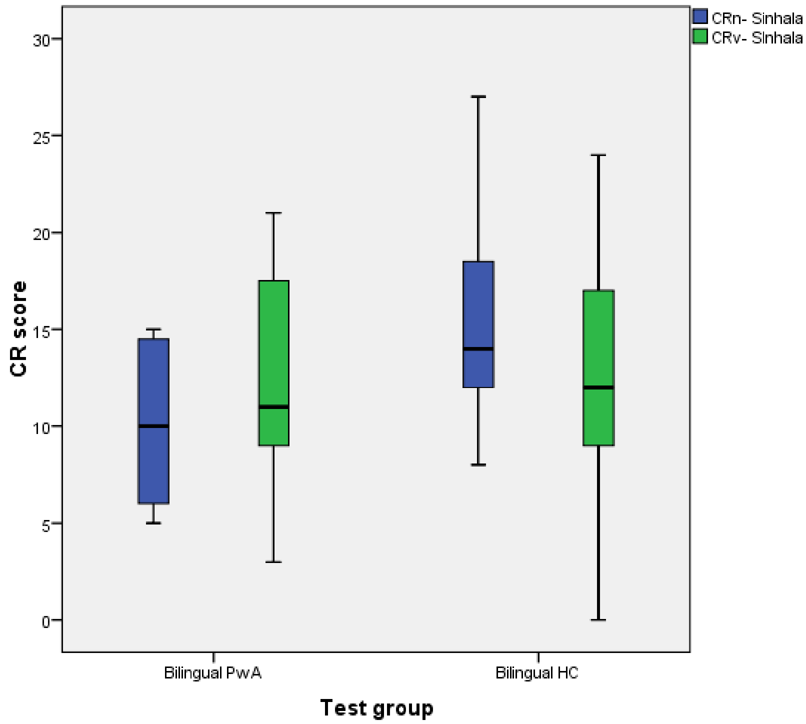

Figure 15.8: Box plot depicting CRn and CRv scores in Sinhala in the BLS PwA and HC groups

The analyses in section 15.2.6.2 above revealed no significant difference between CRn and CRv scores in Sinhala for both BL PwA and HC groups.

Data are shown in table 15.12.

Table 15.12: Comparisons in the BLS CRn and CRv scores

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
BLS PwA - CRn	10.00	BLS PwA -CRv	12.45	-1.936	10	.082
BLS HCs- CRn	15.82	BLS HCs - CRv	11.82	2.217	10	.051

Note: *p≤0.008; **p≤0.001

15.2.6.3 CR scores in English for BLE PwAs and HCs

Figure 15.9 below shows the median, minimum–maximum scores and the interquartile range of CR scores for nouns and verbs in English for the BL PwA and control groups.

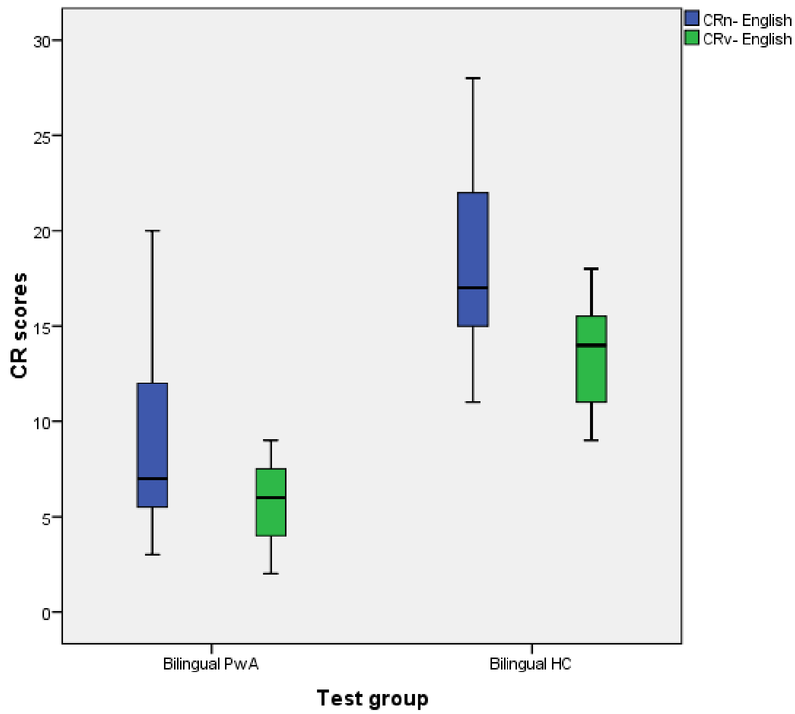

Figure 15.9: Box plot depicting CRn and CRv scores in English for the BL PwA and HC groups

The analyses in section 15.2.6.3 above revealed no significant difference between CRn and CRv scores in English for both BLE PwA and HC groups.

Data are shown in table 15.13.

Table 15.13: Comparisons in the BLE CRn and CRv scores

Condition 1	M	Condition 2	M	t test findings		
				t statistic	df	Sig. at <0.008
BLE PwA - CRn	9.00	BLE PwA -CRv	5.73	2.324	10	.042
BLE HCs- CRn	18.00	BLE HCs - CRv	13.36	2.796	10	.019

Note: *p≤0.008; **p≤0.001

15.2.7. Analysis of TTR data for nouns

This section involves analyses based on TTR scores for nouns across the MLS, BLS and BLE language conditions.

15.2.7.1 Between group comparisons in Sinhala

Figure 15.10 below shows the distribution of TTR scores for nouns in Sinhala for the ML and BL, PwA and HC groups. The graph represents the median, minimum–maximum scores and the interquartile range for the monolingual and bilingual PwA and control groups, separately.

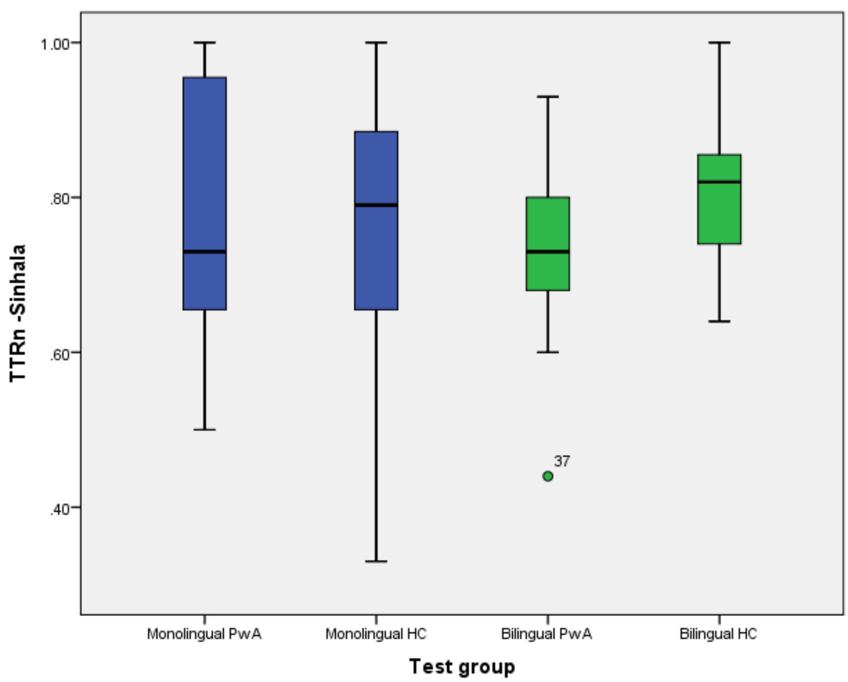

Figure 15.10: Box plot depicting TTRn in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.2.7.1 above revealed no difference in the TTRn scores in Sinhala between MLS and BLS PWA or between MLS and BLS HC groups.

Data are shown in table 15.14.

Table 15.14: Comparisons in MLS and BLS TTRn scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.73	BLS PwA	.79	77.00	-.06	.774
MLS HC	.73	BLS HC	.82	50.50	-.33	.960

Note: *p≤0.025; **p≤0.001

15.2.7.2 Within group comparisons between the languages

Figure 15.11 below shows the median, minimum –maximum scores and the interquartile range of the TTR scores for nouns in English and Sinhala for the bilingual PwA and HC groups.

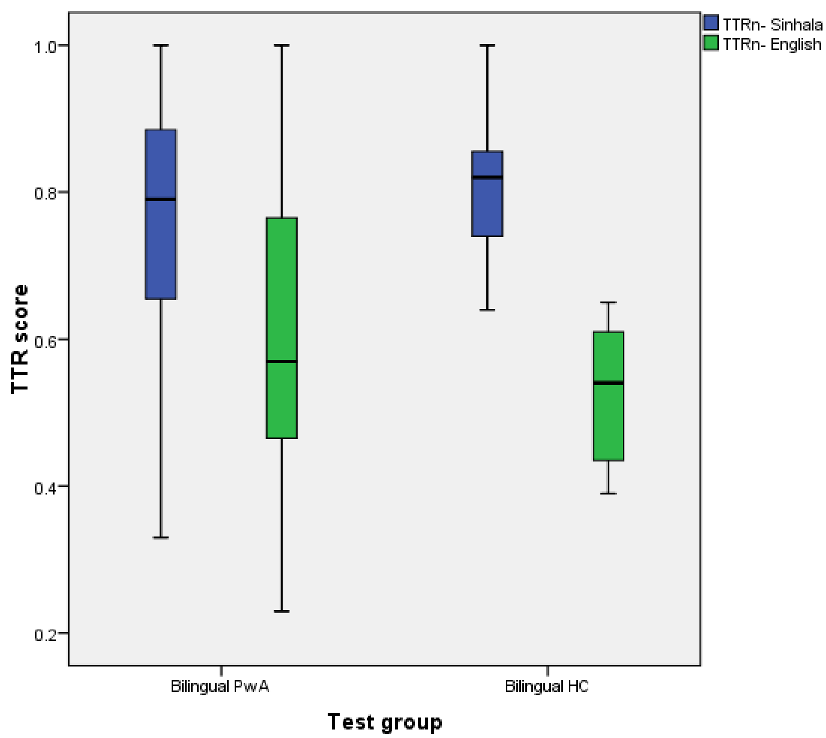

Figure 15.11: Box plot depicting TTRn in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.2.7.2 above revealed no difference between Sinhala and English TTRn scores in the BL PwA group. In the HC group however, the Sinhala TTRn scores were significantly higher than the English TTRn scores. Data are shown in table 15.15.

Table 15.15: Comparisons in the BL TTRn scores in Sinhala and English

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	.79	BLE PwA	.57	-1.511	.131
BLS HCs	.82	BLE HCs	.54	-2.9366	.003*

Note: *p≤0.025; **p≤0.001

15.2.7.3 Comparisons between PwAs and HCs

The analysis in section 15.2.7.3 revealed no significant difference between the TTRn scores for PwAs and HCs in the MLS and BLS language conditions but was significantly different in the BLE language condition.

Data are shown in table 15.16.

Table 15.16: Comparisons in PwA-HC TTRn scores across the language conditions

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.73	MLS HCs	.73	94.50	-.14	.461
BLS PwA	.79	BLS HCs	.82	53.00	-.11	.622
BLE PwA	.57	BLE HCs	.54	16.50	-.62	.002*

Note: *p≤0.017; **p≤0.001

15.2.8 Analysis of TTR data for verbs

This section involves analyses based on TTR scores for verbs across the MLS, BLS and BLE language conditions.

15.2.8.1 Between group comparisons in Sinhala

Figure 15.12 below shows the median, minimum –maximum scores and the interquartile range of the TTR scores for verbs in Sinhala for the BL and ML PwA and control groups.

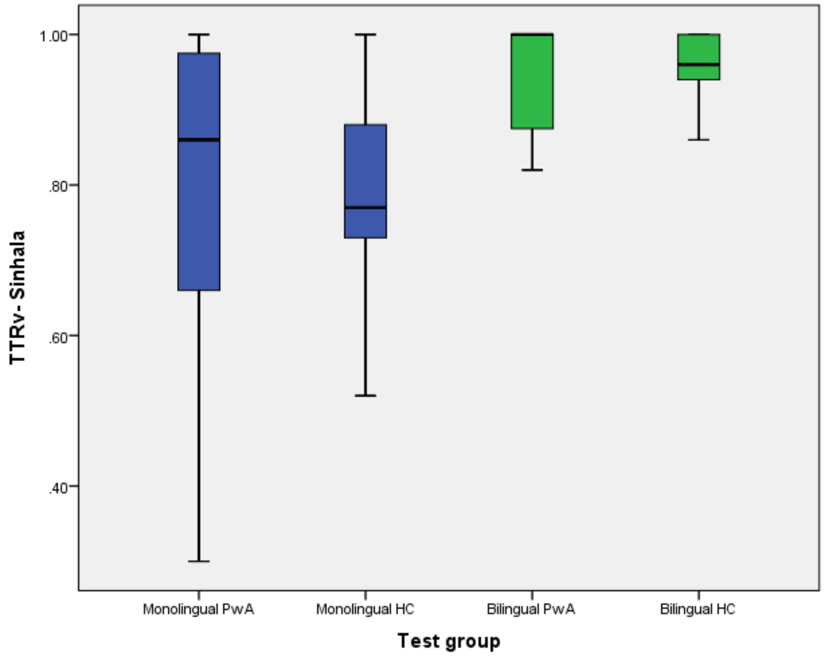

Figure 15.12: Box plot depicting TTRv scores in Sinhala in MLS and BLS PwA and HC groups

The analyses in section 15.2.8.1 above revealed no difference in the TTRv scores in Sinhala between the MLS and BLS PwA or between MLS and BLS HC groups.

Data are shown in table 15.17.

Table 15.17: Comparisons in ML and BL TTRv scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.86	BLS PwA	.77	73.50	-.09	.638
MLS HC	1.00	BLS HC	.96	79.00	-.036	.846

Note: *p≤0.025; **p≤0.001

15.2.8.2 Within group comparisons between the languages

Figure 15.13 below shows the median, minimum–maximum scores and the interquartile range of the TTRv scores in Sinhala and English for BL control and PwA groups.

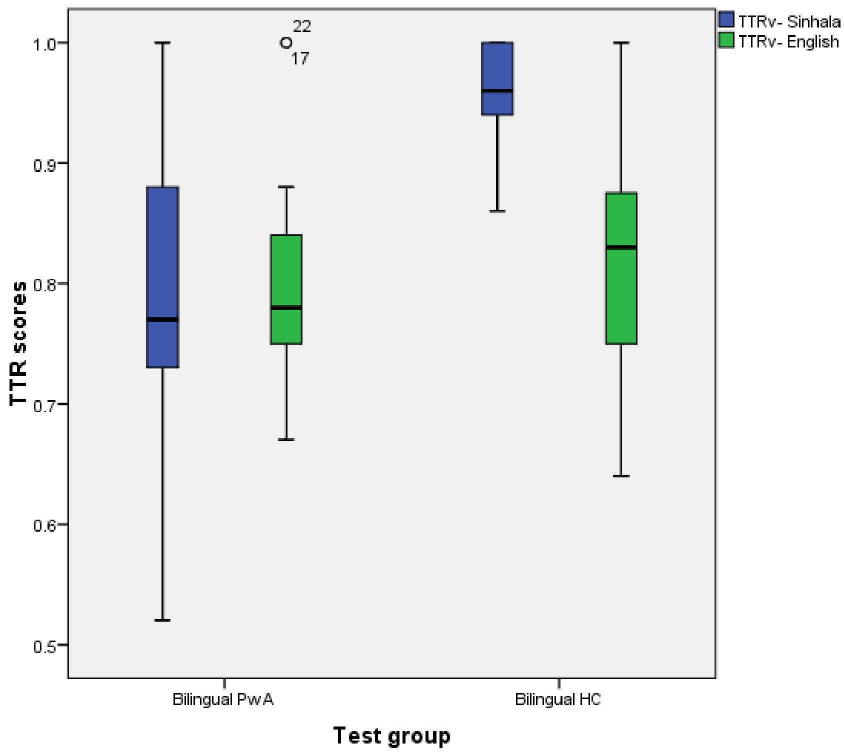

Figure 15.13: Box plot depicting TTRv in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.2.8.2 above revealed no difference between Sinhala and English TTRv scores in the BL PwA group. In the HC group however, the TTRv scores in Sinhala were significantly higher than the TTRv scores in English.

Data are shown in table 15.18.

Table 15.18: Comparisons between the Sinhala and English TTRv scores for the BL groups

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	.77	BLE PwA	.78	-.356	.722
BLS HCs	.96	BLE HCs	.83	-2.851	.004*

Note: *p≤0.025; **p≤0.001

15.2.8.3 Comparisons between PwAs and HCs

The analyses in section 15.2.8.3 revealed no difference between the TTRv scores for PwAs and HCs in the MLS and BLE language conditions although the difference was significant only in the BLS language condition.

Data are shown in table 15.19.

Table 15.19: Comparisons in PwA- HC TTRv scores across the language conditions

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.86	MLS HCs	1.00	63.50	-.038	.036
BLS PwA	.77	BLS HCs	.96	18.50	-.60	.004*
BLE PwA	.78	BLE HCs	.83	55.00	-.079	.748

Note: *p≤0.017; **p≤0.001

15.2.9 Within group comparisons of TTR scores across nouns and verbs

This section involves pairwise analyses across the TTR noun and verb scores, separately for each language condition in the PS task.

15.2.9.1 TTR scores in Sinhala for MLS PwAs and HCs

Figure 15.14 below shows the median, minimum–maximum scores and the interquartile range of noun and verb TTR scores in Sinhala for the ML control and PwA groups.

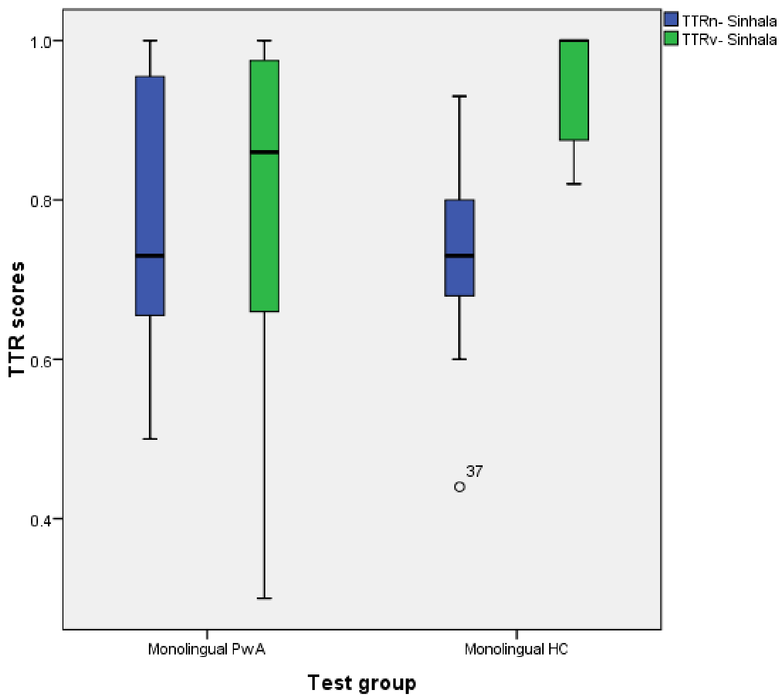

Figure 15.14: Box plot depicting TTRn and TTRv scores in Sinhala in the MLS PwA and HC groups

The analyses in section 15.2.9.1 above revealed no significant difference between TTRn and TTRv scores in the MLS PwA group. TTRv scores were significantly higher than TTRn scores in the MLS HC group.

Data are shown in table 15.20.

Table 15.20: Comparisons in MLS TTRn and TTRv scores

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
MLS PwA - TTRn	.73	MLS PwA -TTRv	.86	-.157	.875
MLS HCs- TTRn	.73	MLS HCs - TTRv	1.00	-3.353	.001*

Note: *p≤0.008; **p≤0.001

15.2.9.2 TTR scores in Sinhala for BLS PwAs and HCs

Figure 15.15 below shows the median, minimum–maximum scores and the interquartile range of noun and verb TTR scores in Sinhala for the BLS control and PwA groups.

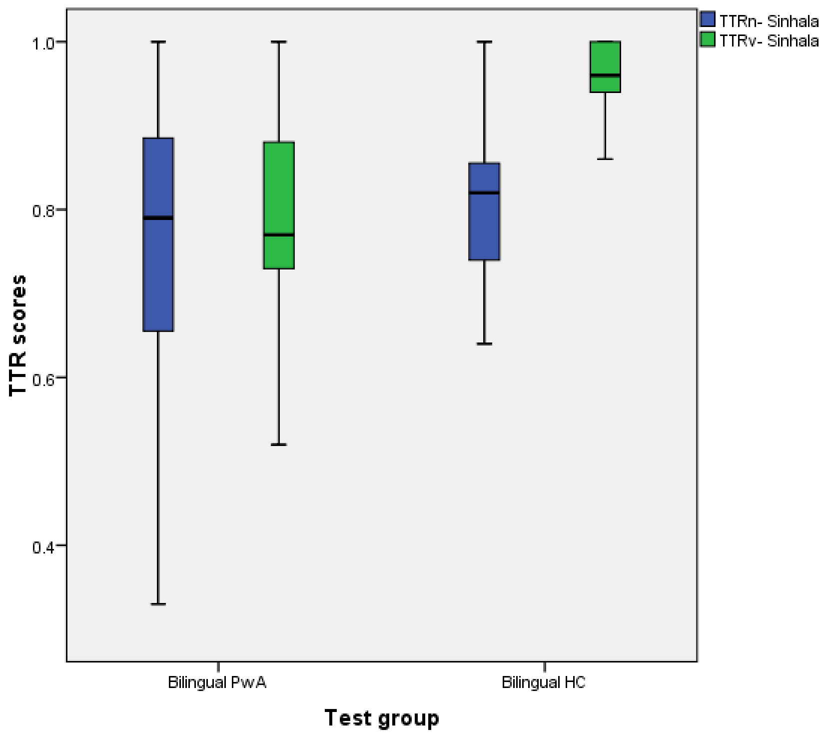

Figure 15.15: Box plot depicting TTRn and TTRv scores in Sinhala in the BLS PwA and HC groups

The analyses in section 15.2.9.2 above revealed higher TTRn scores in the PwA group and higher TTRv scores in the HC group. The TTRn-TTRv difference was significant only in the HC group.

Data are shown in table 15.21

Table 15.21: Comparisons in BLS TTRn and TTRv scores

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLS PwA -TTRn	.79	BLS PwA -TTRv	.77	-.612	.541
BLS HCs -TTRn	.82	BLS HCs -TTRv	.96	-2.803	.005*

Note: *p≤0.008; **p≤0.001

15.2.9.3 TTR scores in English for BLE PwAs and HCs

Figure 15.16 below shows the median, minimum–maximum scores and the interquartile range of TTR scores for nouns and verbs in English for the BLE PwA and control groups.

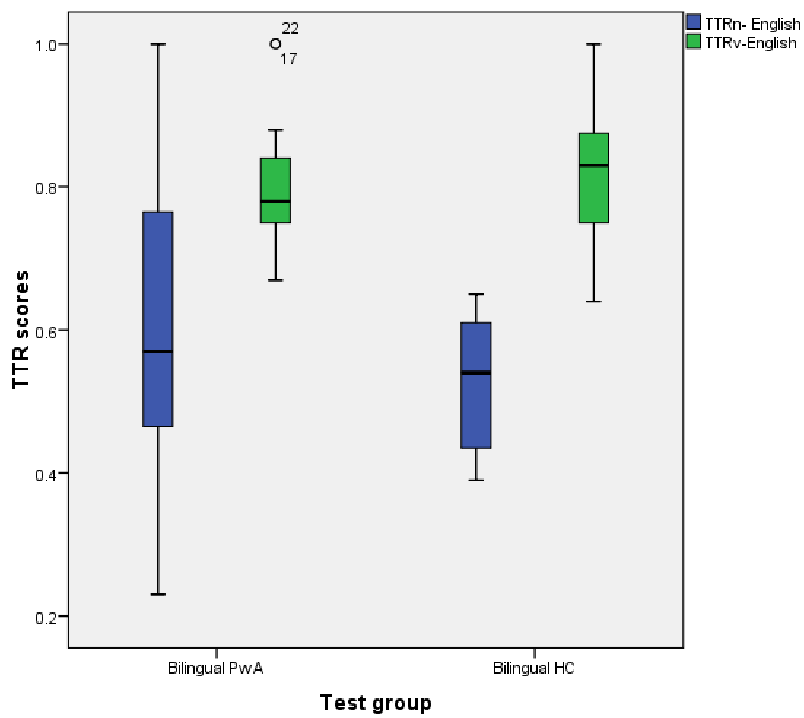

Figure 15.16: Box plot depicting TTRn and TTRv scores in English for the BLE PwA and HC groups

The analyses in section 15.2.9.3 above revealed higher TTRv scores were higher in both PwA and HC comparisons. The difference was statistically significant only in the HC group. Data are shown in table 15.22

Table 15.22: Comparisons in the BLE TTRn and TTRv scores

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLE PwA -TTRn	.57	BLE PwA -TTRv	.78	-2.490	.013
BLE HCs -TTRn	.54	BLE HCs -TTRv	.83	-2.805	.005

Note: *p≤0.008; **p≤0.001

15.2.10 Summary for the PS task

Section I of this chapter presents findings in P3 for the PS task. A series of planned analyses addressed the pre-determined questions outlined in section 15.0. The following sections summarize findings for the same.

15.2.10.1 Comparisons in Sinhala across ML and BL

CR scores were higher for the BLS group in all comparisons except in the PwA comparison for verb scores. TTR scores were higher in the BLS language condition for nouns and the MLS language condition for verbs. Neither comparison showed a statistically significant difference for TTRn or TTRv scores in Sinhala. Findings are summarized in table 15.23.

Table 15.23: Summary: Comparisons in MLS and BLS CR and TTR scores, in Sinhala

Condition 1	**Med.**		**Condition 2**	**Med.**		**Significance level**	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
MLS PwA	6.67	.73	BLS PwA	10	.79	.079	.774
MLS HCs	13.27	.73	BLS HCs	15.82	.82	.244	.960
Verb scores							
MLS PwA	8.53	.86	BLS PwA	12.45	.77	.78	.638
MLS HCs	12.93	1.00	BLS HCs	11.82	.96	.651	.846

Note: $*p \leq 0.025$; $**p \leq 0.001$

15.2.10.2 Comparisons in BL Sinhala versus English scores

In the PwA groups Sinhala CR scores were higher than English CR scores. In the HC groups English CR scores were higher than the Sinhala scores. TTRn scores were higher in Sinhala for all comparisons except the PwA comparison for verb (TTRv) scores. The only significant differences were in the HC group for both noun and verb scores.

Findings are summarized in table 15.24.

Table 15.24: Summary: Comparisons in BL Sinhala and English CR and TTR scores

Condition 1	Med.		Condition 2	Med.		Significance level	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
BLS PwA	10.00	.79	BLE PwA	9.00	.57	.599	.131
BLS HC	15.82	.82	BLE HC	18.00	.54	.899	.003*
Verb scores							
BLS PwA	12.45	.77	BLE PwA	5.73	.78	.017	.722
BLS HC	11.82	.96	BLE HC	13.36	.83	.558	.004*

Note: *p≤0.025; **p≤0.001

15.2.10.3 Comparisons between PwAs and HCs

For CR scores, significant differences were noted in MLS and BLS PwA-HC comparisons for nouns and also in the BLE PwA and HC comparisons for verb scores.

For TTR scores, a significantly higher score was shown in the BLE PwA group than their corresponding HCs.

It was also noted that the BLS PwA group had a higher CR verb score than their corresponding HC group although this difference was not statistically significant.

Findings are summarized 15.25 below.

Table 15.25: Summary: Comparison of PwA-HC groups for CR and TTR

Condition 1	Med.		Condition 2	Med.		Significance level	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
MLS PwA	6.67	.73	MLS HCs	13.27	.73	.001*	.461
BLS PwA	10.00	.79	BLS HCs	15.28	.82	.017*	.622
BLE PwA	9.09	.57	BLE HCs	14.18	.54	.030	.002*
Verb scores							
MLS PwA	8.53	.86	MLS HCs	12.93	1.00	.017*	.036
BLS PwA	12.45	.77	BLS HCs	11.82	.96	.831	.004*
BLE PwA	5.00	.78	BLE HCs	7.73	.83	.071	.748

Note: *p≤0.017; **p≤0.001

15.2.10.4 Comparisons across nouns and verbs within groups

CR noun scores were higher than CR verb scores in all within language condition comparisons except for the MLS and BLS PwA group comparisons. The CRn and CRv difference was not statistically significant in any comparison.

TTR scores were higher for verbs than nouns in all comparisons except in the BLS PwA language condition. Significant differences between TTRn and TTRv scores were noted in the HC groups across all language conditions, MLS, BLS and BLE.

Findings are summarized in table 15.26

Table 15.26: Summary: Comparison between nouns and verbs, within language conditions

Condition 1	Med.		Condition 2	Med.		Significance level	
	CR	TTR		CR	TTR	**CR**	**TTR**
MLS PwA Nouns	6.67	.73	MLS PwA Verbs	8.53	.86	.270	.875
MLS HCs Nouns	13.27	.73	MLS HCs Verbs	12.93	1.00	.670	.001*
BLS PwA Nouns	10.00	.79	BLS PwA Verbs	12.45	.77	.082	.541
BLS HCs Nouns	15.82	.82	BLS HCs Verbs	11.82	.96	.051	.005*
BLE PwA Nouns	9.00	.57	BLE PwA Verbs	5.73	.78	.042	.013
BLE HCs Nouns	18.00	.54	BLE HCs Verbs	13.36	.83	.019	.005*

Note: $*p \leq 0.008$; $**p \leq 0.001$

SECTION II

15.3 Analysis of SP data

15.3.1 Descriptive Statistics

Individual CRn, CRv, TTRn and TTRv scores for participants in the ML and BL PwA and HC groups for the SP task are provided in appendix 15.3.

Tables 15.25 and 15.26 present the descriptive statistics across the test groups for CR scores and TTR scores for nouns and verbs separately.

Table 15.25: Descriptive statistics for HCs in SP task

		Noun Scores			Verb Scores		
		MLS Controls (n=15)	**BLS Controls** (n=11)	**BLE Controls** (n=11)	**MLS Controls** (n=15)	**BLS Controls** (n=11)	**BLE Controls** (n=11)
Correctly recalled score	Mean	10.93	12.36	14.18	7.27	9.00	7.73
	Std. Dev.	4.37	4.23	6.21	3.71	3.66	2.61
	Minimum	5	6	7	4	6	5
	Maximum	23	18	28	15	18	14
Type-token Ration (TTR)	Mean	0.90	0.88	0.87	0.95	0.93	0.85
	Std. Dev.	0.12	0.09	0.11	0.09	0.10	0.14
	Minimum	0.58	0.75	0.71	0.71	0.71	0.62
	Maximum	1.00	1.00	1.00	1.00	1.00	1.00

Table 15.26: Descriptive statistics for PwA in SP task

		Noun Scores			Verbs Scores		
		MLS PwA (n=15)	**BLS PwA** (n=11)	**BLE PwA** (n=11)	**MLS PwA** (n=15)	**BLS PwA** (n=11)	**BLE PwA** (n=11)
Correctly recalled score	Mean	9.13	8.64	9.09	5.87	5.82	5.00
	Std. Dev.	3.58	3.67	3.73	3.14	3.66	3.95
	Minimum	4	3	4	1	0	1
	Maximum	18	16	18	14	12	13
Type-token Ration (TTR)	Mean	0.76	0.77	0.64	0.78	0.88	0.80
	Std. Dev.	0.20	0.17	0.16	0.15	0.14	0.21
	Minimum	0.41	0.50	0.38	0.47	0.67	0.40
	Maximum	1.00	1.00	0.91	1.00	1.00	1.00

Figures 15.17 and 15.18 present the mean scores across the language conditions in the PwA and HC groups for correctly recalled nouns (CRn) and verbs (CRv) (error bars; +/- 2SD) and type token ration for nouns (TTRn) and verbs (TTRv) scores (error bars; +/- 2SD) respectively, in the SP task.

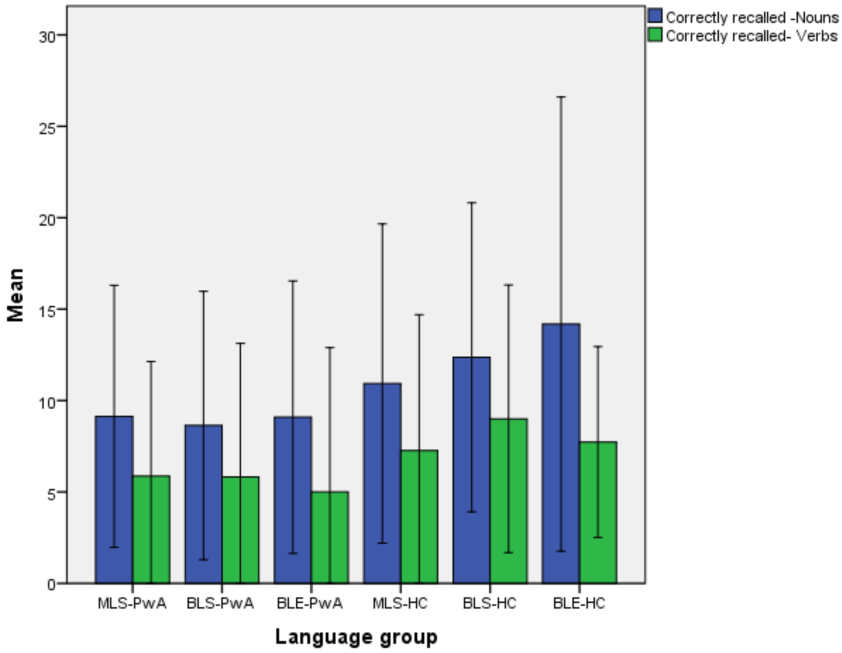

Figure 15.17: Bar charts depicting correctly recalled nouns (CRn) and verbs (CRv) scores across the language conditions in the PwA and HC groups for the SP task

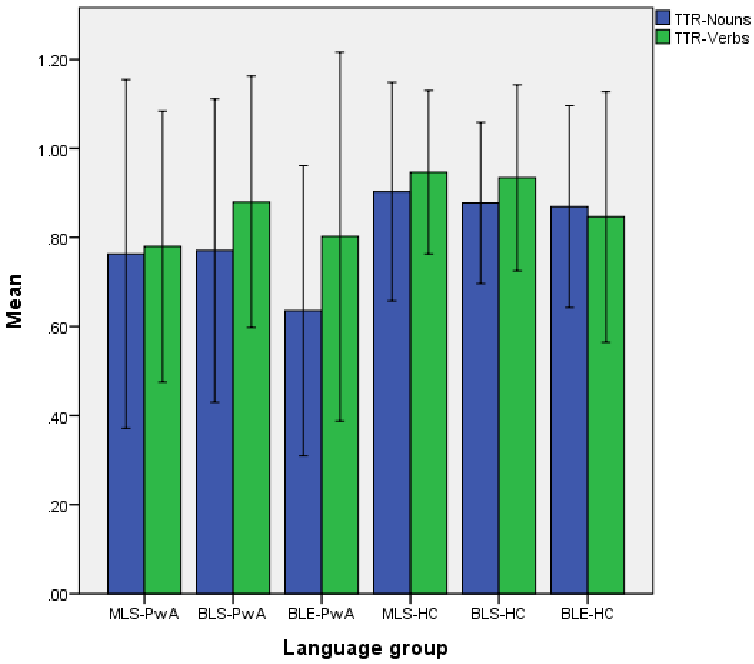

Figure 15.18: Bar charts representing Type token Ratio for nouns (TTRn) and verbs (TTRv) scores across the language conditions in the PwA and HC groups for the SP task

15.3.2 Tests for normality and homogeneity of variance

Prior to analysis, Shapiro-Wilk test for normality and homogeneity of variance was performed on all data sets for all four measurements. Findings are presented in tables 15.27 and 15.28 for all groups across each measurement.

Table 15.27: Shapiro-Wilk findings for Correctly Recalled (CR) scores in the SP task

		Noun			**Verb**		
	n	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
MLS- PwA	15	.936	15	.332	.928	15	.251
BLS- PwA	11	.949	11	.628	.911	11	.251
BLE-PwA	11	.885	11	.122	.872	11	.083
MLS-HC	15	.881	15	.050	**.806**	**15**	**.004****
BLS-HC	11	.924	11	.351	**.803**	**11**	**.010***
BLE-HC	11	.917	11	.294	.877	11	.095

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 15.28: Shapiro-Wilk findings for Type Token Ratio (TTR) scores in the SP task

		Noun			**Verb**		
	n	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
MLS- PwA	15	.914	15	.155	.948	15	.497
BLS- PwA	11	.880	11	.104	**.788**	**11**	**.007****
BLE-PwA	11	.934	11	.449	.885	11	.119
MLS-HCs	15	**.790**	**15**	**.003****	**.663**	**15**	**.000*****
BLS-HCs	11	.901	11	.191	**.698**	**11**	**.000*****
BLE-HCs	11	**.855**	**11**	**.049***	.888	11	.131

Note: *p≤0.05; **p≤0.01; ***p≤0.001

The Q-Q plots depicting the distribution of nouns and verbs for the SP task in Sinhala and English across the BL and ML PwA and HC groups are provided in Appendix 15.4

15.3.3 Selection of statistical tests

As in the PS task, analyses here are based on the correctly recalled (CR) scores and Type Token Ratio (TTR) for nouns and verbs.

Individual raw scores were used throughout this analyses.

Since planned comparisons for CR and TTR involved at least one non-parametric data set, the non-parametric tests, Mann Whitney U and Wilcoxon sign rank test for matched pairs were used for analysing across independent groups and for repeated measures, respectively.

As in the PS task, the Bonferroni correction was applied according to the comparisons made in each section. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In the following sections 15.3.4 through 15.3.9 statistical significance has been reported for pairwise analyses.

15.3.4. Analysis of CR data for nouns

This section involves analyses based on CR scores for nouns across the MLS, BLS and BLE language conditions.

15.3.4.1 Between group comparisons in Sinhala

Figure 15.19 below shows the distribution of CR scores for nouns in Sinhala for the BLS and MLS, PwA and control groups. The graph represents the median, minimum–maximum scores and the interquartile range for the monolingual and bilingual PwA and control groups, separately.

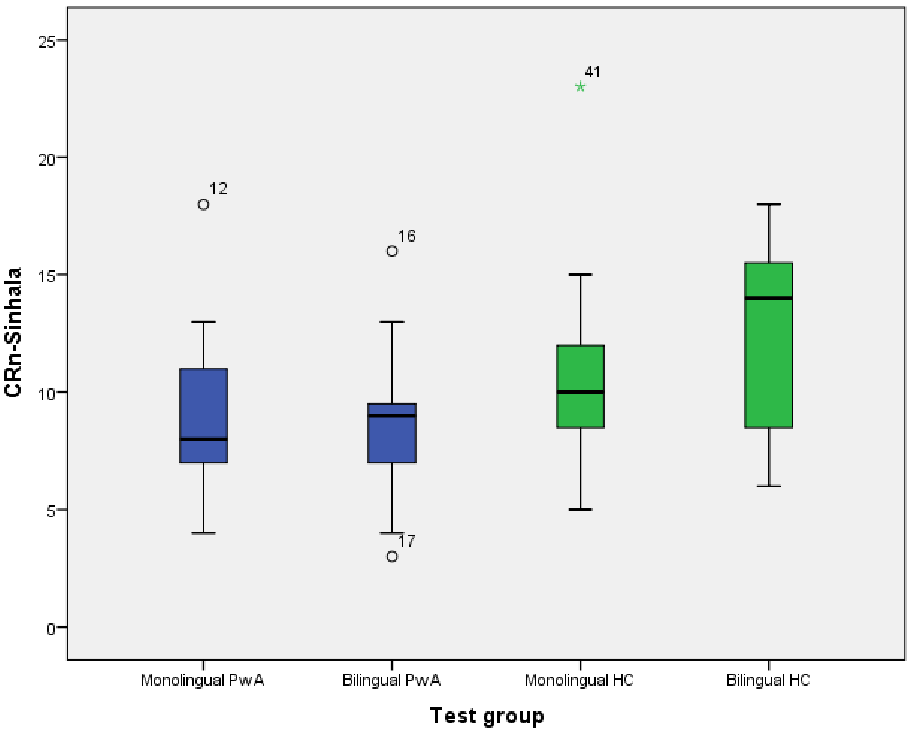

Figure 15.19: Box plot depicting CRn scores in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.3.4.1 above revealed no difference in the CR scores for nouns in Sinhala between ML and BL PWA or between ML and BL HC groups. Data are shown in table 15.29.

Table 15.29: Comparisons in ML and BL CR scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	8.00	BLS PwA	9.00	77.50	-.05	.794
MLS HC	10.00	BLS HC	14.00	63.50	-.19	.330

Note: *p≤0.025; **p≤0.001

15.3.4.2 Within group comparisons between the languages

Figure 15.20 below shows the median, minimum –maximum scores and the interquartile range of the CRn scores in English and Sinhala for the bilingual PwA and HC groups.

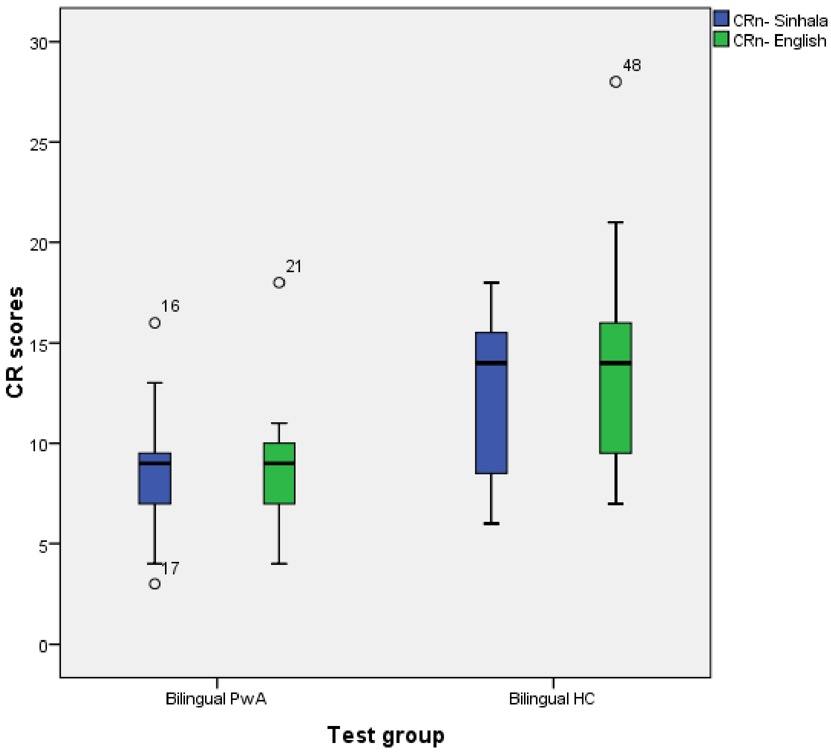

Figure 15.20: Box plot depicting CRn scores in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.3.4.2 above revealed no difference between Sinhala and English CRn scores in the BL PwA and HC groups.

Data are shown in table 15.30.

Table 15.30: Comparisons in BL Sinhala and English CRn scores

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	9.00	BLE PwA	9.00	-.297	.766
BLS HCs	14.00	BLE HCs	14.00	-.352	.725

Note: *p≤0.025; **p≤0.001

15.3.4.3 Comparisons between PwAs and HCs

Findings here showed that the CRn scores for HCs were higher than their corresponding PwAs. The difference was not significant in any language condition.

Data are shown in table 15.31.

Table 15.31: Comparisons between the Sinhala and English CRn scores for the BL groups

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	8.00	MLS HCs	10.00	83.00	-.22	.233
BLS PwA	9.00	BLS HCs	14.00	33.50	-.38	.076
BLE PwA	9.00	BLE HCs	14.00	30.00	-.43	.470

Note: *$p \leq 0.017$; **$p \leq 0.001$

15.3.5 Analysis of CR data for verbs

Analyses here involved the CRv scores across the MLS, BLS, BLE language conditions.

15.3.5.1 Between group comparisons in Sinhala

Figure 15.21 below shows the median, minimum –maximum scores and the interquartile range of the CR scores for verbs in Sinhala for the ML and BL PwA and control groups.

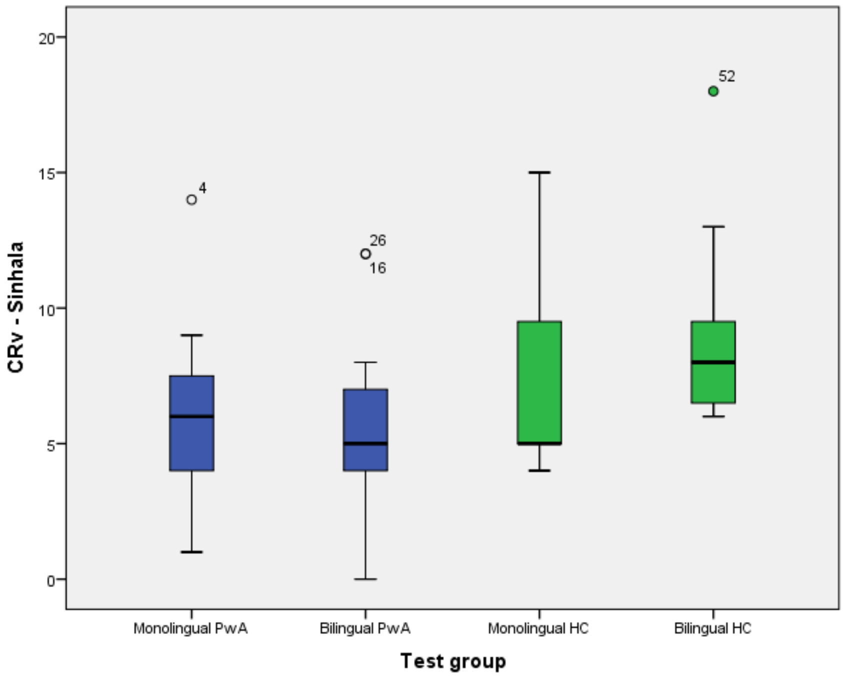

Figure 15.21: Box plot depicting CRv scores in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.3.5.1 above revealed no difference in the CR scores for verbs in Sinhala between ML and BL PWA or between ML and BL HC groups.

Data are shown in table 15.32.

Table 15.32: Comparisons in ML and BL CRv scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	6.00	BLS PwA	5.00	79.00	-.04	.854
MLS HCs	5.00	BLS HCs	8.00	49.00	-.34	.080

Note: *p≤0.025; **p≤0.001

15.3.5.2 Within group comparisons between the languages

Figure 15.22 below shows the median, minimum–maximum scores and the interquartile range of the CR scores for verbs in Sinhala and English for BL control and PwA groups.

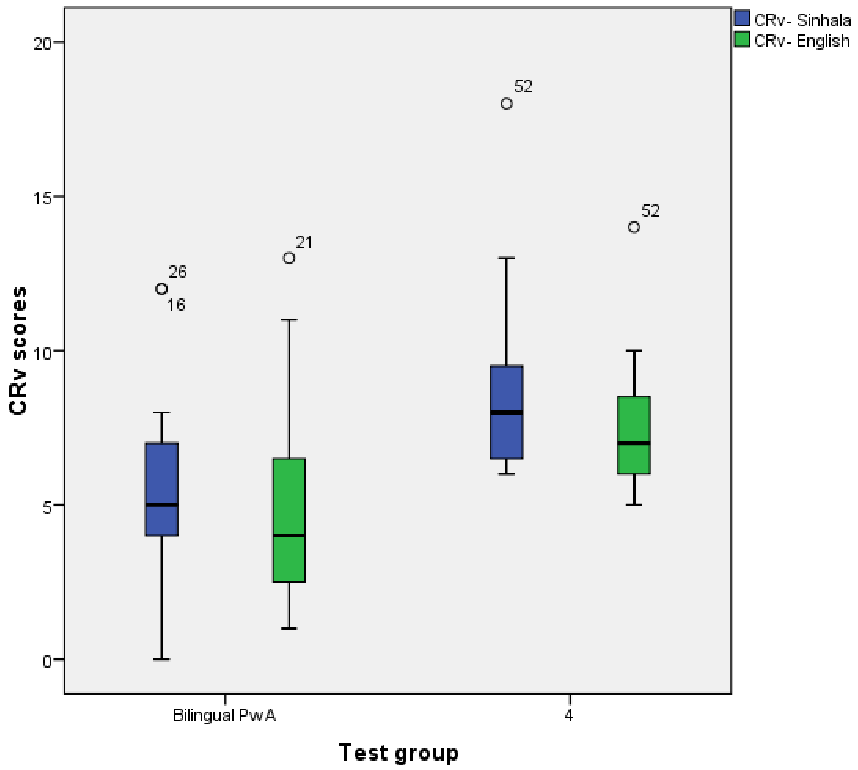

Figure 15.22: Box plot depicting CRv scores in English and Sinhala in the BL PwA and HC groups

The analyses in section 15.3.5.2 above revealed no difference between Sinhala and English CRn scores in the BL PwA and HC groups. Data are shown in table 15.33.

