

**THE ROLE OF GENDER AND HANDEDNESS ON LANGUAGE FUNCTIONS IN
CHILDREN AGED 8-12 IN MANKWENG CIRCUIT, LIMPOPO PROVINCE IN
SOUTH AFRICA**

By

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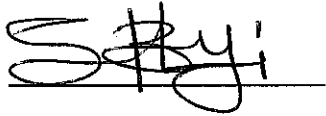
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Declaration

I Khensani Samuel Baloyi declare that the dissertation on the role of gender and handedness on the ability to speak in language functions in children aged 8 to 12 is my own work and has not been submitted in another institution for a request of a degree or related that and all the references I used in the study have been acknowledged in the reference list.

A handwritten signature in black ink, appearing to read 'S. Baloyi', written over a horizontal line.

Signature

15 April 2016

Date

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Dedication

This study is dedicated to my Mother Elizabeth and my young brother Jabulani, without you two, this study should not have been accomplished, and most assuredly to God who was, who is and who will always be with me in difficult and happy times, he always comfort me with his mercy and grace which endures forever.

Abstract

Aim of the study: The aim of the proposed study was to investigate the role of gender and handedness on the ability to speak in language functions in children aged 8 to 12.

Objectives: The current study is aimed to understand the difference in language functions as manifested by children of both genders (male & female) and their handedness (being left-handed children & right-handed children).

Method: The participating sample comprised of two groups (Male & Female) of children. A random sample of 120 primary school learners (children) in the late middle childhood (grade 4 – 7) of the same race (all black). All the participants were sepedi speaking children; they were all living in the Limpopo Province. Phonological processing, Speeded naming test, and Comprehension of Instruction test were administered for data collection.

Results: The results revealed no significant difference of performance in language functions between left-handed and right-handed children on Phonological Processing, Speeded Naming, and Comprehension of Instruction tests (NEPSY Scales). There was also no significant difference of performance between gender and Phonological Processing, Speeded Naming, and Comprehension of Instruction tests (NEPSY Scales).

Conclusions: Gender and Handedness could not influence language functions; therefore, confirmation for hypothesis 1 was not found, as there were no significant different of performance in language functions between male and female children on Phonological Processing, Speeded Naming, and Comprehension of Instruction tests (NEPSY Scales). Hypothesis 2 was also not found, as there were no significant difference of performance in language functions between left-handed and the right-handed children on Phonological Processing, Speeded Naming, and Comprehension of Instruction tests (NEPSY Scales).

Key words: children, difference performance, gender (male & female), language, lateralization, race.