Table 15.33: Comparisons in BL Sinhala and English CRv scores

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	5.00	BLE PwA	4.00	-.772	.440
BLS HCs	8.00	BLE HCs	7.00	-1.61	.107

Note: *p≤0.025; **p≤0.001

15.3.5.3 Comparisons between PwAs and HCs

Here, CRv scores of the MLS HC group was lower than the PwA group. The difference across the PwA and HC groups was not significant across any language condition.

Data are shown in table 15.34.

Table 15.34: Comparisons in PwA-HC CRv scores across language conditions

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	6.00	MLS HCs	5.00	90.50	-.17	.367
BLS PwA	5.00	BLS HCs	8.00	26.50	-.48	.023
BLE PwA	5.00	BLE HCs	7.00	28.00	-.46	.034

Note: *p≤0.017; **p≤0.001

15.3.6 Within group comparisons of CR scores for nouns and verbs

This section involves pairwise analyses across the CR noun and verb scores, separately for each language condition in the SP task.

15.3.6.1 CR scores in Sinhala for MLS PwAs and HCs

Figure 15.23 below shows the median, minimum –maximum scores and the interquartile range of the noun and verb CR scores in Sinhala for the ML control and PwA groups.

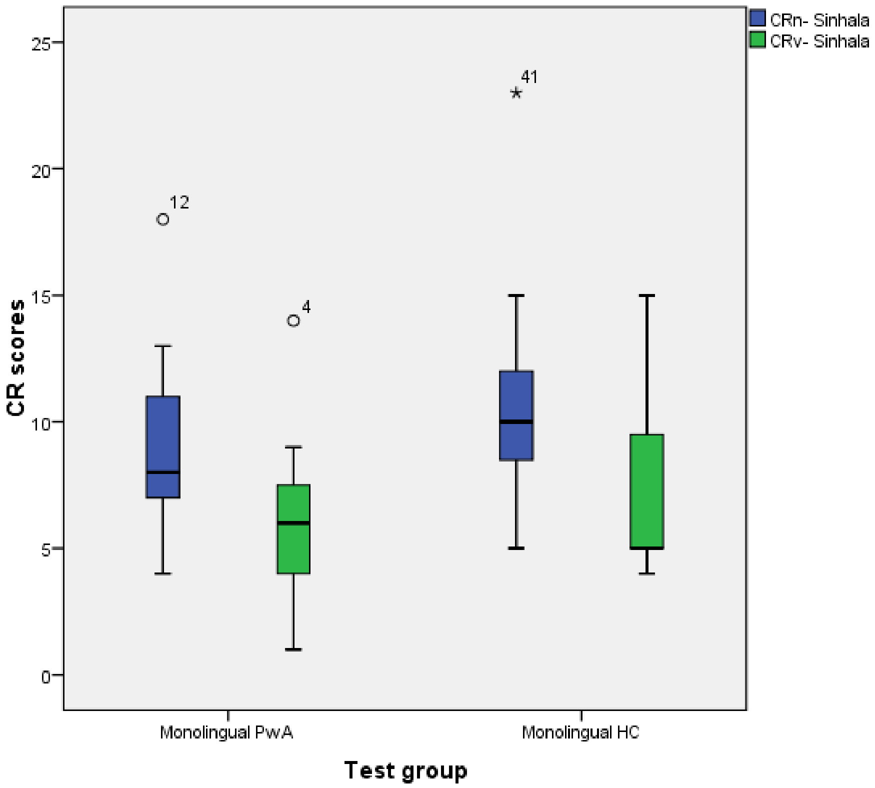

Figure 15.23: Box plot depicting CRn and CRv scores in Sinhala in the MLS PwA and HC groups

The analyses in section 15.3.6.1 above showed significantly higher CRn scores than CRv scores in both PwA and HC groups. Data are shown in table 15.35.

Table 15.35: Comparisons in MLS CRn and CRv scores

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
MLS PwA - CRn	8.00	MLS PwA -CRv	6.00	-3.022	.003*
MLS HCs- CRn	10.00	MLS HCs - CRv	5.00	-3.115	.002*

Note: *p≤0.008; **p≤0.001

15.3.6.2 CR scores in Sinhala for BLS PwAs and HCs

Figure 15.24 below shows the median, minimum–maximum scores and the interquartile range of noun and verb CR scores in Sinhala for the BL control and PwA groups.

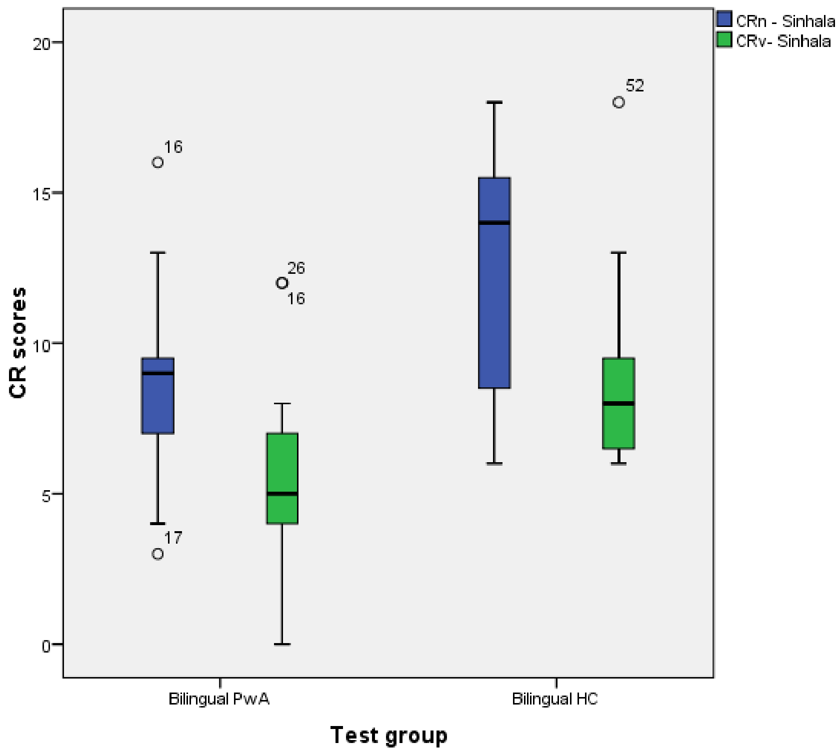

Figure 15.24: Box plot depicting CRn and CRv scores in Sinhala in BLS PwA and HC groups

The analyses in section 15.3.6.2 above showed higher CRn scores in both BLS PwA and HC groups. The CRn- CRv scores were statistically significantly different in only the HC group. Data are shown in table 15.36.

Table 15.36: Comparisons between the Sinhala CRn and CRv scores for the BLS groups

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA - CRn	9.00	BLS PwA -CRv	5.00	-2.088	.037
BLS HCs- CRn	14.00	BLS HCs - CRv	8.00	-2.677	.007*

Note: *p≤0.008; **p≤0.001

15.3.6.3 CR scores in English for BLE PwAs and HCs

Figure 15.25 below shows the median, minimum–maximum scores and the interquartile range of CR scores for nouns and verbs in English for the BL PwA and control groups.

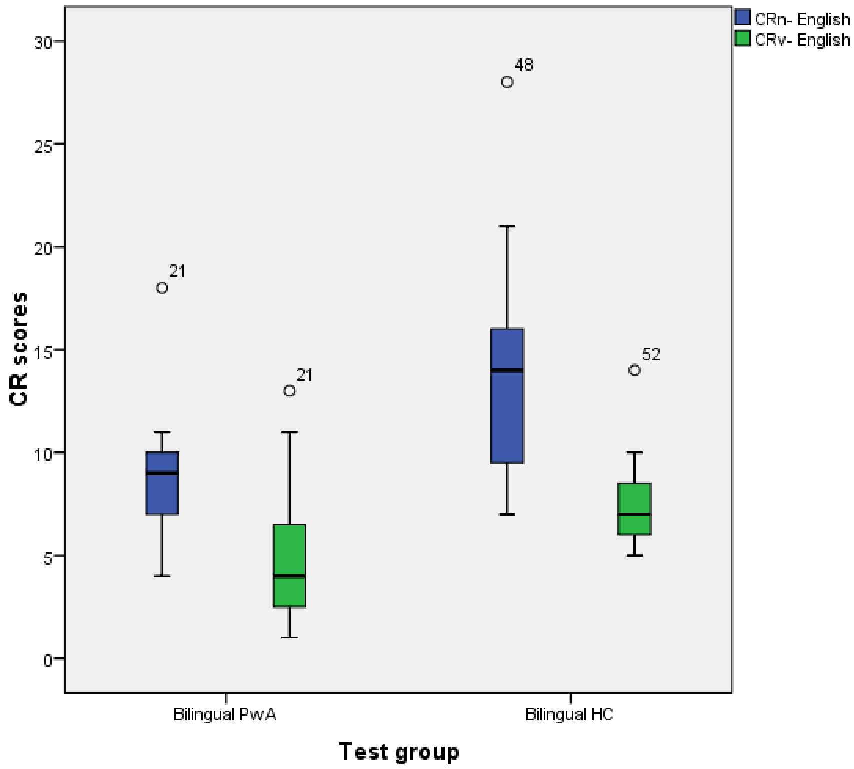

Figure 15.25: Box plot depicting CR scores for nouns and verbs in English for the BL PwA and control groups

The analyses in section 15.3.6.3 above revealed higher CRn scores than CRv scores in both BLE PwA and HC groups. The difference was statistically significant only in the HC group at p≤0.008 significance level.

Data are shown in table 15.37.

Table 15.37: Comparisons between the English CRn and CRv scores for the BLE group

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLE PwA - CRn	9.00	BLE PwA -CRv	4.00	-2.596	.009
BLE HCs- CRn	14.00	BLE HCs - CRv	7.00	-2.805	.005*

Note: *p≤0.008; **p≤0.001

15.3.7. Analysis of TTR data for nouns

This section involves analyses based on TTR scores for nouns across the MLS, BLS and BLE language conditions.

15.3.7.1 Between group comparisons in Sinhala

Figure 15.26 below shows the distribution of TTR scores for nouns in Sinhala for the ML and BL, PwA and control groups. The graph represents the median, minimum–maximum scores and the interquartile range for the ML and BL PwA and control groups, separately.

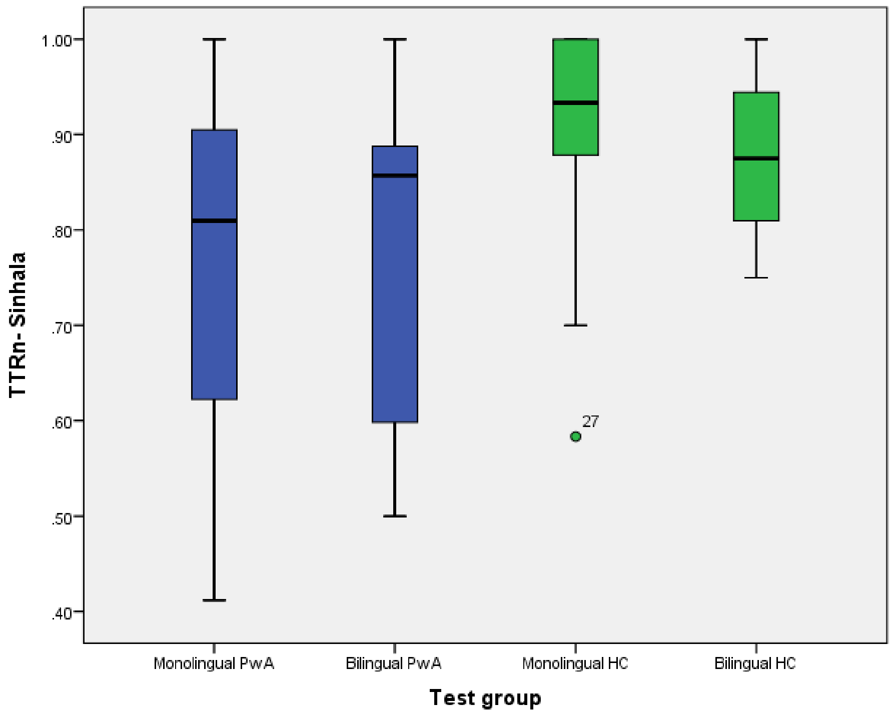

Figure 15.26: Box plot depicting TTRn scores in Sinhala in MLS and BLS PwA and HC groups

The analyses in section 15.3.7.1 above revealed no difference in the TTRn scores in Sinhala between MLS and BLS PwA or between MLS and BLS HC groups.

Data are shown in table 15.38.

Table 15.38: Comparisons in MLS and BLS TTRn scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.81	BLS PwA	.86	79.00	-.04	.855
MLS HC	.93	BLS HC	.88	60. 50	-.23	.243

Note: *p≤0.025; **p≤0.001

15.3.7.2 Within group comparisons between the languages

Figure 15.27 below shows the median, minimum –maximum scores and the interquartile range of the TTR scores for nouns in English and Sinhala for the bilingual PwA and control groups.

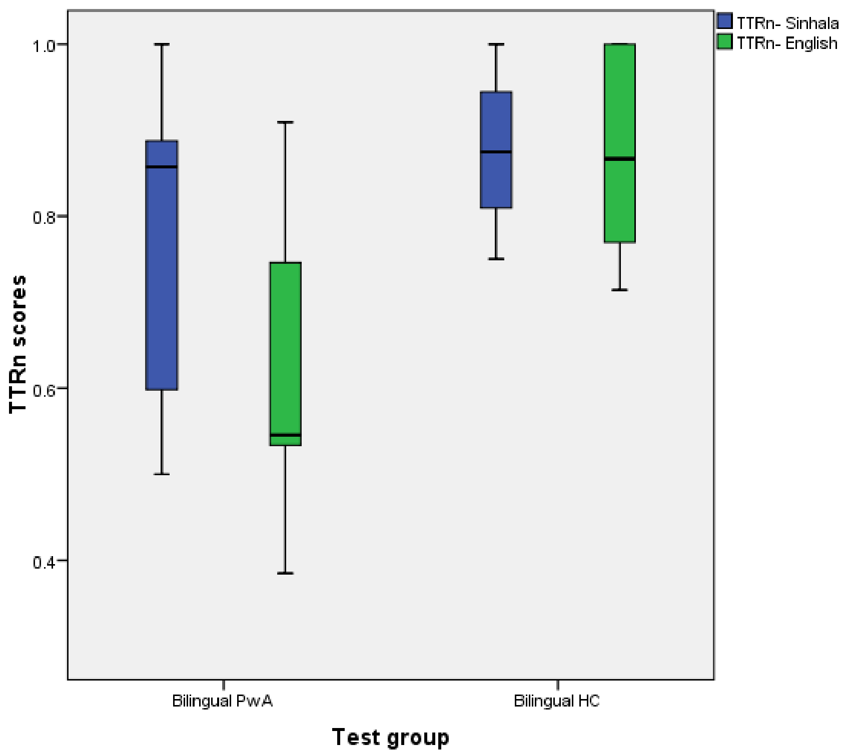

Figure 15.27: Box plot depicting TTRn scores in English and Sinhala in BL PwA and HC groups

The analyses in section 15.3.7.2 above revealed no difference between Sinhala and English TTRn scores in the BL PwA and HC groups. Data are shown in table 15.39.

Table 15.39: Comparisons in BL TTRv scores in Sinhala and English

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	.86	BLE PwA	.55	-1.60	.110
BLS HCs	.88	BLE HCs	.87	-.296	.767

Note: *p≤0.025; **p≤0.001

15.3.7.3 Comparisons between PwAs and HCs

As expected, HC had higher TTRn scores than PwAs. This difference was not significant in the MLS and BLS language conditions but significant in the BLE language condition.

Data are shown in table 15.40.

Table 15.40: Comparisons in PwA-HC TTRn scores across language conditions

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.81	MLS HCs	.93	59.00	-.41	.260
BLS PwA	.86	BLS HCs	.88	43.00	-.25	.270
BLE PwA	.55	BLE HCs	.87	16.50	-.62	.002*

Note: *p≤0.017; **p≤0.001

15.3.8 Analysis of TTR data for verbs

This section involves analyses based on TTR scores for verbs across the MLS, BLS and BLE language conditions.

15.3.8.1 Between the group comparisons in Sinhala

Figure 15.28 below shows the median, minimum –maximum scores and the interquartile range of the TTR scores for verbs in Sinhala for the ML and BL PwA and control groups.

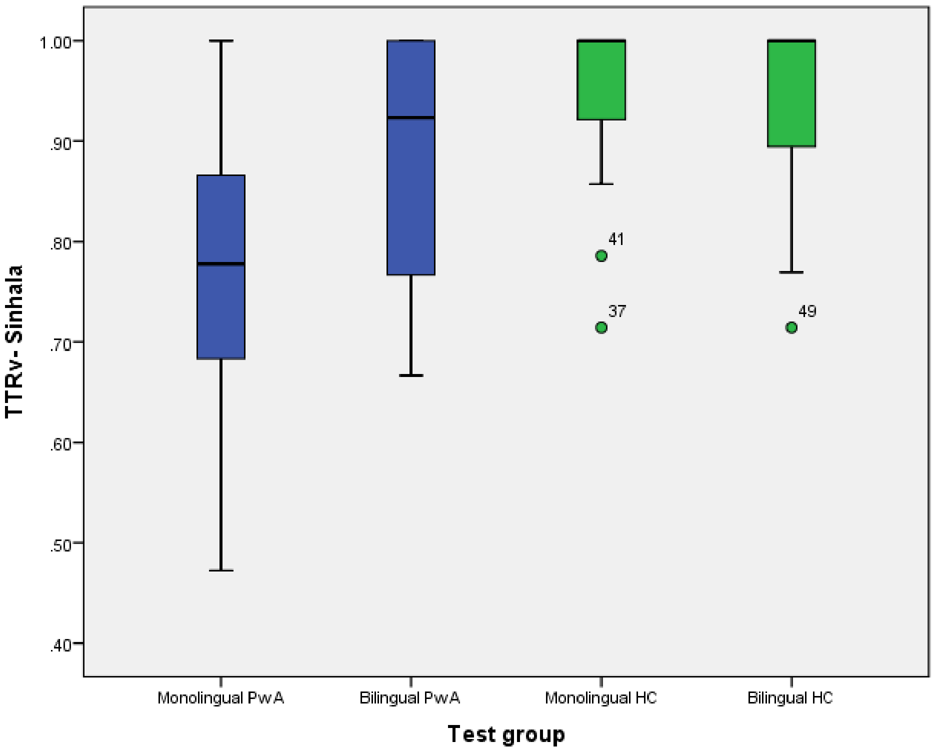

Figure 15.28: Box plot depicting TTRv scores in Sinhala in the MLS and BLS PwA and HC groups

The analyses in section 15.3.8.1 above revealed no difference in the Sinhala TTRv scores between MLS and BLS PwA or between MLS and BLS HC groups.

Data are shown in table 15.41.

Table 15.41: Comparisons in ML and BL TTRv scores in Sinhala

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.78	BLS PwA	.92	53.5	-.30	.126
MLS HC	1.00	BLS HC	1.00	77.50	-.06	.760

Note: *p≤0.025; **p≤0.001

15.3.8.2 Within group comparisons between the languages

Figure 15.29 below shows the median, minimum–maximum scores and the interquartile range of the TTR scores for verbs in Sinhala and English for BL control and PwA groups.

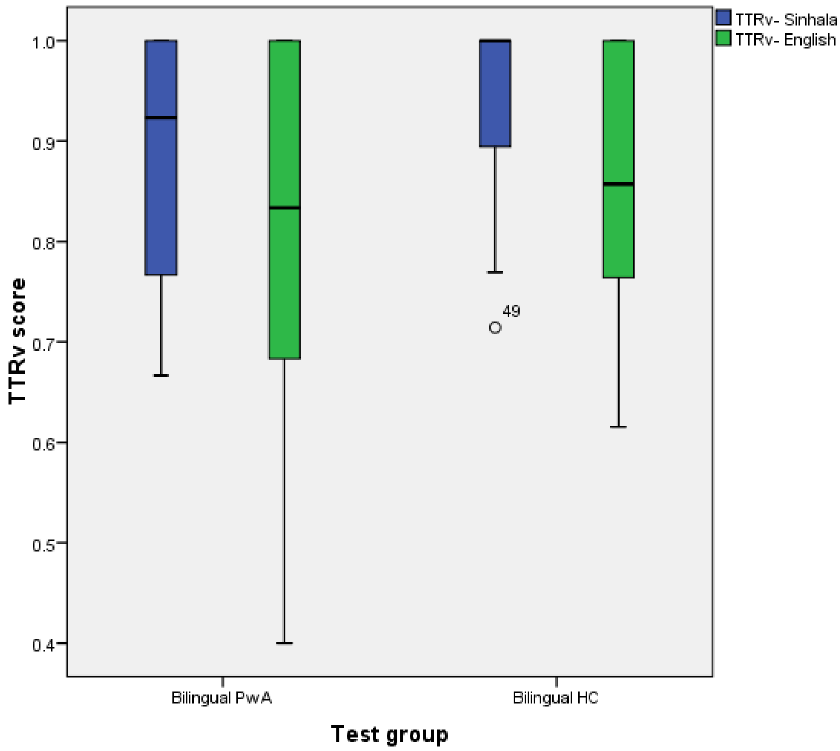

Figure 15.29: Box plot indicating TTRv scores in English and Sinhala in BL PwA and HC groups

The analyses in section 15.3.8.2 above revealed no difference between Sinhala and English TTRv scores in both the BL PwA and HC groups.

Data are shown in table 15.42.

Table 15.42: Comparisons between the Sinhala and English TTRv scores for the BL groups

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA	.92	BLE PwA	.83	-.712	.476
BLS HCs	1.00	BLE HCs	.86	-2.197	.028

Note: $*p \leq 0.025$; $**p \leq 0.001$

15.3.8.3 Comparisons between PwAs and HCs

As expected, HCs had higher TTRv scores than for PwAs in all three language conditions. The difference was significant only in the MLS language condition.

Data are shown in table 15.43.

Table 15.43: Comparisons between the PwA- HCs for TTRv across the groups

Condition 1	Med	Condition 2	Med	Statistic		Sig. at <0.008
				U value	r	
MLS PwA	.78	MLS HCs	1.00	41.00	-.57	.002*
BLS PwA	.92	BLS HCs	1.00	46.00	-.22	.365
BLE PwA	.83	BLE HCs	.85	55.00	-.08	.748

Note: *p≤0.017; **p≤0.001

15.3.9 Within group comparisons of TTR scores across nouns and verbs

This section involves pairwise analyses across the TTR noun and verb scores, separately for each language condition in the SP task.

15.3.9.1 TTR scores in Sinhala for MLS PwAs and HCs

Figure 15.30 below shows the median, minimum –maximum scores and the interquartile range of the noun and verb TTR scores in Sinhala for the ML control and PwA groups.

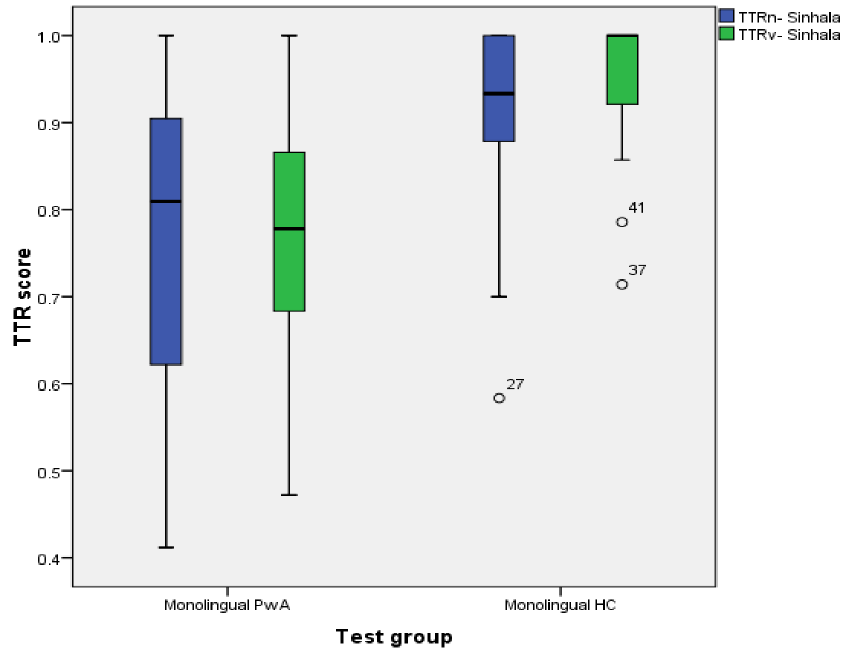

Figure 15.30: Box plot depicting TTRn & TTRv scores in Sinhala in MLS PwA and HC groups

The analyses in section 15.3.9.1 above revealed no significant difference between TTRn and TTRv scores in the MLS PwA and HC group.

Data are shown in table 15.44.

Table 15.44: Comparisons between the Sinhala TTRn and TTRv scores for the MLS group

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
MLS PwA - TTRn	.81	MLS PwA -TTRv	.78	-.706	.480
MLS HCs- TTRn	.93	MLS HCs - TTRv	1.00	-1.304	.192

Note: *p≤0.008; **p≤0.001

15.3.9.2 TTR scores in Sinhala for BLS PwAs and HCs

Figure 15.31 below shows the median, minimum–maximum scores and the interquartile range of noun and verb TTR scores in Sinhala for the BL control and PwA groups.

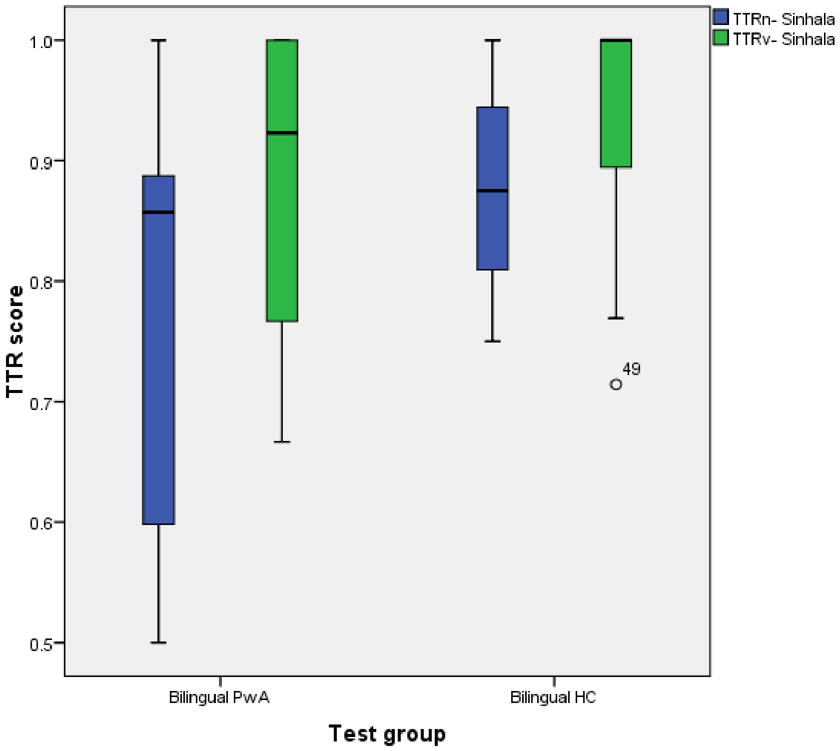

Figure 15.31: Box plot depicting TTRn & TTRv scores in Sinhala in BLS PwA and HC groups

The analyses in section 15.3.9.2 above revealed no significant difference between the Sinhala TTRn and TTRv scores in the BLS PwA and HC groups.

Data are shown in table 15.45

Table 15.45: Comparisons between the Sinhala TTRn and TTRv scores for BL groups

Condition 1	Med	Condition 2	Med	Z Statistic	Significance at <0.008
BLS PwA -TTRn	.86	BLS PwA -TTRv	.92	-1.246	.213
BLS HCs -TTRn	.88	BLS HCs -TTRv	1.00	-1.18	.237

Note: $*p \leq 0.008$; $**p \leq 0.001$

15.3.9.3 TTR scores in English for BLE PwAs and HCs

Figure 15.32 below shows the median, minimum–maximum scores and the interquartile range of TTR scores for nouns and verbs in English for the BL PwA and control groups.

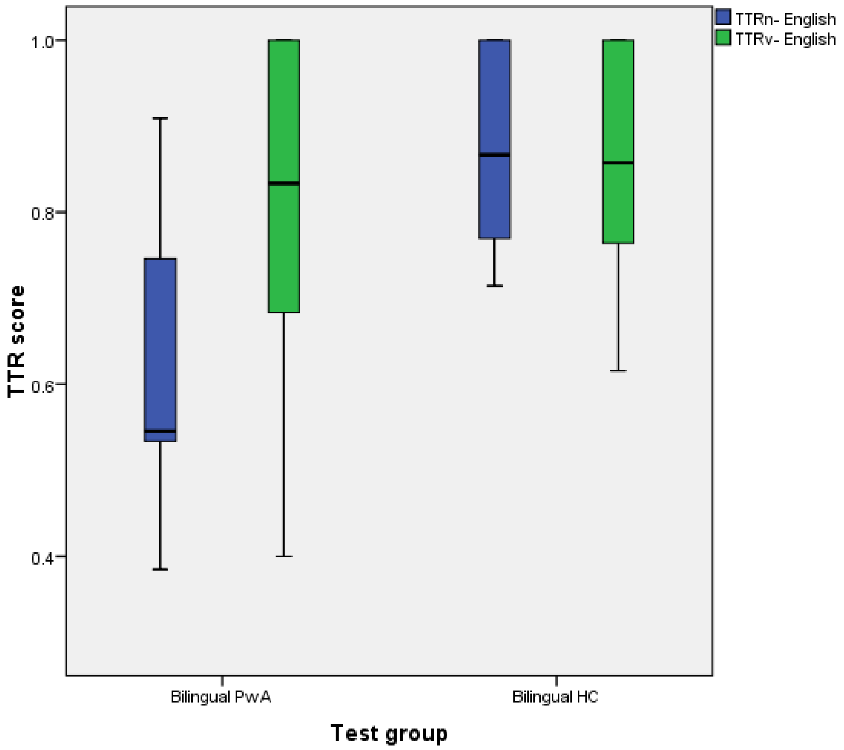

Figure 15.32: Box plot depicting TTRn and TTRv scores in English for the BLE PwA and HC groups

Analyses in section 15.3.9.3 above revealed no significant difference between the Sinhala TTRn and TTRv scores in the BLE PwA and HC groups. Data are shown in table 15.46

Table 15.46: Comparisons between the English TTRn and TTRv scores for the BL group

Condition 1	Med	Condition 2	Med	Z Statistic	Sig. at <0.008
BLE PwA -TTRn	.55	BLE PwA -TTRv	.83	-1.244	.214
BLE HCs -TTRn	.87	BLE HCs -TTRv	.86	-1.246	.213

Note: $*p \leq 0.008$; $**p \leq 0.001$

15.3.10 Summary for the SP task

Section II of this chapter presents findings for the accuracy data for the SP task. All comparisons and measurements were similar to the PS task and addressed the same pre-determined questions outlined in section 15.0. The following sections summarize findings for the same.

15.3.10.1 Comparisons in Sinhala across ML and BL

When medians were compared BLS CR scores were higher in both PwA and HC groups for nouns and only in the HC group for verb scores.

In the PwA groups, TTR scores were higher in the BLS language condition. In HCs, TTR was higher for the MLS language condition only for nouns. Findings were not significant in any of the above.

Findings are summarized in table 15.47

Table 15.47: Summary: Comparison of ML and BL CR and TTR scores in Sinhala

Condition 1	**Med.**		**Condition 2**	**Med.**		**Significance level**	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
MLS PwA	8.00	.81	BLS PwA	9.00	.86	.794	.855
MLS HCs	10.00	.93	BLS HCs	14.00	.88	.323	.243
Verb scores							
MLS PwA	6.00	.78	BLS PwA	5.00	.92	.854	.126
MLS HCs	5.00	1.00	BLS HCs	8.00	1.00	.080	.960

Note: *p<0.025; **p<0.001

15.3.10.2 Comparisons in BL Sinhala versus English scores

CR scores in English and Sinhala for nouns did not differ in both the PwA and HC groups. TTR scores in Sinhala (BLS) was higher than English in both PwA and HC groups. The difference was significant only in the BL HC group for TTR verb scores.

Findings are summarized in table 15.48.

Table 15.48: Summary: Comparison across BL Sinhala and English CR and TTR scores

Condition 1	Med.		Condition 2	Med.		Significance level	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
BLS PwA	9.00	.86	BLE PwA	9.00	.55	.766	.110
BLS HC	14.00	.88	BLE HC	14.00	.87	.725	.767
Verb scores							
BLS PwA	5.00	.92	BLE PwA	4.00	.83	.440	.476
BLS HC	8.00	1.00	BLE HC	7.00	.86	.107	.028*

Note: *p≤0.025; **p≤0.001

15.3.10.3 Comparisons between PwAs and HCs

In all of the above comparisons in section 15.3.10.3, higher medians were reported for HCs as expected, although the difference was significant only in the BLE PwA-HC for comparison noun scores and MLS PwA-HC comparison for verb scores.

Findings are summarized in table 15.49

Table 15.49: Summary: Comparison of PwA-HC groups for CR and TTR

Condition 1	Med.		Condition 2	Med.		Significance level	
	CR	TTR		CR	TTR	**CR**	**TTR**
Noun scores							
MLS PwA	8.00	.81	MLS HCs	10.00	.93	.233	.026
BLS PwA	9.00	.86	BLS HCs	14.00	.88	.076	.270
BLE PwA	9.00	.55	BLE HCs	14.00	.87	.470	.002*
Verb scores							
MLS PwA	6.00	.78	MLS HCs	5.00	1.00	.367	.002*
BLS PwA	5.00	.92	BLS HCs	8.00	1.00	.023	.365
BLE PwA	5.00	.83	BLE HCs	7.00	.85	.034	.748

Note: *p≤0.017; **p≤0.001

15.3.10.4 Comparisons across objects and actions

Analyses here showed that the CR scores were higher for nouns than verbs in all language conditions. The difference was statistically significant in all comparisons except in the BLE PwA group comparison for nouns.

The TTR scores however, were higher for verb scores in all comparisons within language conditions except in the MLS PwA group. The difference was not statistically significant for any pairwise comparison.

Findings are summarized in table 15.50

Table 15.50: Summary: Comparison between nouns and verbs within language conditions

Pair 1	**Med.**		**Pair 2**	**Med.**		**Significance level**	
	CR	TTR		CR	TTR	**CR**	**TTR**
MLS PwA Nouns	8.00	.81	MLS PwA Verbs	6.00	.78	.003*	.480
MLS HC Nouns	10.00	.93	MLS HC Verbs	5.00	1.00	.002*	.192
BLS PwA Nouns	9.00	.86	BLS PwA Verbs	5.00	.92	.037*	.213
BLS HC Nouns	14.00	.88	BLS HC Verbs	8.00	1.00	.007*	.237
BLE PwA Nouns	9.00	.55	BLE PwA Verbs	4.00	.83	.009	.214
BLE HC Nouns	14.00	.89	BLE HC Verbs	7.00	.86	.005*	.213

Note: *p≤0.008; **p≤0.001

Chapter 16: Error analysis in connected speech tasks

16.0 Overview

This chapter presents the analyses carried out on participant errors in the two connected speech tasks picture sequence narration (PS) and single picture description (SP). As in naming, the aim was to identify whether response types differed between language conditions, across the groups and between the word classes in each task. Responses in both the target and non-target languages were included in this analysis. The coding system used to identify errors in connected speech was the same as given in table 12.5. Erroneous responses were categorized similar to that of naming and was previously detailed in section 14.0.

Analyses here addressed the same questions outlined in section 13.0 (and in chapters 14 and 15) and involved the same pairwise comparisons for comparing response types, separately for the PS and SP connected speech tasks.

Similar to chapter 14 questions (i) through (iii) above involved separate analyses for noun and verb response types. The PwA-HC comparisons for question (i) have been included in question (iii). Question (iv) involved a comparison between the noun and verb response types.

16.1 The PS task

16.1.1 Descriptive statistics

Tables 16.1 and 16.2 present descriptive statistics for response types in TL and NTL for nouns and verbs respectively, across the MLS, BLS and BLE language conditions in the PwA group.

Tables 16.3 and 16.4 present descriptive statistics for response types in TL and NTL for nouns and verbs respectively, across the MLS, BLS and BLE language conditions in the HC group.

Table 16.1: Descriptive statistics for response types for nouns in the PS task for PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	7.00	-	2.53	-	1.53	-	.20	-
	SD	4.96		3.09		2.07		.56	
	Min-Max	0-16		0-12		0-7		0-2	
BLS	Mean	10.00	1.64	1.82	.09	.91	-	.82	-
	SD	4.20	1.86	1.47	.302	1.22		1.66	
	Min-Max	5-15	0-5	0-4	0-1	0-3		0-5	
BLE	Mean	9.00	.27	2.00	-	1.27	.09	.18	-
	SD	5.25	.647	2.61		2.05	.302	.41	
	Min-Max	3-20	0-2	0-8		0-7	0-1	0-1	

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

Table 16.2: Descriptive statistics for response types for verbs in the PS task for PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	8.53	-	8.47	-	1.00	-	.20	-
	SD	4.41		12.44		1.31		.56	
	Min-Max	3-17		0-41		0-4		0-2	
BLS	Mean	12.45	.27	1.91	-	.55	-	.09	-
	SD	6.47	.47	1.64		.934		.302	
	Min-Max	3-21	0-1	0-4		0-3		0-1	
BLE	Mean	6.00	.27	2.09	-	.64	-	-	-
	SD	2.37	.47	1.7		1.21			
	Min-Max	2-9	0-1	0-5		0-3			

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

Table 16.3: Descriptive statistics for response types for nouns in the PS task for HCs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	13.27	-	1.07	-	-	-	.07	-
	SD Min-Max	4.79 7-22		1.91 0-7				.26 0-1	
BLS	Mean	15.82	.09	.45	-	-	-	-	-
	SD Min-Max	6.11 8-27	.302 0-1	.688 2-5					
BLE	Mean	18.00	-	1.00	-	-	-	-	-
	SD Min-Max	5.31 11-28		2.19 0-7					

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

Table 16.4: Descriptive statistics for response types for verbs in the PS task for PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	12.93	-	.93	-	-	-	-	-
	SD Min-Max	5.11 7-25		1.28 0-4					
BLS	Mean	13.64	-	.45	-	-	-	-	-
	SD Min-Max	4.82 8-24		.522 0-1					
BLE	Mean	13.36	-	1.18	-	-	-	-	-
	SD Min-Max	2.77 9-18		2.44 0-7					

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

16.1.2 Selection of Statistical Tests

The aim was to identify if response types differed across the language conditions and between word classes (nouns vs. verbs) in the PS task. Data included were all correct or incorrect nouns and verbs elicited in TL or NTL for the MLS, BLS and BLE language conditions. Although the same BL participant group elicited both Sinhala and English data, in analyses data were considered from separate language conditions.

Chi-square tests of independence were used. Since all comparisons made here involved categorical data, raw scores were used to compute the contingency tables for the Chi Square analysis. Two-way statistical comparisons were made in order to allow comparisons across language conditions (BLS and MLS), languages in the BL group (BLS vs. BLE) and stimuli (noun vs. verb).

In order to do so, data were categorized in to a total of five categories. These were (i) accurate responses in TL, (ii) lexical errors (LE) in TL, (iii) non-lexical errors (NLE)[50] (iv) other errors (OE) in TL and (v) all responses in NTL. Responses in NTL were included as a single count and not differentiated in to further categories.

In some pairwise comparisons, where (the accuracy counts were high and error counts were low) the distribution of data did not satisfy test conditions for a chi square analysis and a comparison was not possible. For such cases in the first instance, data were further collapsed in to three categories; accurate responses in TL, error responses in TL (included a sum of LE, NLE and OE) and responses in NTL. A dagger symbol (†) has been used (in both text and summary tables) to indicate comparisons where data were further collapsed and analysed.

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[50] In the error analyses, NLEs that approximated the TL and NLEs of unknown language were categorized separately in the TL count while NLEs that clearly approximated the NTL were included in the NTL count.

In some cases, data even when collapsed did not assume chi square test conditions. Hence no statistical tests were performed on the data. Cases of this have been indicated (in both text and summary tables) with a double dagger symbol (††).

As in chapter 15, the Bonferroni correction was applied according to the comparisons made in each section. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In the following sections 16.1.3 through 16.1.4, statistical significance has been reported for pairwise analyses.

16.1.3 Response types for nouns

Responses across the language conditions were compared. The aim was to identify differences in response types within the language conditions for nouns. Tables 16.5 and 16.6 show the contingency tables prepared for Chi Square tests.

Table 16.5: Contingency table for the PwAs across language conditions for nouns

	Responses in TL (n)				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	105	38	23	0		169
BLS (n=11)	110	20	10	9	18	167
BLE (n=11)	99	22	14	2	4	141

Table 16.6: Contingency table for the HCs across language conditions for nouns

	Responses in TL (n)				**NTL**	**Total**
	AS	**LE**	**NLE**	**OE**		
MLS (n=15)	199	16	0	1	0	216
BLS (n=11)	174	5	0	0	0	179
BLE (n=11)	198	11	0	0	0	209

Chi Square tests of independence were performed on the above data.

16.1.3.1 Between group comparisons in Sinhala

Analyses in section 16.1.3.1 revealed a significant difference between the MLS and BLS PwA groups for response types in noun retrieval in the PS task. The difference was not significant between the MLS and BLS HC groups.

Data are shown in table 16.7.

Table 16.7: Comparisons between MLS and BLS response types for noun production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA	4	30.53	.000**
MLS HC	BLS HC	1	3.88	.049 †

Note: $*p \leq 0.025$; $**p \leq 0.001$

16.1.3.2 Within group comparisons, between the languages

Analyses in section 16.1.3.2 revealed a significant difference between the English and Sinhala response types in the PwA group but not in the HC group.

Data are shown in table 16.8.

Table 16.8: Comparisons in BLS-BLE response types for noun production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	4	12.60	.013*
BLS HCs	BLE HCs	1	.93	.335

Note: $*p \leq 0.025$; $**p \leq 0.001$

16.1.3.3 Comparisons between the PwA and HC groups

Analyses showed a significant difference in response types between the PwA and corresponding HC group in the MLS and BLS groups. A chi square analysis could not be performed for the BLE data.

Findings are shown in table 16.9.

Table 16.9: Comparisons in PwA- HC response types for noun production across language conditions

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	MLS HCs	3	57.14	.000**
BLS PwA	BLS HCs	2	58.35	.000**
BLE PwA	BLE HCs			††

Note: *p≤0.017; **p≤0.001

16.1.4 Response types for verbs

Responses across the language conditions were compared. The aim was to identify differences in response types across the language conditions for verbs.

Individual raw scores were used to compute the following contingency tables separately for the PwAs (table 16.10) and the healthy controls (table 16.11).

Table 16.10: Contingency table for the PwAs across language conditions for verbs.

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	128	127	15	3	0	273
BLS (n=11)	137	21	6	1	0	165
BLE (n=11)	66	23	7	0	0	96

Table 16.11: Contingency table for HCs across language conditions for verbs

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	194	14	0	0	0	208
BLS (n=11)	150	5	0	0	0	155
BLE (n=11)	147	13	1	0	0	161

Chi square tests were performed for between the group comparisons.

16.1.4.1 Between group comparisons in Sinhala

Analyses in section 16.1.4.1 revealed a significant difference between the response types for verbs in the MLS and BLS PwA comparisons but not in the HC comparison.

Data are shown in table 16.12.

Table 16.12: Comparisons in MLS and BLS response types for verb production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA	3	57.98	.000**
MLS HC	BLS HC	1	1.55	.213

Note: *p≤0.025; **p≤0.001

16.1.4.2 Within group comparisons between the languages

A chi square analysis revealed a significant difference between the English and Sinhala response types only in the PwA group.

Data are shown in table 16.13.

Table 16.13: Comparisons in BLS-BLE response types for verb production

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	1	6.36	.012 †
BLS HCs	BLE HCs	1	3.27	.071 †

Note: *p≤0.025; **p≤0.001

16.1.4.3 Comparisons between the PwA and HC groups

The difference in response types between the PwA and corresponding HC group in all three-language conditions were statistically highly significant.

Data are shown in table 16.14.

Table 16.14: Comparisons in PwA-HC response types for verb production across the language conditions

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	MLS HCs	3	115.41	.000**
BLS PwA	BLS HCs	1	14.87	.000** †
BLE PwA	BLE HCs	2	23.12	.000**

Note: *p≤0.017; **p≤0.001

16.1.5 Within group comparisons in naming nouns and verbs

Comparisons were made across the accuracy scores, error scores and language switches within each group and for BL across the language conditions.

16.1.5.1 Comparisons in Sinhala for MLS PwAs and HCs.

The analyses in section 16.1.5.1 revealed a statistically highly significant difference between response types for noun and verb recall in only the PwA group comparison. Data are shown in table 16.15.

Table 16.15: Noun-verb comparisons in MLS for response types in the PS task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA Nouns	MLS PwA Verbs	3	29.10	.000*
MLS HCs Nouns	MLS HCs Verbs	1	0.07	.792

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.

16.1.5.2 Comparisons in Sinhala for BLS PwAs and HCs

The analyses in section 16.1.5.2 revealed statistically highly significant differences between response types for noun and verb recall in both the BLS PwA and HC groups. Data are shown in table 16.16.

Table 16.16: Noun-verb comparisons in BLS for response types in the PS task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA Nouns	BLS PwA Verbs	4	28.36	.000**
BLS HCs Nouns	BLS HCs Verbs	1	1.00	.000**

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.

16.1.5.3 Comparisons in English for BLE PwAs and HCs

The analyses in section 16.1.5.3 revealed no significant difference between response types for noun and verb recall in the BLE HC group. A chi square test could not be performed on the BLE PwA data. Findings are shown in table 16.17.

Table 16.17: Noun verb comparisons in BLE for response types in the PS task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLE PwA Nouns	BLE PwA Verbs			††
BLE HCs Nouns	BLE HCs Verbs	1	1.20	.273 †

Note: *p≤0.008; **p≤0.001
†† Chi Square analysis could not be performed.

16.1.6 Summary of PS data

This chapter presents findings based on a chi square analyses conducted for response types across the language conditions MLS, BLS and BLE for nouns and verbs separately, in the PS task. Findings are summarized below.

16.1.6.1 Comparison in Sinhala across ML and BL

The BLS group had a notably higher number of NTLs than the MLS group for noun production. No NTL responses were produced in either language condition, for verbs. In both nouns and verbs, only the PwA group comparisons were significantly different.

Findings are summarized in table 16.18.