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List of abbreviations

ANOVA – Analysis of Variance

APA – American Psychiatric Association

APA – American Psychological Association

CI – Comprehension of Instruction

fMRI – Functional Magnetic Resonance Imaging

fTCD – Functional Transcranial Doppler Ultrasonography

IQ – Intelligent Quotient

LH – Left Hemisphere

NELP – National Early Literacy Panel

NEPSY – The Developmental Neuropsychological Assessment

PET – Positron emission tomography

PP – Phonological Processing

RH – Right Hemisphere

RS – Recessive

RS + - Dominance

RS – RS – – Relative to left-handers

RS + RS + – Very strong right-handers

SAT – Scholastic Aptitude Test

SN – Speeded Naming

SPSS – Statistical Packages for Social Science

US – United States

WET – Viennese Development Test

ZPD – Zone of Proximal Development

CHAPTER 1

1. Introduction

This chapter introduces the role of gender and handedness on language functions in children, especially gender roles between males and females and their handedness. This pertains to being left-handed and right-handed children and how it affects the functioning of their language in their classroom, at school, at home and social life in general. Given that social-cultural experiences and self-conceptions are inseparable (Bronfenbrenner, 2005), the present study explored how children's perceptions of self and gender-role relate to one's language functional ability during middle childhood, as gender role is the social and behavioural norms considered appropriate in social situations for people of different genders. An understanding of these roles is evident in children as young as age 4 and is extremely important for their social development. Gender roles are influenced by the media, family, environment, and society. A child's understanding of gender roles impacts how they socialise with their peers and form relationships. Many young children have a firm sense of their gender identity, while some children can experience gender identity confusion. Based on a general definition, hand preference refers to the consistent selection of one hand for executing more or less skilled manipulations (Millar, 1994), although disagreements in definitions exist (Kaploun & Abeare, 2010). Handedness is defined as "the individual's preference to use one hand predominantly for uni-manual tasks and/or the ability to perform these tasks more efficiently with one hand" (Corey, Hurley, & Foundas, 2001).

1.1 Historical background of the study

One theoretical approach to gender differences proposes that gender differences arise from social, cultural, psychological, and other environmental forces. Like other gender theories, socio-cultural theories acknowledge the roles of both biological and learned influences. However, the focus has been on one prominent theory, the biosocial constructionist model by Wood and Eagly (2012). According to this theory, two factors determine gender differences which are physical differences between genders and socio-cultural influences. The key physical differences include

women's abilities to bear and nurse children and men's greater size, speed, and strength, which the authors argue have historically created task efficiency differences leading to division of labour. Childbearing and nursing of infants increased women's ability to perform home-based activities (e.g., cooking, caring for the home) and, given their time and energy investment in these activities, reduced their flexibility regarding activities outside of the home. Physical strength and size increased men's ability to obtain resources (e.g., hunt large animals), clear land for farming, and fight in wars. Power differences between the sexes emerged later in more complex societies as new economically productive roles such as accumulation of resources became a role which was dominated more by men than women. Variations that occurred between societies arose from developing novel solutions to local environmental factors, for example, weather and natural resources (Loken & Meyers-Levy, 2015).

The gender division of labour is important because it contributes to the formation of cultural beliefs. Cultural beliefs or gender roles, are shared beliefs that members of a culture hold about men and women. They are formed in a myriad of ways. Socialization of boys and girls occurs by imitation of others (e.g., role modeling of parents' and peers' behaviour) and through learning by reinforcement (e.g., punishing "weak" emotions in boys). Throughout development and into adult life, these beliefs promote ease of categorization by gender. For example, if women are observed to care for children, then women are believed, correspondingly, to be nurturing, kind, and possess other communal traits like emotional intelligence. If men are observed in strength-intensive tasks, they are believed to be assertive and dominant and have skills in leadership, mathematics, and mechanics. These positive stereotypes of communion and agency allow women and men to take pride in their gender roles and are sometimes used to justify continuation of these divisions (Loken & Meyers-Levy, 2015).

An important function of gender roles or cultural beliefs about men and women is to guide behaviour. Societal expectations influence behaviour through social rewards and punishments for conforming or not conforming to roles and may create gender differences that, otherwise, might not have occurred. For example, female leaders are evaluated more negatively than male leaders, and even more so when they exhibit agentic traits like dominance, directness, confidence, or

anger (Koenig, Eagly, Mitchell, & Ristikari, 2011). Men are punished for pursuing female occupations (e.g., ballet) or for communal traits such as agreeableness or being a “nice guy” (Judge, Livingston, & Hurst, 2012). Gender roles create pressures to conform and become internalized as gender identities, such that even when others are not present, people behave consistently with an internalized self-image (Loken & Meyers-Levy, 2015).

Gender roles and beliefs are pervasive, can be activated with subtle priming cues, and their effects on individuals' responses depend on the context. Expectations about male and female skills can enhance or impair performance on gender-typical or atypical tasks. As Wood and Eagly (2012) note, activation of a strong (versus weak) gender stereotype is found to impair performance of social sensitivity in males and math and leadership performance in women. However, the reverse can also occur, thus demonstrating the importance of the social and psychological context. Illustrating this, sometimes priming gender-atypical stereotypes can enhance performance (e.g., women on math tests), and career experiences in gender-atypical fields can immunize women from stereotype threats (Loken & Meyers-Levy, 2015).