Table 16.18: Summary: Comparison of ML and BL response types

Condition 1	Condition 2	Significance level
Noun production		
MLS PwA Noun	BLS PwA Noun	.000*
MLS HCs Noun	BLS HCs Noun	.049 †
Verb production		
MLS PwA Verb	BLS PwA Verb	.000*
MLS HCs Verb	BLS HCs Verb	.213

Note: *p≤0.025; **p≤0.001

16.1.6.2 Comparisons in BL Sinhala versus English scores

A higher number of NTLs were produced in the BLS language condition for nouns. Response types between the Sinhala and English significantly differed only in the PwA comparisons for both nouns and verbs. Findings are summarized in table 16.19

Table 16.19: Summary: Analysis of response types across Sinhala-English in the BL group

Condition 1	Condition 2	Significance level
Noun production		
BLS PwA	BLE PwA	.013*
BLS HC	BLE HC	.335
Verb production		
BLS PwA	BLE PwA	.012* †
BLS HC	BLE HC	.071 †

Note: *p≤0.025; **p≤0.001
† Chi Square analysis performed on collapsed data.

16.1.6.3 Comparisons between PwAs and HCs

PwA-HCs comparisons were significant across all language conditions for noun and verb scores except the BLE PwA-HC comparison whose data could not be statistically analysed.

Findings are summarized 16.20

Table 16.20: Summary: Comparison of PwA-HC response types

Condition 1	Condition 2	Significance level
Noun production		
MLS PwA	MLS HC	.000*
BLS PwA	BLS HC	.000* †
BLE PwA	BLE HC	††
Verb production		
MLS PwA	MLS HC	.000*
BLS PwA	BLS HC	.000* †
BLE PwA	BLE HC	.000*

Note: *p≤0.017; **p≤0.001

16.1.6.4 Comparison across nouns and verbs within groups

Responses in NTL were produced only for nouns in the PwA group. No NTL responses were elicited for verbs.

Within group comparison for noun and verb response types showed significant results for PwAs and HC groups only in the BLS language condition and the PwA group in the MLS language condition. A chi square analysis could not be performed on the BL PwA data.

Findings are summarized in table 16.21

Table 16.21: Summary: Analysis of response types across nouns and verbs

Condition 1	Condition 2	Significance level
PwA ML (S) Noun	PwA ML (S) Verb	.000**
Controls ML (S) Noun	Controls ML (S) Verb	.792
PwA BL (S) Noun	PwA BL (S) Verb	.000**
Controls BL (S) Noun	Controls BL (S) Verb	.000**
PwA BL (E) Noun	PwA BL (E) Verb	††
Controls BL (E) Noun	Controls BL (E) Verb	.273 †

Note: *p≤0.008 **p≤0.001
†† Chi Square analysis could not be performed.

16.2 The SP task

16.2.1 Descriptive statistics

Tables 16.22 and 16.23 present descriptive statistics for response types in TL and NTL for nouns and verbs respectively, across the MLS, BLS and BLE language conditions in the PwA group.

Tables 16.24 and 16.25 present descriptive statistics for response types in TL and NTL for nouns and verbs respectively, across the MLS, BLS and BLE language conditions in the HC group.

Table 16.22: Descriptive statistics for response types for nouns in the SP task for PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	10.13	-	5.07	-	.80	-	.20	-
	SD	5.83	-	8.16	-	2.15	-	.414	-
	Min-Max	0-26		0-26		0-8		0-1	
BLS	Mean	8.64	.36	3.18	.09	.09	-	.09	-
	SD	3.67	.81	4.73	.302	.302	-	.302	-
	Min-Max	3-16	0-2	0-15	0-1	0-1		0-1	
BLE	Mean	9.09	1.55	6.27	.09	.91	-	-	-
	SD	3.73	1.64	5.33	.302	2.43	-	-	-
	Min-Max	4-18	0-5	0-17	0-1	0-8			

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

Table 16.23: Descriptive statistics for response types for verbs in the SP task for PwAs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	5.87	-	6.73	-	-	-	-	-
	SD	3.14		9.25					
	Min-Max	1-14	-	0-27	-	-	-	-	-
BLS	Mean	5.91	.73	1.45	.18	-	-	-	-
	SD	3.73	1.62	1.81	.603				
	Min-Max	0-12	0-4	0-5	0-2	-	-	-	-
BLE	Mean	5.00	.45	3.36	.09	-	-	-	-
	SD	3.95	.934	4.34	.302				
	Min-Max	1-13	0-3	0-13	0-1	-	-	-	-

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

Table 16.24: Descriptive statistics for response types for nouns in the SP task for HCs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	10.93	-	.33	-	-	-	-	-
	SD	4.37		.900					
	Min-Max	5-23		0-3					
BLS	Mean	12.36	.18	.55	-	-	-	-	-
	SD	4.23	.41	1.51					
	Min-Max	6-18	0-1	0-5					
BLE	Mean	14.18	.27	.18	-	-	-	-	-
	SD	6.21	.647	.405					
	Min-Max	7-28	0-2	0-1					

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

Table 16.25: Descriptive statistics for response types for verbs in the SP task for HCs[×]

		Accuracy		Lexical Errors		Non-Lexical Errors		Other Errors	
		TL	NTL	TL	NTL	TL	NTL	TL	NTL
MLS	Mean	7.27	-	.13	-	-	-	-	-
	SD	3.71		.516					
	Min-Max	4-15		0-2					
BLS	Mean	9.00	.09	.36	-	-	-	-	-
	SD	3.66	.302	1.21					
	Min-Max	6-18	0-1	0-4					
BLE	Mean	7.73	-	.36	-	-	-	-	-
	SD	2.61		.92					
	Min-Max	5-14		0-3					

*TL; responses in the target language; NTL; refers to the number responses in the non-target language (language switches within the category)

[×] Data boxes left blank indicate a score of zero while those with minute values are presented as 0.00 when rounded to two decimal points.

16.2.2 Selection of Statistical Tests

The aim was to identify if response types differed across the language conditions and between word classes (nouns vs. verbs) in the SP task. Data included were all correct or incorrect nouns and verbs elicited in TL or NTL for the MLS, BLS and BLE language conditions. Both Sinhala and English data were elicited by the same BL participant group, data were considered from separate language conditions.

As in the PS task, the analyses of SP response types involved the use of chi-square tests of independence. All related details are similar to that of section 16.1.2

As in PS analyses, in some pairwise comparisons data were further collapsed for analysis. Here too, a dagger symbol (†) has been used (in both text and summary tables) to indicate comparisons where data were further collapsed and analysed.

Where no statistical tests were performed on the data, this has been indicated (in both text and summary tables) with a double dagger symbol (††)

As in the PS task above, the Bonferroni correction was applied according to the comparisons made in each section. Hence in analyses, the significance value of p was set at 0.025 (0.05/2), in analysis questions (i) and (ii), at 0.017 (0.05/3) for question (iii) and at 0.008 (0.05/6) for question (iv).

In the following sections 16.2.3 through 16.2.5, statistical significance has been reported for pairwise analyses.

16.2.3 Response types for nouns

Responses across the language conditions were compared. The aim was to identify differences in response types within the language conditions for nouns in the SP task. Tables 16.26 and 16.27 show the contingency tables prepared for Chi Square tests.

Table 16.26: Contingency table for the PwAs across language conditions for nouns

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	152	76	12	3	0	243
BLS (n=11)	95	35	1	1	5	137
BLE (n=11)	100	69	10	0	18	197

Table 16.27: Contingency table for the HCs across language conditions for nouns

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	164	5	0	0	0	169
BLS (n=11)	136	6	0	0	2	144
BLE (n=11)	156	2	0	0	3	161

Chi Square tests of independence were performed on the above data.

16.2.3.1 Between group comparisons in Sinhala

Chi square tests for analyses in section 16.2.3.1 could not be performed (see table 16.28).

Table 16.28: Comparisons between ML and BL response types for noun production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA			††
MLS HC	BLS HC			††

Note: *p≤0.025; **p≤0.001

16.2.3.2 Within group comparisons, between the languages

When data were collapsed, a chi square analysis revealed a significant difference between the English and Sinhala response types in the BL PwA group. A chi square could not be performed on the BL HC group data.

Data are shown in table 16.29.

Table 16.29: Comparisons between BLS- BLE response types for noun production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	2	12.30	.002 †
BLS HCs	BLE HCs			††

Note: *p≤0.025; **p≤0.001

16.2.3.3 Comparisons between the PwAs and HCs

Response types between the PwA and HC groups differed significantly in the MLS (collapsed data) and BLE language conditions. Chi square analysis could not be performed on the BLS data.

Data are shown in table 16. 30.

Table 16. 30: Comparisons between response types in PwA and HC groups for nouns

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	MLS HCs	1	64.43	.000** †
BLS PwA	BLS HCs			††
BLE PwA	BLE HCs	3	93.52	.000**

Note: *p≤0.017; **p≤0.001

16.2.4 Response types for verbs

Responses across the language conditions were compared. The aim was to identify differences in response types within the language conditions for verbs.

Individual scores were used to compute the following contingency tables separately for the PwAs (table 16.31) and the healthy controls (table 16.32).

Table 16.31: Contingency table for the PwAs across language conditions for verbs

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	88	101	0	0	0	189
BLS (n=11)	65	16	0	0	10	91
BLE (n=11)	55	37	0	0	6	98

Table 16.32: Contingency table for HCs across language conditions for verbs

	Responses in TL (n)				NTL	Total
	AS	LE	NLE	OE		
MLS (n=15)	109	2	0	0	0	11
BLS (n=11)	99	4	0	0	1	104
BLE (n=11)	85	4	0	0	0	89

Chi square tests were performed for between the group comparisons.

16.2.4.1 Between the group comparisons in Sinhala

Analyses in section 16.2.4.1 revealed a significant difference between the MLS and BLS PwA groups for response types in verb retrieval in the SP task. A chi square analysis could not be performed on HC data even when collapsed.

Data are shown in table 16.33.

Table 16.33: Comparisons between MLS and BLS response types for verb production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	BLS PwA	2	46.62	.000**
MLS HC	BLS HC			††

Note: *p≤0.025; **p≤0.001

16.2.4.2 Within the group comparisons between the languages

Analyses in section 16.2.4.2 showed a significant difference in response types for the PwA group. HC group data could not be analysed. Data are shown in table 16.34.

Table 16.34: Comparisons between BLS- BLE response types for verb production in Sinhala

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
BLS PwA	BLE PwA	2	9.91	.007*
BLS HCs	BLE HCs			††

Note: *p≤0.025; **p≤0.001

16.2.4.3 Comparisons between the PwA and HC groups

As expected the difference in response types between the PwA and corresponding HC group in were statistically highly significant in the MLS and BLS language conditions. BLE data could not be analysed. Data are shown in table 16.35.

Table 16.35: Comparisons between response types in PwA and HC response types for verbs

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at p<0.008
MLS PwA	MLS HCs	1	80.43	.000**
BLS PwA	BLS HCs	2	20.84	.000**
BLE PwA	BLE HCs			††

Note: *p≤0.017; **p≤0.001

16.2.5 Within group comparisons in naming nouns and verbs

Comparisons were made across the accuracy scores, error scores and language switches within each group and for BL within each language condition.

16.2.5.1 Comparisons in Sinhala for MLS PwA and HCs

The analyses in section 16.2.5.1 revealed a statistically highly significant difference between response types for noun and verb recall in the PwA group. Data from the healthy control group could not be statistically analysed.

Data are shown in table 16.36.

Table 16.36: Noun-verb comparisons in MLS for response types in the SP task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at $p<0.008$
MLS PwA Nouns	MLS PwA Verbs	3	29.31	.000*
MLS HCs Nouns	MLS HCs Verbs			††

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.

16.2.5.2 Comparisons in Sinhala for BLS PwAs and HCs.

The analyses in section 16.2.5.2 revealed a no significant difference between response types for noun and verb recall in both the BLS PwA group. A chi square analysis could not be performed on the HC group data. Data are shown in table 16.37.

Table 16.37: Noun-verb comparisons in BLS for response types in the SP task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at $p<0.008$
BLS PwA Nouns	BLS PwA Verbs	2	6.60	.037
BLS HCs Nouns	BLS HCs Verbs			††

Note: *p≤0.008; **p≤0.001
† Chi Square analysis performed on collapsed data.

16.2.5.3 Comparisons in English for BLE PwAs and HCs

The analyses in section 16.2.5.3 revealed no statistically significant difference between response types for noun and verb recall in the BLE PwA group. A chi square test could not be performed on the BLE HC data.

Findings are shown in table 16.38.

Table 16.38: Noun-verb comparisons in BLE for response types in the SP task

Condition 1	Condition 2	Chi Square statistics		
		df	Test statistic	Significance at $p<0.008$
BLE PwA Nouns	BLE PwA Verbs	3	6.20	.102
BLE HCs Nouns	BLE HCs Verbs			††

Note: $*p\leq0.008$; $**p\leq0.001$
†† Chi Square analysis could not be performed.

16.2.6 Summary of SP data

Section 16.2 presents findings based on a chi square analyses conducted for response types across the MLS, BLS and BLE language conditions for noun and verb recall in the SP task. Findings are summarized below.

16.2.6.1 Comparisons in Sinhala across ML and BL

Chi square analysis could not be conducted on the ML-BL noun comparisons in both PwA and HC groups. For verbs, the ML-BL PwA groups differed significantly in response types. However a chi square analysis could not be performed on the HC data.

Findings are summarized in table 16.39

Table 16.39: Summary: Comparison of ML and BL response types for Sinhala

Condition 1	Condition 2	Significance level
Noun production		
MLS PwA	BLS PwA	††
MLS HC	BLS HC	††
Verb production		
MLS PwA	BLS PwA	.000*
MLS HC	BLS HC	††

Note: *p<0.025; **p<0.001

16.2.6.2 Comparisons in BLs' across Sinhala and English

For both nouns and verbs, within group comparisons showed response types between the Sinhala and English to significantly differ only in the PwA group.

Chi square analyses could not be conducted across language conditions in the BL group for both nouns and verbs.

Findings are summarized in table 16.40

Table 16.40: Summary: Comparison of BL Sinhala and English response types

Condition 1	Condition 2	Significance level
Noun production		
BLS PwA	BLS PwA	.002* †
BLS HC	BLE HC	††
Verb production		
BLS PwA	BLS PwA	.007*
BLS HC	BLE HC	††

Note: *p≤0.025; **p≤0.001

16.2.6.3 Comparison between PwAs and HCs

Chi square analyses could not be conducted on the BLS data for nouns and BLE data for verbs. All other comparisons showed statistically significant differences between the response types of the PwA and HC groups. Findings are summarized in table 16.41.

Table 16.41: Summary: Comparison of PwA-HC response types

Condition 1	Condition 2	Significance level
Noun production		
MLS PwA	MLS HC	.000** †
BLS PwA	BLS HC	††
BLE PwA	BLE HC	.000**
Verb production		
MLS PwA	MLS HC	.000**
BLS PwA	BLS HC	.000**
BLE PwA	BLE HC	††

Note: *p≤0.017; **p≤0.001
†† Chi Square analysis could not be performed.

16.2.6.4 Comparison across nouns and verbs within groups

Noun and verb response type comparisons were significant only in the MLS PwA group. Chi square tests could not be performed in any of the HC group comparisons. Findings are summarized 16.42.

Table 16.42: Summary: Analysis of response types across nouns and verbs

Condition 1	Condition 2	Significance level
PwA ML (S) Noun	PwA ML (S) Verb	.000**
Controls ML (S) Noun	Controls ML (S) Verb	††
PwA BL (S) Noun	PwA BL (S) Verb	.037
Controls BL (S) Noun	Controls BL (S) Verb	††
PwA BL (E) Noun	PwA BL (E) Verb	.102
Controls BL (E) Noun	Controls BL (E) Verb	††

Note: *p≤0.008; **p≤0.001
†† Chi Square analysis could not be performed.

Chapter 17: Interim Discussion 2

17.0 Overview of phases 2 and 3

This chapter includes a discussion of findings in phases 2 and 3. Phase 2 of this study involved pilot testing the developed test battery on speakers with aphasia. Findings from three ML and three BL PwAs and their matched controls[51] were used to identify the modifications required prior to phase 3. Data obtained from 15 ML PwAs and 11 BL PwAs and their matched healthy controls[51] in phase 3 were then analysed to draw the study's main findings.

17.1 Methodological issues

Prior to discussing the findings of the study some methodological difficulties need to be outlined. These relate to the efforts made to match the groups of BL and ML participants for key demographic factors including years spent in education and Sinhala language rating scores.

The BL PwA and ML PwA groups differed in that the BL PwAs had significantly higher number of years in education and lower reported use of Sinhala than their ML counterparts. Since the PwA and control groups were matched for age and language proficiency, the BL HC group too differed from the ML HC as above.

The difference in the education levels between both ML and BL groups could be due to a number of reasons. In Sri Lanka, learning English as a second language is significantly influenced by demographics, family income, parent education and education levels of the speaker. Those from less urban areas, low family socio-economic status, less parent education level, lower education level of the speaker and overall negative attitudes toward the English language are shown to be key characteristics of those with lower English proficiency levels or those who prefer to consider themselves monolingual Sinhala

[51] Controls were matched to PwAs in terms of age, gender, education, handedness and language proficiency

speakers (see Fernando, 2015; Mahroof, 2015; Fernando, 1977). The National Education Commission (2003) of Sri Lanka reported that English language proficiency continues to be an agent of social differentiation in the modern Sri Lankan society.

Further, in the Sri Lankan education system, a stronger English language policy is implemented at higher levels of education. At tertiary levels, English is most often the medium of instruction. In contrast, English learning at primary and secondary levels of education are rather selective with better learning and teaching facilities limited to urban or higher graded schools. This direct relationship between English language knowledge and education may explain the significant difference in education level between ML and BL speakers.

Demographic data obtained for participants recruited to this study show 7/15 participants in the ML PwA group to be employed on low salary employment and 4/15 reported to be unemployed while all participants[52] in the BL group were engaged in highly skilled jobs. Since controls were matched to PwAs, a similar observation was made in the ML-BL control groups.

The significantly lower Sinhala language use scores in both bilingual groups are possibly due to the distribution of language use across the different communication contexts (e.g. home, work) in which they communicate (see Fernando, 1977). In this study, more ML than BL participants were unemployed while all but one BL PwAs were in active employment post-stroke. BLs are likely to speak more English in their work places and possibly at home thereby limiting the use of Sinhala to other situations in which speaking Sinhala is required. Conversely MLs use only Sinhala in all contexts.

In BL speakers the habitual use of language is identified as a strong influence on language proficiency (Pelhams & Abrams, 2011). However, differences in language use was not accompanied with a difference in language proficiency across the MLs and BLs in this

[52] Including one participant who had retired at the time of testing

study, possibly because the language data included here represents self-rated scores in a relatively small and less varied BL sample.

All the findings below need to be viewed in the light of these differences.

17.2 Comparison of word retrieval performance in Sinhala between monolingual Sinhala and bilingual Sinhala-English speakers

Most behavioural studies investigating a bilingual disadvantage in aphasia resort to data obtained through comparisons made between bilingual PwAs with healthy speakers (e.g. Faroqi-Shah, Sampson, Pranger & Baughman, 2016; Munoz & Marquardt, 2003; Roberts & Deslauriers, 1999) or between the bilingual PwAs two known languages (e.g. Hernandez et. al., 2008; Fabbro; 2001). A limited number of studies however, attempt to compare bilingual and monolingual speakers with aphasia across their shared L1.

Evidence derived through the years from studies that have investigated bilingual language performance, both in healthy speakers (e.g. Ivanova & Costa, 2008; Gollan et. al, 2005) and in speakers with aphasia (Hope et. al., 2015; Kambanaros, 2010; Faroqi-Shah & Waked, 2010; Hernandez et. al., 2008) suggest a bilingual disadvantage in lexical retrieval has been reported for both the bilingual's first language (L1) (Ivanova & Costa, 2008) and later learnt language (L2)[53] (e.g. Ivanova & Costa, 2008; Gollan et. al, 2005). Slower lexical retrieval (Rosello et. al., 2000) and/or comparatively limited vocabulary size (Gollan et. al., 2002) have been cited as possible reasons. These findings have been attributed to the fact that activation and selection of lexical items are more demanding, articulation is less rehearsed and error monitoring is more demanding for bilingual speakers (Parker-Jones et. al., 2012).

Contradictory to evidence in support of a bilingual linguistic disadvantage, findings in this study showed that BL speakers did not perform poorer than MLs across most tasks and in

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[53]Here the first acquired language is referred to as L1 while the language later learnt is referred to as L2. In the present study Sinhala was the L1 for all recruited BLs while English was L2. This was a criteria in BL participant recruitment.

both word classes. When MLS and BLS naming scores in Sinhala for PwAs were analysed across the naming, SP and PS tasks, no comparison in any of the above tasks showed a statistically significant difference between the language conditions. There was a tendency towards marginally higher (yet non-significant) scores for the BLS language condition in both word classes for naming as predicted by their advantageous ratings on psycholinguistic variable for both object and action sets of OANB items. Marginally higher (yet non-significant) scores for the BLS language condition was also shown across all other tasks, that is, higher noun accuracy and production scores in the PS task and higher production scores for both nouns and verbs and higher accuracy score for nouns in the SP task. The same findings repeated in the healthy control group.

The fact this pattern recurred across all tasks instead of being limited to the OANB naming task in both PwA and control groups suggests that higher performance in the BLS language condition is real and not an artifact of the test materials.

Despite the presence of a known linguistic disadvantage in bilinguals, there is also evidence of several bilingual advantages (Marian & Shook, 2012; Kovelman, Baker & Petitto, 2008; Kovelman, Shanlinsky, Berens & Petitto, 2008) mostly cognitive but importantly in the context of these findings, a better resistance to cognitive neurological decline (Gollan et al., 2011; Bialystok et. al., 2007)

A probable study design related explanation to this finding could be that most behavioural studies investigate a ML-BL difference through picture naming gather data through response time data as oppose to accuracy data as in this study. Bialystok (2009) note that the BL disadvantage for verbal performance in adults is no longer the case of vocabulary size as it is for children but rather a case of lexical retrieval as seen in slower picture naming (e.g. Gollan et. al., 2005). A similar finding was reported by Ángeles (2015) who noted that naming performance in Spanish-Catalan BL and Spanish ML groups of healthy speakers only differed in terms of response time, where MLs were slightly quicker.

In the context of this study, several other participant related factors may have contributed towards the better performance in bilinguals. These include both BL PwA and HC groups had a significantly higher level of education, a higher number of participants in active employment, a lower median age and for the PwAs, a higher time since the onset of stroke.

17.3 Comparison of performance across Sinhala and English in bilingual speakers

Six patterns of bilingual language recovery described by Paradis (1977) could be converged in to three primary patterns, those are, L1 recovery is better than L2, L2 recovery is better than recovery in L1 or L1 and L2 show near symmetrical recovery. These patterns have been described by two laws, Ribot’s Law (1882) and Pitres’ law. Ribot’s law (1882) suggests the recovery of the native language where in a bilingual, recovery comes first in the bilingual’s mother tongue or native language. de Bot (1992) note that although both L1 and L2 may have direct connections to the conceptual store, the strength of the weight of their connections may differ. Given that L1 is the native language or mother tongue of the bilingual speaker for which exposure is longer, it can be fairly assumed that L1 connections may be comparatively stronger than L2 connections and also more resistant to neurological lesion. Evidence of better preserved L1 have been reported across bilingual speakers of a variety of languages (e.g. Amberber, 2012; Kambanaros, 2010; Detry, Pillon & De Part, 2005; Kambanaros & van Steenbrugge, 2006; Gil & Goral, 2004; Eviatar, Leikin & Ibrahim, 1999)

An alternative notion was proposed in Pitres’ law, which suggests the recovery of the more frequently used language before cortical lesion. This implies that the habitual use of L2 may strongly overshadow developmental advantages of L1 (Pelham & Abrams, 2011). The Revised Hierarchical Model (Kroll & Stewart, 1994), which is in agreement with Pitre’s law, suggests that changes to the L1-L2 lexical links and L2-conceptual link with increasing language proficiency. Evidence in support of a better preserved L2 has also been reported (Adrover-Roig et.al., 2011; Abutalebi et. al., 2009; Fabbro & Paradis, 1995).

The third possibility is the absence of a difference between the bilinguals' L1 and L2, also referred to as parallel impairment (Mehrpour, Motamed, Aghaei, Jalali & Ghoreishi, 2014; Green, 2011; Tschirren et. al., 2011; Kambanaros & Grohmann, 2011; Fabbro, 2001).

In the present study, findings showed no language to be consistently better than the other in the PwA group, although a tendency towards higher scores were seen in L1 Sinhala for a number of tasks and word classes. In general, the absence of a significant and consistent difference between the BL PwAs languages across the tasks suggests equal recovery although individual variations are possible. These findings however, should be viewed cautiously given that a number of factors may influence post stroke recovery in bilinguals. Critical language specific factors specific to bilinguals and as applicable to the present study include the age and modality in which the languages were acquired, pre-morbid language use and proficiency levels, post-stroke language use, degree of linguistic similarity or dissimilarity between the languages and the language used in rehabilitation post stroke (Gray & Kiran, 2013; Ansaldo et. al., 2008). From the above, pre-morbid language abilities have perhaps been identified as the strongest predictor of post stroke language outcome (Gray & Kiran, 2013; Peñaloza, Rao & Kiran, 2017)**.** Given so, the difficulty in precisely quantifying language proficiency, differences in the proficiency levels across the recruited language samples and the high dependency on subjective and self-rating as a method of obtaining language related data are possible factors that may lead to biased conclusions.

Similar to PwAs, comparisons of Sinhala and English in the healthy control group showed a numerical advantage for Sinhala, only some of which were statistically significant. The tendency towards higher scores in Sinhala than in English for this group is also noted in the context that healthy controls rated themselves higher in Sinhala for language use.

17.4 PwA and control group comparisons across the language conditions

The expected finding of HC performing better than PWA was found for all production tasks with two exceptions. These involved the accuracy scores for verbs in the PS task for BLS language condition and the SP task for the MLS language condition. In both of the above cases higher scores were shown for PwAs although the difference was not statistically significant.

Observations across the data sets show extremely poor performance of some controls in comparison to others. The higher median for PwAs in comparison to their healthy controls is explained by the fact that two controls had no correct verbs in their language samples for the PS task. It is unclear why these two healthy participants failed to produce any accurate verbs in the PS task and was an exception from all healthy participants recruited from phase 1 through 3 in this study. Given that these stimuli were pre-tested in a healthy sample and also were able to generate narratives from speakers with aphasia, makes it difficult to suggest that language, stimulus and method related issues could be a probable underlying factor. Participant specific reasons such as illness on the day of testing or misunderstood instructions leading to such isolated incidents could have affected participant performance, instead.

Another observation here was that a significant differences between the PwAs and HCs were found in the picture naming tasks, but not consistently in the connected speech tasks. The fact that connected speech tasks in this study failed to distinctively distinguish speakers with aphasia from healthy speakers may possibly indicate several methodological limitations for the present study.

Firstly, methods that involve a rigid response framework such as in the PS and SP tasks used here and also others such as story re-telling places a high demand for an exact accurate response, similar to that of naming. This makes the connected speech sample obtained for this study, a less-natural one than other methods of semi-spontaneous (e.g.

role play) and spontaneous speech (e.g. discourse) (Prins & Bastiaanse, 2004; Armstrong, 2000). Disadvantages for structured connected speech tasks over unstructured ones, in terms of sample informativeness and validity has been reported (Doyle, Goda & Spencer, 1995; Roberts & Wertz, 1989). The use of visual stimuli may also increase the risk of misinterpretation, particularly in PwAs with agnosia, leading to low accuracy scores. The framework for connected speech analysis in this study was also less rigorous than it was for naming and further complicated by the many language-related differences between Sinhala and English. This posed a significant challenge in establishing symmetry between tasks and between the languages. The high sensitivity of linguistic processes (e.g. vocabulary diversity) to task type (Fergadiotis & Wright, 2011; Armstrong, 2000) places a heightened importance on a reliable, rigorous and valid method for transcription, coding and analysis in connected speech (Harris-Wright, 2011).

Language related issues specific to this study further complicated analysis and coding. In stimuli development cognate, loan and culture specific words were filtered out in the naming task but not for connected speech. In fact, it was assumed that the cultural familiarity of the stimuli would facilitate elicitation in speakers with aphasia. This was true, given that it noted for culture specific words such as *aluth avurudu* [new year], *bulath* [beetle leaves] *raban* [special type of drum] and frequently used loan words such as *ladder-eka* [ladder] were easily recalled by both PwAs and healthy controls. This however had a disadvantage, such that it contributed to the narrowed difference in performance between the groups. This observation is supported by evidence of early learnt and frequently used words remaining accessible in aphasia (Brysbaert & Ellis, 2016).

The use of PS and SP tasks as opposed to methods that produce larger speech samples for analysis, such as in discourse, role-play or even monologues may have posed methodological limitations on the quantity, types and genres of words produced in either word-classes[54]. This may have adverse consequences on the ability to infer consistent and reliable findings from data (Armstrong, 2000)

17.5 Word class effects

Selective deficits of grammatical word classes have been reported in aphasia studies. Referred to as noun-verb dissociation, some studies report of an impairment in verb production relative to nouns (Berndt, Burton, Haendiges & Mitchum, 2010; Kambanaros & Steenbrugge, 2006; Bird, Howard & Franklin, 2003; Kim & Thompson, 2000; Saffran & Schwartz, 1998) while others report of an inverse pattern (Shapiro, Shelton & Caramazza, 2000; Rapp & Caramazza, 1997; Robinson, Rossor & Cipolotti, 1999; Zingeser & Berndt, 1988; Marshall, Pring, Chiat & Robson, 1996b)

An important methodological design in the present study is that the analysis of connected speech tasks were based on two separate measures, a correctly recalled score, which included only the correct[55] noun and verb scores and a type token ratio, which included all nouns or verbs retrieved regardless of its contextual appropriateness. The aim was to provide a common basis on which performance could be compared across naming and connected speech tasks. This is in contrast to previous studies, which compare accuracy scores in naming with measures of word production (e.g. type token ratio) in connected speech tasks (e.g. Kambanaros, 2010).

In the present study, PwAs had higher object naming scores for the picture-naming task in the MLS and BLE language conditions. In the PS task verb accuracy was higher for the BLS and BLE language conditions. In the SP task noun accuracy was higher than verb accuracy in all language conditions. This was the only instance where scores significantly differed between the word classes. In terms of production scores, higher for TTRs for verbs

[54] Other aspects limited such as structural complexity of sentences, inflections, text structure, stress and intonation patterns, and conversational repair do not apply within the context of this study and are therefore not included here.
[55] A correct noun and verb required that it be appropriately produced and used in the context of the PS and SP stimulus

were shown in the MLS and BLE language conditions for the PS task and BLS and BLE language conditions in the SP task.

In the HC group, accuracy scores were significantly higher for nouns in the SP task and were higher but non-significant in the PS task. In naming, higher object accuracy scores were noted in the same two language conditions as in PwAs. Production scores in the PS task were significantly higher for verbs in all language conditions and non-significant but higher for verbs in two out of three language conditions (MLS and BLS) in the SP task.

Overall, the findings yield no conclusive data in support of a word class effect in PwAs. The absence of a consistent and significant noun-verb disassociation for PwAs in this study has been previously reported by Kambanaros (2016) whose findings showed an equal impairment for both nouns and verbs. The variation of word class performance across tasks as observed in the PwA language conditions are in agreement with previous studies that have reported task based differences in word production (Crepaldi et. al., 2011; Pashek & Tompkins, 2002).

Several noteworthy observations were made. Firstly, although statistically, non-significant a greater impairment in verbs in term of accuracy was noted for PwAs. The verb deficit has been viewed in a number of perspectives including its unfavourable linguistic properties that are shallow semantic organization, shared semantic features and multiple permissible argument structures (Vinson & Vigliocco, 2002), higher vulnerability of verbs to the loss of perceptual and functional features (Bird et. al., 2000; Marshall et. al., 1996a; 1996b) and also difficulties in accessing the appropriate verb at lemma level (Nozari et. al., 2010; Kim &Thompson, 2000). Despite lower accuracy scores, higher TTR (production) scores were shown for verbs than nouns in connected speech.

The inconsistencies that occurred across language conditions, within groups and tasks posed severe limitations when conclusions were to be drawn. The presence of non-significant findings here could be due to several reasons.

Firstly, there is evidence that word production performance differs based on aphasia type. For example, Zingeser and Berndt, (1990) noted that verb retrieval impairments for agrammatic PwAs were significantly higher than anomic PwAs as a consequence of the grammatical impairment that leads to failure in accessing the more complex word class, verbs. In connected speech, Berko-Gleason et. al, (1980) reported that agrammatic speakers produce more nouns than verbs while Wernicke's aphasia manifested an inverse profile (also see, Pulvermuller, Mohr, Sedat, Hadler & Rayman, 1996; Chen & Bates, 1998; Berndt et. al., 2002). In the context of this study, higher TTR scores but lesser accuracy could be expected for PwAs with fluent aphasia while the opposite could be expected for the non-fluent types, as it has been previously noted (McCullough, Lance & Beverly, 2017; Nicholas & Brookshire, 1994). The present study did not differentiate PwAs recruited in terms of aphasia subtypes, which may have contributed towards the inconclusive findings.

The non-significant grammatical class differences observed across the participant language conditions in the naming tasks of this study could be attributed to the fact that the object and action item sets were not matched across the groups for stimulus factors such as word length, familiarity or imageability (Bastiaanse, Wieling & Wolthuis, 2016; Crepaldi et. al., 2006; Bird, Franklin & Howard, 2003; Pashek & Tompkins, 2002).

Limitations to the diversity of one word class over the other could also be attributed to the choice of task. In connected speech, the use a structured tasks may have to some degree limited the diversity of verbs required to be produced in comparison to semi spontaneous or spontaneous tasks types such as monologues or conversations (Harris-Wright, 2011;

Matzig et.al., 2009; Armstrong, 2000). In the context of this study it was also noted that the use of pictured stimuli in eliciting connected speech samples led to certain nouns being repeated more frequently than verbs. For example, in the PS stimulus, the word *kite* was produced at least once for each picture as the participant narrated the story. This resulted in a lower type count but higher token count leading to a low TTR score. Each instance of a repeated nouns was counted in the accuracy score, unless repeated consecutively, which may have contributed towards the higher noun accuracy score.

17.6 Error analyses across language tasks

This section of analyses focused on two primary aspects, the distribution of errors and language switches across the MLS, BLS and BLE groups. In the context of this study, the term language switches refer to the number of responses in the Non- Target Language (NTL; non-tested language). Five key observations were drawn.

Firstly, a higher number of language switches were shown in the BL language conditions than the ML language condition. This is in agreement with the many studies that identify code switching as an exclusive bilingual behaviour even in healthy speakers (Heredia & Altarriba, 2001; Green 2011; Poplack, 2001; Meuter & Allport, 1999).

Secondly, language switches were also higher in PwAs in comparison to HCs. Pathological code switching has been reported as an exclusive feature of bi/multilingual speakers with aphasia (Kong, Abutalebi, Lam & Weekes, 2014; Ansaldo et.al., 2007; Bhat & Chengappa, 2003; Chengappa, Daniel & Bhat, 2004; Fabbro, Skrap & Aglioti, 2000). Several explanations have been proposed. The language non-selective approach (BIA and BIA+ models; Dijkstra & Van Heuvan, 1998; 2002) suggests that both languages share a common representation system, where cross-linguistic competition and co-activation are typical. Failure to generate sufficient inhibition effect that is difficulty in suppressing an item's translation equivalent may result in the word from the non-target language being produced (Ansaldo et.al., 2007). In contrast, language selective models such as Green

(1986) and La Heij (2005) propose a pre verbal message that contains details on the target language. Difficulties in PwAs to form this pre-verbal message may result in words produced in the other language.

An alternative to this is that BL PwAs may respond to the encountered language deficit by increasing the frequency of word switching and mixing in the other language known (Bhat & Chengappa 2005). This compensatory behaviour seen in BL PwAs is in agreement with Green's (1986) notion of language activation levels which suggest that although a BL attempts to retrieve words from the selective language (language in use), failure to do so may provoke the speaker to seek an equal alternative from their active or dormant languages.

Thirdly, a higher frequency of language switches observed in the naming task of this study is in agreement with Anslado et.al. (2007) who suggest that code mixing behaviours in PwAs are modulated by task demands (also see, Price, Green & Von Studnitz, 1999). Hence the demand for a more precise and definite response in picture naming, as oppose to the option of word substitute and sentence simplifications allowed in the connected speech tasks may have contributed to higher non-target language responses in the former.

It was also noted that a high number of code switching errors occurred in the BLS language condition in both PwA and HC groups for naming and for only the PwA group in the PS task[56]. This implied that BL participants accessed more English words when tested in Sinhala, than Sinhala words when tested in English. In the SP task, a higher number of non-target language responses were elicited by the BLE language group which then implied that more Sinhala words were produced when the BLs were tested in English than English words when tested in Sinhala.

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[56] In analyses, careful distinction was made between actual code mixing and use of loan words by not counting words with no Sinhala translation (e.g. bus, car, tin) as a word in the non-target language.

The higher language switching in the BLS language condition, substituting words from their L2 English has been reported before (see Boyd, 1993). Chengappa et. al. (2004) noted in bilingual PwAs readily substituted L2 words with the more proficient L1. Heredia and Altarriba (2001) note that following long-term use of the later learnt language (L2) a language shift takes place, as a result of which concepts become easily accessible in L2. The language shift that occurs as a result of changing proficiency has been explained in Kroll and Stewart's Revised Hierarchical Model (RHM; 1994). The RHM proposes stronger lexical links in the L1 to L2 direction and stronger (weighted) L2 conceptual links that occur in bilinguals with increasing proficiency. A similar notion is also proposed in the subsystems hypothesis Paradis (1981; 2001) where inter-language links strengthen with increasing proficiency there by allowing the bilingual to switch between the languages.

In the context of this study, the linguistic structure of Sinhala may explain one probable account for higher code switching in the BLS language condition. The Sinhala language includes a large number of loan words from English (Jayawardane & Rewatha thero, 2015), which in comparison to literal Sinhala are more frequently used in the spoken and colloquial forms (e.g. /*ʈofɪ:*/-/*ɛka*/ [toffee-eka], /*bʌ*s/-/*ɛka*/ [bus-eka]) (Premawardhena, 2003). Yet another category known as hybrid words where an English word is combined with a Sinhala word */pæðʊrʊ/ /pa:rtɪjə/* [paeduru patiya] are abundantly used in the spoken format. Senaratne (2009) reported a similar pattern in Sinhala-English bilingual healthy speakers where the code-switching behaviour manifested an overpowering influence of English.

The opposite pattern observed in the SP task where language switches were higher in the BLE condition are in agreement with studies that suggest easier and quicker word borrowing from the earlier learnt and more proficient L1 (in this case, Sinhala) (e.g. Ansaldo et. al.,2007; Bhat & Chengappa, 2003).

An alternative viewpoint in the context of this study is that the SP task stimulus involved a picture of the Sinhala-Tamil New year. This may have provoked participants to use familiar and frequently used Sinhala words to describe this national event, rather than the less used English translation. (E.g. the traditional sweet was often referred to in its frequently used Sinhala name /*kokıs*/ instead of its English translation ‘oil cakes’).

Finally, it was also observed that code switching also occurred in the MLS language condition, at a higher frequency for naming than in connected speech. This finding is in agreement with Seneratne (2009) who noted that code mixing was an increasingly common behaviour in the monolingual Sinhala speaker, whose behaviour was more prominent at word level than at sentential level.

No in depth analysis was performed further on error types for this study. Comparisons in raw data showed inconsistent findings across language conditions, groups and word classes. The distribution of raw error scores across tasks showed a higher distribution of non-lexical errors for PwAs in contrast error patterns of healthy speakers. Lexical errors were higher for HCs. This pattern of error distribution is similar to that proposed by the aphasia model of Dell et. al. (1997), which distinguished healthy speakers from speakers with aphasia based on their distribution of errors in word retrieval.

Chapter 18: Correlation Analyses

18.0 Overview

This chapter presents findings from the correlation analyses performed using phase 1 and phase 3 data. The data groups for participants with aphasia (PwA) and healthy controls (HCs) used for analyses here were similar to that of chapter 13. (Table 13.1)

Correlation analyses performed here addressed two primary questions.

(a) How did word production scores correlate across naming and connected speech tasks, for objects/nouns and action/verbs?

(b) Which psycholinguistic variables from amongst those rated in phase 1[57] influenced naming performance of PwAs recruited to phase 3?

18.1 Performance across the picture naming and connected speech tasks

Individual participant data of PwAs and HCs recruited to phase 3 who completed the picture naming, the PS task and SP task were included here. Word production scores included here were the accuracy score [AS] for naming objects and actions in the naming task and the correctly recalled noun (CRn) and correctly recalled verb (CRV) scores for the PS and SP tasks. The data were analysed across the three language conditions, monolingual Sinhala (MLS), bilingual Sinhala (BLS) and bilingual English (BLE) separately for PwA and HC participant groups recruited to phase 3. Correlations were also separate for object/noun and actions/verbs. Data were analysed to address the following questions.

(a) How did word production scores correlate across object naming in the picture-naming task and noun production in the PS and SP tasks?

(b) How did word production scores correlate across action naming in the picture-naming task and verb production in the PS and SP tasks?

[57] Objects and actions in phase 1 were scored for naming accuracy and rated for age of acquisition, imageability, familiarity and visual complexity

18.1.1 Tests for normality and homogeneity of variance

Prior to performing correlations, a Shapiro-Wilk test for normality and homogeneity of variance was performed on all data sets for all three tasks, naming, PS task and SP task. Findings are presented in table 18.1 for object/nouns scores and table 18.2 for action/verbs scores.

Table 18.1: Shapiro Wilk findings for object/noun production scores

	Data **Set (DS)**	n	**NAS (object naming score)***			**PS task (CRn)**			**SP task (CRn)**		
			Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
MLS PwA	1	15	.937	15	.348	.955	15	.609	.936	15	.332
BLS PwA	**2**	11	.879	11	.101	**.852**	**11**	**.046***	.949	11	.628
BLE PwA	**3**	**11**	**.761**	**11**	**.003****	.916	11	.287	.885	11	.122
MLS HCs	**4**	**15**	**.806**	**15**	**.004****	.933	15	.299	**.881**	**15**	**.050***
BLS HCs	5	11	.921	11	.330	.872	11	.083	.924	11	.351
BLE HCs	6	11	.947	11	.611	.952	11	.675	.917	11	.294

* Object items from the OANB= 69

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 18.2: Shapiro Wilk findings for action/verb production scores

	Data Set (DS)	n	**NAS (action naming score)***			**PS task (CRv)**			**SP task (CRv)**		
			Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
MLS PwA	1	15	.918	15	.183	.935	15	.325	.928	15	.251
BLS PwA	2	11	.914	11	.271	.909	11	.235	.911	11	.251
BLE PwA	3	11	.953	11	.687	.958	11	.741	.872	11	.083
MLS HCs	**4**	15	.893	15	.074	.908	15	.127	**.806**	**15**	**.004****
BLS HCs	**5**	11	**.644**	**11**	**.000*****	.945	11	.583	**.803**	**11**	**.010****
BLE HCs	6	11	.939	11	.514	.953	11	.681	.877	11	.095

* Action items from the OANB= 38

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Shapiro-wilk findings for objects showed DS2, DS3 and DS4 to have data that were not normally distributed. In actions, DS4 and DS5 had data that were not normally distributed.

18.1.2 Selection of statistical tests

For all groups of data that assumed normality, Pearson product-moment correlation coefficient was used. For other groups of data that did not assume normal distribution, Spearman's rank correlation coefficient (spearman's rho) was used. No Bonferroni adjustment was applied.

18.1.3 Descriptive statistics

Table 18.3 below provides the descriptive statistical data for object/noun scores across the tasks for all language conditions in the PwA and HC groups.

Table 18.3: Descriptive statistics for object-noun scores across the task

	n	Naming task (object naming score)*				PS task (CRv)				SP task (CRv)			
		Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
MLS PwA	15	33.20	19.38	5	65	6.67	4.84	0	16	9.03	3.58	4	18
BLS PwA	11	39.36	20.89	13	67	10.00	4.20	5	15	8.64	3.67	3	16
BLE PwA	11	40.45	16.30	5	56	9.00	5.25	3	20	9.09	3.73	4	18
MLS HCs	15	64.80	4.06	54	69	13.27	4.79	7	22	10.93	4.37	5	23
BLS HCs	11	64.55	3.83	58	69	15.82	6.11	8	27	12.36	4.23	6	18
BLE HCs	11	63.82	4.05	56	69	18.00	5.31	11	28	14.18	6.21	7	28

Table 18.4: Descriptive statistics for action-verb scores across the task

	n	Naming task (object naming score)*				PS task (CRv)				SP task (CRv)			
		Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
MLS PwA	15	16.27	10.42	0	30	8.53	4.41	3	17	5.87	3.14	1	14
BLS PwA	11	20.00	10.75	4	34	12.46	6.47	3	21	5.82	3.66	0	12
BLE PwA	11	21.09	7.83	8	33	5.73	2.15	2	9	5.00	3.95	1	13
MLS HCs	15	34.20	3.76	26	38	12.93	5.11	7	25	7.27	3.71	4	15
BLS HCs	11	37.09	1.64	33	38	11.82	7.35	0	24	9.00	3.66	6	18
BLE HCs	11	34.09	2.77	30	38	13.36	2.77	9	18	7.73	2.61	5	14

18.1.4 Findings in correlation analyses

18.1.4.1 Correlations across tasks for object/noun production scores

Table 18.5 below presents the findings for the correlations performed for each language condition in the PwA group.

Table 18.6 below presents the findings for the correlations performed for each language condition in the HC group.

Table 18.5: Across task correlations for object-noun scores in the PwA language conditions

Language condition	n	PN-PS	PN-SP	PS-SP
MLS PwA	15	R=0.643 p=.010*	R=0.097 p=.730	R=0.221 p=.428
BLS PwA	11	R=0.422 + p=.196	R=0.368 + p=.266	R=0.392 + p=.233
BLE PwA	11	R=0.277 + p=.410	R=0.480 + p=.135	R=0.199 + p=.557

Key: PN- Picture naming task; PS- PS task; SP- SP task
* Significant at p≤0.05 ** p≤0.001
+ Spearman's rho

Table 18.6: Across task correlations for object-noun scores in the HC group

Language condition	n	PN-PS	PN-SP	PS-SP
MLS HCs	15	R= -0.051 + p= .857	R=0.588 + p=.021*	R=0.322 + p=.242
BLS HCs	11	R=0.474 p=.140	R=0.623 p= .041*	R= 0.196 p=.563
BLE HCs	11	R=0.447 p=.168	R=0.228 p=.499	R= -0.085 p=.804

Key: PN- Picture naming task; PS- PS task; SP- SP task
* Significant at p≤0.05 ** p≤0.001
\+ Spearman's rho

Correlation analysis conducted for object/noun scores across the picture naming, PS and SP tasks showed a statistically significant large[58] positive correlations only between the naming and PS task for the MLS PwA language condition, the naming and SP task in the MLS HC language condition and the naming and SP task in the BLS HC language condition. Correlation between the naming- PS task correlation in the MLS HC language condition and the PS task-SP task in the BLE HC language condition showed negative correlations.

18.1.4.2 Correlations across tasks for action/verb production scores

Table 18.7 below presents the findings for the correlations performed for each language condition in the PwA group.

Table 18.8 below presents the findings for the correlations performed for each language condition in the HC group.

[58] Strength of association for correlations: Small- .1 to .3; Medium- .3 to .5; Large: .5 to 1.0

Table 18.7: Across task correlations for action-verb scores in the PwA group

Language condition	n	PN-PS	PN-SP	PS-SP
MLS PwA	15	R=0.037 p=.895	R=0.156 p=.578	R=0.414 p=.125
BLS PwA	11	R=0.512 p=.108	R=0.700 p=.017*	R=0.486 p=.130
BLE PwA	11	R=0.768 p=.006*	R=0.634 p=.036*	R=0.471 p=0.143

Key: PNt- Picture naming task; PSt- PS task; SPt- SP task
* Significant at p≤0.05 ** p≤0.001
+ Spearman's rho

Table 18.8: Across task correlations for action-verb scores in the HC group

Language condition	n	PN-PS	PN-SP	PS-SP
MLS HCs	15	R= -0.279 + p=0.314	R=0.614 + p=.015*	R=0.039 + p=.891
BLS HCs	11	R= -0.202 + p=.552	R= 0.179 + p= .598	R= -0.109 + p=.750
BLE HCs	11	R= -0.135 p=.692	R=0.183 p=.590	R=0.154 p=.652

Key: PN- Picture naming task; PS- PS task; SP- SP task
* Significant at p≤0.05 ** p≤0.001
+ Spearman's rho

In the PwA group, all tasks positively correlated. Significant relationships were shown between the naming and SP task for BLS and BLE language conditions and between the naming and PS task for the BLE language condition.