Gender roles can be used by men and women to self-regulate their behaviour. The emotions experienced by men and women can serve as feedback and reinforce behavioural change in more gender-typical ways. As a result, males and females with strong (versus weak) gender identities experience higher self-esteem and positive feedback when they conform to gender standards (Witt & Wood, 2010). Both genders also prefer brands with personalities that match their own gender identity (Grohmann, 2009). Because of their communal tendencies, women may be particularly sensitive to environmental cues, making them more likely than men to modify their behaviour in context-appropriate ways (Wood & Eagly, 2012).

The socio-cultural perspective also proposes that gender roles and behaviors should change across cultures and time. Cultures with more *versus* less gender equality exhibit weaker communal–agentic stereotypes (Glick & Fiske, 2001) and smaller gender differences in domains such as preferences for mates with gender-typical attributes, scores on math tests, and sexual

activity. Self-reported measures of gender-typical attributes show fewer cross-cultural effects (Wood & Eagly, 2012).

Across time, gender roles and behaviors have changed, particularly for women (Wood & Eagly, 2012). While communal–agentic roles remain, the stereotype for women has broadened to accommodate an increased focus on careers and greater acceptability of agentic traits like assertiveness. The male stereotype has also changed, and an example is men's increased responsiveness to social influence; however, lack of acceptance of most feminine attributes in males has remained fixed. Changes in these social role beliefs mirror those seen in society, such as an increase of women in male-dominated occupations, a slower increase of men in female-dominated occupations, and decreased support by both sexes for gender inequality (Wood & Eagly, 2012).

Hand preference is most commonly assessed via questionnaires and, less frequently, using observational protocols. However, its assessment has not been standardized due to differences in classification of individuals and the lack of a common format for hand preference measurement (Papadatou-Pastou, Martin, & Munafo', 2013). Furthermore, different instruments of measuring handedness, in conjunction with gender differences, possibly affect the way individuals and groups complete questionnaires. For example, males have been less prone to provide extreme answers, which, consequently, results in heightened laterality scores for females (Bryden, 1977). Papadatou-Pastou et al. (2013), on the other hand, argued that reaction to extreme responses in such questionnaires is not due to gender as the phenomenon is equally observed among right- and left-handers. Other studies, which employed questionnaires, revealed that right-handed individuals consistently report right hand preference from childhood to adulthood, but the same is not true for left-handed individuals (Scharoun & Bryden, 2014).

In neuropsychology, hand preference or handedness indirectly indicates cerebral laterality (Van der Elst, Meijs, Hurks, Wassenberg, Van Boxtel, & Jolles, 2011), and it is the most representative example of specialized function or activity on one side of the body. It has a strong hereditary basis (McKeever, 2000; McManus, 1991; Ocklenburg, Burger, Westermann,

Schneider, Biedermann, & Gunturkun, 2010; Scharoun & Bryden, 2014) and has been essential in the development of higher kinesthetic and cognitive functions that have their basis on fine motor skills (Gutwinski, Lo" Scher, Mahler, Kalbitzer, Heinz, & Bermpohl, 2011).

There are different functional specializations of the left and right hemispheres for processing sensory information (Toga & Thompson, 2003). Cerebral lateralization allows for disparate specialized processing to operate in parallel within the left and right hemispheres, which decreases the duplication of functioning across hemispheres and eliminates the initiation of simultaneous and incompatible responses (Rogers, Zucca, & Vallortigara, 2004; Tommasi, 2009; Vallortigara & Rogers, 2005). As a result, the left hemisphere controls the right side of the body, and the right hemisphere controls the left side of the body. Thus, hemispheric specialization can manifest as contralateral physical actions (Hellige, 1993). The most prominent examples of a shared lateral bias for human anatomical and functional hemispheric specialization is handedness, and the neural regions associated with speech production (Broca, 1865) and comprehension (Wernicke, 1874). It is commonly reported that the human population exhibits approximately 90% right-handedness (McManus, 2002), and within the right-handed population, approximately 95% of individuals have language-processing regions situated in the left hemisphere of the brain (Foundas, Leonard, & Heilman, 1995). Therefore, left hemisphere specialization is prominent in right-handed individuals (Knecht, Deppe, Dräger, Bobe, Lohmann, & Ringelstein, 2000).