The HC group showed negative correlations across several comparisons. A significant and positive correlation was shown only between the naming and SP task in the MLS language condition.

18.2 Influence of psychometric variables on naming performance of PwAs in phase 3

Individual participant data of PwAs recruited to phase 3 who completed the picture-naming task were included here. Data were analysed separately for each language condition, MLS, BLS and BLE. The psychometric variables considered were NAS and ratings for age of acquisition, familiarity, imageability, visual complexity and word length. Data for the above variables were obtained in phase 1.

Correlations here were performed to address the following questions.

(a) Which psycholinguistic variables influenced naming performance of PwAs?

(b) What is the nature of relationship between each psychometric variable tested here and naming performance in PwAs?

18.2.1 Tests for normality and homogeneity of variance

Prior to performing correlations, a Shapiro-Wilk test for normality and homogeneity of variance was performed on all data sets for all three tasks, naming, PS task and SP task. Findings are presented in table 18.9 for object naming scores in phase 3 and related NAS (for objects) and psycholinguistic ratings in the MLS, BLS and BLE language conditions. Table 18.10 includes the same for action naming scores.

Table 18.9: Shapiro-Wilk findings for object naming

	MLS			BLS			BLE		
	Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
AoA	.932	69	**.002****	.952	69	**.010****	.960	69	**.027***
Familiarity	.908	69	**.000*****	.658	69	**.000*****	.716	69	**.000*****
Imageabilty	.416	69	**.000*****	.698	69	**.000*****	.718	69	**.000*****
Visual Complexity	.527	69	**.000*****						
Word length	.940	69	**.002****	.874	69	**.000*****	.855	69	**.000*****
NAS	.759	69	**.000*****	.232	69	**.000*****	.675	69	**.000*****
PwA naming scores	.978	69	.277	.952	69	**.010****	.951	69	**.009****

Note: *p≤0.05; **p≤0.01; ***p≤0.001

Table 18.10: Shapiro-Wilk findings for action naming

	MLS			BLS			BLE		
	Statistic	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**	**Statistic**	**df.**	**Sig.**
AoA	.912	38	**.006****	.896	38	**.002****	.963	38	.241
Familiarity	.703	38	**.000*****	.672	38	**.000*****	.804	38	**.000*****
Imageabilty	.588	38	**.000*****	.738	38	**.000*****	.809	38	**.000*****
Visual Complexity	.600	38	**.000*****						
Word length	.852	38	**.000*****	.782	38	**.000*****	.845	38	**.000*****
NAS	.808	38	**.000*****	.688	38	**.000*****	.728	38	**.000*****
PwA naming scores	.969	38	.355	.955	38	.126	.958	38	.157

Note: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

All data sets showed to be not normally distributed for all of the above except for MLS and BLS PwA (phase 3) data in object naming and BLE AoA data, MLS, BLS and BLE PwA data for action naming,

18.2.2 Selection of statistical tests

Spearman's rank correlation coefficient (spearman’s rho) was used for all analyses. No Bonferroni adjustment was applied here.

18.2.3 Findings in correlation analyses

Tables 18.11 and 18.12 below present correlation findings between naming scores of PwAs in phase 3 and the psycholinguistic variables rated in phase 1 for objects and actions respectively.

Table 18.11: Correlations between PwA scores and psycholinguistic variables for objects (n=69)

Data set	NAS	AoA	Familiarity	Imageability	VC	Word Length
MLS PwA	R= 0.328 + p =.006 *	R= -0.221 + p =0.068	R=0.188 + p =.122	R=0.310 + p =.009*	R=0.316 + p =.008**	R=0.032 + p =.791
BLS PwA	R=0.389 + p =.001**	R= -0.525 + p =.000 **	R=0.399 + p =.001 **	R=0.484 + p =.000 **	R=0.156+ p =.201	R= -0.248 + p =.040 *
BLE PwA	R=0.358 + p =.003*	R= -0.334 + p =.005 *	R=0.404 + p =.001 **	R=0.431 + p =.000 **	R=0.094 + p =.440	R= -0.227 + p =.061

* Significant at $p \leq 0.05$ ** $p \leq 0.001$
+ Spearman's rho

Table 18.12: Correlations between PwA scores and psycholinguistic variables for actions (n=38)

Data set	NAS	AoA	Familiarity	Imageability	VC	Word Length
MLS PwA	R=0.354 + p =.029 *	R=0.345 + p =.034 *	R=0.456 + p =.004 *	R= -0.066 + p =.694	R=0.378 p =.019 *	R= -0.266 + p =.107
BLS PwA	R=0.293 + p =.074	R= -0.408 + p =.011 *	R=0.183 + p =.255	R=0.391 + p =.015*	R=0.054 + p =.201	R= -0.200 + p =.230
BLE PwA	R=0.608 + p =.000 **	R= -0.563 + p =.000 **	R=0.319 + p =.051	R=0.513 + p =.001 **	R=-0.180 + p =.278	R= -0.014 + p =.936

* Significant at $p \leq 0.05$ ** $p \leq 0.001$
+ Spearman's rho

Analysis for nouns showed significant relationships for NAS and imageability across all language conditions. AoA and familiarity were significant in both bilingual language conditions while VC was significant in only the MLS language condition.

For actions, only AoA was significant for all language conditions. NAS was significant for the MLS and BLE language conditions and imageability for both BL language conditions. Familiarity and VC was significant in only the ML language condition.

18.3 Summary

This section presents correlation statistics for investigating (a) Task specific effects on noun/object- verb/action production (b) the influence of selected psycholinguistic variables on PwA naming in phase 3.

Findings for (a) showed only a few correlations to be significant. No consistent trend was noted. All pairwise correlations performed across the tasks in the PwA language conditions were positively correlated. A few illogical negative correlations were noted in the HC group.

Findings for (b) showed a significant correlation for NAS and imageability in object naming across all PwA language conditions. Familiarity and AoA were significantly correlated with object naming only in the BL groups. For actions, AoA was significant across all groups while imageability was significant only in BLs. For both object and actions VC was significant only in the MLS language condition.

Findings are further discussed in chapter 18.

Chapter 19: Interim Discussion 3

19.0 Overview

This chapter includes a discussion research questions vi and vii outlined in chapter 1 section 1.6.2 (see pg.14)

19.1 Impact of psycholinguistic variables on naming

The effect of psycholinguistic variables on object and action naming accuracy was investigated only for PwAs recruited to phase 3 of this study. Due to the data being non-normally distributed it was not possible to conduct multiple regression analyses and only correlations were completed.

In object naming, NAS and imageability scores obtained in phase 1 significantly correlated with PwA naming accuracy, across all three language conditions. Familiarity and AoA were also significant for both bilingual conditions BLS and BLE, while visual complexity was also a significant factor for the ML condition. Word length was a significant factor for the BLS language condition.

For action naming age of acquisition correlated with naming accuracy scores in all PwA language conditions. Imageability was also significant in both BL language conditions BLS and BLE. Familiarity and visual complexity were also significant factors in the ML condition. Word length was not significant in any language conditions.

In terms of NAS, reported research (e.g.Vitkovitch and Tyrrell, 1995) have largely focused on name agreement suggesting that higher naming accuracy is retained for words with fewer alternative names. Similar findings have been reported for other languages including Spanish (Rodriguez-Ferreiro et. al., 2009), French (Kremin et. al., 2001) and Persian (Nilipour, Bakhtiar, Momenian & Weekes, 2017). The influence of name agreement on action naming performance has been less investigated in comparison to object naming. Despite this, there is evidence that the name agreement variable is similarly influential in action naming (e.g. Kemmerer & Tranel, 2000). Name agreement is also known to differ across word classes, languages and populations (Sirois et. al., 2006) which may perhaps explain the variations across significance levels and effect size in the MLS, BLS and BLE language conditions for objects and actions.

The presence of a significant relationship for imageability implied that more imageable words led to better performance on object naming. In aphasia, words with higher imageability are thought to be better preserved due to the higher quantity of semantic representation nodes (Plaut & Shallice, 1993). This is in agreement with previous studies that indicated imageability as a strong predictor of PwA naming performance at single word level in monolinguals (Nil pour, Bakhtiar, Momenian & Weekes, 2017; Bird et.al, 2003; Berndt, Haendiges, Burton & Mutchum, 2002; Luzzatti et. al., 2002; Nickels & Howard, 1994) and also in bilingual speakers (e.g. Poncelet, Majerus, Raman, Warginaire & Weekes, 2007; Kiran & Tuchtenhagen, 2005). Paivio and Desrochers (1980) based on the dual coding theory note that separate verbal and imagery systems are present in L1 and L2 for both concrete and abstract words but interconnects to form a shared image system only for concrete words thereby allowing access in either language. Similarly, Van Hell and de Groot (1998) note that concrete words differ from abstract words based on the higher amount of conceptual elements shared between L1 and L2 for the more imageable concrete words.

Poncelet et. al. (2007) in a study involving bilinguals noted that imageability was a stronger predictor for object naming than for action naming. A similar pattern is reflected in this study. Conversely, there have also been studies that suggest a lesser influence of imageability on aphasic naming (e.g. Cuetos, Aguado, Izura & Ellis, 2002 in Spanish). It is possible that these differences may occur due to differences in test methods and particularly in the tested study sample).

Numerous studies on healthy speakers have shown AoA to be a critical factor in monolingual (Ellis & Morrison, 1998; Vaskevitch & Tyrrell, 1995) and bilingual (e.g.

Hirsh, Morrison Gasket & Carnicer, 2003) speech output. These imply that better naming scores for words that are learnt early as explained by the logged model (Morton, 1969). In bilinguals, this has been based on two possible viewpoints (Morrison, Hirsh, Chapel & Ellis, 2002). One is that similar to that in monolinguals early-acquired lexemes, particularly in L2 can be accessed more efficiently that the later-acquired ones. Alternatively, better established connections could be predicted between conceptual representations and early-acquired words in L2. Morrison et. al (1992) note that in aphasia, the effect of AoA on PwAs may possibly imply that words learnt in early childhood may resist the effects of brain lesion than word learnt later (also see, Brysbaert & Ellis, 2015).

The fact that AoA was statistically significant for both BL groups (BLS and BLE) for both action and object naming in this study suggests AoA to be strongly influential in bilingual PwA speech production. However, these findings need to be viewed cautiously as AoA is also thought to be highly correlated with familiarity, resulting in a cumulative effect (Lewis, Gerhand & Ellis, 2001; Nickels & Howard, 1995; Bonin et.al., 2003; Brown & Watson, 1987).

In this study familiarity replaced frequency as it better distinguishes metaphoric and actual usage of the word (Colombo et. al. 2006; Snodgrass & Vanderwart, 1980). The significance of familiarity in bilingual naming performance may be a critical factor based on the fact that bilinguals may differ in usage and proficiency between their L1 and L2 (de Groot & Christoffels, 2006). Support for this premise could be drawn from Hernandez and Kohnert (1999) who suggests that higher familiarity through continuous and prolonged use of both L1 and L2 is perhaps a stronger influential factor in bilingual speakers.

Findings in this study suggest that in bilinguals, familiarity was significantly related with object naming scores but not with action naming. Evidence suggestive of higher familiarity effect on objects than actions have been reported (Law, Kong, Lai & Lai, 2015). However, as noted before, further analyses is required to eliminate the possibility of a cumulative effect of AoA and familiarity on naming.

A noteworthy finding in this study was that visual complexity, for which data was obtained form only the ML group in phase 1 was significantly correlated with only the MLS PwA naming scores, for both object and action naming.

The lack of VC effect in both object and action naming for both BL language conditions is in agreement with studies that have previously reported the absence of a VC effect in naming (e.g. Nickels & Howard, 1994). It has also been suggested that VC is a less important factor in aphasia but rather more important in those with visual agnosia. However, the fact that results of this study showed VC to be influential only for the ML group that rated it is in agreement with previous findings from Sirios et. al., (2006) and Britt, Ferrara and Mirman (2016) who noted that the influence of VC on naming performance is possibly more population dependent that it is known to be. In this study, only by the ML group rated all OANB items for VC.

Word length is recognized as an influential factor in naming (Meyer, Roelofs & Levelt, 2003). This is particularly true to bilinguals as word length for a given item may significantly differ between L1 and L2. The effect of word length was shown here although the effect was significant only in the BLS language condition for object naming.

Previous studies testing the effect of psycholinguistic variables on naming have reported mixed results as above (e.g. Edmond & Donovan, 2012). Although the data obtained here provide preliminary findings for Sinhala MLs and Sinhala-English BLs further analysis is required to draw definite conclusions.

19.2 The relationship between naming and connected speech tasks

Reports of PwAs who perform better in connected speech than in single word naming have been reported before (e.g.Kambanaros & Steenbrugge, 2006; Pashek & Tompkins, 2002; Zingeser & Berndt, 1990). Inverse profiles of PwAs with better performance in single word naming are also known (e.g. Wilshire & McCarthy, 2002; Manning & Warrington, 1996). The differences have been attributed to variations in cognitive demands (e.g. attention, memory) and linguistic factors (e.g. syntactic formulation, pragmatic factors) across the tasks (Fergadiotis & Wright, 2011; Pashek & Tompkins, 2002; Penn, 2000).

In this section, scores between tasks (that is, naming, PS and SP tasks) were compared to evaluate the relationships between the tasks and cast light on whether the tasks were addressing the same language processing function. In general this was the case, with most pairs of presumed related tasks positively correlating with each other and only a few were illogical.

In the PwA group a significant relationship was observed between the naming and SP task for the BLS and BLE language conditions and for the naming and PS task in the BLE language condition.

In the HC group, a significant relationship was noted only between the picture naming and SP task for action-verb correlations. Findings here were inconclusive in contrast to studies, which have predicted the presence (Herbert et. al., 2008) or absence (Mayer & Murray, 2003) of strong relationships between single word production and discourse tasks. Mixed results have been reported in previous studies investigating relationships between naming and narrative tasks (Berndt et. al., 2002; Pashek & Tompkins, 2002).

Task choice has been shown to be a significant influence in naming performance (Law, Kong, Lai & Lai, 2013). The difference between word production ability across tasks has been associated with a number of task related attributes including methods, stimuli, assessment measures and analysis, which may contribute towards these differences between studies. For example, the Herbert et. al (2008) study differs from the present study as it compares naming to a discourse sample obtained in a home setting, using a comprehensive analytical tool for discourse with multiple measures. As a result, comparison across studies investigating the same may be challenging.

Chapter 20: Implications, Limitations and Future directions

20.0 Contributions to research

This study is one of the very few behavioural studies that report a better performance in language production tasks for bilinguals than monolinguals. Comparisons made between the bilinguals' languages showed a symmetrical impairment across the bilinguals' languages. An error analysis showed varied of patterns of code mixing, which were influenced by word class and language task. The effect of language conditions on the psycholinguistic properties of pictured items and their subsequent differential influence on naming performance was noted.

This study provides a number of contributions towards research in Sri Lanka. This is the first extensive study on language production, word class effects and language task effects in Sinhala monolingual and Sinhala-English bilingual speakers with and without aphasia. Aphasia studies in bilinguals is a timely need given that there is a clinical caseload shift towards speakers of multiple languages in Sri Lanka, as it is around the world. This study therefore provides a valuable insight on aphasia research in bilingualism and a basis on which similar research could develop.

To date, there is no published assessment material for speakers of native languages in Sri Lanka. As a result, a majority of research depends on translations and adaptations of foreign developed material. This study provides detailed guidelines on methods and protocols that should be followed in adapting and translating test materials developed for speakers of other languages.

Alario and Ferrand (1999) note that the lack of a normative database for speakers of any language may result in researchers developing highly idiosyncratic tests. This subsequently affects the reliability of data and the ability to compare between studies. The preliminary normative data base for both ML Sinhala and BL Sinhala- English speakers presented in this study will be useful in future research of similar interest. This study also presents a preliminary database for Sinhala ML and Sinhala-English BL speakers with aphasia, which is useful for future aphasia studies. The coding system developed specifically for Sinhala ML and Sinhala- English BL speakers, both healthy and PwA is beneficial for studies involving response coding methods in naming or connected speech tasks.

On a larger scale, this study also contributes to the cross-linguistic database investigating word production for both nouns and verbs in both monolinguals and bilinguals across a different language tasks. It also includes specific information in test development, administration and findings where Sinhala differed from English and also where Sri Lankan English differed from other native English speakers. This is of use to other non-English researchers who may embark in similar research in the future.

20.1 Contribution to clinical practice

This study provides a set of normative data for use. The normative data were obtained across a number of adapted and developed tasks and across participants ranging between 18-70 years of age. This allowed clinicians to note that impairments in aphasia need to be viewed against healthy ageing related performance decline.

This study contributes towards a number of other important clinical implications. Firstly, it asserts on the importance of testing participants across different language contexts and tasks, clinically. It also provides guidelines to clinicians in the Sri Lankan context who engage in developing informal assessments for day-to-day clinical use by pointing out on the test design and protocol features that could be generally applied to both monolingual and bilingual speakers and also those aspects that needs to be differed between the groups. This study also produced several novel materials along with normative and PwA data for the same. Importantly it also developed a comprehensive, yet concise and PwA-friendly language proficiency questionnaire, which could be used to draw critical language, related information in aphasia clinically. Findings also outline the barriers faced in adapting formal commercially available test material in to Sinhala and methods followed in overcoming the same. The design features in adapting assessments are of critical use to clinicians who quite frequently use assessment material developed for foreign language speakers.

Yet another significant clinical contribution was that the study developed a comprehensive coding system for analyzing response in picture naming and two types of connected speech. The coding system and methods used in the analysis of response accuracy, error analysis and subsequent comparison of data across tasks are of significant importance to clinicians. It also emphasizes on the differences that may exist in the choice of methods selected for the analysis of data and the influence of the selected method on subsequent findings.

20.2 Limitations in the study

This research is the first study involving an in-depth linguistic analysis with Sinhala-English bilingual and Sinhala monolingual speakers with and without aphasia. Due to the unavailability of norms or previous research data, this study was designed in three phases which began with developing tools, collecting norms, pilot testing on PwAs before collecting the actual PwA data which analysed and inferences drawn. As it is in research, this study has several methodological limitations, which should be of importance in the planning and implementation of similar research in the future.

Firstly, Sri Lanka lacks standardized and published assessment material developed for Sinhala speakers or Sinhala-English bilinguals. As a result, a significant amount of time and effort was taken in selecting suitable material developed for English speakers, translating and adapting these tests and assessing healthy speakers for normative data.

A related issue here was the linguistic differences between Sinhala and English (e.g. differences in tenses between the target word in English and the NAS established target word in Sinhala, single word actions in English when translated to Sinhala were two words) and within Sinhala (e.g. the existence of a large number of borrowed or loan words from English, target English words when translated led to a polysemous Sinhala word, the numerous forms and dialects of Sinhala), which posed a significant methodological challenge in the attempt to establish maximum symmetry between the original test material and its translated version.

Picture naming was assessed with the OANB, a published picture naming test for English speakers. In doing so, a single group of participants were involved in establishing a NAS and rating for all other selected psycholinguistic variables. Stimuli were later selected based on the NAS. A number of disadvantages arose from this. Almost always, items with higher NAS were scored better on some or all of the rated psycholinguistic variables. For participants, identifying the stimulus often led to them rating it high in imageability, visual complexity, familiarity and at times low on AoA. It was noted that 100% of object items and 100% of action items were rated above 4 for familiarity, Imageabilty and visual complexity. For AoA 94.2%, 97.1% and 79.7% of the object items and 92.1%, 89.5% and 73.7% of the action items were rated as < 3 by the monolinguals, bilinguals in Sinhala and bilinguals in English, respectively. Since items were selected based on NAS a 100% of the items had a NAS score of >80%. As a result, the selected sub-set used for subsequent testing lacked diversity for the variables selected. This resulted in a less diverse stimuli set for reliably testing the actual influence of the variable on naming performance. The need for matched sets of stimuli to disentangle effects of variables that are intercorrelated has been noted before (Nickels & Howard, 1995). Future studies should attempt to recruit separate groups of participants for naming and also select stimuli based on an item-based analysis to ensure a better distribution of lexical and psycholinguistic properties across test items.

Normative data obtained in phase 1 involved 30 monolingual and 45 bilingual speakers. A larger sample size could have been favourable for several reasons. Firstly, it would have reduced the task load on participants, particularly on bilingual speakers leading to shorter test times and more reliable data. Secondly, given that this study is the first time that such normative data have been collected from Sinhala monolingual and bilingual speakers, a larger sample normative database would have been advisable. Wang and Chen (2005) note a sample size of 100 or more is advisable in order to ensure reliable data.

There was also no discrimination between the aphasia types or severity for PwA speakers of phase 3. Participants were compared across only 3 CAT tasks and no composite scores were calculated. The severe limitations placed on the ability to draw inferences from group data in aphasia have been noted citing the extreme heterogeneity in the aphasia population (Caramazza & Hillis, 1990). Future studies involving speakers with aphasia should attempt to establish sample homogeneity based on findings from language profiling tests.

20.3 Future directions

Despite the above-listed limitations, this study marks the first ever attempt to investigate word production in the Sri Lankan monolingual and Sinhala-English bilingual speakers in Sri Lanka. It is also the first to describe code-mixing behaviour in monolingual Sinhala speakers and also be true to other unknown bilingual contexts.

Findings from this study can be used for similar research, recruiting a larger number of participants, particularly when establishing normative data. Further extensions to this study could involve reinvestigating the same after addressing the identified limitations. An individual analysis of PwAs could also be incorporated for understanding the relationship between their error types and locus of language breakdown, which then can be compared across MLs and BLs and also between the languages spoken by the BL. The study design implemented in this study for developing novel material, obtaining population specific data and constructing language specific coding systems can used in constructing assessment tools and also in future studies of similar interest.

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Lexical retrieval in bilingual Sinhala-English and monolingual Sinhala healthy speakers and speakers with aphasia

Volume II

A thesis submitted for the requirement of the degree of

Doctor of Philosophy in Human Communication Sciences

Dinushee Atapattu-Bakmeewewa
Department of Human Communication Sciences
Faculty of Medicine, Dentistry and Health
University of Sheffield

December 2017

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The University Of Sheffield.

Antonella Dinushee Shihani Atapattu <aatapattu1@sheffield.ac.uk>

Fwd: Comprehensive aphasia test

Ruth E Herbert <r.herbert@sheffield.ac.uk> 22 November 2017 at 01:08
To: aatapattu1@sheffield.ac.uk

Hi
Good news in a bad day from the CAT publishers. Can you print this out to include in thesis?
Phew

R

Sent from my iPhone

Begin forwarded message:

From: Academic Books Permissions <mpkbookspermissions@tandf.co.uk>
Date: 21 November 2017 at 13:44:09 GMT
To: Ruth E Herbert <r.herbert@sheffield.ac.uk>
Subject: RE: Comprehensive aphasia test

Dear Dr Herbert

-

9781841693798 | COMPREHENSIVE APHASIA TEST | Edn. 1

-

Further to your email, permission is granted for use of the above material in your Students forthcoming PhD, subject to the following conditions:

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From: Parker, Adele
Sent: 20 November 2017 13:56
To: Ruth E Herbert <r.herbert@sheffield.ac.uk>
Cc: Davey, Sarah <Sarah.Davey@tandf.co.uk>
Subject: RE: Comprehensive aphasia test

Dear Ruth

Thank you for your email. I think a free of charge permission licence would be the best way forward. I've copied in my colleague Sarah who can assist.

Best wishes

Adele

Adele Parker

Rights Manager

Taylor & Francis Group

3 Park Square

Milton Park

Abingdon

OX14 4RN

Direct line: +44 (0) 207 017 6183

Email: adele.parker@tandf.co.uk

www.tandf.co.uk

LANGUAGE PROFICIENCY QUESTIONNAIRE

Note: This form is to be completed by the researcher or the research assistant based on information received from participants. It is mandatory that this form is completed for <u>both</u> groups of participants; that is, Persons with Aphasia (PwA's) and normal controls. In the event that the participant with Aphasia is unable to provide the needed information, a significant other, familiar and well known to the participant may contribute.

Details should be clearly written ahead of each question or as instructed. When required, indicate irrelevant questions as 'NA' (Not Applicable)

---

1. General information on language:

1.1 Select the participant's native language (L1)

	Sinhala
	English
	Other

1.2 Do you speak other language(s) (L2)? Yes/No

1.3 If 'Yes' in 1.2, please list languages in the box below.

2. Information on the participant's native language (L1)

2.1 Was Sinhala acquired before the age of 12 years? Yes/No

2.2 Was the participant able to carry out a conversation competently in Sinhala, by the age of 10 years? Yes/No

2.3 Was the participant able to read and write Sinhala, by the age of 12 years? Yes/No

2.4 Rate the participant's proficiency in Sinhala (*To be rated by the participant*)

1	2	3	4	5
Poor	Marginal	Average	Good	Excellent

2.5 Estimate the participant's functional use of Sinhala on a routine day *(To be rated by the participant)*

1	2	3	4	5
<25%	25%	50%	75%	100%

3. Information on the participant's other language

3.1 Was English acquired after Sinhala? Yes/No

3.2 How was English acquired?

3.3 Was the participant able to carry out a conversation competently in English by the age of 10 years? Yes/No

3.4 Was the participant able to read and write in English by the age of 12 years? Yes/No

3.5 Rate the participant's proficiency in English (*To be rated by the participant or significant other*)

1	2	3	4	5
Very Poor	Poor	Average	Good	Excellent

3.6 Estimate the participant's functional use of L2 on a routine day *(To be rated by the participant or significant other)*

1	2	3	4	5
<25%	25%	50%	75%	100%

4. Please strike off the irrelevant response

- The language spoken mostly at home is ____________ *English/Sinhala/Equal use in both languages*
- The language (which used to be) spoken mostly at work is ________ *English/ Sinhala/ Equal use in both languages*
- When talking to someone (equally proficient in both Sinhala and English), I am most comfortable speaking in _________________ *Sinhala/English/ Either language*
- I prefer watching television in ____________ *Sinhala/English/Either language*
- If given a text to read, I prefer it to be in _____________ *Sinhala/ English/ Either language*
- When writing a quick note to someone who understands both languages, I would be most comfortable writing in ________________ *Sinhala/English/ Either language*

CASE HISTORY FOR PARTCIPANTS

***Note**: This form is to be completed by the researcher or the research assistant based on information received from participants. It is mandatory that this form is completed for both groups of participants; that is, Persons with Aphasia (PwA's) and normal controls.*

In the event that the participant with Aphasia is unable to provide the needed information, a significant other, familiar and well known to the participant may contribute.

Details should be clearly written ahead of each title or as instructed. Indicate irrelevant sections of information as 'NA' (Not Applicable)

I. Personal Details(

Name (

Gender (

Date of Birth (

Age in years completed (

Highest level of education (

	No formal education
	Primary education
	Secondary education or higher

Primary (Pre morbid) occupation (

II Physical and Medical status (

Current setting (

	Hospital based
	Institutionalized
	Home based

(Pre morbid) handedness :

	Right handed
	Left handed
	Ambidextrous

Is the participant able to read with or without the use of reading glasses?

☐ Yes
☐ No

Is the participant able to hear with or without the use of a hearing aid ?

☐ Yes
☐ No

III. Neurological Details (

Time since of Onset of Aphasia *(in months)* **:** ☐☐

Information based on CT findings: *(note down information written down on medical report)*

Stroke related signs (

Sign		**YES**	**NO**	**Comment**
Dysarthria				
Apraxia				
Hemiplegia				Side of weakness: Left/ Right
Hemianopia				Side of visual blindness: Left/ Right

Is the participant's speech intelligible to the clinician at the time of assessment?

☐ Yes

☐ No

Does the participant show signs of memory loss or confusion at the time of assessment?

☐ Yes

☐ No

IV. Speech-Language and Communication Status :

Current verbal fluency Level (

☐ Verbal Fluent Aphasic

☐ Verbal Non fluent aphasic

Intelligibility *(perceptual measurement of intelligibility- to be rated by the researcher)*

1.	Completely intelligible in conversation
2.	Mostly intelligible in conversation
3.	Somewhat intelligible in conversation
4.	Mostly unintelligible in conversation
5.	Completely unintelligible in conversation

Nature of Verbal Communication Difficulties

Communication area	**Comments** *(Identify deficits in aspects indicated in italics)*
Spontaneous speech *(Comment on information content, grammatical competence and fluency)*	
Auditory verbal comprehension (*(Comment on stimulus complexity, ability to distinguish between words and non words and response time)*	
Word finding/Naming (*Comment on stimulus type, cues or contexts that facilitate word finding. Also types of errors observed*)	
Word fluency *(test by asking participant to name as many items as possible in a selected category within 1 minute. Note response rate and errors, if any)*	

Repetition *(Comment on ability to repeat stimulus immediately and with delay, repetition of words and non words and effect of stimulus complexity)*	
Verbal concept formation/ Story telling *(Comment on information content, fluency and grammatical structure. Note errors)*	
Memory for verbal information *(Comment on verbal errors and/or errors due to declined STM)*	
Reading skills *(Comment on ability to identify letter, read and match word to picture. Note errors in response and also cues or contextual facilitators)*	
Writing skills *(Comment on clarity of written output, ability to copy and errors in dictation)*	

V. Social History

Areas/topics of interest (

Family support and information on frequent communication partners (

Strategies used to increase efficiency in functional communication *(list here)***:**

TO BE FILLED BY CLINICIAN (

Does the participant fulfill the criteria required to be qualified as eligible for the current study? Yes/No

Date and time assigned for participant ....………………….............................

Ethics Review Committee

A SIDCER(Strategic Initiative for Developing Capacity in Ethical Review)recognized ERC

Faculty of Medicine,University of Kelaniya, Sri Lanka
FWA00013225

18.11.2015

Ref. No. P/183/11/2015

Ms. A.Dinushee.S. Atapattu Bakmeewewa
Lecturer
Dept. of Disability Studies
Faculty of Medicine
Ragama.

Subject: Lexico Syntactic Retrieval and Cohesive Speech In Sinhala-English Speaking Bilingual Aphasics

Authors: A.Dinushee.S. Atapattu- Bakmeewewa

Thank you for submitting the above research proposal. Ethics Review Committee which met on 17.11.2015 granted conditional approval to the above study and made following suggestions.

Make Participants Information Sheet relevant and summarized.

Include ERC contact details in the Participants Information Sheet.

With best wishes,

Yours sincerely,

Dr. W.N.S. Perera
Secretary/ERC

Address all correspondence to: Secretary, Ethics Review Committee,
Faculty of Medicine, University of Kelaniya, PO Box 06, Thalagolla Road, Ragama, Sri Lanka.
Telephone: +94 -112961000, Fax : +94-112958337 /+94-112955280

The University Of Sheffield.

Downloaded: 06/10/2015
Approved: 01/10/2015

Antonella Dinushee Shihani Atapattu Bakmeewewa
Registration number: 120113587
Human Communication Sciences
Programme: Human Communication Sciences (PhD/Human Comm Sciences PT)

Dear Antonella Dinushee Shihani

PROJECT TITLE: Lexico Syntactic retrieval and cohesive speech in Sinhala-English speaking bilingual aphasics
APPLICATION: Reference Number 006298

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 01/10/2015 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 006298 (dated 09/09/2015).
- Participant information sheet 1012253 version 1 (09/09/2015).
- Participant consent form 1012252 version 1 (09/09/2015).

The following optional amendments were suggested:

Please carefully proofread the Participant Information Sheet; there are some typos and duplicated words. Additionally, this should be shortened. The descriptions of the staff involved should be edited down, and their pictures need only appear once. Their details could also be moved to the end of the PIS, rather than at the beginning. Some consideration should be given to the assignment into monolingual/bilingual groups by the researcher. Might a potential participant be upset if s/he rates his bilingual language ability higher than the researcher? This doesn't require any amendment to any documents, but is simply something the researcher is urged to consider. In the LPQ, many of the questions seem rather odd (e.g., did you acquire your L1 before the age of 12 years; did you acquire your L2 after your L1?) Please review this with your supervisor(s) before attempting to administer it.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Rachel Ralph
Ethics Administrator
Human Communication Sciences

The University Of Sheffield.

Volunteers needed

→ Are you over 40 Years of age?

→ Do you speak and understand Sinhala and/or English?

→ Can you spare a few hours to take part in a research study?

I am looking for volunteers to take part in a study that investigates language skills after stroke.

People with stroke often have difficulties with language, a condition known as Aphasia.
We want to see how, previously known languages behave in a person with aphasia.

Your participation will tell us how the healthy brain processes the languages you know

If you volunteer, you will have to participate in two or three short testing sessions involving;

- Simple problem solving tests involving language
- Naming pictures on a computer
- Rating pictures/words on a computer
- Describing a picture or event

I am able to see you at the nearest hospital, clinic or in the community. Home visits can also be arranged.

We can arrange for mutually convenient dates and times.

If you are interested or want to know more, contact me on, 0779427481/ 0112053299 or email at, aatapattu1@sheffield.ac.uk

Head of Department
Prof. Patricia Cowell BA, MS, PhD

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http://www.kln.ac.lk/medicine/

DETERMINING THE ABILITY TO RETRIEVE WORD NAMES IN ISOLATION AND IN CONNECTED SPEECH

The following information sheet describes a research project at the University of Sheffield in the UK, which is forms the basis of an ongoing doctoral degree. The primary researcher, **Dinushee Atapattu-Bakmeewewa** is enrolled as a Part time distance-learning Post Graduate Research candidate since 2012. Her PhD study **looks at language after stroke in people who speak Sinhala and in people who speak English and Sinhala.**

This is the **first phase of the study's data collection**. The primary aim of this phase is to develop culturally appropriate test material, including the trialing of several published international language tests.

As a participant of this research study, it is important to know what the study is about and your role in it, as well as your rights as a participant. Kindly take a few minutes to read the detailed information sheet below.

THE RESEARCH TEAM

Primary researcher: Dinushee Atapattu-Bakmeewewa

Supervisors: Dr. Ruth Herbert

Dr. Emma Gregory

- **Dinushee Atapattu-Bakmeewewa- Primary Researcher**

Dinushee Atapattu-Bakmeewewa, a qualified Speech-Language Therapist, will play a lead role in assisting you and guiding you to complete the tasks. She holds a Bachelors Degree in Speech-Language

Pathology and Audiology from The University of Mangalore, India, a Masters Degree in Speech Difficulties from The University of Sheffield, United Kingdom and is currently reading for her PhD at the same. She is registered at the Sri Lanka Medical Council (SLMC Reg. No. 51) and affiliated to the Ragama Medial Faculty as a permanent academic staff member.

- **Dr. Ruth Herbert**

Dr. Herbert is a qualified speech and language therapist with a doctoral degree from University College London. She has been attached to The University of Sheffield since 2003 and is currently the Departmental Director of Research.

Dr. Herbert is registered with the Health and Care Professional Council of UK, Royal College of Speech and Language Therapists and is also and honorary member the British Aphasiology Society. Dr Herbert has been awarded many research grants from the NHS and Stroke Association (UK) for research in Acquired Language Disorders.

- **Dr. Emma Gregory**

Emma Gregory is a Lecturer and course director of the MMedSci program at the University of Sheffield. Having completed her PhD in 2012, Dr. Gregory has worked with adults with acquired neurological communication and swallowing disorders in Mansfield PCT and Sheffield PCT. She holds an honorary contract with Sheffield Children's Hospital NHS Trust.

THE STUDY

WHAT IS THIS STUDY ABOUT?

The primary focus of this study is **language skills after a stroke**. After a stroke, many people have difficulties understanding and using language, which is known as **'Aphasia'**.

Most research has been carried out with English speakers alone. We want to explore language use in Sinhala speakers and in bilingual English-Sinhala speakers.

In this phase, we first take a look at the performance of healthy, non-brain damaged adults on our language tasks.

WHO ARE WE RECRUITING?

We are recruiting **healthy Sri Lankan adults who are functionally, either Sinhala only or Sinhala and English speakers.** Participants will be recruited into **two groups**., the monolingual test group and the bilingual test group.

WHAT IS THE PROCEDURE IF I DO DECIDE TO TAKE PART?

The Screen

We will first conduct a **quick screen, ask a few questions and review your medical records.** N**ot everyone screened, would be able to participate in the study.**

We will then administer a simple **Language Proficiency Questionnaire** and based on your responses, allocate you to a group, that is, the monolingual or bilingual test groups.

The Main Test

In the main testing, you would be required to **name a few pictures/ describe a few pictures/ rate a few pictures** presented on a laptop computer and **participate in a few conversational tasks.**

All tasks will be conducted **only in Sinhala for the Monolingual group** and in **both Sinhala and English for the bilingual group.** Response sheets will be provided for some tasks, while some responses may be **audio recorded**.

WHERE, WHEN AND HOW LONG WILL TESTING BE?

If you are identified as eligible to participate, Dinushee will allocate a mutually convenient date, time and place for testing.

We expect the **screen to last no longer than one hour** and if selected, **the primary testing to last no longer than 2 hours.**

IS IT COMPULSORY THAT I TAKE PART? AND WHAT IF I NEED TO WITHDRAW?

No. It is not compulsory that you take part. Participation is on a **voluntary basis**.

You can withdraw from the study at any time**.**

You do not have to justify your reasons to participate, not participate, or withdraw.

WILL THERE BE ANY PAYMENTS OR REWARDS, IF I AGREE TO PARTICIPATE?

There will be no financial reimbursement of your time.

However, provided that the researcher is unable to visit you at your home or at your closest or regular hospital on a routine Speech therapy clinic day and you travel to a mutually agreed location **specifically for participating in this study**, a traveling cost **exceeding LKR100 but no more than LKR500** will be reimbursed. The participant is required to provide a **signed receipt** in order to claim the travel cost.

CONFIDENTIALITY

WHAT WILL MY RECORDINGS AND TEST RESULTS BE USED FOR?

All responses, recordings and test results will be used in analyzing the outcome of this project alone. The researcher will use analyzed data to **write her doctoral thesis**. She may also present the data at **scientific conferences** and **publish in scientific journals**.

You can consent or refuse for the audio recordings to be used for teaching students, research presentations, and future analyses of the data.

You can consent or refuse for your data to be used in future research.

If you do not wish that your data be used in future research, your data will be destroyed at the **end of this study.**

If you consent to future analysis of the data beyond this study, the researcher will preserve the data under secure conditions.

WILL I BE IDENTIFIABLE AS A PARTICIPANT OF THE STUDY?

No. A strict procedure is implemented to ensure participant confidentiality. As the findings are transferred in to a database or record, data will be **anonymised** such that each participant will be **allocated an identification code**. No participant will be identified by his or her name.

All participant details will be known only to Dinushee Atapattu-Bakmeewewa. All reports of the study will use anonymised identification codes to refer to participants.

However, if you do consent to your audio recordings to be used in future academic or research forums or for the purpose of teaching, there is a possibility that a listener may identify you, **though we ensure that your name would not be used.**

HOW SECURE ARE MY RECORDINGS AND TEST RESULTS?

All audio recordings will be stored securely **in a password locked computer specifically allocated to Dinushee, for use in this project alone**.

All paper-based information will be stored in a **locked filing cabinet**. **Only** the researcher, Dinushee will have access to these.

Dinushee's Supervisors, Dr. Ruth Herbert and Dr. Emma Gregory may also view the electronic recordings and paper-based information, when interpreting the data of this project.

Furthermore **two other externally recruited Speech-Language Therapists (SLTs)** will view partial sections of your data. **The two external SLTs will not have access to the section of responses that is not allocated for being scrutinized by them and therefore will not know your complete assessment responses.** None of the data will be accessible to anyone outside the above-mentioned persons.

POTENTIAL BENEFITS AND RISKS

Risks

The methods of data collection used here are **non-invasive language assessments** and therefore **poses no significant physical risks to**

the participants. However, participants may feel fatigued. **If you feel tired, you may request for a break. You may also request for testing to be stopped for the day and rescheduled.** Throughout testing, Dinushee would provide maximum guidance, support and training to minimize it's adverse effects on the participant.

Benefits

It is unlikely that participation in this study will result in any direct benefits. However, your participation and contribution in this study would **support the cause of developing aphasia research in the Sri Lankan clinical context allowing clinicians to better assess and treat people with aphasia.**

ETHICS AND CONSENT

Dinushee's PhD has been approved by Ethical Review Committees (ERCs) of the University of Sheffield (UK) and the University of Kelaniya's Faculty of Medicine, Ragama (SL).

FUNDERS

WHO ARE THE FUNDING SOURCES IN THIS RESEARCH?

Dinushee's PhD is been funded by grants awarded by the **University of Kelaniya, Faculty of Medicine (Ragama) and University Grants Commission of Sri Lanka.** However no aspect of the participant

recruitment, methods, procedures or data handling of this research study has been subjected to terms and conditions of any awarding agency.

CONCERNS AND COMPLAINTS

I HAVE MORE QUESTIONS/ CONCERNS/ COMPLAINTS. WHO DO I CONTACT?

If you need to know more about this research or anything related, please feel free to contact the researcher, **Dinushee Atapattu-Bakmeewewa** at;

Department of Disability Studies
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Thank you for reading this information Sheet.

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Dean: Prof. Nilanthi de Silva

Control Participant Consent Form

Research Team: Dinushee Atapattu-Bakmeewewa (Researcher), Dr. Ruth Herbert (Supervisor), Dr. Emma Gregory (Supervisor)

Note: *Please read the following and **if** you do agree, initial in the box placed before it.*

1. I have read and understood the information sheet. ☐

2. I was given the opportunity to ask questions. ☐

3. I understand that my participation in this study is voluntary. ☐

4. I understand that my participation in this study does not involve direct personal benefits. ☐

5. I understand that I am free to withdraw at any time of the study, without having to provide any justification and experience no adverse consequences due to withdrawal. ☐

6. I understand that my identity and personal informational will be strictly confidential. ☐

7. I understand that my speech responses will be audio recorded. ☐

8. I understand that all of the recorded responses will be strictly confidential. ☐

9. I give permission for the research team to access my anonymised responses. ☐

10. I agree that my results could be used as data in Dinushee's Doctoral thesis. ☐

11. I agree that my recorded speech and results could be presented as data in scientific and research forums. ☐

12. I agree that data derived from my results could be used in teaching. ☐

13. I agree that data derived from my results could be used in future research. ☐

☐

14. I am willing to participate in this study.

Signature of Participant	Name (in words) of Participant	Date

Signature of researcher	Date

Table 1: Object lists in English (n=125)

Stimulus Number	List 01	List 02	List 03	List 04
01	Iron	Feather	Cheese	Ladder
02	Elephant	Pocket	Frog	Key
03	Heart	Letter	Ticket	Brush
04	Arrow	Sun	Crack	Umbrella
05	Tunnel	Fruit	Bee	Fence
06	Stamp	Bell	Mushroom	Lion
07	Eye	Radio	Fish	Castle
08	Horse	Witch	Clown	Basket
09	Roots	Fork	Library	Tie
10	Square	Grapes	Banana	Judge
11	Leg	Bread	Chain	Leaf
12	pig	Money	Window	Short
13	Book	Tent	Camel	Road
14	Duck	Conductor	Flower	Pond
15	Arm	Shadow	Belt	Cat
16	Tiger	Envelope	Axe	Bedroom
17	Stool	Box	Plug	Shoe
18	Brain	Devil	King	Hat
19	Moon	Flag	Church	Knot
20	Dog	Cow	Bed	Pram
21	Finger	Scissor	Wheel	Bird
22	Hospital	Watch	Clock	Table
23	Map	Tree	Cigarette	Weight
24	Angel	Curtain	Bucket	Nun
25	Candle	Hair	Foot	Roof
26	Butterfly	Shirt	Sword	Bath
27	House	Kitchen	Cork	Office
28	Chair	Drum	Bridge	Sheep
29	Tourist	Triangle	Tongue	Comb
30	Circle	Mouse	Nest	Anchor
31	Garden	bone	Crown	Button
32				Spoon

Table 2: Object lists in Sinhala (n=125)

Stimulus Number	List 01	List 02	List 03	List 04
01	මුද්දරය	කෙස්	ප්‍රවේශ පත්‍රය	කර පටිය
02	ස්ත්‍රික්කය	සාක්කුව	කේජු	යතුර
03	අලියා	මීයා	ගෙම්බා	බූරුැසුව
04	හදවත	ලියුම	පැල්ම	ඉණිමඟ
05	උමඟ	කටුව	මී මැස්සා	වැට
06	ඊතලය	පළතුරු	පල්ලිය	කූඩය
07	සමචතුරස්‍රය	ගුවන් විදුලිය	කෙසෙල් ගෙඩිය	සිංහයා
08	ඇස	මායාකාරී	විකටයා	මාළිගාව
09	මුල්	රැවුල	දම්වැල	පොකුණ
10	කකුල	කමිසය	මාළුවා	විනිසුරුවරයා
11	සිතියම	සල්ලි	පුස්තකාලය	පත්‍රය
12	අශ්වයා	ගැරුප්පුව	ජනේලය	තොප්පිය
13	බංකුව	මෙහෙයවන්නා	කූඩය	ඔටුවා
14	තාරාවා	කූඩාරම	බඳ පටිය	සපත්තුව
15	කොටියා	සෙවනැල්ල	රජතුමා	පූසා
16	පොත	ලියුම් කවරය	ඔරලෝසුව	කොට කලිසම
17	ඇඟිල්ල	පිහාටුව	පේනුව	නිදන කාමරය
18	සංචාරකයා	කොඩිය	මල	ගැටය
19	හඳ	යක්ෂයා	බාල්දිය	ළදරු කරත්තය
20	මොළය	එළදෙන	ඇඳ	පාර
21	රෝහල	අත් ඔරලෝසුව	රෝදය	සමනලයා
22	අත	ගස	පොරව	කුරුල්ලා
23	ඌරා	කතුර	සුරුට්ටුව	බොත්තම
24	සුරදූතයා	තිර රෙද්ද	බිම්මල්	මේසය
25	ගෙදර	පෙට්ටිය	කඩුව	නාන බේසම
26	ඉටිපන්දම	මිදි	ඇබය	වහලය
27	රවුම	බෙරය	පාලම	කන්‍යාසොයුරිය
28	පුටුව	කුස්සිය	දිව	බැටළුවා
29	බල්ලා	ත්‍රිකෝණය	කුරුලු කූඩුව	පනාව
30	ගෙවත්ත	ඉර	ඔටුන්න	හැන්ද
31	නැංගුරම	සීනුව	පාදය	කාර්යයාලය
32				බර

Table 3: Action lists in English (n=94)

Stimulus Number	**List 01**	**List 02**	**List 03**	**List 04**
01	Smoking	Smiling	Planting	Kicking
02	Rocking	Crawling	Crying	Writing
03	Blowing	Bouncing	Drinking	Lighting
04	weighing	Touching	Sleeping	Skating
05	stopping	Kneeling	Praying	Catching
06	cooking	Carrying	Running	Dripping
07	Begging	Watching	Cutting	Ringing
08	Dreaming	Dropping	Drilling	Sliding
09	Sewing	Fishing	Eating	Ironing
10	Kissing	Pouring	Posting	Peeling
11	Biting	Melting	Skipping	Waving
12	Leaning	Knitting	Combing	Swimming
13	Sinking	Flying	Diving	Riding
14	Watering	Stroking	Painting	Licking
15	Reading	Tying	Shooting	Pinching
16	Driving	Washing	Walking	Snowing
17	Sneezing	Raining	Opening	Digging
18	Crossing	Jumping	Playing	Knocking
19	Yawing	Floating	Stirring	Tickling
20	Barking	Sitting	Bending	Shaving
21	Dancing	Weaving	Climbing	Pushing
22	Roaring	Building	Drawing	Bleeding
23	Folding	Pulling	Pointing	Sailing
24		Swinging	Singing	

Table 4: Action lists in Sinhala (n=94)

Stimulus Number	List 01	List 02	List 03	List 04
01	පතිනවා	වහිනවා	අඬනවා	පයින් ගහනවා
02	බර කිරනවා	නරඹනවා	තල්ලු කරනවා	අල්ලනවා
03	හිඟනවා	පොලා පනිනවා	නැමෙනවා	නමනවා
04	සිහින දකිනවා	දණ ගහනවා	ලේ ගලනවා	හිම සරණය
05	මහනවා	අල්ලනවා	යාඥ කරනවා	පීරනවා
06	හැඳිගානවා	ඔසවාගෙන යනවා	කපනවා	කනවා
07	කිවිසුම් අරිනවා	වට්ටනවා	හිටවනවා	කාන්දු වෙනවා
08	පද්දනවා	බඩ ගානවා	විදිනවා	ලිස්සා යනවා
09	සිප ගන්නවා	වියනවා	රැවුල බානවා	නාද කරනවා
10	හපනවා	මාලු බානවා	අඳිනවා	මදිනවා
11	වතුර දනවා	පියාඹනවා	අසු පදවනවා	අත වනනවා
12	උයනවා	දියවෙනවා	දල්වනවා	පීනනවා
13	කියවනවා	ගොතනවා	වෙඩි තබනවා	ලෙලි ගහනවා
14	ඇඹුම් අරිනවා	වත්කරනවා	පිඹිනවා	හාරනවා
15	ධාවනය කරනවා	අත ගානවා	තැපැල් කරනවා	කොනිත්තනවා
16	හේත්තු වෙනවා	දුම් බොනවා	ඉල්පීම	ලෙව කනවා
17	ගිලෙනවා	හෝදනවා	සෙල්ලම් කරනවා	බොනවා
18	බුරනවා	ගැට ගහනවා	අරිනවා	තට්ටු කරනවා
19	පාර පනිනවා	පැද්දෙනවා	කිමිදෙනවා	හිම වැටෙනවා
20	නටනවා	අදිනවා	තීන්ත ගානවා	නිදනවා
21	ගොරවනවා	ඉඳගන්නවා	පෙන්නනවා	කුචි කවනවා
22	ලියනවා	ගොඩනගනවා	ගායනා කරනවා	දුවනවා
23	නවත්වනවා	සිනාසෙනවා	නගිනවා	යාත්‍රා කරනවා
24		පාවෙනවා	ඇවිදිනවා	

CHAPTER 7: Appendix 7.2 - Sample response scales for rating OANB stimulus for AoA, imageability, familiarity and visual complexity in phase 1.

SAMPLE RATING SCALES

1. <u>Rating for Age of Acquisition (AoA)</u>

Response Booklet for rating Age of Acquisition. Actions. English Version

Note: *For each stimulus, mark with a cross, the age band, which corresponds most closely to your response.*

LIST NO…………………

Stimulus number	**Stimulus Name**	**Age band**						
		0-2y	2-4y	4-6y	6-8y	8-10y	10-12y	>13y
1.								
2.								

2. <u>Rating for Imageability</u>

Response Sheet for rating Imageability – Actions – English Version

1.

Difficult to visualize the word	1	2	3	4	5	Easy to visualize the word

3. <u>Rating for Familiarity</u>

Response sheet for rating Stimulus Familiarity- Actions - English Version

1.

Not at all familiar	1	2	3	4	5	Extremely familiar

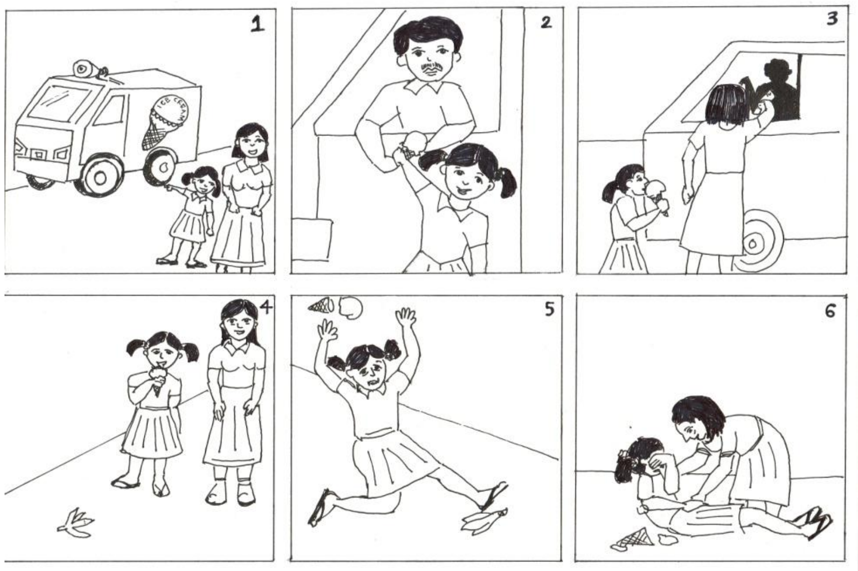
4. <u>Rating for Visual Complexity</u>

Response sheet for rating Visual Complexity – Actions – Sinhala Version

1.

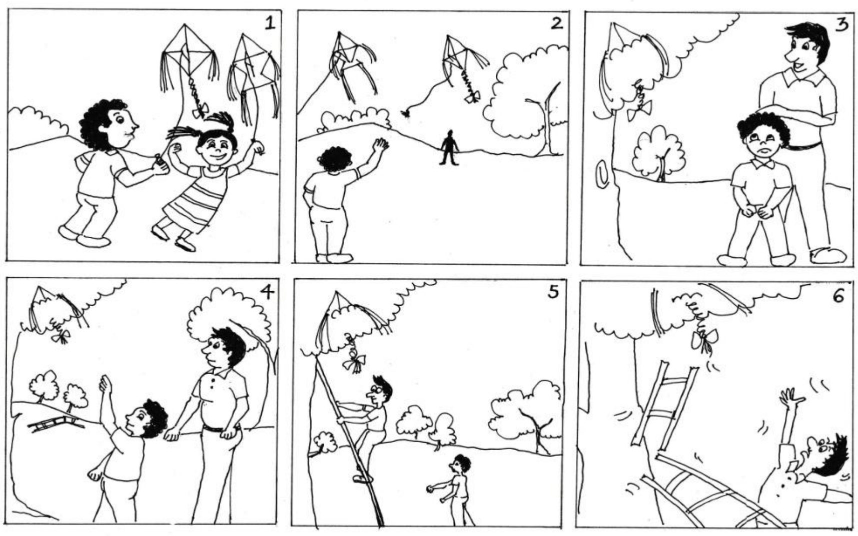
සංකීර්ණ චිත්‍රයකි/ චිත්‍රය තේරුම් ගැනීම අපහසුය	1	2	3	4	5	සරල චිත්‍රයකි/ චිත්‍රය පහසුවෙන් තේරුම් ගත හැක

PS 1

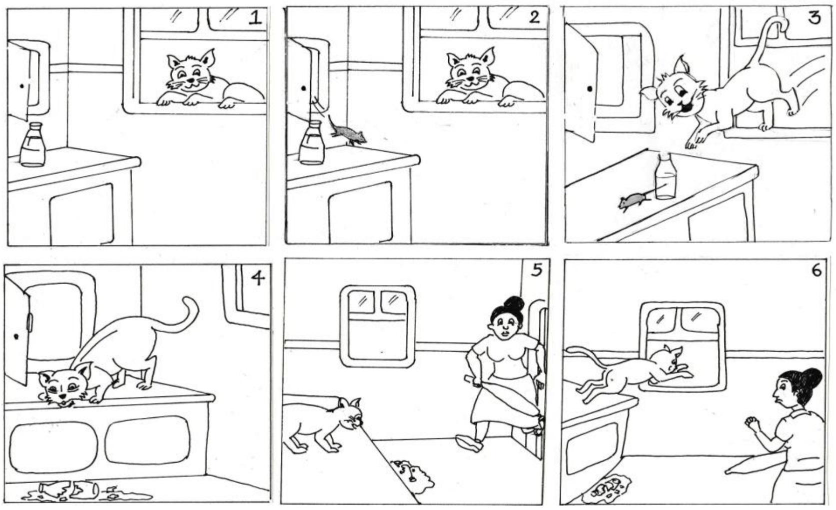


PS 2

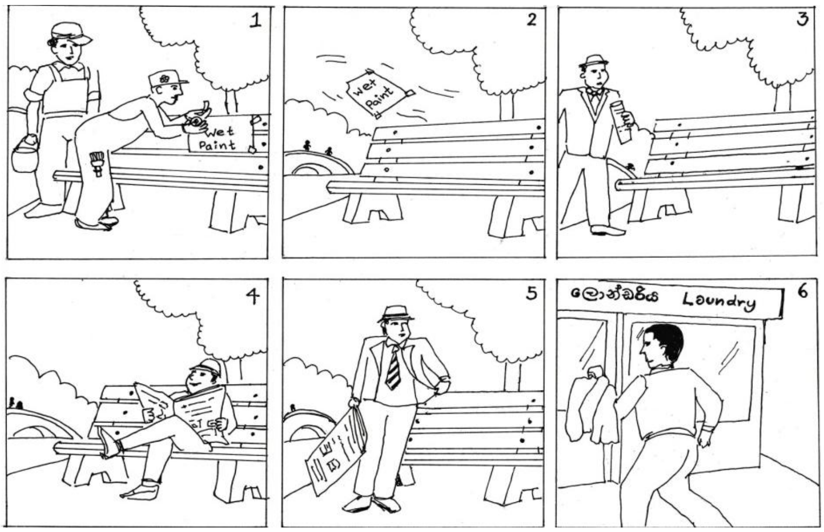
PS 3



PS 4



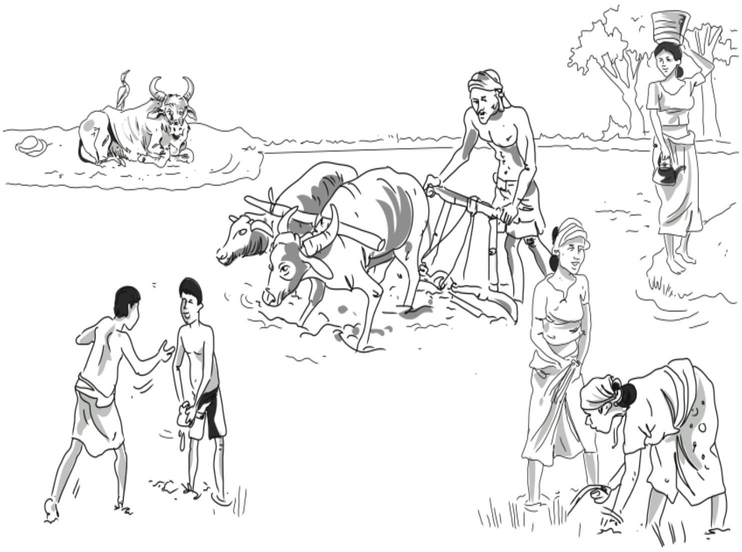
PS 5



SP 1

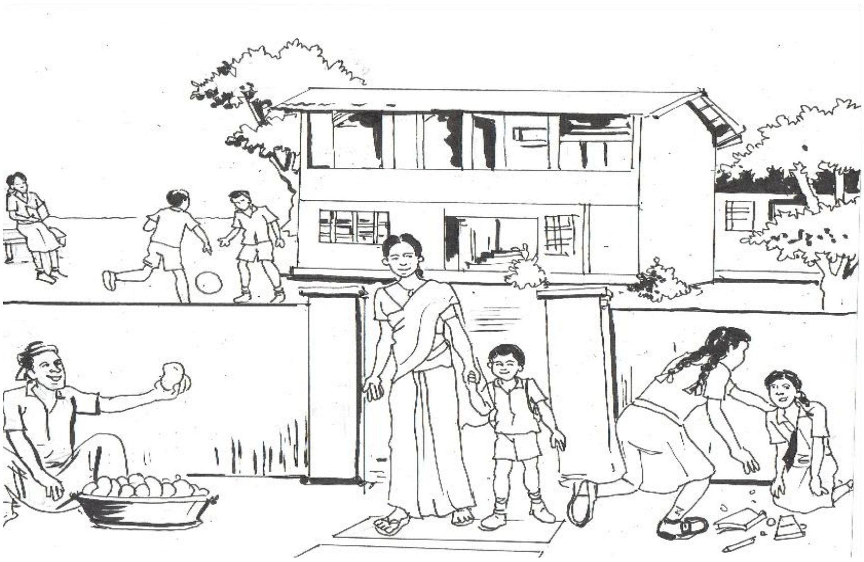
SP 2

SP 3



SP 4

SP 5



Example provided at the start of each booklet

Response Booklet for rating visual complexity. Single Complex Pictures .

චිත්‍රවල සංකීර්ණතාවය ඇගයීම- තනි චිත්‍රය

සහභාගිවන්නන් සඳහා උපදෙස්:

පහත සඳහන් සෑම වචනයක් සඳහා, ඔබේ පිළිතුරට අදාළ අගය සහිත රවුම කතිරයකින් සළකුණු කරන්න. පිළිතුරු දීමේදී, පහත පිළිතුරු උපකාරකය සහ උදාහරණය උපයෝගි කරගන්න.

පිළිතුරු උපකාරකය:

මෙම චිත්‍රය කෙතරම් පැහැදිලිතාවයකින් ඇඳ තිබේද?

උදාහරණය:

චිත්‍ර අංක 1:

Image retrieved at http://maelanie.deviantart.com/art/children-s-playground-142898180

සංකීර්ණ චිත්‍රයකි/ චිත්‍රය තේරුම් ගැනීම අපහසුය	1	2	3	4	5	සරල චිත්‍රයකි/ චිත්‍රය පහසුවෙන් තේරුම් ගත හැක

Rating scale

Response Booklet for rating visual complexity. Single Complex Pictures .

1.

සංකීර්ණ චිත්‍රයකි/ චිත්‍රය තේරුම් ගැනීම අපහසුය	1	2	3	4	5	සරල චිත්‍රයකි/ චිත්‍රය පහසුවෙන් තේරුම් ගත හැක

Table 1 – Name Agreement for individual object items tested across MLS, BLS & BLE groups in phase 1

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
1.	Iron	26.7	73.3	100
2.	Elephant	100	100	100
3.	Heart	13.3	60	100
4.	Arrow	93.3	100	100
5.	Tunnel	73.3	86.7	100
6.	Stamp	26.7	66.7	73.3
7.	Eye	100.0	100	93.3
8.	Horse	93.3	100	86.7
9.	Roots	100.0	93.3	93.3
10.	Square	26.7	46.7	93.3
11.	Leg	93.3	86.7	93.3
12.	Pig	100.0	100.0	100
13.	Book	100.0	100.0	100
14.	Duck	86.7	93.3	80
15.	Arm	100.0	100	40
16.	Tiger	93.3	86.7	100
17.	Stool	13.3	53.3	73.3
18.	Brain	93.3	100	93.3
19.	Moon	93.3	86.7	86.7
20.	Dog	100.0	100	100
21.	Finger	100.0	100	100
22.	Hospital	53.3	86.7	93.3
23.	Map	80.0	73.3	100
24.	Angel	13.3	46.7	73.3
25.	Candle	100.0	100	100
26.	Butterfly	100.0	100	100

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
27.	House	100.0	100	86.7
28.	Chair	100.0	100	100
29.	Tourist	13.3	46.7	73.3
30.	Circle	100.0	93.3	86.7
31.	Garden	20.0	60.0	100
32.	Feather	93.3	100	93.3
33.	Pocket	80	93.3	100
34.	Letter	100	100	100
35.	Sun	100	100	100
36.	Fruit	93.3	100	100
37.	Bell	60	80	100
38.	Radio	0	40	100
39.	Witch	40	33.3	93.3
40.	Fork	93.3	100	100
41.	Grapes	86.7	86.7	100
42.	Bread	93.3	100	100
43.	Money	100	93.3	100
44.	Tent	53.3	73.3	86.7
45.	Conductor	13.3	20	33.3
46.	Shadow	100	100	100
47.	Envelope	73.3	100	93.3
48.	Box	100	100	100
49.	Devil	6.7	53.3	60
50.	Flag	100	100	93.3
51.	Cow	80	67	100
52.	Scissor	100	100	100
53.	Watch	0	26.6	100

CHAPTER 9: Appendix 9.1: Name Agreement for object and action items tested across the MLS, BLS and BLE groups in phase 1

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
54.	Tree	100	100	100
55.	Curtain	26.7	26.6	100
56.	Hair	100	100	100
57.	Shirt	6.7	53.3	93.3
58.	Kitchen	73.3	86.7	73.3
59.	Drum	33.3	53.3	100
60.	Triangle	86.7	93.3	100
61.	Mouse	100	100	73.3
62.	bone	86.7	86.7	100
63.	Cheese	13.3	20	86.7
64.	Frog	93.3	100	100
65.	Ticket	6.7	73.3	86.7
66.	Crack	26.7	46.7	80
67.	Bee	86.7	73.3	80
68.	Mushroom	93.3	93.3	86.7
69.	Fish	100	100	100
70.	Clown	6.7	26.7	66.7
71.	Library	66.7	73.3	93.3
72.	Banana	86.7	100	100
73.	Chain	93.3	100	86.7
74.	Window	53.3	80	93.3
75.	Camel	100	100	100
76.	Flower	100	100	100
77.	Belt	20	46.7	100
78.	Axe	93.3	93.3	100
79.	Plug	6.7	40	100
80.	King	93.3	93.3	100

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
81.	Church	80	100	100
82.	Bed	100	100	100
83.	Wheel	93.3	100	86.7
84.	Clock	100	100	93.3
85.	Cigarette	40	53.3	53.3
86.	Bucket	100	86.7	86.7
87.	Foot	13.3	20	80
88.	Sword	86.7	100	86.7
89.	Cork	13.3	33.3	46.7
90.	Bridge	93.3	93.3	86.7
91.	Tongue	93.3	93.3	93.3
92.	Nest	66.7	73.3	100
93.	Crown	80	93.3	80
94.	Ladder	100	93.3	100
95.	Key	93.3	100	100
96.	Brush	0	53.3	86.7
97.	Umbrella	100	100	100
98.	Fence	33.3	86.7	93.3
99.	Lion	100	100	93.3
100.	Castle	20	86.7	86.7
101.	Basket	66.7	53.3	53.3
102.	Tie	0	6.7	100
103.	Judge	33.3	46.7	86.7
104.	Leaf	6.7	13.3	100
105.	Short	13.3	40	86.7
106.	Road	86.7	100	100
107.	Pond	20	60	100

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
108.	Cat	100	100	100
109.	Bedroom	53.3	73.3	86.7
110.	Shoe	100	93.3	100
111.	Hat	93.30	93.3	100
112.	Knot	86.7	100	80
113.	Pram	0	6.7	66.7
114.	Bird	100	100	100
115.	Table	93.3	100	93.3
116.	Weight	20	33.3	86.7
117.	Nun	13.3	40	60
118.	Roof	93.3	100	100
119.	Bath	0	20	60
120.	Office	33.3	66.7	100
121.	Sheep	93.3	93.3	93.3
122.	Comb	100	100	100
123.	Anchor	40	73.3	93.3
124.	Button	53.3	93.3	93.3
125.	Spoon	100	100	100

CHAPTER 9: Appendix 9.1: Name Agreement for object and action items tested across the MLS, BLS and BLE groups in phase 1

Table 2 – Name Agreement for individual Action items tested across MLS, BLS & BLE groups in P1

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
1.	Smoking	93.3	80	100
2.	Rocking	0.0	13.33	13.3
3.	Blowing	100	100	86.7
4.	weighing	80	86.7	40
5.	stopping	53.3	73.3	100
6.	cooking	86.7	86.7	93.3
7.	Begging	66.7	86.7	100
8.	Dreaming	73.3	100.0	100
9.	Sewing	100	100	100
10.	Kissing	6.67	46.67	100
11.	Biting	86.67	100.0	93.3
12.	Leaning	73.3	60	60
13.	Sinking	93.3	93.3	80
14.	Watering	80	100	86.7
15.	Reading	66.7	66.7	86.7
16.	Driving	26.67	46.67	100
17.	Sneezing	73.3	80.0	93.3
18.	Crossing	60	86.7	100
19.	Yawing	73.3	100	66.7
20.	Barking	93.3	100	93.3
21.	Dancing	86.7	100	100
22.	Roaring	80.0	73.33	60
23.	Folding	86.7	93.3	80
24.	Smiling	73.3	100	93.3
25.	Crawling	20	33.3	73.3
26.	Bouncing	0	0	73.3
27.	Touching	100	100	66.7
28.	Kneeling	60	80	73.3
29.	Carrying	80	73.3	53.3
30.	Watching	6.7	0	100
31.	Dropping	20	53.3	66.7
32.	Fishing	100	100	93.3
33.	Pouring	60	73.3	100
34.	Melting	46.7	93.3	66.7
35.	Knitting	40	66.7	46.7
36.	Flying	100	100	93.3
37.	Stroking	53.3	80	66.7
38.	Tying	80	66.7	80
39.	Washing	93.3	100	100
40.	Raining	100	100	100
41.	Jumping	93.3	93.3	100
42.	Floating	73.3	93.3	80
43.	Sitting	93.3	86.7	100
44.	Weaving	80	100	73.3
45.	Building	26.7	33.3	80
46.	Pulling	66.7	73.3	60

Table 2 – Name Agreement for individual Action items tested across MLS, BLS & BLE groups in P1

	Stimulus Name	NA (ML) %	NA (BL/S) %	NA (BL/E) %
47.	Swinging	100.0	66.7	73.3
48.	Planting	100	86.7	86.7
49.	Crying	100	93.3	100
50.	Drinking	100	100	100
51.	Sleeping	100	100	100
52.	Praying	93.3	93.3	93.3
53.	Running	100	100	100
54.	Cutting	100	100	100
55.	Drilling	53.3	40	86.7
56.	Eating	100	93.3	100
57.	Posting	46.7	33.3	86.7
58.	Skipping	0	0	73.3
59.	Combing	100	100	100
60.	Diving	6.7	0	46.7
61.	Painting	73.3	66.7	100
62.	Shooting	93.3	93.3	100
63.	Walking	80	100	100
64.	Opening	93.3	100	100
65.	Playing	73.3	100	100
66.	Stirring	13.33	53.33	66.7
67.	Bending	86.7	93.3	100
68.	Climbing	60	93.3	86.7
69.	Drawing	86.7	100	89.7
70.	Pointing	53.3	60	53.3
71.	Singing	80	100	100
72.	Kicking	60	66.7	80
73.	Writing	100	100.0	100
74.	Lighting	100	100	86.7
75.	Skating	0	6.7	60
76.	Catching	6.7	33.3	93.3
77.	Dripping	0	6.7	60
78.	Ringing	33.3	33.3	80
79.	Sliding	20	20	60
80.	Ironing	66.7	100	100
81.	Peeling	46.7	60	80
82.	Waving	53.3	73.3	100
83.	Swimming	100	100	100
84.	Riding	6.66	0	93.3
85.	Licking	86.7	93.3	86.7
86.	Pinching	80	86.7	73.3
87.	Snowing	66.7	93.3	80
88.	Digging	80	86.7	86.7
89.	Knocking	93.3	100	100
90.	Tickling	46.7	86.7	73.3
91.	Shaving	86.7	80	86.7
92.	Pushing	100	100	86.7
93.	Bleeding	40	80	86.7
94.	Sailing	0	13.3	60

Number	English Word	Sinhala Word	Word Length	Word Length	NA ML (%)	NABL (%)	NABL (%)	AOA ML (S)	AOA BL (S)	AOA BL (E)	Fam ML (S)	Fam BL (S)	Fam BL (E)	Imag ML (S)	Imag BL (S)	Imag BL (E)	VC (ML) Avg
			(S)	(E)	(S)	(S)	(E)	µ SD	µ SD	µ SD	µ SD	µ SD	µ SD	µ SD	µ SD	µ SD	µ SD
1	Elephant	අලියා	5	7	100	100	100	2.5 (1.13)	1.6 (0.63)	2.3 (0.90)	4.7 (0.72)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)
2	Arrow	ඊතලය	7	3	93.3	100	100	3.7 (1.28)	3.3 (1.03)	4.4 (1.40)	4.4 (1.30)	4.9 (0.26)	4.7 (0.80)	4.9 (0.26)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
3	Eye	ඇස	3	1	100	100	93.3	2.1 (0.96)	1.7 (0.90)	3.4 (1.55)	4.9 (0.35)	5.0 (0.00)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	4.9 (0.00)	4.9 (0.35)
4	Roots	මුල්	3	4	100	93.3	93.3	3.3 (1.03)	3.4 (1.45)	5.4 (1.40)	4.6 (0.74)	4.7 (0.62)	4.5 (0.92)	4.9 (0.35)	4.1 (0.88)	4.7 (0.88)	3.9 (1.53)
5	Pig	ඌරා	3	3	100	100	100	2.6 (0.91)	1.9 (0.80)	3.2 (1.47)	4.4 (1.30)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	4.8 (0.56)	4.9 (0.56)	5.0 (0.00)
6	Book	පොත	4	3	100	100	100	2.0 (0.85)	1.8 (0.68)	2.7 (0.98)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)
7	Brain	මොළය	6	4	93.3	100	93.3	5.1 (1.62)	4.4 (1.12)	5.5 (1.36)	4.6 (0.91)	4.9 (0.26)	4.7 (0.80)	5.0 (0.00)	4.5 (0.99)	4.7 (0.99)	4.9 (0.52)
8	Dog	බල්ලා	5	3	100	100	100	1.7 (0.90)	1.3 (0.49)	2.5 (0.92)	4.9 (0.52)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
9	Finger	ඇඟිල්ල	6	5	100	100	100	1.9 (0.70)	1.5 (0.64)	2.9 (1.06)	4.9 (0.26)	5.0 (0.00)	4.9 (0.26)	5.0 (0.00)	4.9 (0.26)	5.0 (0.26)	5.0 (0.00)
10	Candle	ඉටිපන්දම	10	5	100	100	100	3.0 (1.07)	2.5 (0.64)	4.4 (1.72)	4.9 (0.35)	5.0 (0.00)	4.9 (0.26)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
11	Butterfly	සමනලයා	10	7	100	100	100	2.1 (0.80)	1.7 (0.62)	2.5 (1.06)	4.8 (0.56)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
12	Chair	පුටුව	6	3	100	100	100	2.1 (0.96)	1.6 (0.51)	2.6 (1.06)	4.9 (0.52)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)
13	Horse	අශ්වයා	6	3	93.3	100	86.7	2.7 (0.98)	2.3 (1.05)	3.2 (1.32)	4.5 (0.99)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.00)	4.8 (0.56)
14	Leg	කකුල	6	3	93.3	86.7	93.3	1.7 (0.72)	1.5 (0.64)	2.7 (1.16)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
15	Moon	හඳ	4	3	93.3	86.7	86.7	1.6 (0.74)	1.5 (0.64)	3.1 (1.16)	4.8 (0.56)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	4.9 (0.26)
16	House	ගෙදර	6	3	100	100	86.7	1.7 (0.70)	1.6 (0.74)	2.8 (1.21)	4.9 (0.52)	4.9 (0.52)	4.9 (0.26)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	4.9 (0.35)
17	Circle	රවුම	6	5	100	93.3	86.7	2.2 (1.08)	2.3 (0.80)	3.6 (1.92)	4.6 (0.91)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	5.0 (0.26)	5.0 (0.00)
18	Duck	තාරාවා	6	3	86.7	93.3	80.0	2.4 (1.30)	1.5 (0.64)	3.0 (1.46)	4.6 (0.83)	4.9 (0.52)	4.8 (0.41)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	4.7 (0.59)
19	Tiger	කොටියා	6	4	93.3	86.7	100	2.3 (1.29)	2.1 (0.83)	2.9 (0.99)	4.5 (1.25)	5.0 (0.00)	4.9 (0.26)	5.0 (0.00)	4.9 (0.35)	4.9 (0.35)	4.9 (0.26)
20	Feather	පිහාටුව	8	4	93.3	100	93.3	2.3 (0.98)	2.6 (0.83)	4.5 (1.81)	4.5 (0.26)	5.0 (0.00)	4.7 (0.49)	5.0 (0.00)	4.7 (0.59)	4.5 (0.59)	5.0 (0.00)
21	Letter	ලියුම	6	4	100	100	100	3.1 (0.74)	3.0 (0.53)	4.1 (1.51)	4.7 (0.72)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.8 (0.26)	4.9 (0.26)
22	Sun	ඉර	3	3	100	100	100	1.7 (0.80)	1.8 (0.56)	2.7 (0.90)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.9 (0.26)	5.0 (0.00)
23	Fruit	පළතුරු	8	4	93.3	100	100	2.2 (1.01)	2.3 (0.82)	2.5 (0.83)	4.9 (0.52)	5.0 (0.00)	5.0 (0.00)	5.0 (0.00)	4.9 (0.26)	4.8 (0.26)	4.8 (0.56)
24	Fork	ගෑරුප්පුව	9	3	93.3	100	100	4.0 (1.51)	3.0 (0.93)	4.2 (1.93)	4.5 (0.52)	4.7 (0.00)	4.7 (0.59)	4.9 (0.35)	4.9 (0.35)	4.8 (0.35)	5.0 (0.00)

CHAPTER 9: Appendix 9.2 - Psycholinguistic variables of OANB object items selected for phase 2 & 3.

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Table - Psycholinguistic variables of OANB object items (n=69) selected for phase 2 & 3.

Number	English Word	Sinhala Word	Word Length	Word Length	NA ML (%)	NABL (%)	NABL (%)	AOA ML (S)		AOA BL (S)		AOA BL (E)		Fam ML (S)		Fam BL (S)		Fam BL (E)		Imag ML (S)		Imag BL (S)		Imag BL (E)		VC (ML) Avg	
			(S)	(E)	(S)	(S)	(E)	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD
25	Beard	රැවුල	6	3	93.3	100	100	2.9	(1.06)	3.1	(1.39)	4.8	(1.93)	4.5	(1.25)	4.9	(0.26)	4.2	(1.32)	5.0	(0.00)	4.7	(0.59)	4.6	(0.59)	4.7	(0.80)
26	Money	සල්ලි	5	4	100	93.3	100	2.3	(0.62)	2.5	(0.99)	3.6	(1.45)	4.9	(1.12)	5.0	(0.52)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	4.7	(0.72)
27	Shadow	සෙවනැල්ල	9	4	100	100	100	3.2	(1.52)	3.5	(1.36)	4.5	(1.73)	4.7	(0.83)	4.8	(0.80)	4.8	(0.56)	4.7	(0.82)	4.5	(1.06)	4.5	(1.06)	4.5	(1.06)
28	Box	පෙට්ටිය	7	4	100	100	100	2.5	(1.13)	2.5	(0.92)	3.1	(1.16)	4.7	(1.16)	5.0	(0.74)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.26)	4.9	(0.26)
29	Flag	කොඩිය	6	4	100	100	93.3	2.4	(0.91)	2.6	(0.63)	3.9	(1.39)	4.5	(1.25)	5.0	(0.00)	4.9	(0.52)	4.9	(0.26)	4.9	(0.52)	4.9	(0.52)	5.0	(0.00)
30	Scissor	කතුර	6	4	100	100	100	2.6	(0.99)	2.1	(0.52)	3.8	(1.74)	4.8	(0.70)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
31	Tree	ගස	4	3	100	100	100	2.0	(1.07)	1.9	(0.74)	2.7	(0.90)	4.7	(0.83)	5.0	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.52)
32	Hair	කෙස්	3	2	100	100	100	2.5	(1.19)	2.4	(0.99)	2.9	(1.30)	4.7	(0.80)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	4.8	(0.56)	5.0	(0.56)	5.0	(0.00)
33	Grapes	මිදි	4	5	86.7	86.7	100	2.1	(1.06)	2.1	(1.28)	2.9	(1.13)	4.5	(0.72)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
34	Triangle	ත්‍රිකෝණය	9	8	86.7	93.3	100	3.1	(1.13)	3.1	(1.03)	4.0	(2.04)	4.6	(0.52)	4.9	(0.00)	4.8	(0.56)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	5.0	(0.00)
35	Bone	කටුව	6	3	86.7	86.7	100	3.5	(1.55)	2.9	(0.92)	4.7	(1.84)	4.5	(0.99)	4.5	(0.74)	4.7	(0.70)	4.5	(1.25)	4.3	(0.82)	4.8	(0.82)	4.9	(0.52)
36	Pocket	සාක්කුව	7	5	80.0	93.3	100	2.3	(0.82)	2.7	(0.62)	4.2	(1.61)	4.9	(0.52)	5.0	(0.00)	4.9	(0.52)	4.9	(0.26)	4.9	(0.35)	4.8	(0.35)	4.9	(0.35)
37	Frog	ගෙම්බා	5	4	93.3	100	100	2.2	(0.77)	2.3	(0.88)	2.5	(0.99)	4.7	(0.59)	5.0	(0.00)	4.9	(0.52)	4.9	(0.26)	4.8	(0.56)	4.9	(0.56)	4.9	(0.26)
38	Fish	මාළුවා	6	3	100	100	100	1.9	(1.28)	1.7	(0.62)	1.9	(1.03)	4.6	(1.12)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.52)	4.9	(0.52)	5.0	(0.00)
39	Camel	ඔටුවා	5	5	100	100	100	3.3	(1.11)	2.8	(0.56)	3.3	(1.68)	4.5	(1.13)	4.9	(0.26)	4.7	(0.62)	5.0	(0.00)	4.9	(0.35)	4.8	(0.35)	5.0	(0.00)
40	Flower	මල	4	5	100	100	100	1.5	(0.52)	1.4	(0.51)	1.7	(0.80)	4.7	(0.70)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)
41	Axe	පොරව	6	3	93.3	93.3	100	3.7	(1.18)	3.7	(1.40)	3.7	(1.53)	4.5	(1.19)	4.7	(0.70)	4.3	(0.90)	5.0	(0.00)	4.8	(0.41)	4.9	(0.41)	4.9	(0.26)
42	King	රජතුමා	8	3	93.3	93.3	100	2.5	(0.92)	2.8	(0.77)	2.4	(0.74)	4.4	(1.18)	4.8	(0.56)	4.9	(0.52)	4.8	(0.41)	4.6	(0.83)	4.7	(0.83)	4.5	(1.19)
43	Bed	ඇඳ	3	3	100	100	100	1.9	(0.59)	1.8	(0.56)	1.7	(0.70)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.26)	5.0	(0.00)
44	Clock	ඔරලෝසුව	9	4	100	100	93.3	2.7	(1.45)	2.7	(0.98)	2.5	(1.25)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	5.0	(0.00)
45	Tongue	දිව	4	3	93.3	93.3	93.3	2.1	(0.88)	1.7	(0.80)	2.5	(1.64)	5.0	(0.00)	4.9	(0.52)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.7	(0.00)	4.9	(0.52)
46	Mushroom	බිම්මල්	6	6	93.3	93.3	86.7	4.4	(1.59)	4.5	(1.55)	3.6	(1.50)	4.6	(0.74)	4.4	(1.24)	4.9	(0.26)	5.0	(0.00)	4.7	(0.62)	4.7	(0.62)	4.9	(0.35)
47	Banana	කෙසෙල් ගෙඩිය	11	6	86.7	100	100	2.0	(1.00)	1.9	(0.83)	1.9	(1.03)	4.7	(0.70)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	4.9	(0.26)
48	Chain	දම්වැල	7	3	93.3	100	86.7	3.3	(1.33)	3.3	(0.96)	3.2	(1.52)	4.3	(1.23)	4.8	(0.77)	4.9	(0.26)	5.0	(0.00)	4.9	(0.52)	4.8	(0.52)	5.0	(0.00)

CHAPTER 9: Appendix 9.2 - Psycholinguistic variables of OANB object items selected for phase 2 & 3.

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Number	English Word	Sinhala Word	Word Length	Word Length	NA ML (%)	NABL (%)	NABL (%)	AOA ML (S)		AOA BL (S)		AOA BL (E)		Fam ML (S)		Fam BL (S)		Fam BL (E)		Imag ML (S)		Imag BL (S)		Imag BL (E)		VC (ML) Avg	
			(S)	(E)	(S)	(S)	(E)	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD
49	Wheel	රෝදය	6	3	93.3	100	86.7	2.9	(1.13)	2.2	(0.77)	2.7	(1.45)	4.5	(1.13)	4.9	(0.52)	4.9	(0.35)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	4.9	(0.26)
50	Bucket	බාල්දිය	7	5	100	86.7	86.7	2.1	(0.74)	2.8	(1.08)	2.6	(1.30)	4.8	(0.77)	5.0	(0.00)	4.7	(0.46)	4.9	(0.26)	4.9	(0.52)	4.9	(0.52)	5.0	(0.00)
51	Sword	කඩුව	6	4	86.7	100	86.7	3.9	(1.46)	3.0	1.20)	4.1	(1.77)	4.3	(1.45)	4.7	(0.70)	4.1	(1.39)	5.0	(0.00)	4.9	(0.35)	4.0	(0.35)	5.0	(0.00)
52	Bridge	පාලම	6	4	93.3	93.3	86.7	3.8	(1.37)	3.0	(1.07)	3.5	(1.55)	5.0	(0.00)	4.9	(0.26)	4.6	(0.74)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	4.9	(0.35)
53	Church	පල්ලිය	7	3	80.0	100	100	3.5	(1.55)	2.3	(0.90)	3.0	(1.25)	4.5	(1.19)	4.9	(0.26)	4.7	(1.05)	5.0	(0.00)	4.9	(0.26)	4.7	(0.26)	4.8	(0.56)
54	Crown	ඔටුන්න	6	4	80.0	93.3	80.0	2.7	(0.98)	3.1	(1.03)	3.3	(1.29)	4.4	(1.18)	4.9	0.35)	4.5	(1.06)	5.0	(0.00)	4.7	(0.72)	4.7	(0.72)	5.0	(0.00)
55	Ladder	ඉණිමඟ	7	4	100	93.3	100	3.5	(1.41)	3.2	(0.68)	3.3	(1.28)	4.4	(1.40)	4.9	(0.52)	4.9	(0.35)	5.0	(0.00)	4.7	(0.46)	4.9	(0.46)	5.0	(0.00)
56	Key	යතුර	6	2	93.3	100	100	2.9	(1.25)	2.6	(0.63)	2.6	(1.24)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)
57	Umbrella	කුඩය	6	7	100	100	100	2.3	(1.18)	2.1	(0.64)	2.5	(1.41)	4.9	(0.26)	4.9	(0.26)	4.9	(0.26)	5.0	(0.26)	4.9	(0.41)	4.9	(0.41)	5.0	(0.00)
58	Lion	සිංහයා	7	4	100	100	93.3	2.2	(1.01)	2.0	(0.76)	2.3	(0.96)	4.6	(1.12)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)	4.9	(0.35)	4.7	(0.35)	5.0	(0.00)
59	Cat	පූසා	4	3	100	100	100	1.9	(0.92)	1.3	(0.49)	1.5	(0.92)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
60	Shoe	සපත්තුව	8	2	100	93.3	100	2.5	(1.30)	1.9	(0.59)	1.9	(0.96)	4.8	(0.56)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.26)	5.0	(0.00)
61	Hat	තොප්පිය	7	3	93.3	93.3	100	2.4	(1.12)	2.5	(0.74)	2.3	(1.05)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.8	(0.56)	5.0	(0.56)	5.0	(0.00)
62	Bird	කුරුල්ලා	7	3	100	100	100	2.1	(1.06)	1.7	(0.72)	1.7	(0.80)	4.8	(0.56)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
63	Table	මේසය	6	5	93.3	100	93.3	2.7	(1.49)	1.9	(0.74)	1.9	(1.39)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
64	Roof	වහලය	8	3	93.3	100	100	2.9	(1.53)	2.5	(0.64)	2.8	(1.19)	4.9	(0.26)	4.9	(0.26)	4.9	(0.35)	5.0	(0.00)	4.9	(0.26)	4.8	(0.26)	5.0	(0.00)
65	Sheep	බැටළුවා	8	3	93.3	93.3	93.3	3.6	(1.64)	2.8	(0.86)	2.9	(1.41)	4.4	(1.18)	4.9	(0.26)	4.7	(0.72)	4.9	(0.35)	4.7	(0.46)	4.8	(0.46)	5.0	(0.00)
66	Comb	පනාව	6	4	100	100	100	2.3	(1.11)	2.1	(0.70)	2.3	(1.33)	5.0	(0.00)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)	4.9	(0.26)	4.8	(0.26)	4.9	(0.29)
67	Spoon	හැන්ද	5	4	100	100	100	2.6	(1.50)	1.6	(0.74)	2.3	(1.58)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)	5.0	(0.00)
68	Road	පාර	4	3	86.7	100	100	2.6	(1.30)	2.2	(0.68)	2.5	(1.19)	4.9	0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.7	(0.90)
69	Knot	ගැටය	6	3	86.7	100	80.0	4.3	(1.80)	3.6	(1.24)	4.0	(1.25)	4.3	1.18)	4.7	(0.46)	4.3	(0.98)	4.7	(0.80)	4.4	(1.06)	4.3	(1.06)	5.0	(0.00)

Table - Psycholinguistic variables of OANB action items (n=38) selected for phase 2

Number	English Word	Sinhala Word	Word Length	Word Length	NA ML (%)	NA BL (%)	NA BL (%)	AOA ML (S)		AOA BL (S)		AOA BL (E)		Fam ML (S)		Fam BL (S)		Fam BL (E)		Imag ML (S)		Imag BL (S)		Imag BL (E)		VC (ML) Avg	
			(S)	(E)	(S)	(S)	(E)	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD
1	Barking	බුරනවා	8	5	93.3	100	93.3	2.5	(1.25)	2.1	(0.64)	4.2	(1.70)	4.9	(0.52)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)
2	Dancing	නටනවා	8	6	86.7	100	100	2.4	(1.50)	2.4	(0.74)	3.6	(1.30)	4.9	(0.52)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.8	(0.00)
3	Blowing	පිඹිනවා	8	6	100	100	86.7	2.5	(0.74)	2.5	(0.74)	4.5	(1.85)	4.8	(0.77)	5.0	(0.00)	4.8	(0.56)	5.0	(0.00)	4.8	(0.41)	4.9	(0.26)	4.7	(0.72)
4	Watering	වතුර දනවා	12	7	80.0	100	86.7	2.5	(1.19)	2.3	(0.59)	4.7	(1.58)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.7	(0.82)	5.0	(0.00)
5	Smoking	දුම් බොනවා	9	6	93.3	80	100	4.7	(1.23)	4.3	(1.59)	5.4	(1.12)	4.6	(1.06)	4.9	(0.52)	4.7	(0.62)	4.7	(1.03)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)
6	Cooking	උයනවා	7	6	86.7	86.7	93.3	2.5	(1.41)	2.2	(0.68)	3.4	(1.24)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)
7	Sinking	ගිලෙනවා	8	6	93.3	93.3	80	3.5	(1.30)	3.3	(0.88)	5.7	(1.40)	4.7	(0.59)	4.9	(0.35)	4.1	(1.28)	5.0	(0.00)	4.7	(1.05)	4.3	(1.05)	4.4	(0.00)
8	Sewing	මහනවා	8	4	100	100	100	3.1	(1.28)	3.3	(0.96)	5.1	(1.49)	4.8	(0.56)	5.0	(0.00)	4.7	(0.59)	4.9	(0.35)	5.0	(0.00)	4.7	(0.62)	4.9	(0.26)
9	Biting	හපනවා	8	5	86.7	100	93.3	2.3	(1.16)	2.3	(0.80)	4.6	(1.40)	4.8	(0.77)	4.9	(0.26)	4.5	(1.25)	4.9	(0.26)	4.9	(0.35)	4.7	(0.70)	4.8	(0.00)
10	Fishing	මාලු බානවා	10	5	100	100	93.3	3.8	(1.15)	4.1	(0.83)	4.6	(1.24)	4.7	(0.82)	4.7	(0.70)	4.7	(0.72)	5.0	(0.00)	5.0	(0.00)	4.8	(0.41)	5.0	(0.00)
11	Flying	පියාඹනවා	10	4	100	100	93.3	2.3	(0.98)	2.6	(0.63)	3.9	(1.41)	4.8	(0.77)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.8	(0.56)	4.9	(0.26)
12	Washing	හෝදනවා	8	5	93.3	100	100	2.3	(0.96)	2.2	(0.77)	3.5	(1.51)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)
13	Raining	වහිනවා	8	5	100	100	100	1.7	(0.70)	2.0	(0.53)	3.3	(1.10)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	4.9	(0.35)	5.0	(0.00)
14	Jumping	පනිනවා	8	6	93.3	93.3	100	2.4	(1.24)	2.3	(0.62)	3.1	(1.16)	4.9	(0.52)	5.0	(0.00)	4.8	(0.56)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)
15	Sitting	ඉඳගන්නවා	10	5	93.3	86.7	100	2.1	(0.80)	2.0	(0.53)	3.1	(1.25)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	5.0	(0.00)
16	Crying	අඬනවා	7	4	100	93.3	100	2.0	(0.76)	1.5	(0.52)	2.1	(1.06)	4.9	(0.52)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)
17	Drinking	බොනවා	6	7	100	100	100	1.8	(0.86)	1.7	(0.70)	2.1	(0.92)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)	5.0	(0.00)
18	Sleeping	නිදනවා	8	6	100	100	100	1.9	(0.96)	2.3	(1.05)	2.1	(0.80)	4.9	(0.52)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.52)
19	Praying	යාඥා කරනවා	13	5	93.3	93.3	93.3	5.1	(1.79)	3.9	(1.62)	3.1	(0.96)	4.5	(1.06)	4.6	(0.91)	4.9	(0.35)	4.9	(0.35)	4.8	(0.41)	4.7	(0.59)	5.0	(0.00)
20	Running	දුවනවා	8	5	100	100	100	1.9	(0.70)	1.9	(0.59)	2.2	(0.77)	4.9	(0.52)	5.0	(0.00)	4.9	(0.52)	4.9	(0.26)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)

CHAPTER 9: Appendix 9.3 - Psycholinguistic variables of OANB action items selected for phase 2 & 3.