Language is, generally lateralized to the left-hemisphere of the brain but can occasionally also be found in the right hemisphere (Knecht et al., 2000). This variability indicates the high degree of freedom with which the brains can instantiate language. Factors associated with lateralization inform us about limitation to this freedom and may also be important limitations in the recovery from aphasia after stroke by recruitment of the intact hemisphere. One factor that has been associated with language dominance is handedness. On average, males are more lateralized for language and more often left-handed than females (Papadatou-Pastou, Martin, Munafo & Jones, 2008). The lateralization of language function is a striking feature of human brain function and one that was recognized by both Broca (1863) and Wernicke (1874).

Another debate relates to the origin of hand preference. Annett (1985) supported that the underlying natural asymmetry between the hands does not alter, even though practice can indeed improve the performance of the non-preferred hand. Therefore, preference for right or left hemispheric function, with regard to motor tasks, seems to be a matter of natural variation. On the other hand, although it is thought that handedness is genetically determined, a purely genetic model has failed to satisfactorily explain some observations regarding hand preference. Thus, when researchers apply models that attempt to interpret handedness, it is essential that factors other than genetic (e.g., environmental and cultural) are taken into account (Ocklenburg et al., 2010). For instance, experience, learning, practice (Scharoun & Bryden, 2014), early-life environment and social pressures (Suzuki & Ando, 2014) affect handedness decisively, while hand preference in people with severe visual impairments depends on a set of factors such as cultural expectations, experience, task requirements, strategy preferences, familiarity with the material, and reading habits in addition to accounting for individual differences on handedness (Sadato, 2005). Specifically for the visually impaired, Ittyerah (2009) indicated the possibility of improving the proficiency of both hands with practice on visuospatial tasks in the absence of vision. In his view, the seemingly lower performance of the non-preferred hand is a consequence of its spatial orientation during performance and does not necessarily express a lack of ability. Thus, equipotentiality is likely to be observed between the hands for both prehensile and non-prehensile actions (Ittyerah, 2010).

A study conducted by Vlachos, (1998) suggested that 70–90% of the world population is right-handed. What we do not know yet-, however, is why left-handedness is less prevalent (Gutwinski et al., 2011). Empirical evidence has suggested that the frequency of left-handedness varies with culture and region (Peters, Reimers, & Manning, 2006), and it is more common in men than in women (McKeever, 2000; McManus, 1991; Raymond, Pontier, Dufour, & Moller, 1996), although Vlachos, Avramidis, Dedousis, Katsigianni, Ntalla, and Giannakopoulou (2013) disputed the robust gender differences widely reported in the literature on the prevalence of left-handedness. It is estimated that 10% of the general population is left-handed (McManus, 1991; Vlachos, 1998). Vlachos et al. (2013) found similar results in a large sample of Greek adolescents. Actually, 7.3% of the participants were classified as left-handers, and these findings

are consistent with data from other countries. Kaploun and Abeare (2010) put forth the hypothesis that differences in cerebral organization (observed with left-handers) might have functional consequences on cognitive functioning. As for cerebral laterality, they reported large variability within the population of left-handers. Other studies, on the other hand, have suggested that men are more prone to ambidexterity compared to women (Papadatou-Pastou et al., 2008; Vlachos et al., 2013).