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Number	English Word	Sinhala Word	Word Length	Word Length	NA ML (%)	NA BL (%)	NA BL (%)	AOA ML (S)		AOA BL (S)		AOA BL (E)		Fam ML (S)		Fam BL (S)		Fam BL (E)		Imag ML (S)		Imag BL (S)		Imag BL (E)		VC (ML) Avg	
			(S)	(E)	(S)	(S)	(E)	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD	μ	SD
21	Cutting	කපනවා	8	5	100	100	100	2.6	(0.63)	2.3	(0.72)	2.5	(0.83)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)
22	Eating	කනවා	6	4	100	93.3	100	1.8	(0.77)	1.7	(0.59)	1.9	(0.64)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.7	(0.72)
23	Combing	පීරනවා	8	5	100	100	100	2.3	(0.72)	2.5	(1.19)	2.7	(1.40)	4.8	(0.77)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)	4.9	(0.26)	4.7	(0.59)	5.0	(0.00)
24	Shooting	වෙඩි තබනවා	12	5	93.3	93.3	100	3.9	(1.62)	3.9	(1.36)	3.9	(1.44)	4.6	(1.12)	4.6	(0.83)	4.7	(0.59)	5.0	(0.00)	4.9	(0.26)	4.8	(0.41)	4.8	(0.56)
25	Opening	අරිනවා	7	5	93.3	100	100	2.7	(0.82)	2.3	(0.80)	2.3	(1.05)	4.8	(0.77)	5.0	(0.00)	5.0	(0.00)	4.7	(0.80)	4.9	(0.35)	4.8	(0.56)	5.0	(0.00)
26	Planting	හිටවනවා	10	7	100	86.7	86.7	3.1	(0.88)	2.5	(0.74)	3.1	(1.19)	4.9	(0.52)	5.0	(0.00)	4.9	(0.35)	5.0	(0.00)	4.8	(0.41)	4.9	(0.35)	5.0	(0.00)
27	Bending	නැමෙනවා	8	6	86.7	93.3	100	2.9	(0.83)	2.8	(0.68)	3.9	(1.81)	4.9	(0.52)	4.9	(0.26)	4.8	(0.56)	4.9	(0.26)	4.9	(0.35)	4.8	(0.56)	5.0	(0.00)
28	Walking	ඇවිදිනවා	9	5	80.0	100	100	2.3	(0.88)	2.1	(0.59)	2.3	(0.80)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)
29	Drawing	අඳිනවා	7	6	86.7	100	86.7	2.7	(1.03)	2.4	(0.74)	2.7	(1.05)	4.9	(0.52)	4.9	(0.52)	4.9	(0.26)	4.9	(0.26)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)
30	Singing	ගායනා කරනවා	14	6	80.0	100	100	3.7	(1.33)	3.7	(1.39)	2.4	(0.99)	4.7	(0.90)	4.7	(0.70)	4.8	(0.52)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	4.9	(0.26)
31	Swimming	පීනනවා	8	6	100	100	100	3.2	(1.42)	2.9	(0.74)	3.1	(1.36)	4.9	(0.52)	4.9	(0.52)	4.7	(1.05)	5.0	(0.00)	5.0	(0.00)	4.9	(0.52)	5.0	(0.00)
32	Knocking	තට්ටු කරනවා	13	5	93.3	100	100	2.7	(1.16)	2.9	(1.03)	3.7	(1.54)	4.9	(0.52)	5.0	(0.00)	4.6	(1.06)	5.0	(0.00)	5.0	(0.00)	4.8	(0.41)	4.9	(0.52)
33	Licking	ලෙව කනවා	10	5	86.7	93.3	86.7	2.9	(1.22)	2.9	(0.83)	3.9	(1.73)	4.8	(0.56)	4.7	(0.59)	4.2	(1.26)	4.9	(0.26)	4.8	(0.56)	4.5	(0.83)	5.0	(0.00)
34	Pushing	තල්ලු කරනවා	13	5	100	100	86.7	2.7	(0.80)	2.5	(0.64)	3.2	(1.26)	4.9	(0.52)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)	5.0	(0.00)	4.9	(0.26)	5.0	(0.00)
35	Digging	හාරනවා	8	5	80.0	86.7	86.7	3.7	(1.50)	2.9	(0.88)	4.1	(1.49)	4.8	(0.77)	4.5	(1.13)	4.5	(0.83)	5.0	(0.00)	4.7	(0.46)	4.6	(0.74)	5.0	(0.00)
36	Shaving	රැවුල බානවා	12	5	86.7	80	86.7	4.3	(1.18)	4.2	(1.37)	4.3	(1.67)	4.7	(0.59)	4.7	(0.70)	4.5	(1.25)	5.0	(0.00)	4.9	(0.26)	4.9	(0.52)	5.0	(0.00)
37	Writing	ලියනවා	8	5	100	100	100	2.4	(0.99)	2.3	(0.70)	2.5	(0.64)	4.9	(0.52)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	5.0	(0.00)	4.9	(0.00)
38	Lighting	දල්වනවා	9	5	100	100	86.7	3.7	(1.39)	4.2	(1.57)	3.5	(0.92)	4.9	(0.52)	4.5	(1.13)	4.7	(0.62)	4.9	(0.26)	4.7	(0.90)	4.5	(1.00)	5.0	(0.00)

CHAPTER 9: Appendix 9.3 - Psycholinguistic variables of OANB action items selected for phase 2 & 3.

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Table 1: Data and the calculated differences for total word count

Variables	Groups	PS2	PS3
Total Word Count	MLS	33.73	36.20
Total Word Count	BLS	38.93	38.27
Total Word Count	BLE	59.07	55.53
Absolute Differences	**MLS vs. BLS**	5.20	2.07
	MLS vs. BLE	25.34	19.33
	BLS vs. BLE	20.14	17.26
Mean differences		**16.89**	**12.89**

Table 2: Data and the calculated differences for correctly recalled nouns

Variables	Groups	PS2	PS3
Correctly recalled nouns	MLS	10.53	11.67
Correctly recalled nouns	BLS	12.53	12.47
Correctly recalled nouns	BLE	13.73	11.60
Absolute Differences	**MLS vs. BLS**	2.00	0.80
	MLS vs. BLE	3.20	0.07
	BLS vs. BLE	1.20	0.87
Mean differences		**2.13**	**0.58**

Table 3: Data and the calculated differences for Type-N

Variable	Groups	PS2	PS3
Type-N	MLS	7.53	9.73
Type-N	BLS	9.53	11.40
Type-N	BLE	8.40	7.20
Absolute Differences	MLS vs. BLS	2.00	1.67
	MLS vs. BLE	0.87	2.53
	BLS vs. BLE	1.13	4.20
Mean differences		**1.33**	**2.80**

Table 4: Data and the calculated differences for Token-N

Variable	Groups	PS2	PS3
Token-N	MLS	11.27	12.07
Token-N	BLS	13.20	13.40
Token-N	BLE	13.80	10.87
Absolute Differences	MLS vs. BLS	1.93	1.33
	MLS vs. BLE	2.53	1.20
	BLS vs. BLE	0.60	2.53
Mean differences		1.69	1.69

Table 5: Data and the calculated differences for TTR-N

Variable	Groups	PS2	PS3
TTR-N	MLS	0.69	0.84
TTR-N	BLS	0.72	0.87
TTR-N	BLE	0.61	0.65
Absolute Differences	MLS vs. BLS	0.03	0.03
	MLS vs. BLE	0.08	0.19
	BLS vs. BLE	0.11	0.22
Mean differences		0.07	0.15

Table 6: Data and the calculated differences for correctly recalled verbs

Variables	Groups	PS2	PS3
Correctly recalled verbs	MLS	9.80	11.87
Correctly recalled verbs	BLS	10.80	12.87
Correctly recalled verbs	BLE	8.33	9.93
Absolute Differences	MLS vs. BLS	1.00	1.00
	MLS vs. BLE	1.47	1.94
	BLS vs. BLE	2.47	2.94
Mean differences		1.65	1.96

Tables 7: Data and the calculated differences for Type-V

Variable	Groups	PS2	PS3
Type-V	MLS	10.00	12.47
Type-V	BLS	10.40	12.53
Type-V	BLE	7.87	9.20
Absolute Differences	MLS vs. BLS	0.40	0.06
	MLS vs. BLE	2.13	3.27
	BLS vs. BLE	2.53	3.33
Mean differences		1.69	2.22

Table 8: Data and the calculated differences for Token-V

Variable	Groups	PS2	PS3
Token-V	MLS	10.47	13
Token-V	BLS	11.40	13.80
Token-V	BLE	8.33	10.07
Absolute Differences	MLS vs. BLS	0.93	0.80
	MLS vs. BLE	2.14	2.93
	BLS vs. BLE	3.07	3.73
Mean differences		2.05	2.49

Table 9: Data and the calculated differences for TTR-V

Variable	Groups	PS2	PS3
TTR-V	MLS	0.97	0.97
TTR-V	BLS	0.93	0.92
TTR-V	BLE	0.95	0.92
Absolute Differences	MLS vs. BLS	0.04	0.05
	MLS vs. BLE	0.02	0.05
	BLS vs. BLE	0.02	0.00
Mean differences		0.03	0.03

Table - Individual participant scores for measurements of lexical diversity for the selected PS 3

Language Group	Pt. ID no.	CRN	Token-N	Type-N	TTR-N	CRV	Token-V	Type-V	TTR-V
BLS	BLG3/1	11	13	13	1.00	14	16	15	0.93
BLS	BLG3/2	10	10	9	0.90	11	11	10	0.90
BLS	BLG3/3	15	17	15	0.88	22	22	16	0.86
BLS	BLG3/4	15	15	14	0.93	12	12	12	1.00
BLS	BLG3/5	16	17	15	0.88	14	17	17	1.00
BLS	BLG3/6	18	19	16	0.84	14	14	13	0.92
BLS	BLG3/7	5	5	5	1.00	10	10	8	0.80
BLS	BLG3/8	4	4	4	1.00	14	14	14	1.00
BLS	BLG3/9	11	11	10	0.90	11	11	11	1.00
BLS	BLG1/11	14	14	13	0.92	14	14	14	1.00
BLS	BLG3/11	12	12	10	0.83	10	12	11	0.91
BLS	BLG3/12	7	7	6	0.85	13	13	12	0.92
BLS	BLG3/13	17	18	14	0.78	11	13	11	0.84
BLS	BLG3/14	14	16	12	0.75	10	10	8	0.80
BLS	BLG3/15	18	23	15	0.65	13	18	16	0.89
MLS	MLG2/1	16	16	12	0.75	15	16	15	0.94
MLS	MLG2/2	15	15	13	0.87	13	13	13	1.00
MLS	MLG2/3	9	9	8	0.89	10	10	9	0.90
MLS	MLG2/4	20	20	16	0.80	14	14	14	1.00
MLS	MLG2/5	17	18	13	0.72	11	13	13	1.00
MLS	MLG2/6	9	9	9	1.00	11	11	10	0.91
MLS	MLG2/7	13	14	14	1.00	8	9	9	1.00
MLS	MLG2/8	10	10	6	0.60	13	13	13	1.00
MLS	MLG2/9	7	7	7	1.00	6	7	7	1.00

Language Group	Pt. ID no.	CRN	Token-N	Type-N	TTR-N	CRV	Token-V	Type-V	TTR-V
MLS	MLG2/10	10	10	9	0.90	10	10	10	1.00
MLS	MLG2/12	7	9	9	1.00	7	14	14	1.00
MLS	MLG2/13	4	4	4	1.00	13	15	15	1.00
MLS	MLG2/14	17	18	7	0.39	23	26	21	0.81
MLS	MLG2/15	9	10	8	0.80	12	12	12	1.00
BLE	BLG1/1	12	12	7	0.58	11	11	9	0.81
BLE	BLG1/2	9	9	5	0.55	9	9	9	1.00
BLE	BLG1/3	17	17	8	0.47	13	13	12	0.92
BLE	BLG1/4	11	11	8	0.72	7	7	7	1.00
BLE	BLG1/5	16	16	7	0.43	10	10	8	0.80
BLE	BLG1/6	11	11	7	0.63	13	13	10	0.77
BLE	BLG1/7	14	14	7	0.50	7	9	9	1.00
BLE	BLG1/8	6	6	5	0.83	9	9	8	0.89
BLE	BLG1/9	11	11	9	0.81	11	11	10	0.90
BLE	BLG1/10	12	12	7	0.58	9	9	9	1.00
BLE	BLG3/10	12	1	8	0.67	8	8	8	1.00
BLE	BLG1/12	14	14	9	0.64	13	13	11	0.84
BLE	BLG1/13	7	7	7	1.00	7	7	7	1.00
BLE	BLG1/14	12	12	8	0.67	12	12	12	1.00
BLE	BLG1/15	10	10	6	0.60	10	10	9	0.90

Key: CRN/ CRV: Correctly Recalled Nouns/Verbs
Token-N/ Token-V; Token Nouns/Verbs
Type-N/Type-V; Type Nouns/Verbs
TTR-N/TTR-V; Type Token Ratio-Nouns/ Verbs

Table 1: Data and the calculated differences for total word count

Variables	Groups	SP1	SP5
Total Word Count	MLS	20	31.07
Total Word Count	BLS	27.87	42.40
Total Word Count	BLE	42.47	64.53
Absolute Differences	**MLS vs. BLS**	7.87	11.33
	MLS vs. BLE	22.47	33.46
	BLS vs. BLE	14.60	22.13
Mean differences		**14.98**	**22.31**

Table 2: Data and the calculated differences for correctly recalled nouns

Variables	Groups	SP1	SP5
Correctly recalled nouns	MLS	7.80	11.80
Correctly recalled nouns	BLS	11.27	16.47
Correctly recalled nouns	BLE	11.40	17.13
Absolute Differences	MLS vs. BLS	3.47	4.67
	MLS vs. BLE	3.60	5.33
	BLS vs. BLE	0.13	0.66
Mean differences		2.40	3.55

Table 3: Data and the calculated differences for Type-N

Variable	Groups	SP1	SP5
Type-N	MLS	7.40	10.60
Type-N	BLS	10.67	14.80
Type-N	BLE	10.00	12.93
Absolute Differences	MLS vs. BLS	3.27	4.20
	MLS vs. BLE	2.60	2.33
	BLS vs. BLE	0.67	1.87
Mean differences		2.18	2.80

Tables 4: Data and the calculated differences for Token-N

Variable	Groups	SP1	SP5
Token-N	MLS	7.93	12.33
Token-N	BLS	11.53	16.67
Token-N	BLE	11.53	17.13
Absolute Differences	MLS vs. BLS	3.60	4.34
	MLS vs. BLE	3.60	4.80
	BLS vs. BLE	0.00	0.46
Mean differences		2.40	3.20

Tables 5: Data and the calculated differences for TTR-N

Variable	Groups	SP1	SP5
TTR-N	MLS	0.96	0.86
TTR-N	BLS	0.94	0.89
TTR-N	BLE	0.89	0.77
Absolute Differences	MLS vs. BLS	0.02	0.03
	MLS vs. BLE	0.07	0.09
	BLS vs. BLE	0.05	0.12
Mean differences		0.05	0.08

Table 6: Data and the calculated differences for correctly recalled verbs

Variables	Groups	SP1	SP5
Correctly recalled verbs	MLS	6.47	10.27
Correctly recalled verbs	BLS	7.73	10.13
Correctly recalled verbs	BLE	5.87	7.40
Absolute Differences	MLS vs. BLS	1.26	0.14
	MLS vs. BLE	0.60	2.87
	BLS vs. BLE	1.86	2.73
Mean differences		1.24	1.91

Table 7: Data and the calculated differences for Type-V

Variable	Groups	SP1	SP5
Type-V	MLS	6.27	9.53
Type-V	BLS	7.00	9.33
Type-V	BLE	5.47	6.80
Absolute Differences	MLS vs. BLS	0.73	0.20
	MLS vs. BLE	0.80	2.73
	BLS vs. BLE	1.53	2.53
Mean differences		1.02	1.82

Table 8: Data and the calculated differences for token count of verbs

Variable	Groups	SP1	SP5
Token-V	MLS	6.67	10.27
Token-V	BLS	7.93	10.47
Token-V	BLE	6.13	7.53
Absolute Differences	MLS vs. BLS	1.26	0.20
	MLS vs. BLE	0.54	2.74
	BLS vs. BLE	1.80	2.94
Mean differences		1.20	1.96

Tables 9: Data and the calculated differences for verb Type Token Ratio

Variable	Groups	SP1	SP5
TTR-V	MLS	0.96	0.93
TTR-V	BLS	0.93	0.91
TTR-V	BLE	0.89	0.91
Absolute Differences	MLS vs. BLS	0.03	0.02
	MLS vs. BLE	0.07	0.02
	BLS vs. BLE	0.04	0.00
Mean differences		0.05	0.01

Table - Individual participant scores for measurements of lexical diversity for the selected SP 1

Language Group	Pt. ID no.	CRN	Token-N	Type-N	TTR-N	CRV	Token-V	Type-V	TTR-V
BLS	BLG1/1	13	13	12	0.92	6	7	7	1.00
BLS	BLG1/2	16	16	15	0.94	8	8	8	1.00
BLS	BLG1/3	17	17	13	0.76	7	7	7	1.00
BLS	BLG1/4	14	14	12	0.86	11	11	11	1.00
BLS	BLG1/5	23	23	23	1.00	19	19	12	0.63
BLS	BLG1/6	10	11	10	0.91	9	9	8	0.89
BLS	BLG1/7	1	1	1	1.00	4	4	4	1.00
BLS	BLG1/8	7	7	7	1.00	5	5	5	1.00
BLS	BLG1/9	4	5	5	1.00	4	5	5	1.00
BLS	BLG1/10	12	12	11	0.92	8	8	7	0.88
BLS	BLG1/11	10	10	10	1.00	5	5	5	1.00
BLS	BLG1/12	6	6	6	1.00	4	4	4	1.00
BLS	BLG1/13	8	8	7	0.88	8	8	6	0.75
BLS	BLG1/14	17	19	17	0.89	14	15	12	0.80
BLS	BLG1/15	11	11	11	1.00	4	4	4	1.00
MLS	MLG1/1	3	4	3	0.75	7	10	8	0.80
MLS	MLG1/2	23	23	17	0.73	18	18	16	0.88
MLS	MLG1/3	3	3	3	1.00	6	6	6	1.00
MLS	MLG1/4	7	7	7	1.00	4	4	4	1.00
MLS	MLG1/5	12	12	12	1.00	11	11	10	0.90
MLS	MLG1/6	11	11	10	0.90	6	6	6	1.00
MLS	MLG1/7	11	11	11	1.00	9	9	8	0.89
MLS	MLG1/8	8	8	8	1.00	5	5	5	1.00

Language Group	Pt. ID no.	CRN	Token-N	Type-N	TTR-N	CRV	Token-V	Type-V	TTR-V
MLS	MLG1/9	4	5	5	1.00	4	4	4	1.00
MLS	MLG1/10	6	6	6	1.00	5	5	5	1.00
MLS	MLG1/11	7	7	7	1.00	5	5	5	1.00
MLS	MLG1/12	4	4	4	1.00	4	4	4	1.00
MLS	MLG1/13	7	7	7	1.00	5	5	5	1.00
MLS	MLG1/14	5	5	5	1.00	3	3	3	1.00
MLS	MLG1/15	6	6	6	1.00	5	5	5	1.00
BLE	BLG2/1	14	14	14	1.00	9	9	8	0.89
BLE	BLG2/2	16	16	12	0.75	8	8	8	1.00
BLE	BLG2/3	15	15	11	0.73	6	6	5	0.83
BLE	BLG2/4	16	16	15	0.93	5	6	4	0.67
BLE	BLG2/5	6	6	6	1.00	4	4	4	1.00
BLE	BLG2/6	6	8	8	1.00	6	7	6	0.86
BLE	BLG2/7	15	15	9	0.60	4	4	3	0.75
BLE	BLG2/8	17	17	13	0.76	7	7	7	1.00
BLE	BLG2/9	12	12	10	0.83	8	8	5	0.62
BLE	BLG2/10	10	11	10	0.90	5	5	5	1.00
BLE	BLG2/11	11	10	9	0.90	8	9	9	1.00
BLE	BLG2/12	11	11	11	1.00	4	5	4	0.80
BLE	BLG2/13	10	10	10	1.00	7	7	7	1.00
BLE	BLG2/14	8	8	8	1.00	4	4	4	1.00
BLE	BLG2/15	4	4	4	1.00	3	3	3	1.00

Key: CRN/ CRV: Correctly Recalled Nouns/Verbs
Token-N/ Token-V; Token Nouns/Verbs
Type-N/Type-V; Type Nouns/Verbs
TTR-N/TTR-V; Type Token Ratio-Nouns/ Verbs

The University Of Sheffield.

Downloaded: 17/10/2017
Approved: 01/10/2015

Antonella Dinushee Shihani Atapattu Bakmeewewa
Registration number: 120113587
Human Communication Sciences
Programme: Human Communication Sciences (PhD/Human Comm Sciences PT)

Dear Antonella Dinushee Shihani

PROJECT TITLE: Lexico Syntactic retrieval and cohesive speech in Sinhala-English speaking bilingual aphasics
APPLICATION: Reference Number 006298

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 01/10/2015 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 006298 (dated 09/09/2015).
- Participant information sheet 1012253 version 2 (22/10/2015).
- Participant consent form 1012252 version 1 (09/09/2015).

The following optional amendments were suggested:

Please carefully proofread the Participant Information Sheet; there are some typos and duplicated words. Additionally, this should be shortened. The descriptions of the staff involved should be edited down, and their pictures need only appear once. Their details could also be moved to the end of the PIS, rather than at the beginning. Some consideration should be given to the assignment into monolingual/bilingual groups by the researcher. Might a potential participant be upset if s/he rates his bilingual language ability higher than the researcher? This doesn't require any amendment to any documents, but is simply something the researcher is urged to consider. In the LPQ, many of the questions seem rather odd (e.g., did you acquire your L1 before the age of 12 years; did you acquire your L2 after your L1?) Please review this with your supervisor(s) before attempting to administer it.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Rachel Ralph
Ethics Administrator
Human Communication Sciences

Lexico Syntactic retrieval and cohesive speech in Sinhala- English speaking bilingual aphasics

Changes made to ethics application 007306

Comment/Detail	Change
1. Change the number of session for aphasics on the information sheets	Changed in document
2. Decide on audio/video/both recording and change consent /information sheet accordingly	All documents have been changed to only require audio recordings. Therefore, consent has also been requested only for audio recordings
3. Substitute ticks for smiley faces	Changed in document
4. Re word 'pilot phase	Word changed/ re phrased to 'trial phase
5. Remove name from case history	Changed in document
6. Add examples of the tasks they are going to do; for examples the types of pictures they may be asked to name or the types of conversations etc.	Changed in healthy/control information sheets.
7. The information sheet for the family/care giver of the person with aphasia is written as though they are going to take part in the study- re word.	Changes made to document
8. The information sheet for the participants with aphasia is very long (as are the others) it might be worth having a look to see if you can shorten them at all.	Possible reductions were made to the content. However, research and research participation is novel in Sri Lanka and a major reduction on content may lead to misconceptions and miscommunications.
9. Some of the photos also did not seem to support the information ('you don't have to tell us why you quit', taking a break).	Changes made to document
10. Re write section on how participants would be invited for the study	The content was modified as follows; The recruitment of Persons with Aphasia will be through information made available by resident Speech Language Therapists (SLTs) employed at several identified data collection points. Therapists will be provided with a brief checklist, in which ideal an participant (eligibility criteria) will be described. Based on available clinical records, SLTs will be

	requested to note patients fulfilling necessary criteria and therefore eligible for recruitment. The SLT will make contact with such participants and provide them with the information sheet. Participants will then be invited for a meeting with the primary researcher. Here an opportunity will be provided to clarify further and willing participants may provide consent. Participants and researcher may also use this meeting (session) to decide on convenient dates and venues for testing. Those recruited for these phases (Phases 2 & 3) will only be those, who at the time of testing, for any given reason, do not receive any sort of services from a registered Speech Language Therapist. The recruitment of healthy non-brain damaged participants will take place through identified social groups and elders homes. The researcher will use flyers and where necessary, write to administrators with study details for distribution amongst attendees. Those identified as eligible, if interested, can contact the researcher directly or via the administrator.

Lexico Syntactic retrieval and cohesive speech in Sinhala- English speaking bilingual aphasics

Changes made to ethics application 007306

11. Write what measures would be taken if participants should fatigue	The content was modified as follows; In order to minimize this, participants will be offered regular intervals during testing. Testing can be extended across a number of days and in several sessions. Participants are allowed to request for extended rest periods or for temporary suspension of testing. Testing is also conducted as individual sessions and therefore allows more flexibility in catering to the participants' individual needs and ability. The primary researcher will also provide sufficient guidance to participants for successful completion of all language tests.
12. Versions of information sheets	New/modified documents (Version 2) have been uploaded for both accessible and control versions. **Please Note:** An Error occurred in uploading document #1014757- Version 2 was erroneously updated. Please consider Version 3 (PIS_healthy_controls-Main.pdf)
13. Versions of consent forms	New/modified documents (Version 2) have been uploaded for both accessible and control versions. **Please Note:** An Error occurred in uploading document #1014735- Version 2 was erroneously updated. Please consider Version 3 (Control_consent_-_Pilot.pdf)

The University Of Sheffield.

Downloaded: 17/10/2017
Approved: 28/04/2016

Antonella Dinushee Shihani Atapattu Bakmeewewa
Registration number: 120113587
Human Communication Sciences
Programme: PhD Human Communication Sciences

Dear Antonella Dinushee Shihani

PROJECT TITLE: Lexico Syntactic retrieval and cohesive speech in Sinhala-English speaking bilingual aphasics
APPLICATION: Reference Number 007306

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 28/04/2016 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 007306 (dated 21/04/2016).
- Participant information sheet 1017170 version 2 (21/04/2016).
- Participant information sheet 1014732 version 3 (21/04/2016).
- Participant information sheet 1014727 version 4 (21/04/2016).
- Participant information sheet 1014726 version 3 (21/04/2016).
- Participant information sheet 1014756 version 3 (21/04/2016).
- Participant information sheet 1014757 version 4 (21/04/2016).
- Participant consent form 1014734 version 2 (17/04/2016).
- Participant consent form 1014733 version 2 (17/04/2016).
- Participant consent form 1014736 version 2 (17/04/2016).
- Participant consent form 1014735 version 3 (17/04/2016).

The following optional amendments were suggested:

Just one small comment - on your consent forms you should change 'e'ffect to 'a'ffect.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

John Mason
Ethics Administrator
Human Communication Sciences

Ethics Review Committee

A SIDCER(Strategic Initiative for Developing Capacity in Ethical Review)recognized ERC

Faculty of Medicine,University of Kelaniya, Sri Lanka
FWA00013225

18.11.2015

Ref. No. P/183/11/2015

Ms. A.Dinushee.S. Atapattu Bakmeewewa
Lecturer
Dept. of Disability Studies
Faculty of Medicine
Ragama.

Subject: Lexico Syntactic Retrieval and Cohesive Speech In Sinhala-English Speaking Bilingual Aphasics

Authors: A.Dinushee.S. Atapattu- Bakmeewewa

Thank you for submitting the above research proposal. Ethics Review Committee which met on 17.11.2015 granted conditional approval to the above study and made following suggestions.

Make Participants Information Sheet relevant and summarized.

Include ERC contact details in the Participants Information Sheet.

With best wishes,

Yours sincerely,

Dr. W.N.S. Perera
Secretary/ERC

Address all correspondence to: Secretary, Ethics Review Committee,
Faculty of Medicine, University of Kelaniya, PO Box 06, Thalagolla Road, Ragama, Sri Lanka.
Telephone: +94 -112961000, Fax : +94-112958337 /+94-112955280

QUESTIONNAIRE: SLT QUICK SCREEN FOR PARTICIPANT SELECTION

Instructions to SLTs*: Please fill out a single form per participant. Tick in either the 'YES' or 'NO' boxes. Indicate where information is not available. Kindly return the filled form to the researcher, by email or post. If further clarifications, kindly contact, Dinushee on 0779427481 or email, dinushee@kln.ac.lk or aatapattu1@sheffield.ac.uk*

	Yes	No
1. Above 40 years of age?		
2. Has sustained a **single left** hemispheric CVA?		
3. Presents signs and symptoms indicative of Aphasia?		
4. Has completed a period of at least 6 months post stroke?		
5. Has medical records and reports of CT findings available for inspection by the researcher?		
6. The language difficulties ARE NOT associated with cognitive and psychiatric difficulties.		
7. Is the speech intelligible enough to carry out meaningful analysis?		
8. Has preserved or partially-preserved skills of auditory verbal comprehension, sufficient to understand simple test instructions?		
9. Has a noticeable deficit in naming; yet demonstrates some amount of preserved naming skill?		
10. Reports of a minimum of five (5) years of formal education?		
11. Has adequate physical capacity for participation?		
12. (Reports of an) absent of a history of;		
i. Neurological problems		
ii. Psychiatric Disorders		
iii. Developmental Speech and Language difficulties		
iv. Learning difficulties		
v. Visual Difficulties		
vi. Auditory Impairment		
vii. Problems in Moods and Personality		
viii. Alcohol and intractable substances		
13. Has an identified healthy and well familiar conversation- partner willing to voluntarily participate in the study		

	Yes	No
14. Able to complete the following tests		
- Naming a picture		
- Describing a picture sequence		
- Describing a single picture		
- Carry out a simple conversation with a family member		
15. Willing to participate in the research study		

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Prof. Patricia Cowell BA, MS, PhD

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email : hcs-support@sheffield.ac.uk
http://www.shef.ac.uk/hcs

Cadre Chair, Senior Professor and Dean
Prof. Nilanthi de Silva MBBS (C'bo), MSc (London), MD (C'bo)

Faculty of Medicine
University of Kelaniya
PO Box 6, Thalagolla road, Ragama
Sri Lanka

Tel: +94-11-2955280
Fax: +94112958337
Email: deanmed@kln.ac.lk
http://www.kln.ac.lk/medicine/

Naming and Language Assessment in Persons with Aphasia (PWAs)

Primary Researcher/ PhD student:

Dinushee Atapattu-Bakmeewewa

SLMC Reg. No: 51

0112958039/ 0779427481

Primary Supervisor; Dr. R. Herbert

Director of Research
Department of
Human
Communication
Sciences
University of
Sheffield
United Kingdom
+44 (0) 114 222 2403
r.herbert@sheffield.ac.uk

Secondary Supervisor; Dr. Emma Gregory

Lecturer & Course Director (MMedSci.)
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+44 (0) 114 222 2417
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Address of the Overseas Institution

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362 Mushroom Lane, Sheffield S10 2TS
United Kingdom
Tel: +44 (0) 114 222 2418
email : hcs-support@sheffield.ac.uk

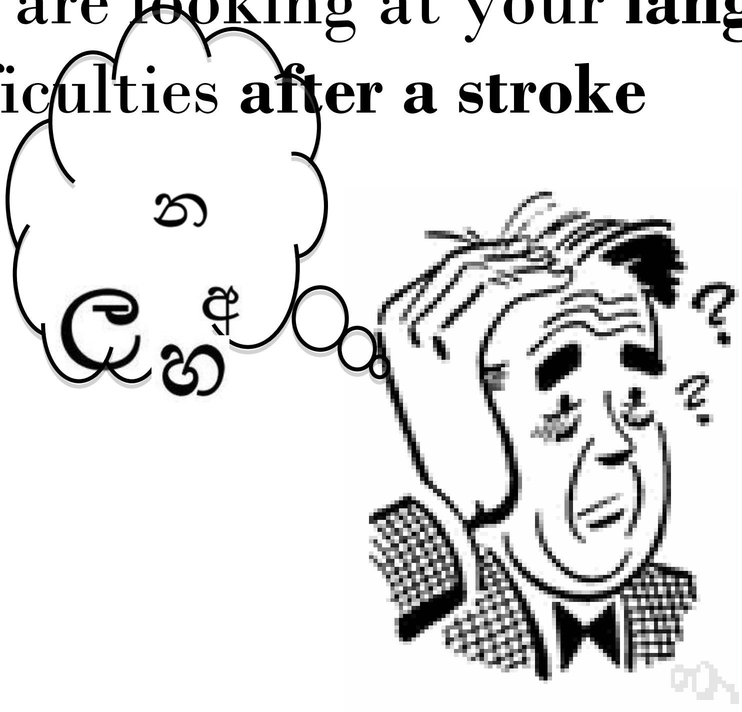
Address of Local Institution (of employment)

Faculty of Medicine
University of Kelaniya
P.O Box 6, Thalagolla Road ,Ragama
Sri Lanka

Telephone: 0112961000 Email: info.med@kln.ac.lk

About the Study –

We are looking at your **language** difficulties **after a stroke**



About the Study -

We are looking for **volunteers** diagnosed **with Aphasia**

About the Study –

We are looking for those who speak Sinhala

You **don't** have to be very **fluent**

The Study

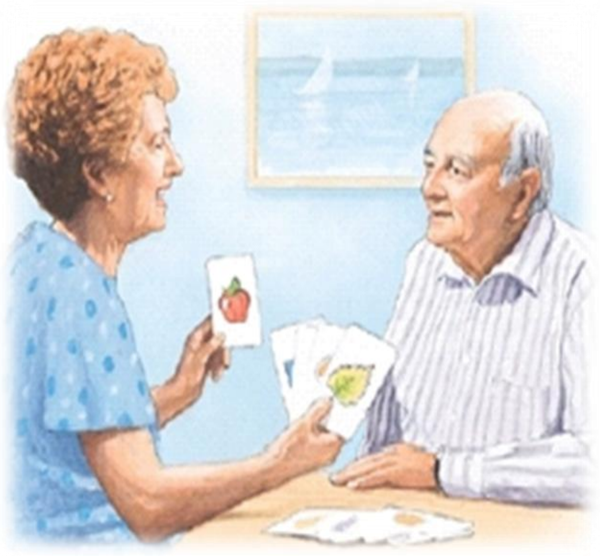
You must speak **Sinhala** as your **first language**

The Study

Sinhala must be the language you **frequently spoke** in your routine work.

The study

We will ask you to **name some pictures**



The study

We will **speak to you**

The Study

Some assessments will be done on a **computer**

The Study

This is **NOT** therapy

Taking part

It will take about **2 hours**

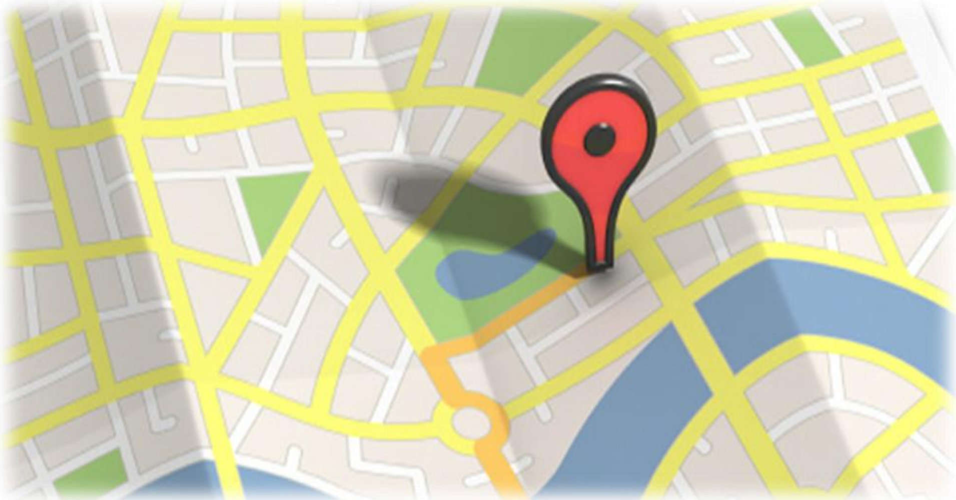
Taking part

Dinushee will meet you through **6-8 sessions**.

It can be scheduled on days convenient to you.

Taking Part

You can decide on a mutually convenient location



Taking Part

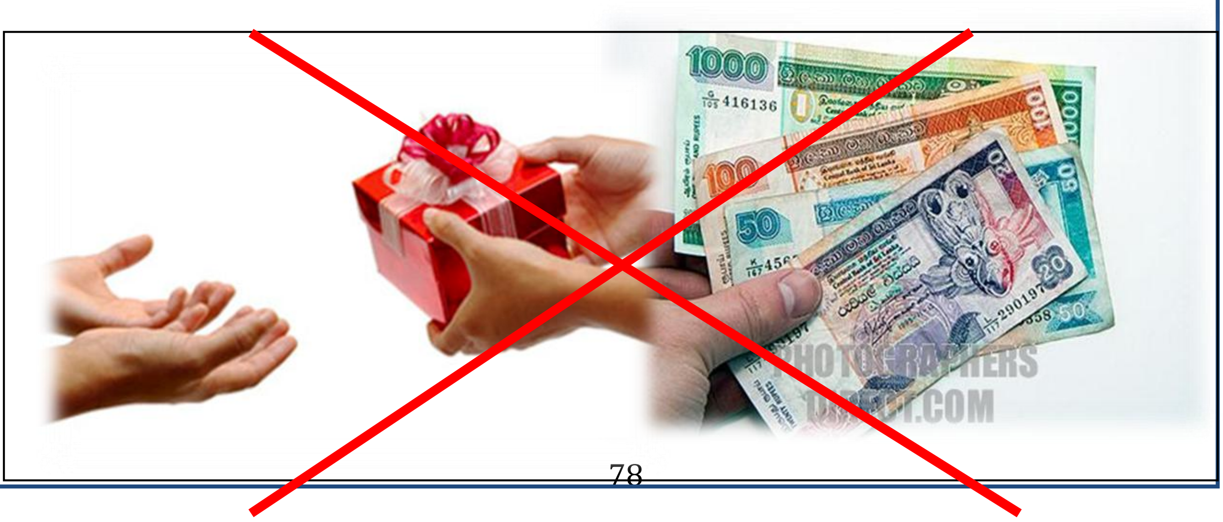
Or Dinushee can visit you at **home**

Taking Part

You can claim between **LKR100 - LKR500 for transport**

Taking Part

There will be **no other** monetary or tangible rewards for your participation



Taking Part

Some people will **like** to participate

Some may **not**

Taking Part

You can **take rest anytime.**

Taking part

You can **stop any time**

Taking part

You can **refuse** to participate any time

Taking part

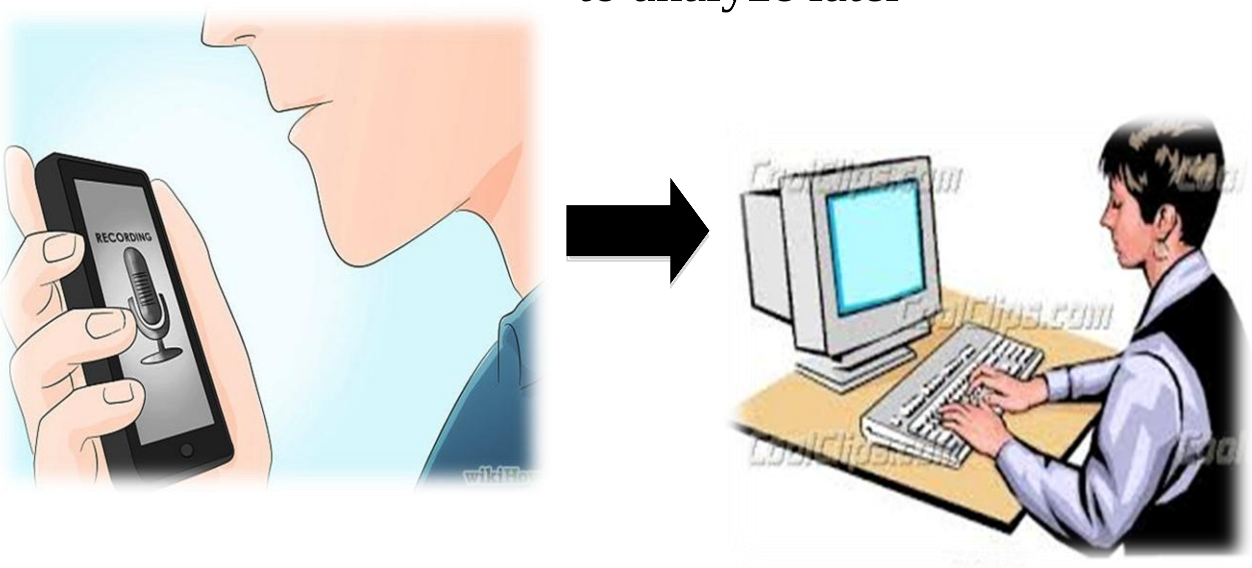
You don’t have to tell us why you quit.

Taking part

Your decisions will **not effect future participation** in speech therapy

Recordings

Dinushee will **audio record** your responses to analyze later



Recordings

Your recordings are **confidential.**

Your name will **not** be put anywhere

Recordings

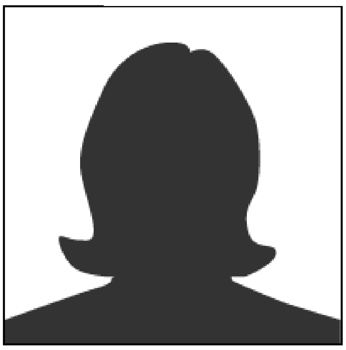
We will keep your recordings **safely**

Recordings

Dinushee, her supervisors and two other SLTs will listen to your recordings

SLT1

SLT2



Recordings

You can choose if your recordings could be used at public presentations

Responses

Your test results are **confidential.**

Your name will **not** be put on reports

Test Results

We will keep your results **locked.**

Results

Only **Dinushee and her supervisors** will look at your test results

Results

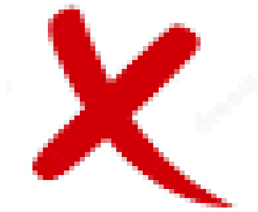
Dinushee will **write** your results in her **thesis**

Results

Dinushee will discuss your results at **conferences**

Do you want to take part?

Please let us know if you wish to take part



Questions?

Dinushee Atapattu - Bakmeewewa
Telephone: +94779427481
Email: aatapattu1@sheffield.ac.uk

Concerns or Complaints?

Prof. Rajitha Wickramasinghe
Sr. Professor,
Department of Public Health,
Faculty of Medicine, Ragama
Tel: 0094112953411
Email: arwicks@kln.ac.lk

OR

Prof. Patricia Cowell
Head of Department
Department of Human Communication Sciences
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p.e.cowell@sheffield.ac.uk

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Naming and Language Assessment in Persons with Aphasia (PWAs)

Primary Researcher/ PhD student:

Dinushee Atapattu-Bakmeewewa

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0112958039/ 0779427481

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Faculty of Medicine
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P.O Box 6, Thalagolla Road ,Ragama
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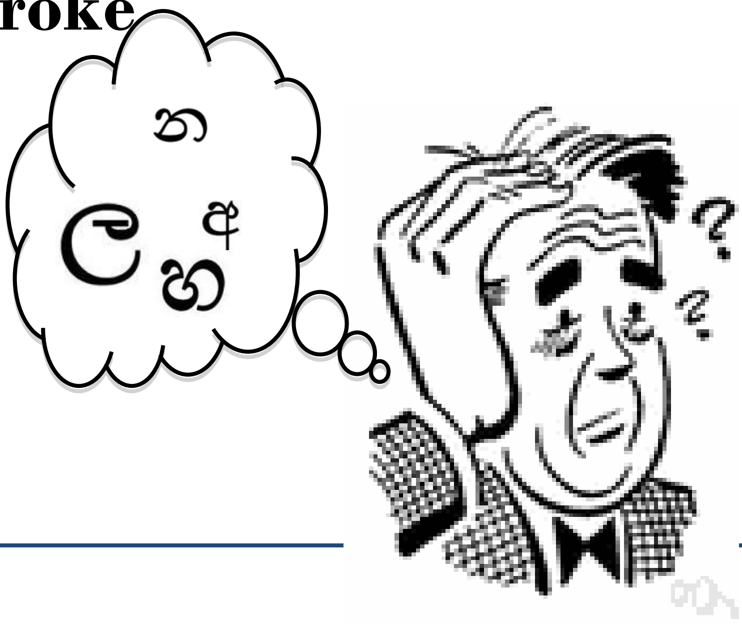
Telephone: 0112961000 Email: info.med@kln.ac.lk

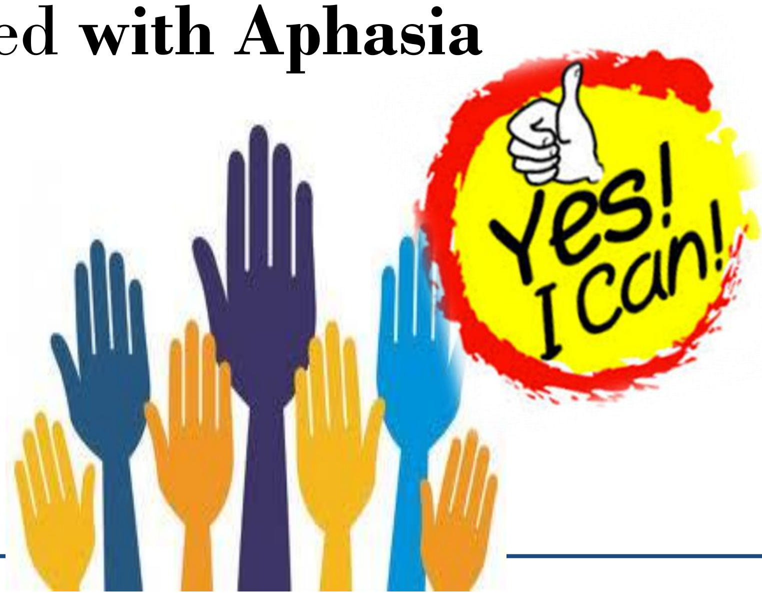
About the Study –

We are looking at your **language** difficulties **after a stroke**



About the Study -

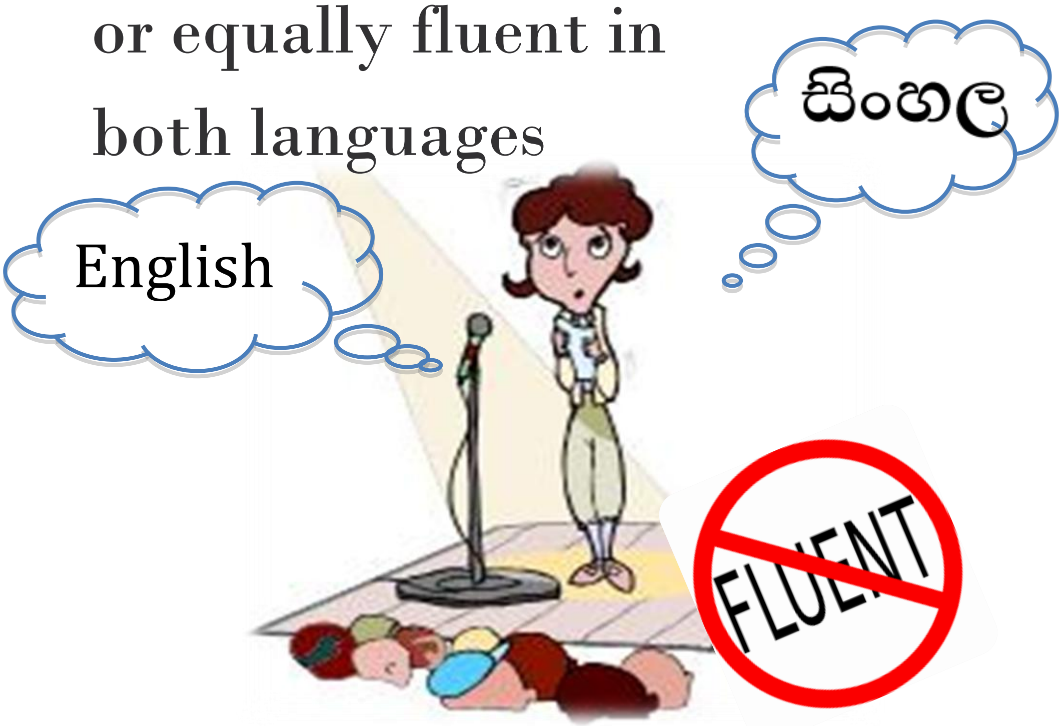
We are looking for **volunteers** diagnosed **with Aphasia**



About the Study

You must have understood and spoke **Sinhala AND English before the stroke**

You don't have to be very fluent or equally fluent in both languages



The Study

You must speak **Sinhala** as your **first language**

The Study

English should be **learnt later** (from home or school)

The study

We will **ask you to name some pictures**

The study

We will **speak to you**

The Study

Some assessments will be done on a **computer**

The Study

This is **NOT** therapy

Taking part

It will take about **2 hours**

Taking part

Dinushee will meet you through **6-8 sessions**.

It can be scheduled on days convenient to you.

Taking Part

You can decide on a mutually convenient location

Taking Part

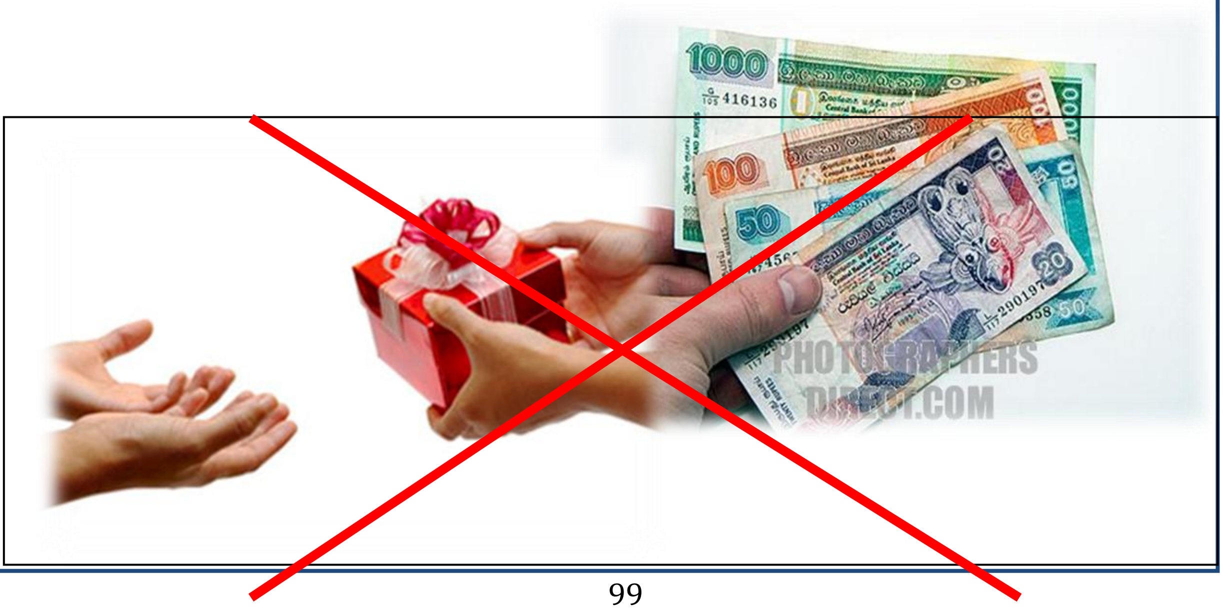
Or Dinushee can visit you at **home**

Taking Part

You can claim between **LKR100 - LKR500 for transport**

Taking Part

There will be **no other** monetary or tangible rewards for your participation



Taking Part

Some people will **like** to participate

Some may **not**

Taking Part

You can **take rest anytime.**

Taking part

You can **stop any time**

Taking part

You can **refuse** to participate any time

Taking part

You don't have to tell us why you quit.

Taking part

Your decisions will **not effect future participation** in speech therapy

Recordings

Dinushee will **audio record** your responses to analyze later

Recordings

Your recordings are **confidential.**

Your name will **not** be put anywhere

Recordings

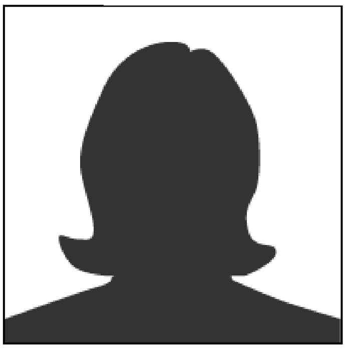
We will keep your recordings safely

Recordings

Dinushee, her supervisors and two other SLTs will listen to your recordings

SLT1

SLT2



Recordings

You can choose if your recordings could be used at public presentations

Responses

Your test results are **confidential.**

Your name will **not** be put on reports

Test Results

We will keep your results **locked.**

Results

Only **Dinushee and her supervisors** will look at your test results

Results

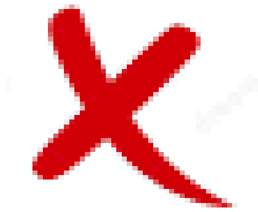
Dinushee will **write** your results in her **thesis**

Results

Dinushee will discuss your results at **conferences**

Do you want to take part?

Please let us know if you wish to take part



Questions?

Dinushee Atapattu - Bakmeewewa
Telephone: +94779427481
Email: aatapattu1@sheffield.ac.uk

Concerns or Complaints?

Prof. Rajitha Wickramasinghe
Sr. Professor,
Department of Public Health,
Faculty of Medicine, Ragama
Tel: 0094112953411
Email: arwicks@kln.ac.lk

OR

Secretary
The Ethics Review Committee
Faculty of Medicine
University of Kelaniya
PO Box 06, Thalagolla Road, Ragama, Sri Lanka
Tel: +94 11 2961000
Fax: +94 11 2958337
Email: ercmedfac@kln.ac.lk

Off Shore contacts:

Prof. Patricia Cowell
Head of Department
Department of Human Communication Sciences
University of Sheffield
United Kingdom
+44 (0) 114 222 2426
p.e.cowell@sheffield.ac.uk

OR

Office of the Registrar and Secretary
Firth court
Western Bank
Sheffield S10 2TN, UK
Tel: +4 1142221100
Fax: +4 1142221103
Email: registrat@sheffield.ac.uk

The University Of Sheffield.

Department of Human Communication Sciences
University of Sheffield
362 Mushroom Lane, Sheffield, S10 2TS
United Kingdom

Faculty of Medicine
University of Kelaniya
PO Box 6, Thalagolla road, Ragama
Sri Lanka

LANGUAGE ASSESSMENT IN APHASIA

THE MAIN (SECOND) PHASE

Consent Form

Research Team: Dinushee Atapattu-Bakmeewewa (Researcher), Dr. Ruth Herbert (Supervisor), Dr. Emma Gregory (Supervisor)

The information sheet

1. The information sheet has been read to me ✓ ✗

2. I understand the information sheet ✓ ✗

3. I was allowed time to ask questions ✓ ✗

<u>The Study</u>

4. I understand that my participation in this study is of my own free will. ✓ ✗

5. I understand that I can stop or rest anytime during testing ✓ ✗

6. I understand that I can withdraw from the study at anytime ✓ ✗

7. I understand that participation this is not speech therapy. ✓ ✗

8. I understand that not participating or withdrawal from this study would not effect my right to access speech therapy services in the future. ✓ ✗

Speech recordings

9. I understand that my speech will be audio recorded ✓ ✗

10. I understand that the research team Will listen to my speech recordings ✓ ✗

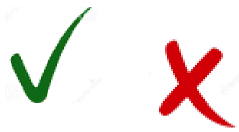
Confidentiality:

11. I understand that my identity will be kept confidential and my name will not appear on any research data or resources. ✓ ✗

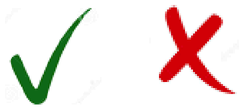
Future Research:

12. I give permission for the research team in this study to contact me, should they need more information or clarifications, post testing. ✓ ✗

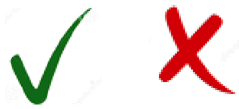
13. I agree to allow my speech recordings to be used in future research.



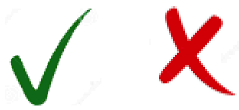
14. I agree to allow my test results to be used in future research.



15. My results may be presented at research conferences. I agree to this.



16. I agree to participate in this study



Name of participant	Date
Name of researcher	Date

The University Of Sheffield.

Department of Human Communication Sciences
University of Sheffield
362 Mushroom Lane, Sheffield, S10 2TS
United Kingdom

Faculty of Medicine
University of Kelaniya
PO Box 6, Thalagolla road, Ragama
Sri Lanka

DETERMINING THE ABILITY TO RETRIEVE WORD NAMES IN ISOLATION AND IN CONNECTED SPEECH

The following information sheet describes a research project at the University of Sheffield in the UK, which is forms the basis of an ongoing doctoral degree. The primary researcher, **Dinushee Atapattu-Bakmeewewa** is enrolled as a Part time distance-learning Post Graduate Research candidate since 2012. Her PhD study **looks at language after stroke in people who speak Sinhala and in people who speak English and Sinhala.**

This is the **second phase of the study's data collection**. **As a family members/caregivers of a participant of this research study, it is important to know what the study is about and what it involves.** Kindly take a few minutes to read the detailed information sheet below.

THE RESEARCH TEAM

Primary researcher: Dinushee Atapattu-Bakmeewewa

Supervisors: Dr. Ruth H. Herbert

Dr. Emma Gregory



- **Dinushee Atapattu-Bakmeewewa- Primary Researcher**

Dinushee Atapattu-Bakmeewewa, a qualified Speech-Language Therapist, will play the lead role in assisting and guiding participants to complete the tasks. She holds a Bachelors Degree in Speech-Language Pathology and Audiology from The University of Mangalore, India, a Masters Degree in Speech Difficulties from The University of Sheffield, United Kingdom and is currently reading for her PhD at the same. She is registered at the Sri Lanka Medical Council (SLMC Reg. No. 51) and affiliated to the Ragama Medial Faculty as a permanent academic staff member.

- **Dr. Ruth H. Herbert**

Dr. Herbert is a qualified speech and language therapist with a doctoral degree from University College London. She has been attached to The University of Sheffield since 2003 and is currently the Departmental Director of Research. Dr. Herbert is registered with the Health and Care Professional Council of UK, Royal College of Speech and Language Therapists and is also and honorary member the British Aphasiology Society. Dr Herbert has been awarded many research grants from the NHS and Stroke Association (UK) for research in Acquired Language Disorders.

- **Dr. Emma Gregory**

Emma Gregory is a Lecturer and course director of the MMedSci program at the University of Sheffield. Having completed her PhD in 2012, Dr. Gregory has worked with adults with acquired neurological communication and swallowing disorders in Mansfield PCT and

Sheffield PCT. She holds an honorary contract with Sheffield Children's Hospital NHS Trust.

THE STUDY

WHAT IS THIS STUDY ABOUT?

The primary focus of this study is **language skills after a stroke**. After a stroke, many people have difficulties understanding and using language, which is known as **'aphasia'**.

Most research has been carried out with English only speakers. We want to explore language use in Sinhala speakers and in bilingual English-Sinhala speakers.

In this study we will identify the ability of such people with aphasia to understand and produce words in their languages in different linguistic situations.

It is expected that the findings of this study will **contribute towards the assessment and treatment of aphasia in the Sri Lankan clinical context**

WHO ARE WE RECRUITING?

We are recruiting **adults with aphasia post stroke, aged above 40 years.** Participants will be recruited into **two groups**.

Group 1: The Monolingual Group

Recruited to this group are participants **whose only known and frequently/functionally used language is Sinhala**. **Sinhala should**

be your mother tongue and **should be most frequently used** to communicate during your routine activities.

Group 2: The Bilingual Group

Recruited to this group are participants **familiar with both Sinhala and English**. **Sinhala should be the mother tongue (first language)** and **should be most frequently used** to communicate during routine activities. **English should be a language later learnt**, either at home or school.

WHAT HAPPENS IF A PARTICIPANT DOES DECIDE TO TAKE PART?

The Screen

We will first conduct a **quick screen, ask a few questions and review their medical records.** This is done in order to confirm that s/he is eligible for the study. Therefore, **not everyone screened would be able to participate in the study.**

If one is recruited to the study, we will allocate them to the monolingual or bilingual group based on their language proficiency.

The Main Test

In the main test, the participant would be required to **name a few pictures** (Example: Fish, Comb, Butterfly) presented on a laptop computer and **participate in a few speech tasks** (Example: Describing a picture of a beach, narrating a story sequence and participating in an informal conversation).

All language assessments will be conducted **only in Sinhala for the Monolingual group** and in **both Sinhala and English for the bilingual group.** Responses will be **audio recorded**.

WHEN AND HOW LONG WILL TESTING BE?

If identified as eligible to participate in the main study, Dinushee will allocate a mutually convenient date and time for testing. We expect the **screen to last no longer than one hour** and if selected, **primary testing to last no longer than 2 hours.**

WHERE WILL IT TAKE PLACE?

Participants may discuss a convenient venue for testing with the primary researcher. Participants could arrange to meet at the **auditorium of the Department of Disability Studies, Faculty of Medicine, Ragama**. Alternatively, Dinushee can also **visit you at your local community centre or even at home.**

IS IT COMPULSORY TO TAKE PART? AND WHAT IF A PARTICIPANT NEEDS TO WITHDRAW?

No. Participation is not compulsory. It is on a **voluntary basis**.
Participants can withdraw from the study at any time**.**
Participants do not have to justify their reasons to participate, not participate, or withdraw.

WILL THERE BE ANY PAYMENTS OR REWARDS, IF AGREED TO PARTICIPATE?

There will be no financial reimbursement of ones time. Participation will also not affect charges for speech and language therapy services at any point of time. However in an event that the participant requires to travel to a mutually agreed location specifically for participating in this study, **a traveling cost exceeding LKR 100 but no more than LKR500 will be reimbursed.**

CAN THE PARTICIPANT TAKE A BREAK IN BETWEEN TESTING?

Yes, s/he can. Testing is carefully arranged across several days in order to minimize chances of fatigue. Within any single day of testing, sessions are planned with regular breaks in between. However, if the participant does wish to rest **any time or exceed the allocated rest time**, s/he may let the researcher know and do so.

CONFIDENTIALITY

WHAT WILL THE RECORDINGS AND TEST RESULTS BE USED FOR?

All responses, recordings and test results will be used in analyzing the outcome of this project alone. The researcher will use analyzed data to **write her doctoral thesis**. She may also present the data at **scientific conferences** and **publish in scientific journals**.

A participant can provide or refuse consent to allow the audio recordings to be used for teaching students, research presentations, and future analyses of the data.

A participant can provide or refuse consent to allow the data to be used for future research or not.

If a participant does not consent to using his/her data in future research, such data will be destroyed at the **end of this study.**

If a participant consent to future analysis of the data beyond this study the researcher will maintain the data under secure conditions.

WILL THE PARTICIPANT BE IDENTIFIED IN THE STUDY?

No. A strict procedure is implemented to ensure participant confidentiality. As the findings are transferred in to a database or record, data will be **anonymized** such that each participant will be **allocated an identification code**. No participant will be identified by his or her name.

All participant details will be known only to Dinushee Atapattu-Bakmeewewa. All reports of the study will use anonymised codes to refer to participants.

However, if you do consent to your audio recordings to be used in future academic or research forums or for the purpose of teaching, there is a possibility that you may be identified by a listener **though we ensure that your name would not be used.**

HOW SECURE ARE THE RECORDINGS AND TEST RESULTS?

All audio recordings will be stored securely **in a password locked computer specifically allocated to Dinushee, for use in this project alone**.

All paper-based information will be stored in a **locked filing cabinet**. **Only** the researcher, Dinushee will have access to these.

Dinushee's Supervisors, Dr. Ruth Herbert and Dr. Emma Gregory may also view the electronic recordings and paper-based information, when interpreting the data of this project. Furthermore **two other externally recruited Speech-Language Therapists (SLTs)** will view partial sections of participant data. **The two external SLTs will also**

not have access to the section of responses that is not allocated for being scrutinized by them and therefore will not know the complete assessment responses of any given participant. None of the data will be accessible to anyone outside the above-mentioned persons.

POTENTIAL BENEFITS AND RISKS

Risks

The methods of data collection used here are **non-invasive language assessments** and therefore **poses no significant physical risks to the participant**. However, since this task may require the use of a an audio/voice recorder, participants may feel some discomfort.

On such occasions the research Dinushee would provide maximum guidance, support and training to minimize it's adverse effects on the participant.

Should the participant still feel tired, he/she may request for a break or stop at anytime they wish. Additionally, participants are also provided with the opportunity to discuss the possibility of extending assessment sessions across more days than allocated

Benefits

It is unlikely that participation in this study will result in any direct benefits. However, participation in this study would **support the cause of developing aphasia research in the Sri Lankan clinical context allowing clinicians to better assess and treat people with aphasia.**

ETHICS AND CONSENT

Dinushee's PhD has been approved by Ethical Review Committees (ERCs) of the University of Sheffield (UK), University of Kelaniya's Faculty of Medicine (SL) and the relevant ERC's of hospitals at which data will be collected.

FUNDERS

WHO ARE THE FUNDING SOURCES IN THIS RESEARCH?

Dinushee's PhD has been funded by grants awarded by the **University of Kelaniya, Faculty of Medicine (Ragama) and University Grants Commission of Sri Lanka.** However no aspect of the participant recruitment, methods, procedures or data handling of this research study has been subjected to terms and conditions of any awarding agency. That is, the primary researcher is allowed independent decision-making through out the course of the complete study.

CONCERNS AND COMPLAINTS

I HAVE MORE QUESTIONS/ CONCERNS/ COMPLAINTS. WHO DO I CONTACT?

If you need to know more about this research or anything related, please feel free to contact the researcher, **Dinushee Atapattu-Bakmeewewa** at;

Department of Disability Studies
Faculty of Medicine (University of Kelaniya)
PO Box 6, Talagolla Road, Ragama

Office: +94 11 2958039/ 2956159 / 2956188

Mobile: +94779427481

If you wish to speak to her foreign supervisors, you may mail (postal), e-mail or telephone them at;

Dr. Ruth Herbert

Reader in Aphasia Research/ Dept. Director of Research and Innovation

Department of Human Communication Sciences, University of Sheffield

362 Mushroom Lane

Sheffield, S10 2TS, United Kingdom

Tel: +44 (0) 114 222 2403 Fax: +44 (0) 114 222 2439

email : r.herbert@sheffield.ac.uk

Dr. Emma Gregory

Lecturer and Course Director, MMedSci

Department of Human Communication Sciences, University of Sheffield

362 Mushroom Lane, Sheffield, S10 2TS, United Kingdom

Tel: +44 (0) 114 22 22417 Fax: +44 (0) 114 222 2439

email : emma.gregory@sheffield.ac.uk

If you wish to speak to a locally based authority and/or someone unrelated to the project, you may contact,

Prof. Nilanthi de Silva
Dean
Faculty of Medicine
PO Box6, Talagolla Road, Ragama, Sri Lanka
Tel: +94-11-2955280
email: deanmed@kln.ac.lk

OR

Prof. Rajitha Wickramasinghe
Professor, Department of Public Health
Faculty of Medicine
PO Box6, Talagolla Road, Ragama, Sri Lanka
Tel: 0112953411
Email: arwicks@kln.ac.lk

If you or your related participant, are not satisfied with how your concerns have been dealt with you may write to,

Local Contact:

Ms. Thamara Hadinnapola
Senior Personal Secretary to the Vice Chancellor

University of Kelaniya,

Kelaniya 11600, Sri Lanka

Phone: 011 2914474, 011 2903101 Fax: 011 2911485

email: vcoffice@kln.ac.

Off Shore Contact:

Office of the Registrar and Secretary

Firth Court

Western Bank

Sheffield S10 2TN, UK

Telephone: 0114 222 1100

Fax: 0114 222 1103 email : registrar@sheffield.ac.uk

Thank you for reading this information Sheet.

The University Of Sheffield.

Volunteers needed

→ Are you over 40 Years of age?

→ Do you speak and understand Sinhala and/or English?

→ Can you spare a few hours to take part in a research study?

I am looking for volunteers to take part in a study that investigates language skills after stroke.

People with stroke often have difficulties with language, a condition known as Aphasia. We want to see how, previously known languages behave in a person with aphasia.

Your participation will tell us how the healthy brain processes the languages you know

If you volunteer, you will have to participate in two or three short testing sessions involving;

- Simple problem solving tests involving language
- Naming pictures on a computer
- Describing a picture or event

I am able to see you at the nearest community space or at the Ragama Medical Faculty (Department of Disability Studies). Home visits can also be arranged.

We can arrange for mutually convenient dates and times.

If you are interested or want to know more, contact me on, 0779427481/ 0112053299 or email at, aatapattu1@sheffield.ac.uk

Department of Human Communication Sciences
University of Sheffield
362 Mushroom Lane, Sheffield, S10 2TS
United Kingdom

Faculty of Medicine
University of Kelaniya
PO Box 6, Thalagolla road, Ragama
Sri Lanka

DETERMINING THE ABILITY TO RETRIEVE WORD NAMES IN ISOLATION AND IN CONNECTED SPEECH

The following information sheet describes a research project at the University of Sheffield in the UK, which is forms the basis of an ongoing doctoral degree. The primary researcher, **Dinushee Atapattu-Bakmeewewa** is enrolled as a Part time distance-learning Post Graduate Research candidate since 2012. Her PhD study **looks at language after stroke in people who speak Sinhala and in people who speak English and Sinhala.**

This is the **second phase of the study's data collection**. **As a participant of this research study, it is important to know what the study is about and your role in it, as well as your rights as a participant.** Kindly take a few minutes to read the detailed information sheet below.

The Research Team

Primary researcher: Dinushee Atapattu-Bakmeewewa

Supervisors: Dr. Ruth H. Herbert

Dr. Emma Gregory



- **Dinushee Atapattu-Bakmeewewa- Primary Researcher**

Dinushee Atapattu-Bakmeewewa, a qualified Speech-Language Therapist, will play a lead role in assisting you and guiding you to complete the tasks. She holds a Bachelors Degree in Speech-Language Pathology and Audiology from The University of Mangalore, India, a Masters Degree in Speech Difficulties from The University of Sheffield, United Kingdom and is currently reading for her PhD at the same. She is registered at the Sri Lanka Medical Council (SLMC Reg. No. 51) and affiliated to the Ragama Medial Faculty as a permanent academic staff member.

- **Dr. Ruth H. Herbert**

Dr. Herbert is a qualified speech and language therapist with a doctoral degree from University College London. She has been attached to The University of Sheffield since 2003 and is currently the Departmental Director of Research. Dr. Herbert is registered with the Health and Care Professional Council of UK, Royal College of Speech and Language Therapists and is also and honorary member the British Aphasiology Society. Dr Herbert has been awarded many research grants from the NHS and Stroke Association (UK) for research in Acquired Language Disorders.

- **Dr. Emma Gregory**

Emma Gregory is a Lecturer and course director of the MMedSci program at the University of Sheffield. Having completed her PhD in 2012, Dr. Gregory has worked with adults with acquired neurological communication and swallowing disorders in Mansfield PCT and Sheffield PCT. She holds an honorary contract with Sheffield Children's Hospital NHS Trust.

THE STUDY

WHAT IS THIS STUDY ABOUT?

The primary focus of this study is **language skills after a stroke**. After a stroke, many people have difficulties understanding and using language, which is known as **'Aphasia'**.

Most research has been carried out with English only speakers. We want to explore language use in Sinhala speakers and in bilingual English-Sinhala speakers.

In this study we will identify the ability of such people with aphasia to understand and produce words in their languages in different linguistic situations.

It is expected that the findings of this study will **contribute towards the assessment and treatment of aphasia in the Sri Lankan clinical context**

WHO ARE WE RECRUITING?

We are recruiting **healthy adults above the age of 40 years.** Participants will be recruited into **two groups**.

Group 1: The Monolingual Group

Recruited to this group are participants **whose only known and frequently/functionally used language is Sinhala**. **Sinhala should be your mother tongue** and **should be most frequently used** to communicate during your routine activities.

Group 2: The Bilingual Group

Recruited to this group are participants **familiar with both Sinhala and English**. **Sinhala should be your mother tongue** and **should be most frequently used** to communicate during your routine activities. **English should be a language later learnt**, either at home or school.

WHAT IS THE PROCEDURE IF I DO DECIDE TO TAKE PART?

The Screen

We will first conduct a **quick screen, ask a few questions and review your medical records.** This is done in order to confirm that you are eligible for the study. Therefore, **not everyone screened would be able to participate in the study.**

We will then administer a simple **Language Proficiency Questionnaire** and based on your responses, allocate you to a group, group, monolingual or bilingual speakers.

The Main Test

In the main testing, you would be required to **name/ describe a few pictures** presented on a laptop computer and **participate in a few conversational tasks.**

All language assessments will be conducted **only in Sinhala for the Monolingual group** and in **both Sinhala and English for the bilingual group.** Responses will be **audio recorded**.

WHEN AND HOW LONG WILL TESTING BE?

If you are identified as eligible to participate in the main study, Dinushee will allocate a mutually convenient date and time for testing.

We expect the **screen to last no longer than one hour** and if selected, **the primary testing to last no longer than 2 hours.**

WHERE WILL IT TAKE PLACE?

Depending on your convenience, you could either come to the **Department of Disability Studies, Faculty of Medicine, Ragama** or to the **Sri Jayewardenepura, General Hospital**. Alternatively, depending on availability, we could arrange to meet at a **hospital or clinic in your locality**. Dinushee can also **visit you at your home.**

IS IT COMPULSORY THAT I TAKE PART? AND WHAT IF I NEED TO WITHDRAW?

No. It is not compulsory that you take part. Participation is on a **voluntary basis**.

You can withdraw from the study at any time**.**

You do not have to justify your reasons to participate, not participate, or withdraw.

WILL THERE BE ANY PAYMENTS OR REWARDS, IF I AGREE TO PARTICIPATE?

There will be no financial reimbursement of your time. Participation will also not affect charges for speech and language therapy services at any point of time.

However, provided that the researcher is unable to visit you at your home or at your closest or regular hospital on a routine Speech therapy clinic day and you travel to a mutually agreed location **specifically for participating in this study**, a traveling cost

exceeding LKR100 but no more than LKR500 will be reimbursed. The participant is required to provide a **signed receipt** in order to claim the travel cost.

CAN I TAKE A BREAK IN BETWEEN TESTING?

Yes, you can. Testing is carefully arranged across several days in order to minimize chances of fatigue. Within any single day of testing, sessions are planned with regular breaks in between. However, if you do wish to rest **any time or exceed the allocated rest time**, you may let the researcher know and do so.

CONFIDENTIALITY

WHAT WILL MY RECORDINGS AND TEST RESULTS BE USED FOR?

All responses, recordings and test results will be used in analyzing the outcome of this project alone. The researcher will use analyzed data to **write her doctoral thesis**. She may also present the data at **scientific conferences** and **publish in scientific journals**.

You can provide or refuse consent to allow the audio recordings to be used for teaching students, research presentations, and future analyses of the data.

You can provide or refuse consent to allow the data to be used for future research or not.

If you prefer that your data is not used in future research your data will be destroyed at the **end of this study.**

If you consent to future analysis of the data beyond this study the researcher will maintain the data under secure conditions.

WILL I BE IDENTIFIABLE AS A PARTICIPANT OF THE STUDY ?

No. A strict procedure is implemented to ensure participant confidentiality. As the findings are transferred in to a database or record, data will be **anonymised** such that each participant will be **allocated an identification code**. No participant will be identified by his or her name.

All participant details will be known only to Dinushee Atapattu-Bakmeewewa. All reports of the study will use anonymised codes to refer to participants.

However, if you do consent to your audio recordings to be used in future academic or research forums or for the purpose of teaching, there is a possibility that you may be identified by a listener **though we ensure that your name would not be used.**

HOW SECURE ARE MY RECORDINGS AND TEST RESULTS?

All audio recordings will be stored securely **in a password locked computer specifically allocated to Dinushee, for use in this project alone**.

All paper-based information will be stored in a **locked filing cabinet**. **Only** the researcher, Dinushee will have access to these.

Dinushee's Supervisors, Dr. Ruth Herbert and Dr. Emma Gregory may also view the electronic recordings and paper-based information, when interpreting the data of this project. Furthermore **two other externally recruited Speech-Language Therapists (SLTs)** will view partial sections of the your data. **The two external SLTs will also not have access to the section of responses that is**

not allocated for being scrutinized by them and therefore will not know your complete assessment responses. None of the data will be accessible to anyone outside the above-mentioned persons.

POTENTIAL BENEFITS AND RISKS

Risks

The methods of data collection used here are **non-invasive language assessments** and therefore **poses no significant physical risks to the participants**. However, since this task may require the use of a an audio/voice recorder, participants may feel some discomfort.

On such occasions the research Dinushee would provide maximum guidance, support and training to minimize it's adverse effects on the participant. **If you feel tired, you may request a break. The conversational sample may then be re-recorded at a convenient time.**

Benefits

It is unlikely that participation in this study will result in any direct benefits. However, your participation and contribution in this study would **support the cause of developing aphasia research in the Sri Lankan clinical context allowing clinicians to better assess and treat people with aphasia .**

Ethics and Consent

Dinushee's PhD has been approved by Ethical Review Committees (ERCs) of the University of Sheffield (UK), University of Kelaniya's Faculty of Medicine (SL) and the relevant ERC's of hospitals at which data will be collected.

Funders

Who are the funding sources in this research?

Dinushee's PhD has been funded by grants awarded by the **University of Kelaniya, Faculty of Medicine (Ragama) and University Grants Commission of Sri Lanka.** However no aspect of the participant recruitment, methods, procedures or data handling of this research study has been subjected to terms and conditions of any awarding agency.

Concerns and Complaints

I have more Questions/ concerns/ complaints. Who do I contact?

If you need to know more about this research or anything related, please feel free to contact the researcher, **Dinushee Atapattu-Bakmeewewa** at;

Department of Disability Studies
Faculty of Medicine (University of Kelaniya)
PO Box 6, Talagolla Road, Ragama
Office: +94 11 2958039/ 2956159 / 2956188 Mobile: +94779427481
Email: aatapattu1@sheffield.ac.uk

If you wish to speak to her primary supervisor, you may mail (postal), e-mail or telephone them at;

Dr. Ruth Herbert
Reader in Aphasia Research/ Dept. Director of Research and Innovation
Department of Human Communication Sciences, University of Sheffield
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If you wish to speak to a locally based authority and/or someone unrelated to the project, you may contact,

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If you are not satisfied with how your concerns have been dealt with you may write to,

Local Contact:

Ms. Thamara Hadinnapola

Senior Personal Secretary to the Vice Chancellor

University of Kelaniya,

Kelaniya 11600, Sri Lanka

Phone: 011 2914474, 011 2903101   Fax: 011 2911485

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Office of the Registrar and Secretary

Firth Court

Western Bank

Sheffield S10 2TN, UK

Telephone: 0114 222 1100

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Thank you for reading this information Sheet.

Department of Human Communication Sciences
University of Sheffield
362 Mushroom Lane, Sheffield, S10 2TS
United Kingdom

Faculty of Medicine
University of Kelaniya
PO Box 6, Thalagolla road, Ragama
Sri Lanka

TESTING WORD NAME RETRIEVAL ABILITY – SECOND PHASE

Consent Form

Research Team: Dinushee Atapattu-Bakmeewewa (Researcher), Dr. Ruth Herbert (Supervisor), Dr. Emma Gregory (Supervisor)

Note: Please read through the following and initial in the box before.

1. I have read and understood the information sheet ☐

2. I was given the opportunity to ask questions ☐

3. I understand that my participation in this study is voluntary. ☐

4. I understand that my participation in this study does not involve direct personal benefits ☐

5. I understand that I am free to withdraw at any time of the study without having to provide any justification ☐

6. I understand that my identity and personal information will be strictly confidential. ☐

7. I understand that my speech responses will be audio recorded. ☐

8. I understand that my audio recorded responses will be strictly confidential. ☐

9. I give permission for the research team to access my anonymised responses. ☐

10. I'm happy to be contacted again, should the research team need more information or clarifications ☐

11. I agree that this data could be used in in Dinushee's Doctoral thesis ☐

12. I agree that this data could be used in in future research ☐

13. I am willing to participate in the second test-phase of this study ☐

Signature of Participant	Name (in words) of Participant	Date

Signature of researcher	Date

APPENDIX 10.9: An overview of the areas assessed by the CAT

Table: Overview of the language areas profiled by the Comprehensive Aphasia Test

Assessed modality		Subtests	No. of items
Comprehension	i.	Comprehension of spoken words	15
	ii.	Comprehension of written words	15
	iii.	Comprehension of spoken sentences	16
	iv.	Comprehension of written sentences	16
	v.	Comprehension of spoken paragraphs	8
Repetition	i.	Repetition of words	16
	ii.	Repetition of complex words	3
	iii.	Repetition of non-words	5
	iv.	Repetition of digit strings	12
	v.	Repetition of sentences	8
Spoken naming	i.	Naming objects	24
	ii.	Naming actions	5
	iii.	Spoken Picture description	1
Reading Aloud	i.	Reading words	24
	ii.	Reading complex words	3
	iii.	Reading function words	3
	iv.	Reading non-words	5

Testing Protocol for monolingual PwAs

Session number	Tasks
1	Case History, Language Proficiency Questionnaire (LPQ Comprehensive Aphasia Testing (CAT) – Part 1
2	Comprehensive Aphasia Testing (CAT) – Part 2
3	Object naming (30 items)
4	Object naming (39 items)
5	Action naming (38 items)
6	Picture Description (5 stimuli)
7	Picture Sequence Narration (5 stimuli)

Testing Protocol for bilingual PwAs

Session number	Tasks
1	Case History, Language Proficiency Questionnaire (LPQ) Comprehensive Aphasia Testing (CAT) – Language 1: Part 1
2	Comprehensive Aphasia Testing (CAT) – Language 1: Part 2 Object naming (30 items) - Language 1
3	Object naming (39 items) - Language 1
4	Action naming (38 items) - Language 1
5	Picture Description (5 stimuli) – Language 1
6	Picture Sequence Narration (5 stimuli) – Language 1
7	Comprehensive Aphasia Testing (CAT) – Language 2: complete test
8	Picture Sequence Narration (5 stimuli) – Language 2
9	Picture Description (5 stimuli) - Language 2
10	Action naming (38 items) - Language 2
11	Object naming (39 items) - Language 2
12	Object naming (30 items) - Language 2

Testing Protocol for monolingual healthy controls

Session number	Tasks
1	Case History, Language Proficiency Questionnaire (LPQ) Comprehensive Aphasia Testing (CAT)
2	Object naming (69 items) Action naming (38 items)
3	Picture Description (5 stimuli) Picture Sequence Narration (5 stimuli)

Testing Protocol for bilingual healthy controls

Session number	Tasks
1	Case History, Language Proficiency Questionnaire (LPQ) Comprehensive Aphasia Testing (CAT) – Language 1: Complete test
2	Object naming (69 items) – Language 1 Action naming (38 items) - Language 1
3	Picture Description (5 stimuli) – Language 1 Picture Sequence Narration (5 stimuli) – Language 1
4	Comprehensive Aphasia Testing (CAT) – Language 2
5	Action naming (38 items) - Language 2 Object naming (69 items) – Language 2
6	Picture Sequence Narration (5 stimuli) – Language 2 Picture Description (5 stimuli) - Language 2

Table 1 - Individual CAT scores for ML PwAs in phase 2

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLA/01	46	27	19	23	9	5	26	6	8	6	6	28	6	5	20	0	0	0
MLA/02	52	26	24	24	14	2.5	22	5	8	8	8	22	6	0	34	2	4	2
MLA/15	24	24	20	18	8	2.5	28	6	10	6	6	15	0	5	28	0	6	5

Table 2 - Individual CAT scores for BL PwAs for Sinhala in phase 2

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)												
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLA/03	30	26	25	21	22	3.5	28	6	10	8	6	21	6	-18.5	36	0	6	0
BLA/06	35	28	24	26	12	4	32	6	10	6	6	23	5	-13	41	5	6	3
BLA/09	80	27	28	29	25	4	28	6	9	14	14	28	10	33	33	6	6	9

Table 3 - Individual CAT scores for BL PwAs for English in phase 2

Participant number	Age /Sex	Receptive Language (English)					Expressive Language (English)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken	Comprehension of written	Comprehension of spoken	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLA/03	30	21	9	23	13	2.5	24	4	10	6	6	14	4	-1	45	2	6	10
BLA/06	35	24	15	24	22	3	29	4	4	4	0	18	2	-3	27	4	4	6
BLA/09	80	30	26	28	26	3.5	32	6	10	10	8	38	2	7	36	4	6	6

Table 1 – Individual CAT scores for ML HCs in phase 2

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLC/01	49	30	23	28	23	4	32	6	10	10	12	44	10	37	48	6	6	10
MLC/02	52	28	30	28	30	4	32	6	10	12	12	38	8	27	48	6	6	10
MLC/15	26	28	26	26	28	4	32	6	5	12	12	43	7	31	48	6	6	10

Table 2 – Individual CAT scores for BL HCs for Sinhala in phase 2

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLC/03	30	26	26	24	24	4	32	6	10	14	10	40	10	43	48	6	6	10
BLC/06	30	29	27	26	27	4	32	6	10	14	12	43	8	39	32	6	6	9
BLC/09	28	30	30	29	29	4	32	6	10	14	10	46	10	41	48	6	6	10

Table 3 – Individual CAT scores for BL HCs for English in phase 2

Participant number	Age /Sex	Receptive Language (English)					Expressive Language (English)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLC/03	30	19	20	26	25	4	32	6	8	14	12	31	10	39	48	6	6	10
BLC/06	30	26	28	27	29	4	32	6	10	14	12	46	10	43	48	6	6	10
BLC/09	28	27	29	27	27	4	31	6	10	12	12	42	8	29	46	6	6	10

Table 1 – Individual CAT scores of ML PwAs in phase 3

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLA/04	46	30	24	29	28	3.5	20	2	3	6	2	32	6	24	43	2	4	3
MLA/05	52	28	12	24	24	3	18	2	4	6	0	30	6	8.5	20	0	0	0
MLA/06	24	24	22	14	17	3.5	29	6	9	4	6	31	1	12.5	6	0	0	0
MLA/07	56	26	19	14	4	3	26	6	6	4	8	27	6	8	12	0	4	0
MLA/08	30	28	24	28	20	4	26	6	7	8	8	31	6	27	44	6	6	5
MLA/11	64	26	27	22	18	2.5	26	2	8	10	8	29	6	-4	36	6	6	9
MLA/12	47	30	9	26	16	2.5	16	4	2	4	4	30	4	19	21	3	4	4
MLA/13	36	28	28	26	22	4	32	6	8	4	6	25	6	12	36	6	4	0
MLA/14	71	26	18	28	21	1	27	4	8	4	6	3	0	-18	36	4	6	4
MLA/16	33	28	20	28	13	3.5	20	0	0	4	0	15	0	-8.5	4	0	0	0

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLA/18	47	28	23	24	26	4	32	6	10	12	12	27	7	2.5	46	6	6	10
MLA/19	46	22	20	24	19	3	28	6	8	10	4	9	8	-2	28	2	6	4
MLA/21	56	21	17	27	10	2.5	23	2	0	6	0	4	2	0	46	6	4	10
BLA/05/ML	31	28	24	28	26	4	32	5	10	6	6	40	5	2	44	4	6	5

Table 2 – Individual CAT scores of BL PwAs for Sinhala in phase 3

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLA/01	30	28	31	28	31	4	29	6	10	10	14	46	10	50	48	6	6	4
BLA/02	35	28	22	23	24	4	30	6	10	6	6	18	4	-6	48	4	6	6
BLA/04	80	21	21	16	14	3.5	32	6	10	10	14	21	5	2	48	6	6	5
BLA/07	35	29	21	28	19	4	23	0	6	3	6	1	0	-2	24	0	4	0
BLA/08	53	30	25	30	26	4	32	6	10	10	10	22	7	-2.5	48	6	6	9
BLA/10	41	20	14	24	15	4	26	4	3	4	4	24	0	-6	14	0	0	0
BLA/11	72	8	18	20	17	3.5	31	6	8	8	8	24	9	2	48	6	6	4
BLA/13	68	30	23	24	28	4	32	6	9	12	14	42	8	34	48	6	6	5
BLA/14	36	27	28	28	28	4	32	6	10	10	12	48	10	21	48	6	6	9
BLA/15	46	30	23	24	26	3	32	6	10	8	14	44	7	30	48	6	6	9
BLA/16	31	29	23	26	28	4	32	6	10	8	14	33	7	19.5	48	6	6	7

Table 3 – Individual CAT scores of BL PwAs for English in phase 3

Participant number	Age /Sex	Receptive Language (English)					Expressive Language (English)											
		Comprehensio n of spoken	Comprehensio n of written	Comprehensio n of spoken	Comprehensio n of written	Comprehensio n of spoken	Repetition of words	Repetition of complex	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex	Reading function words	Reading non words
BLA/01	30	24	22	30	22	4	28	4	10	14	8	26	8	-4	32	6	6	0
BLA/02	35	28	21	24	19	3	30	3	10	6	6	16	2	-9	44	6	6	6
BLA/04	80	13	21	24	18	3	31	6	5	14	14	17	8	0.5	46	6	6	10
BLA/07	35	30	19	30	24	1	30	2	2	6	6	33	2	32	32	0	6	0
BLA/08	53	24	21	30	17	4	31	6	10	14	8	30	6	19	48	6	6	8
BLA/10	41	28	21	30	23	2	28	2	3	6	8	34	2	30	32	4	6	2
BLA/11	72	17	6	24	12	3.5	30	6	7	10	8	24	8	1	48	6	6	9
BLA/13	68	26	26	26	22	4	25	6	4	12	8	29	8	17.5	35	5	6	2
BLA/14	36	25	27	26	27	4	32	5	10	12	8	32	4	23.5	41	2	6	8
BLA/15	46	18	23	30	26	3	28	6	10	6	0	32	6	20.5	41	4	6	2
BLA/16	31	27	25	23	27	4	32	6	10	10	12	32	8	20	42	4	6	8

Table 1 - Individual CAT scores of ML HCs in phase 3

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLC/04	49	30	30	28	32	3.5	32	6	10	10	12	41	7	34	48	6	6	10
MLC/05	52	30	32	30	32	4	32	6	10	14	12	43	7	37	48	6	6	10
MLC/06	26	30	28	29	32	3.5	32	6	10	12	12	42	10	64	48	6	6	10
MLC/07	55	30	30	28	28	4	32	6	10	12	10	41	6	32	48	6	6	10
MLC/08	28	30	32	30	30	4	32	6	10	14	12	48	8	39	48	6	6	10
MLC/11	62	28	30	26	24	4	32	6	10	12	12	41	9	26	48	6	6	10
MLC/12	48	30	31	27	29	4	32	6	10	10	12	46	10	31	48	4	6	10
MLC/13	33	30	31	30	30	4	32	6	10	12	12	44	7	29	48	6	6	10
MLC/14	71	30	23	26	26	4	32	6	10	10	12	42	8	12	8	6	6	10
MLC/16	32	30	32	30	32	4	32	6	10	14	12	42	7	49	48	6	6	10

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
MLC/17	60	30	28	22	26	4	32	6	10	12	12	48	10	44	48	6	6	10
MLC/18	46	30	28	31	30	4	32	6	10	10	10	44	10	23	48	6	6	10
MLC/19	47	28	27	30	26	3.5	32	6	10	10	12	46	10	35	48	6	6	10
MLC/21	55	28	28	32	32	4	32	6	10	14	13	45	10	28	48	6	6	10
BLA/05/ML	31	28	28	32	32	4	32	6	10	12	12	46	10	66	48	6	6	10

Table 2 - Individual CAT scores of BL HCs for Sinhala in phase 3

Participant number	Age /Sex	Receptive Language (Sinhala)					Expressive Language (Sinhala)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLC/01	30	32	30	30	4	32	6	10	14	12	48	10	38	48	6	6	10	30
BLC/02	30	27	28	32	4	32	6	10	12	12	43	10	41	48	6	6	10	30
BLC/04	28	30	27	28	4	32	6	10	8	10	45	10	35	48	6	6	6	28
BLC/07	28	32	29	30	4	32	6	10	14	12	40	10	38	48	6	6	10	28
BLC/08	30	30	30	29	4	32	6	10	12	12	48	10	42	48	6	6	10	30
BLC/10	30	29	32	32	4	32	6	10	14	12	48	10	34	48	6	6	10	30
BLC/11	29	31	30	26	4	32	6	10	12	12	45	10	33	48	6	6	10	29
BLC/13	30	32	29	30	4	32	6	10	14	12	46	10	37	48	6	6	10	30
BLC/14	30	30	32	31	4	32	6	10	14	12	45	10	46	48	6	6	10	30
BLC/15	28	32	28	32	4	32	6	10	14	12	48	10	57	48	6	6	10	28
BLC/16	30	32	30	29	4	32	6	10	14	12	48	10	41	48	6	6	10	30

Table 3 - Individual CAT scores of BL HCs for English in phase 3

Participant number	Age /Sex	Receptive Language (English)					Expressive Language (English)											
		Comprehension of spoken words	Comprehension of written words	Comprehension of spoken sentences	Comprehension of written sentences	Comprehension of spoken paragraphs	Repetition of words	Repetition of complex words	Repetition of non words	Repetition of digit strings	Repetition of sentences	Naming objects	Naming actions	Spoken picture description	Reading words	Reading complex words	Reading function words	Reading non words
BLC/01	30	29	31	28	31	4	32	6	10	14	12	38	9	40	48	6	6	10
BLC/02	30	30	28	30	32	4	32	6	10	12	12	43	10	39	36	4	6	8
BLC/04	28	28	25	28	28	4	32	6	6	8	12	44	10	40	48	6	6	10
BLC/07	28	27	27	28	30	4	31	6	10	14	12	43	10	41	46	6	6	10
BLC/08	30	30	32	30	28	4	30	6	10	12	12	46	10	43	48	6	6	10
BLC/10	30	30	27	25	29	4	32	6	10	14	12	43	10	38	48	6	6	10
BLC/11	29	29	27	28	28	4	32	6	10	12	12	44	10	36	48	6	6	10
BLC/13	30	30	28	29	26	4	32	6	10	12	12	44	9	42	48	6	6	10
BLC/14	30	28	31	27	29	4	32	6	10	14	12	43	8	39	48	6	6	10
BLC/15	28	29	28	30	28	4	32	6	10	14	12	48	10	42	48	6	6	10
BLC/16	30	30	32	27	28	4	32	6	10	14	12	45	10	41	48	6	6	10

Table 1 - Individual Scores for naming in the ML PWA group in Sinhala

Participant Number	Age/Sex	Accuracy Score[1]				Errors											
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
ML/A/04	46/F	48	0.70	25	0.66	2	0.03	4	0.11	13	0.19	4	0.11	5	0.07	4	0.11
ML/A/05	52/F	30	0.43	11	0.29	22	0.32	15	0.39	11	0.16	8	0.21	5	0.07	4	0.11
ML/A/06	24/F	37	0.54	25	0.66	9	0.13	7	0.18	1	0.01	0	0.00	20	0.29	5	0.13
ML/A/07	55/M	48	0.70	19	0.50	13	0.19	9	0.24	0	0.00	1	0.03	8	0.12	8	0.21
ML/A/08	30/M	65	0.94	30	0.79	0	0.00	4	0.11	3	0.04	1	0.03	1	0.01	2	0.05
ML/A/11	64/M	34	0.49	16	0.42	14	0.20	13	0.34	11	0.16	4	0.11	9	0.13	5	0.13
ML/A/12	47/F	34	0.49	14	0.37	1	0.01	7	0.18	4	0.06	0	0.00	29	0.42	17	0.45
ML/A/13	36/F	44	0.64	25	0.66	6	0.09	1	0.03	0	0.00	0	0.00	14	0.20	12	0.32
ML/A/14	71/M	7	0.10	0	0.00	4	0.06	3	0.08	2	0.03	0	0.00	56	0.81	35	0.92
ML/A/16	34/M	22	0.32	5	0.13	4	0.06	9	0.24	9	0.13	1	0.03	34	0.49	23	0.61
ML/A/17	60/M	7	0.10	2	0.05	9	0.13	13	0.34	7	0.10	1	0.03	46	0.67	22	0.58
ML/A/18	47/M	46	0.67	28	0.74	9	0.13	5	0.13	6	0.09	0	0.00	7	0.10	4	0.11
ML/A/19	46/M	11	0.16	5	0.13	17	0.25	11	0.29	7	0.10	2	0.05	34	0.49	20	0.53
ML/A/21	56/F	5	0.07	10	0.26	9	0.13	2	0.05	1	0.01	0	0.00	54	0.78	26	0.68
BLA/05ML	32/F	60	0.87	29	0.76	3	0.04	6	0.16	2	0.03	2	0.05	3	0.04	1	0.03

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language.

[2] Includes, only error responses that constitute a real word in the target language.

[3] Includes, error responses that does not constitute a real word but is identified as belonging to the target language.