Past research shows that second-order or interpretive reasoning may influence children's ability to understand speech acts such as lies, jokes, sarcasm, and irony (Filippova & Astington, 2008, 2010; Leekam, 1993), and in their ability to understand self-representational display rules (Banerjee & Yuill, 1999; Banerjee & Watling, 2007). Given that advanced or higher order social reasoning may also help adolescents understand the ambiguous nature of personal and social silences (Bosacki, 2008), some researchers suggest such advanced reasoning is also fundamental to adolescents' understanding of social moral emotions (be embarrassed or proud), their sense of self and other persons, and social interactions (Hughes, 2011). The school classroom provides children with a valuable opportunity to learn social and emotional messages regarding interactions and others' mental states.

Although research shows that knowledge about self and others' thoughts and emotions continues to develop during middle to late childhood (Hughes, 2011). Studies conducted by Pine and Siegler (2003) suggest that psychological understanding is linked to higher-order; metacognitive thought or more advanced reasoning. That is, children who provide psychological explanations are more likely to "think about their own and others thinking" and engage in critical philosophical enquiry and shared dialogue during the school day (Haynes, 2002).

1.2 Statement of the problem

Language function studies have a long history among Westerners. Handedness and lateralisation remains a topic for debate today since the foundation of human laterality by Broca (1863). Mulenga, Ahonen, and Aro (2001) conducted a study on language functions using schoolchildren

aged 9 and 11 from Zambia. These children were given core and expanded tests on the NEPSY, and their performance was scored according to age-equivalent norms for U.S children. The study indicates that in urban, literate Zambian children, the NEPSY is relatively insensitive to language and cultural influences that often compromise the applicability of Western tests in the developing world. However, there is little research conducted on human handedness and language functions among African children. There remains a gap of research on gender role and handedness on language functions in children. The current study investigates the role of gender and handedness on language functions in children in the African context (specifically, in Mankweng Circuit, Limpopo Province, in South Africa).

1.3 Aim of the study

The aim of the current study was to investigate the role of gender and handedness on the ability to speak in language functions in children aged 8 to 12.

1.4 Objective of the study

The objective of the study is to understand the difference in language functions as manifested by children of both genders (male and female) and their handedness (being left-handed and right-handed children).

1.5 Hypotheses

1.5.1 There are significant difference of performance in language functions between male and female children on phonological processing, speed naming and comprehension of instruction.

1.5.2 There is a significant difference of performance in language functions between left-handed and right-handed children on phonological processing, speed naming and comprehension of instruction.

1.6 Scope of the study

The proposed study was conducted using learners from Primary Schools in the Mankweng area of the Department of Education Mankweng Circuit in the Capricorn District of Limpopo Province, in South Africa.

1.7 Significance of the study

This proposed study will contribute to an increased understanding of the role of gender and handedness on language functioning in children from a non-Westernized society. Language is one of our most precious abilities, yet we usually take it for granted. Despite its apparent use by most of us, there is little doubt that language is one of the most complex cognitive and motor skills. Language is the expression of human spiritual power and is both the key to the self and the foundation of social life. Literature by Mulenga, et al. (2001) has reported that there are many factors that influence language development in children. The researcher will advance knowledge on the role of gender and handedness on language functions in children between the ages of 8 and 12 from a non-westernized background.

This study will help children to gain knowledge, communicate ideas, and to comment on situations. It will also help them to socialize (for example, to teach the children what behaviour is appropriate in certain social situations and convey cultural knowledge to them). Children learn, for instance, to adjust their speech to fit the social situation (for example, that it is more effective to ask, "May I please have a biscuit?" than to say "Give me a biscuit"). However, language is also an outcome of socialisation (for example, to use the correct language in certain situations), and also helps children to establish and maintain relationships (Burman, 1994; Newcombe, 1996).

1.8 Conclusion

In conclusion, this chapter provided a background to the study, problem statement, significance of the study as well as the aim and objectives. In the next chapter, the main concepts will be operationalised, and the theoretical perspectives and framework will be discussed.