[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 2 - Individual Scores for naming in the BL PWA group in Sinhala

Participant Number	Age/Sex	Accuracy Score[1]				Errors											
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
BLA/01	30/F	67	0.97	34	0.89	2	0.03	1	0.03	0	0.00	0	0.00	0	0.00	2	0.05
BLA/02	35/M	18	0.26	7	0.18	0	0.00	3	0.08	3	0.04	0	0.00	47	0.68	27	0.71
BLA/04	80/F	28	0.41	14	0.37	6	0.09	6	0.16	4	0.06	0	0.00	24	0.35	18	0.47
BLA/07	35/M	13	0.19	8	0.21	2	0.03	2	0.05	5	0.07	2	0.05	32	0.46	16	0.42
BLA/08	53/M	43	0.62	26	0.68	13	0.19	5	0.13	0	0.00	0	0.00	12	0.17	6	0.16
BLA/10	41/M	21	0.30	4	0.11	9	0.13	0	0.00	11	0.16	0	0.00	16	0.23	26	0.68
BLA/11	72/M	19	0.28	15	0.39	1	0.01	5	0.13	0	0.00	0	0.00	41	0.59	16	0.42
BLA/13	68/M	38	0.55	23	0.61	6	0.09	4	0.11	14	0.20	4	0.11	8	0.12	6	0.16
BLA/14	36/M	63	0.91	31	0.82	0	0.00	2	0.05	1	0.01	0	0.00	4	0.06	4	0.11
BLA/15	46/M	64	0.93	28	0.74	2	0.03	3	0.08	3	0.04	3	0.08	0	0.00	3	0.08
BLA/16	31/M	59	0.86	30	0.79	2	0.03	1	0.03	0	0.00	0	0.00	4	0.06	3	0.08

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language.
[2] Includes, only error responses that constitute a real word in the target language.
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the target language.
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 3 - Individual Scores for naming in the BL PWA group in English

Participant Number	Age/Sex	Accuracy Score[1]				Errors											
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
BLA/01	30/F	50	0.72	22	0.58	7	0.10	4	0.11	5	0.07	3	0.08	5	0.07	6	0.16
BLA/02	35/M	5	0.07	9	0.24	2	0.03	0	0.00	0	0.00	0	0.00	62	0.90	28	0.74
BLA/04	80/F	48	0.70	18	0.47	10	0.14	11	0.29	0	0.00	0	0.00	11	0.16	9	0.24
BLA/07	35/M	48	0.70	33	0.87	7	0.10	0	0.00	5	0.07	3	0.08	8	0.12	2	0.05
BLA/08	53/M	42	0.61	18	0.47	4	0.06	4	0.11	1	0.01	1	0.03	19	0.28	14	0.37
BLA/10	41/M	52	0.75	29	0.76	3	0.04	2	0.05	3	0.04	0	0.00	10	0.14	7	0.18
BLA/11	72/M	39	0.57	19	0.50	6	0.09	5	0.13	0	0.00	0	0.00	24	0.35	14	0.37
BLA/13	68/M	13	0.19	8	0.21	4	0.06	1	0.03	16	0.23	7	0.18	36	0.52	22	0.58
BLA/14	36/M	46	0.67	25	0.66	5	0.07	6	0.16	2	0.03	0	0.00	10	0.14	5	0.13
BLA/15	46/M	56	0.81	28	0.74	7	0.10	6	0.16	4	0.06	1	0.03	2	0.03	3	0.08
BLA/16	31/M	46	0.67	23	0.61	5	0.07	2	0.05	7	0.10	2	0.05	8	0.12	10	0.26

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language.
[2] Includes, only error responses that constitute a real word in the target language.
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the target language.
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 1 - Individual Scores for naming in the ML HC group in Sinhala

Participant Number	Age/ Sex	Accuracy Score[1]				Errors											
						Lexical Errors[3]				Non lexical Errors[4]				Other Errors[5]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
ML/C/04	49/F	67	0.97	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ML/C/05	52/F	67	0.97	35	0.92	2	0.03	1	0.03	0	0.00	0	0.00	0	0.00	1	0.03
ML/C/06	26/F	69	1.00	35	0.92	0	0.00	3	0.08	0	0.00	0	0.00	0	0.00	0	0.00
ML/C/07	54/M	64	0.93	32	0.84	3	0.04	4	0.11	0	0.00	0	0.00	2	0.03	2	0.05
ML/C/08	28/M	68	0.99	36	0.95	1	0.01	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00
ML/C/11	68/M	65	0.94	32	0.84	2	0.03	3	0.08	0	0.00	0	0.00	2	0.03	2	0.05
ML/C/12	48/F	66	0.96	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00
ML/C/13	33/F	67	0.97	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ML/C/14	70/M	54	0.78	29	0.76	9	0.13	5	0.13	0	0.00	0	0.00	5	0.07	1	0.03
ML/C/16	36/M	68	0.99	38	1.00	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ML/C/17	63/M	58	0.84	26	0.68	6	0.09	8	0.21	1	0.01	0	0.00	3	0.04	3	0.08
ML/C/18	46/M	62	0.90	30	0.79	2	0.03	6	0.16	1	0.01	0	0.00	4	0.06	1	0.03
ML/C/19	47/M	65	0.94	34	0.89	3	0.04	2	0.15	0	0.00	0	0.00	1	0.01	1	0.03
ML/C/21	56/F	65	0.94	34	0.89	1	0.01	2	0.15	0	0.00	0	0.00	1	0.01	0	0.00
BL/C/05/ML	34/F	67	0.97	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language
[2] Includes, all correct responses given in the target language and error responses which constitute a real word in the target language
[3] Includes, only error responses which constitute a real word in the target language
[4] Includes, error responses that does not constitute a real word but is identified as belonging to the target language
[5] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 2 - Individual Scores for naming in the BL HC group in Sinhala

Participant Number	Age/Sex	Accuracy Score[1]				Errors											
						Lexical Errors[3]				Non lexical Errors[4]				Other Errors[5]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
BLC/01	31/F	68	0.99	38	1.00	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
BLC/02	34/M	65	0.94	37	0.97	3	0.04	1	0.03	0	0.00	0	0.00	1	0.01	0	0.00
BLC/04	83/F	61	0.88	33	0.87	7	0.10	4	0.11	0	0.00	0	0.00	1	0.01	1	0.03
BLC/07	32/M	69	1.00	38	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
BLC/08	54/M	69	1.00	38	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
BLC/10	42/M	58	0.84	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00
BLC/11	69/M	64	0.93	38	1.00	2	0.03	0	0.00	2	0.03	0	0.00	1	0.01	0	0.00
BLC/13	67/M	59	0.86	35	0.92	4	0.06	0	0.00	1	0.01	0	0.00	3	0.04	1	0.03
BLC/14	36/M	66	0.96	37	0.97	3	0.04	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00
BLC/15	47/M	67	0.97	38	1.00	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
BLC/16	28/M	64	0.93	38	1.00	3	0.04	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language
[2] Includes, all correct responses given in the target language and error responses which constitute a real word in the target language
[3] Includes, only error responses which constitute a real word in the target language
[4] Includes, error responses that does not constitute a real word but is identified as belonging to the target language
[5] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 3 - Individual Scores for naming in the BL PWA group in English

Participant Number	Age/Sex	Accuracy Score[1]				Errors											
						Lexical Errors[3]				Non lexical Errors[4]				Other Errors[5]			
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions	
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS
BLC/01	31/F	64	0.93	35	0.92	4	0.06	1	0.03	0	0.00	1	0.03	1	0.01	1	0.03
BLC/02	34/M	59	0.86	32	0.84	4	0.06	2	0.05	2	0.03	4	0.11	4	0.06	0	0.00
BLC/04	83/F	61	0.88	33	0.87	5	0.07	1	0.03	0	0.00	0	0.00	3	0.04	4	0.11
BLC/07	32/M	69	1.00	37	0.97	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00
BLC/08	54/M	69	1.00	38	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
BLC/10	42/M	65	0.94	34	0.89	4	0.06	3	0.08	0	0.00	0	0.00	0	0.00	1	0.03
BLC/11	69/M	62	0.90	30	0.79	3	0.04	3	0.08	0	0.00	1	0.03	4	0.06	4	0.11
BLC/13	67/M	56	0.81	31	0.82	8	0.12	1	0.03	0	0.00	1	0.03	3	0.04	5	0.13
BLC/14	36/M	65	0.94	32	0.84	3	0.04	3	0.08	0	0.00	0	0.00	1	0.01	3	0.08
BLC/15	47/M	67	0.97	38	1.00	1	0.01	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00
BLC/16	28/M	65	0.94	35	0.92	3	0.04	2	0.05	0	0.00	0	0.00	0	0.00	0	0.00

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the target language
[2] Includes, all correct responses given in the target language and error responses which constitute a real word in the target language
[3] Includes, only error responses which constitute a real word in the target language
[4] Includes, error responses that does not constitute a real word but is identified as belonging to the target language
[5] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 1 - Individual Scores for naming in the ML PWA group in Sinhala

Participant Number	Age/Sex	Accuracy Score[1]				Errors												Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]				Objects	Actions
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions			
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS		
ML/A/04	46/F	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	1	0.03	0	0.00	0	0.00	1	1
ML/A/05	52/F	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	1	1
ML/A/06	24/F	2	0.03	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	1
ML/A/07	55/M	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/A/08	30/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/A/11	64/M	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0
ML/A/12	47/F	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0
ML/A/13	36/F	3	0.04	0	0.00	1	0.01	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	5	0
ML/A/14	71/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/A/16	34/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/A/17	60/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/A/18	47/M	0	0.00	1	0.03	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1
ML/A/19	46/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/A/21	56/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLA/05ML	32/F	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0

*RS: Raw Score; PS: Proportional Scor

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL,
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL,
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word confusion, no responses and miscellaneous responses.

Table 2 - Individual Scores for naming in the BL PWA group in Sinhala

	Age/Sex	Accuracy Score[1]				Errors														Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]							
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions				Objects	Actions
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS				
BLA/01	30/F	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	1
BLA/02	35/M	0	0.00	1	0.03	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			1	1
BLA/04	80/F	3	0.04	0	0.00	2	0.03	0	0.00	2	0.03	0	0.00	0	0.00	0	0.00			7	0
BLA/07	35/M	14	0.20	10	0.26	1	0.01	0	0.00	1	0.01	0	0.00	1	0.01	0	0.00			17	10
BLA/08	53/M	1	0.01	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			1	1
BLA/10	41/M	11	0.16	8	0.21	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			12	8
BLA/11	72/M	6	0.09	1	0.03	2	0.03	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00			8	2
BLA/13	68/M	1	0.01	0	0.00	0	0.00	1	0.03	2	0.03	0	0.00	0	0.00	0	0.00			3	1
BLA/14	36/M	1	0.01	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			1	1
BLA/15	46/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	1
BLA/16	31/M	2	0.03	4	0.11	1	0.01	0	0.00	1	0/01	0	0.00	0	0.00	0	0.00			4	1

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL.
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL.
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 3 - Individual Scores for naming in the BL PWA group in English

Participant Number	Age/Sex	Accuracy Score[1]				Errors												Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]					
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions		Objects	Actions
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS		
BLA/01	30/F	2	0.03	3	0.08	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	3
BLA/02	35/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
BLA/04	80/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLA/07	35/M	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	1	0
BLA/08	53/M	0	0.00	0	0.00	2	0.03	0	0.00	0	0.00	0	0.00	1	0.01	1	0.03	3	1
BLA/10	41/M	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0
BLA/11	72/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLA/13	68/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLA/14	36/M	0	0.00	2	0.05	3	0.04	0	0.00	0	0.00	0	0.00	3	0.04	0	0.00	6	2
BLA/15	46/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLA/16	31/M	2	0.03	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	3	1

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL.
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL.
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 1 - Individual Scores for naming in the ML HC group in Sinhala

Participant Number	Age/ Sex	Accuracy Score[1]				Errors												Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]					
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions		Objects	Actions
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS		
ML/C/04	49/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/05	52/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	0	1
ML/C/06	26/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/07	54/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/08	28/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/C/11	68/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/C/12	48/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/13	33/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/14	70/M	1	0.01	3	0.08	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	3
ML/C/16	36/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
ML/C/17	63/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00	1	1
ML/C/18	46/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/C/19	47/M	0	0.00	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1
ML/C/21	56/F	1	0.01	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	2	0.05	2	2
BL/C/05/ML	34/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL,
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL,
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 2 - Individual Scores for naming in the BL HC group in Sinhala

Participant Number	Age/Sex	Accuracy Score[1]				Errors														Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]							
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions				Objects	Actions
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS				
BLC/01	31/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/02	34/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/04	83/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/07	32/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/08	54/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/10	42/M	6	0.09	0	0.00	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			8	0
BLC/11	69/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/13	67/M	1	0.01	1	0.03	1	0.01	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00			2	2
BLC/14	36/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/15	47/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00			0	0
BLC/16	28/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.03	0	0.00			2	0

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL,
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL,
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 3 - Individual Scores for naming in the BL HC group in English

Participant Number	Age/Sex	Accuracy Score[1]				Errors												Total Responses in NTL	
						Lexical Errors[2]				Non lexical Errors[3]				Other Errors[4]				Objects	Actions
		Objects		Actions		Objects		Actions		Objects		Actions		Objects		Actions			
		RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS	RS	PS		
BLC/01	31/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/02	34/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/04	83/F	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/07	32/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/08	54/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/10	42/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/11	69/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/13	67/M	2	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0
BLC/14	36/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/15	47/M	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
BLC/16	28/M	1	0.01	1	0.03	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1

*RS: Raw Score; PS: Proportional Score

[1] Includes, all correct responses given in the non target language (NTL),
[2] Includes, only error responses which constitute a real word in the NTL,
[3] Includes, error responses that does not constitute a real word but is identified as belonging to the NTL,
[4] Includes, all other responses including circumlocutions, comments indicating difficulty to recall word, confusion, no responses and miscellaneous responses.

Table 1 - Individual CR and TTR scores in the ML PwA group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
ML/A/04	46/F	4	10	1.00	0.90
ML/A/05	52/F	1	6	1.00	0.73
ML/A/06	24/F	6	3	0.67	1.00
ML/A/07	55/M	14	15	0.56	0.82
ML/A/08	30/M	8	10	0.88	0.90
ML/A/11	64/M	2	5	1.00	0.86
ML/A/12	47/F	11	6	0.64	0.59
ML/A/13	36/F	11	7	0.91	1.00
ML/A/14	71/M	2	11	0.71	0.40
ML/A/16	34/M	6	6	0.64	0.50
ML/A/17	60/M	7	12	0.73	0.30
ML/A/18	47/M	9	17	0.73	0.95
ML/A/19	46/M	3	3	1.00	1.00
ML/A/21	56/F	0	13	0.80	0.81
BLA/05ML	32/F	16	4	0.50	1.00

Table 2 - Individual CR and TTR scores in the BL PwA group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLA/01	30/F	15	21	0.69	0.77
BLA/02	35/M	5	14	0.89	0.78
BLA/04	80/F	10	8	0.64	0.70
BLA/07	35/M	5	3	0.67	1.00
BLA/08	53/M	15	21	0.61	0.71
BLA/10	41/M	5	4	1.00	0.75
BLA/11	72/M	15	21	0.33	0.52
BLA/13	68/M	14	10	0.79	0.90
BLA/14	36/M	9	11	1.00	1.00
BLA/15	46/M	7	10	0.88	0.75
BLA/16	31/M	10	14	0.83	0.86

Table 3 - Individual CR and TTR scores in the BL PwA group in English

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLA/01	30/F	20	6	0.36	0.75
BLA/02	35/M	3	2	1.00	1.00
BLA/04	80/F	5	7	0.43	0.67
BLA/07	35/M	15	8	0.50	0.78
BLA/08	53/M	6	4	0.67	0.78
BLA/10	41/M	6	6	0.50	0.67
BLA/11	72/M	4	4	1.00	1.00
BLA/13	68/M	11	4	0.23	0.88
BLA/14	36/M	13	9	0.57	0.80
BLA/15	46/M	7	8	0.75	0.78
BLA/16	31/M	9	5	0.78	0.75

Table 1 - Individual CR and TTR scores in the ML HC group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
ML/C/04	49/F	13	10	0.93	0.83
ML/C/05	52/F	17	15	0.82	1.00
ML/C/06	26/F	12	16	0.75	0.94
ML/C/07	54/M	22	19	0.68	0.84
ML/C/08	28/M	13	7	0.85	1.00
ML/C/11	68/M	10	11	0.60	1.00
ML/C/12	48/F	8	9	0.78	1.00
ML/C/13	33/F	13	10	0.69	1.00
ML/C/14	70/M	11	14	0.64	1.00
ML/C/16	36/M	7	9	0.86	1.00
ML/C/17	63/M	9	10	0.44	0.82
ML/C/18	46/M	19	19	0.71	0.96
ML/C/19	47/M	8	7	0.75	1.00
ML/C/21	56/F	16	13	0.68	0.87
BL/C/05/ML	34/F	21	25	0.73	0.88

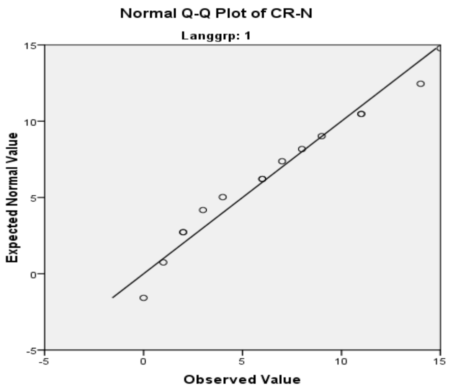
Table 2 - Individual CR and TTR scores in the BL HC group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLC/01	31/F	14	12	1.00	1.00
BLC/02	34/M	13	11	0.85	1.00
BLC/04	83/F	11	17	0.73	0.94
BLC/07	32/M	14	0	0.79	0.91
BLC/08	54/M	25	18	0.64	0.94
BLC/10	42/M	11	0	0.83	1.00
BLC/11	69/M	8	8	0.75	1.00
BLC/13	67/M	14	17	0.86	0.94
BLC/14	36/M	15	10	0.82	1.00
BLC/15	47/M	27	24	0.89	0.96
BLC/16	28/M	22	13	0.70	0.86

Table 3 - Individual CR and TTR scores in the BL HC group in English

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLC/01	31/F	23	14	0.61	0.93
BLC/02	34/M	11	11	0.50	0.83
BLC/04	83/F	11	12	0.55	0.83
BLC/07	32/M	23	16	0.42	0.71
BLC/08	54/M	18	16	0.61	0.88
BLC/10	42/M	28	11	0.54	0.82
BLC/11	69/M	16	18	0.39	0.65
BLC/13	67/M	17	15	0.65	0.87
BLC/14	36/M	14	11	0.64	0.64
BLC/15	47/M	16	9	0.44	1.00
BLC/16	28/M	21	14	0.43	0.79

PS Q-Q Plots –



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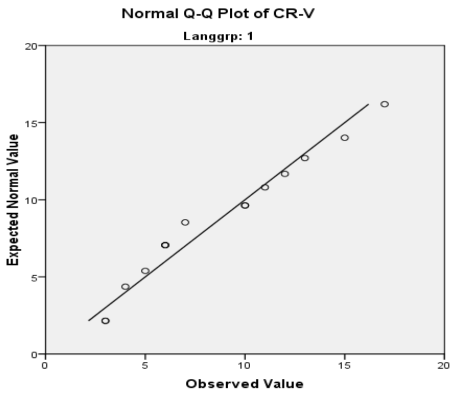

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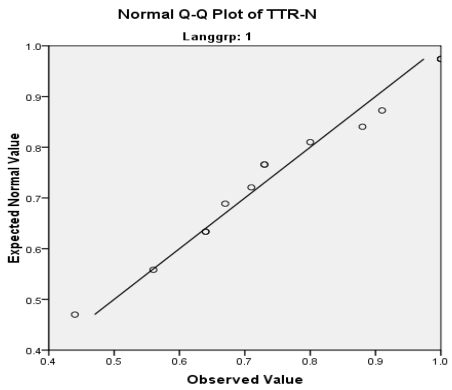

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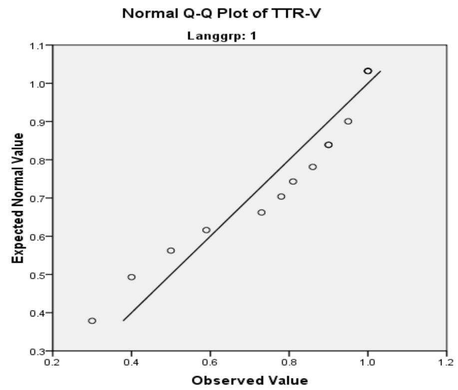

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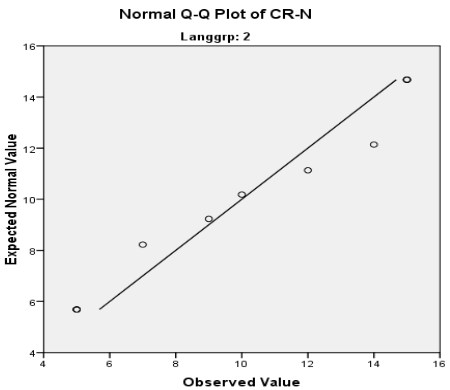

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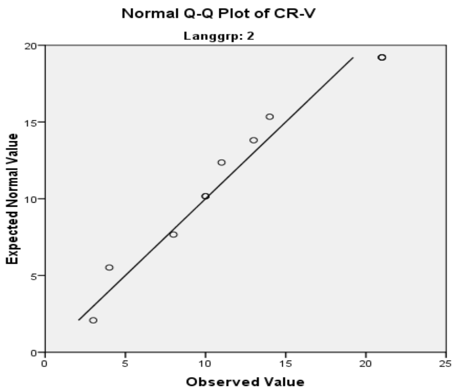

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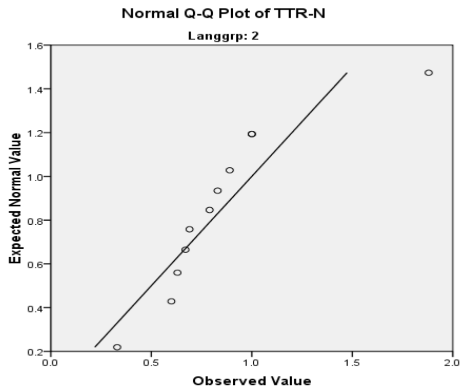

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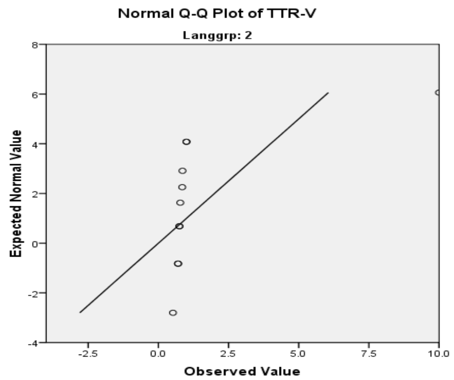

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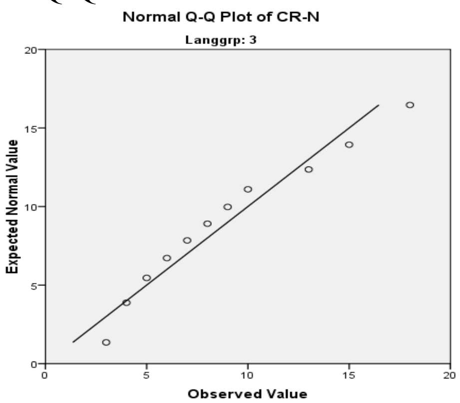

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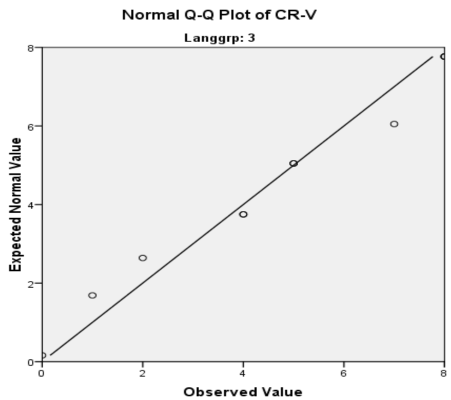

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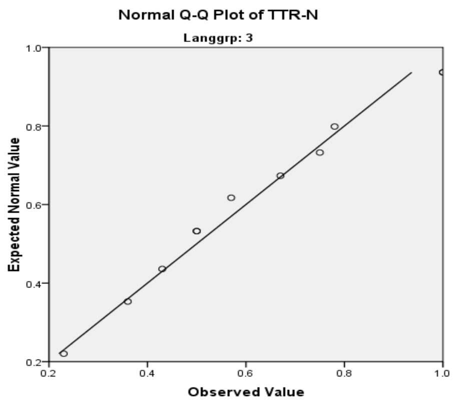

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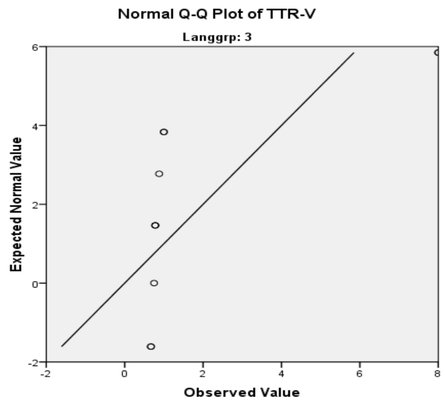

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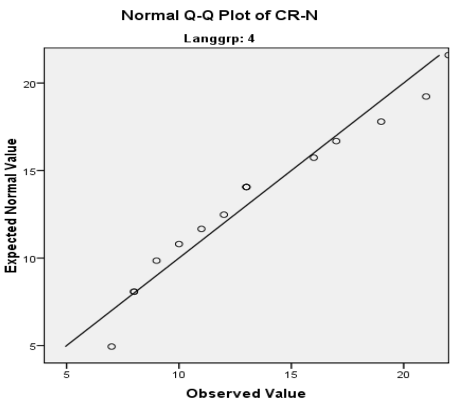

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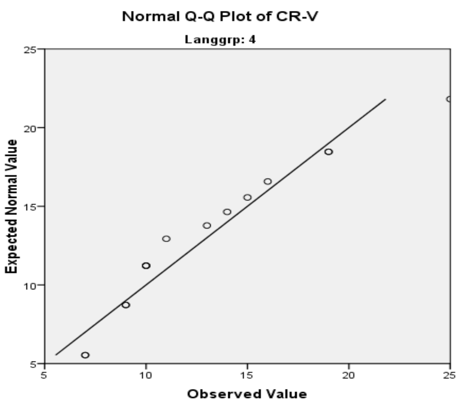

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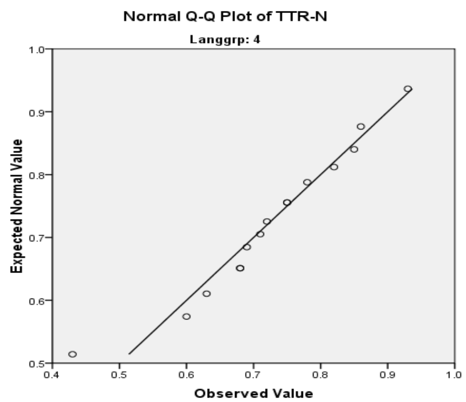

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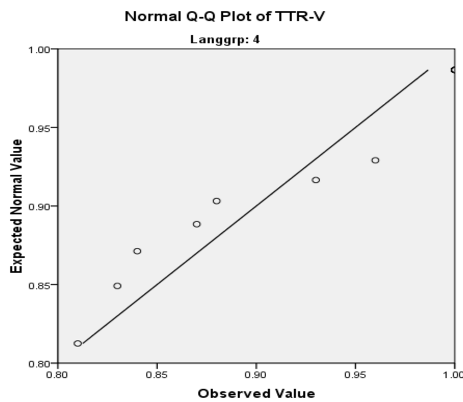

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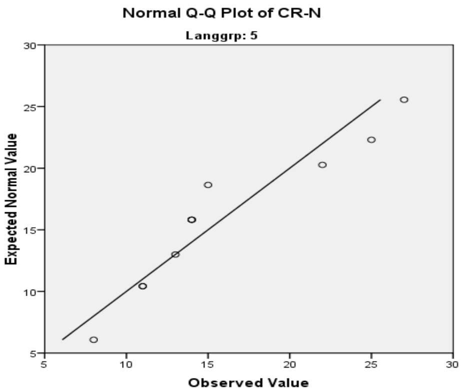

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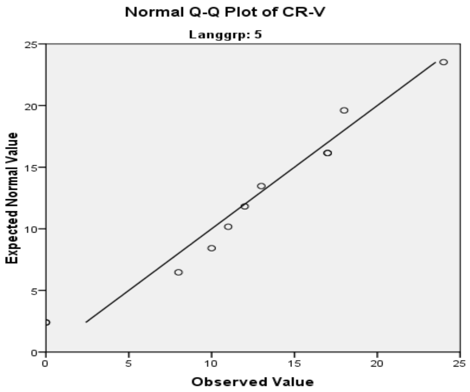

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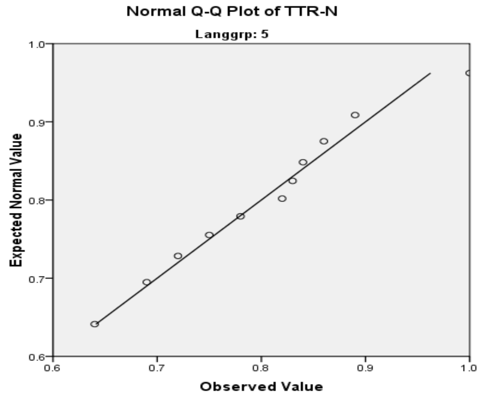

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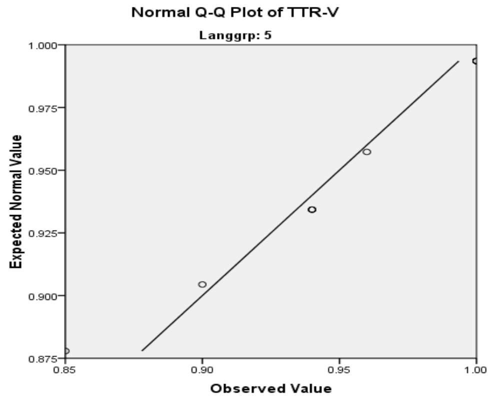

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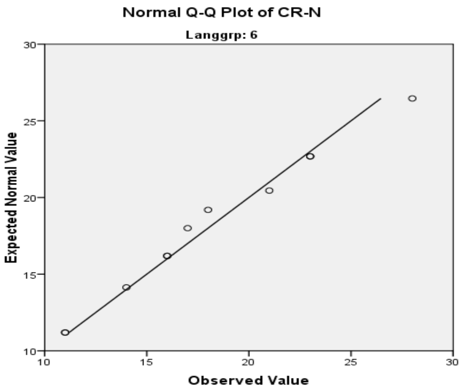

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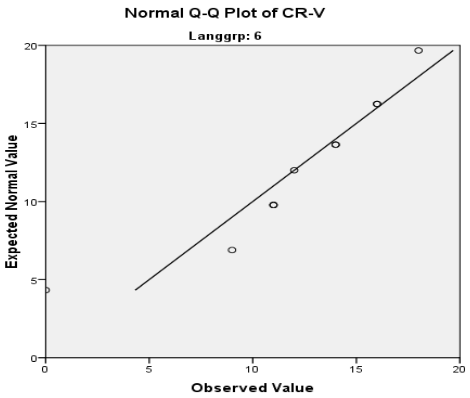

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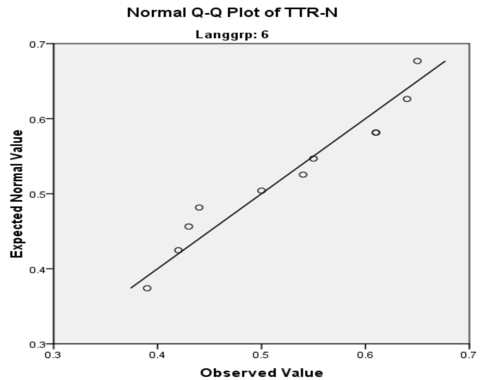

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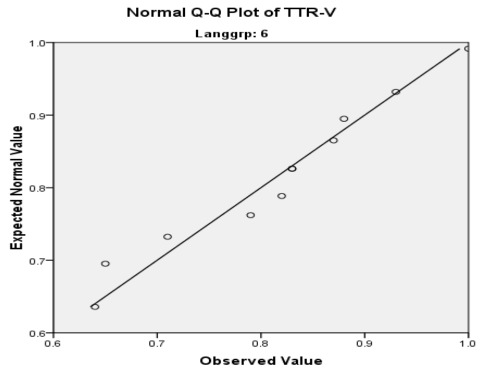


DS 9

Table 1 - Individual CR and TTR scores in the ML PwA group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
ML/A/04	46/F	6	4	1.00	0.83
ML/A/05	52/F	5	4	1.00	1.00
ML/A/06	24/F	8	4	0.82	1.00
ML/A/07	55/M	12	14	0.59	0.67
ML/A/08	30/M	6	3	1.00	1.00
ML/A/11	64/M	13	8	0.79	0.70
ML/A/12	47/F	8	6	0.78	0.78
ML/A/13	36/F	10	7	0.90	0.86
ML/A/14	71/M	12	1	0.47	0.67
ML/A/16	34/M	4	3	0.50	0.63
ML/A/17	60/M	8	9	0.41	0.47
ML/A/18	47/M	18	8	0.81	0.80
ML/A/19	46/M	8	5	0.82	0.88
ML/A/21	56/F	9	6	0.66	0.71
BLA/05ML	32/F	10	6	0.91	0.71

Table 2 - Individual CR and TTR scores in the BL PwA group in Sinhala

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLA/01	30/F	16	12	0.81	0.67
BLA/02	35/M	3	3	1.00	0.67
BLA/04	80/F	7	5	0.86	1.00
BLA/07	35/M	13	0	0.57	1.00
BLA/08	53/M	9	4	0.50	1.00
BLA/10	41/M	4	4	0.57	1.00
BLA/11	72/M	9	6	0.63	0.70
BLA/13	68/M	8	6	0.88	0.83
BLA/14	36/M	7	4	0.86	1.00
BLA/15	46/M	10	8	0.91	0.89
BLA/16	31/M	9	12	0.90	0.92

Table 3 - Individual CR and TTR scores in the BL PwA group in English

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLA/01	30/F	10	2	0.71	0.83
BLA/02	35/M	4	3	0.38	1.00
BLA/04	80/F	5	6	0.83	0.67
BLA/07	35/M	10	11	0.91	0.91
BLA/08	53/M	10	1	0.54	0.40
BLA/10	41/M	18	13	0.54	0.54
BLA/11	72/M	9	4	0.71	0.70
BLA/13	68/M	8	3	0.50	1.00
BLA/14	36/M	11	4	0.53	1.00
BLA/15	46/M	9	7	0.78	0.78
BLA/16	31/M	6	1	0.55	1.00

Table 1 - Individual CR and TTR scores in the ML HC group in Sinhala

Participant number	**Age/Sex**	**Correctly recalled scores**		**Type- Token Ratio**	
		CRn	**CRv**	**TTRn**	**TTRv**
ML/C/04	49/F	10	6	0.58	1.00
ML/C/05	52/F	13	11	1.00	1.00
ML/C/06	26/F	9	11	1.00	0.91
ML/C/07	54/M	11	5	0.91	1.00
ML/C/08	28/M	15	15	0.93	0.93
ML/C/11	68/M	7	4	0.86	1.00
ML/C/12	48/F	11	5	1.00	1.00
ML/C/13	33/F	15	7	0.93	0.86
ML/C/14	70/M	9	5	1.00	1.00
ML/C/16	36/M	11	8	0.82	1.00
ML/C/17	63/M	7	5	0.70	0.71
ML/C/18	46/M	5	4	1.00	1.00
ML/C/19	47/M	8	4	1.00	1.00
ML/C/21	56/F	10	5	0.90	1.00
BL/C/05/ML	34/F	23	14	0.91	0.79

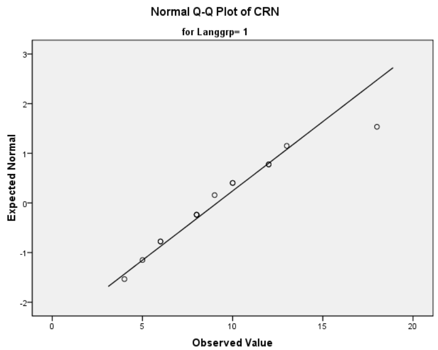
Table 2 - Individual CR and TTR scores in the BL HC group in Sinhala

Participant number	**Age/Sex**	**Correctly recalled scores**		**Type- Token Ratio**	
		CRn	**CRv**	**TTRn**	**TTRv**
BLC/01	31/F	15	9	1.00	1.00
BLC/02	34/M	14	9	0.86	1.00
BLC/04	83/F	7	6	0.75	0.90
BLC/07	32/M	14	13	0.79	0.77
BLC/08	54/M	17	8	0.78	1.00
BLC/10	42/M	6	6	1.00	1.00
BLC/11	69/M	16	6	1.00	1.00
BLC/13	67/M	9	7	0.89	0.71
BLC/14	36/M	12	10	0.83	1.00
BLC/15	47/M	8	7	0.88	1.00
BLC/16	28/M	18	18	0.89	0.89

Table 3 - Individual CR and TTR scores in the BL HC group in English

Participant number	Age/Sex	Correctly recalled scores		Type- Token Ratio	
		CRn	CRv	TTRn	TTRv
BLC/01	31/F	12	6	1.00	1.00
BLC/02	34/M	14	5	0.87	1.00
BLC/04	83/F	7	7	1.00	0.86
BLC/07	32/M	15	10	0.75	0.62
BLC/08	54/M	15	5	0.87	1.00
BLC/10	42/M	8	7	1.00	0.86
BLC/11	69/M	28	8	0.71	0.67
BLC/13	67/M	9	8	0.78	0.75
BLC/14	36/M	10	6	1.00	1.00
BLC/15	47/M	21	9	0.76	0.78
BLC/16	28/M	17	14	0.82	0.79

PS Q-Q Plots –



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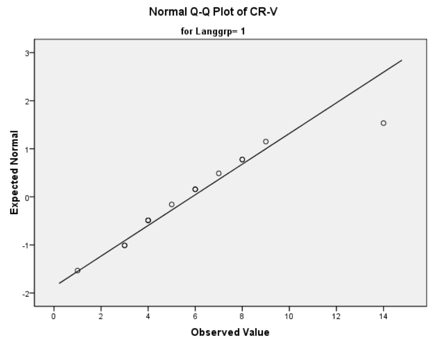

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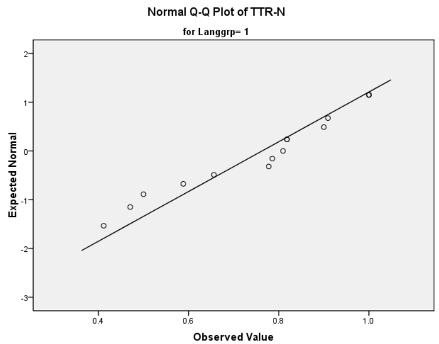

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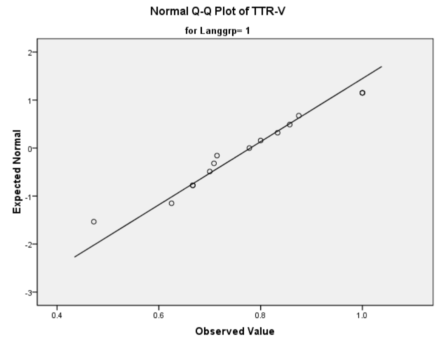

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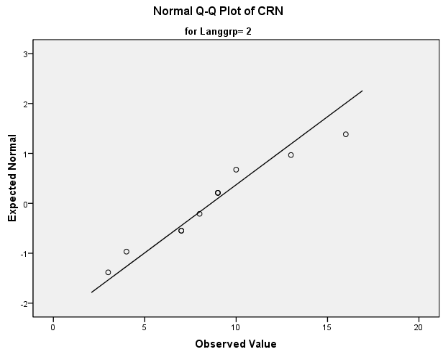

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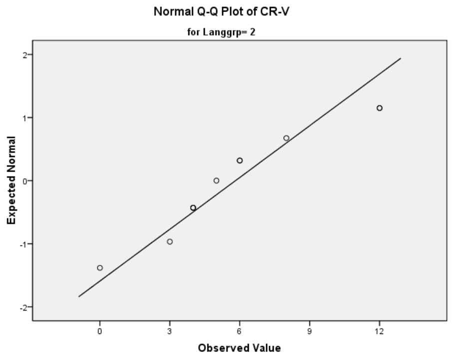

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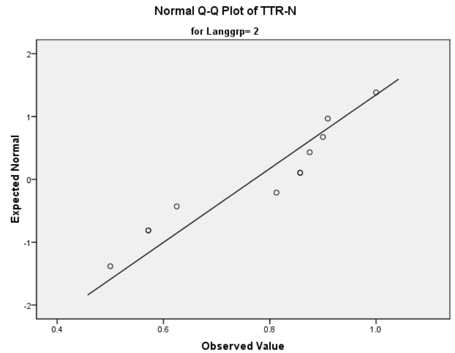

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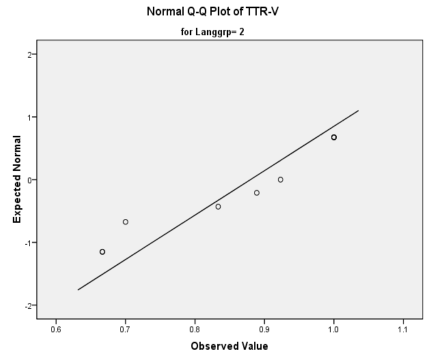

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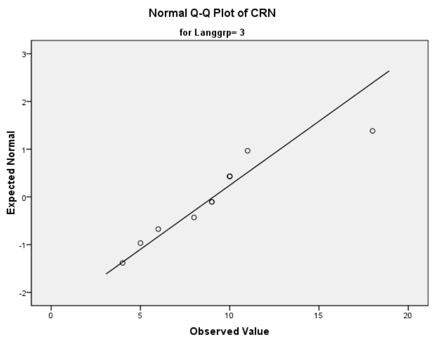

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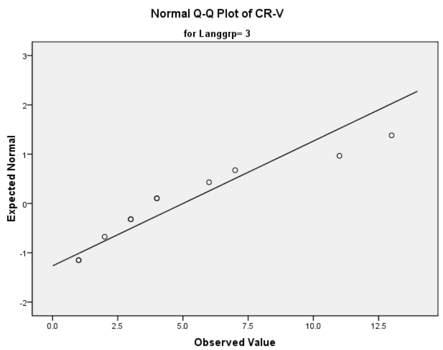

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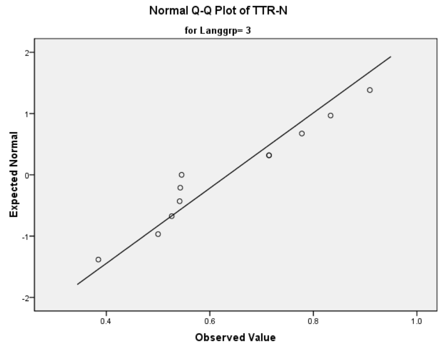

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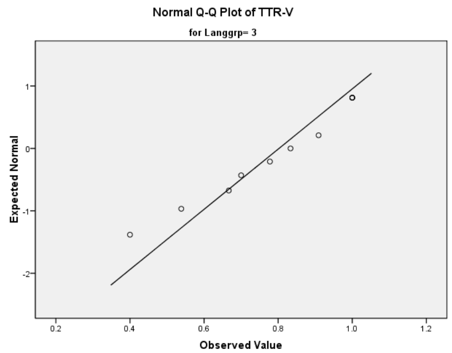

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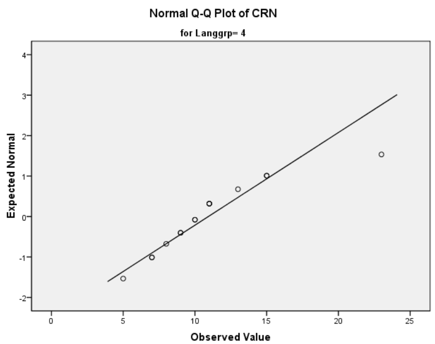

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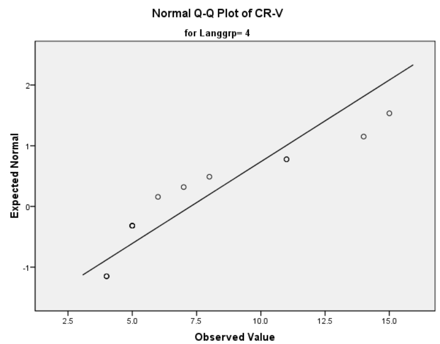

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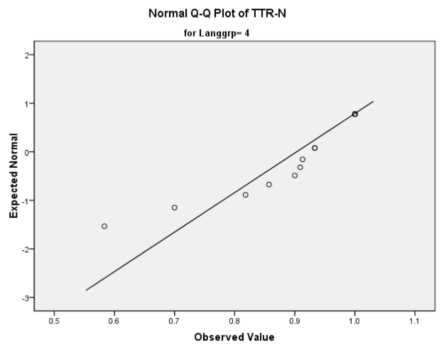

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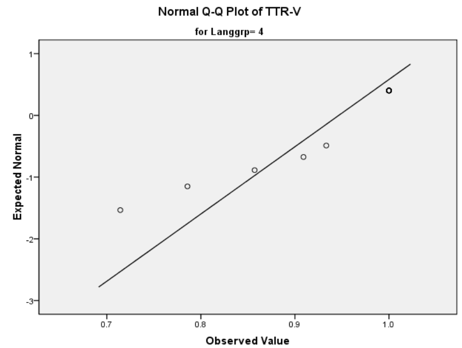

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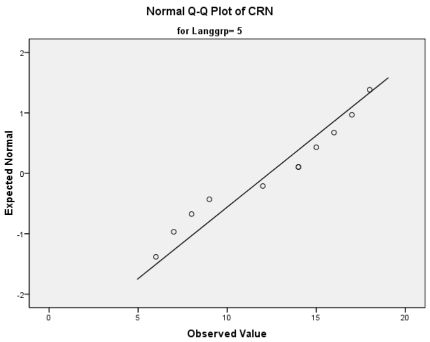

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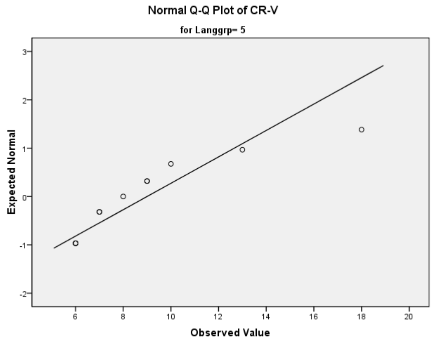

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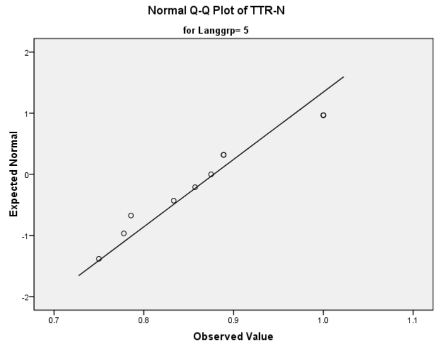

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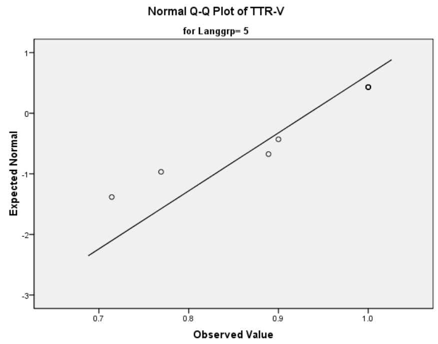

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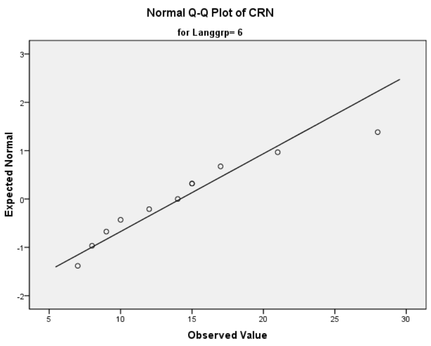

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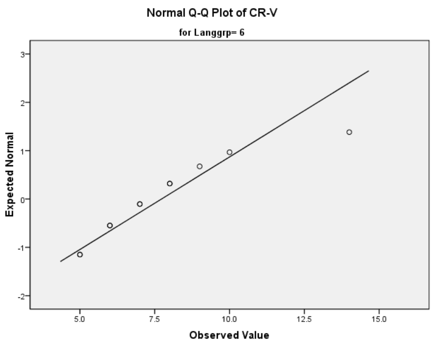

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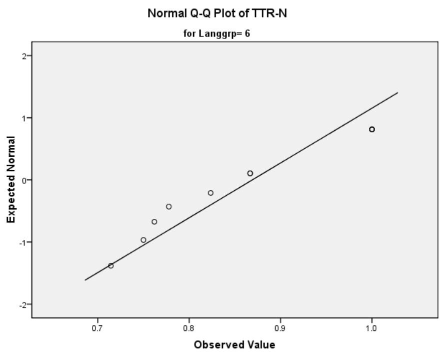

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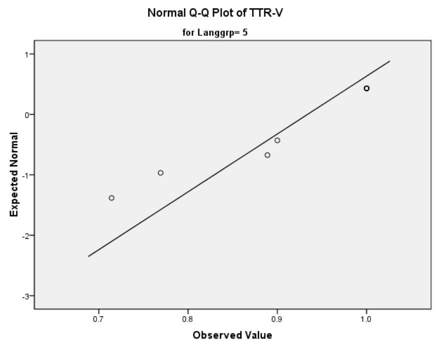

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