CHAPTER 2

Theoretical concepts

2. Introduction

In this chapter, terms and the concepts used in the study are defined and explained. Furthermore, theoretical perspectives and theoretical framework which support the understanding of the study are discussed.

2.1 Operational definition of concepts

The following terms used in this study are operationalised.

2.1.1 Gender

A concept defined by the American Psychiatric Association (2013) as the socially constructed roles, behaviours, activities, and attributes that a given society considers appropriate for boys and men or girls and women. These influence the ways that people act, interact, and feel about themselves. While aspects of biological sex are similar across different cultures, aspects of gender may differ. The researcher has adopted the same definition for the current study.

2.1.2 Handedness

This is a concept defined by Annett (2009) as an attribute of humans defined by their unequal distribution of fine motor skill between the left and right hands. An individual who is more dexterous with the right hand is called right-handed, and one who is more skilled with the left hand is said to be left-handed. Handedness, in the current study, refers to the individuals (learner's) hand preference when performing the task given.

2.1.3 Language

From the psychological perspective, there are three major domains of direct language application, namely: communication, self-regulation, and cognitive operation (thinking) (Vygotsky, 1986). Language in the current study refers to the English language as the medium of instruction used in South African Schools for teaching and learning.

2.1.4 Language function

Language function refers to the purpose for which speech or writing is being used. In speech, these include: giving instructions, introducing ourselves, and making requests. In academic writing, we use a range of specific functions in order to communicate ideas clearly. These include: describing processes, comparing or contrasting things or ideas, and classifying objects or ideas (Pozzi, 2004). In this study, the researcher made use of the same method to conduct the study, whereby learners were introduced to the study; the researcher describes the process where learners were asked to compare ideas, and classifying objects according to its specifications on the questionnaire.

2.2 Introduction to theoretical framework

The most sterling contributions were made by Broca (1881) and Wernicke (1874) on language functions. Kaplan and Sadock's (2007) state that the clearest known example of hemispheric lateralization is the localization of language functions to the left hemisphere. Due to the major role of verbal and written language in human communication, the neuroanatomical basis of language is the most completely understood association function. Broca (1881) and Wernicke (1874) discovered language disorder called aphasia, and it was diagnosed in routine conversation. Perceptual disorders may escape notice, except during detailed neuropsychological testing, although these disorders may be caused by injury or an equal volume of cortex. Among the earliest models of cortical localization of function were Broca's 1865 description of a loss of

fluent speech caused by a lesion in the left inferior frontal lobe and Wernicke's (1874) localization of language comprehension to the left superior temporal lobe.

Language most clearly demonstrates hemispheric localization of function. In most persons, the hemisphere dominance for language also directs the dominant hand. Ninety percent of the population is right-handed, and 99 percent of right-handers have left hemispheric dominance for language. Of the 10 percent who are left-handers, 67 percent also have left hemispheric language dominance; the other 33 percent have either mixed or right hemispheric language dominance. This innate tendency to lateralization of language in the left hemisphere is highly associated with an asymmetry of the planum temporal, a triangular cortical patch on the superior surface of the temporal lobe that appears to harbour Wernicke's area. Patients with mixed hemispheric dominance for language lack the expected asymmetry of the planum temporal. That asymmetry has been observed in prenatal brains and suggests a genetic determinant. Indeed, the absence of asymmetry runs in families, although both genetic and intrauterine influences probably contribute to the final pattern (Kaplan & Sadock's, 2007).

Language comprehension involves a variety of capacities, skills, processes, knowledge, and dispositions that are used to derive meaning from spoken, written, and signed language. In this broad sense, language comprehension includes reading comprehension as well as comprehension of sign language (Ylvisaker, Turkstra, Coehlo, Yorkston, Kennedy, Sohlberg, & Avery, 2007).

Language comprehension is processed at three levels. First, in phonological processing, individual sounds such as vowels or consonants are recognized in the inferior gyrus of the frontal lobes. Phonological processing improves if lip reading is allowed, if speech is slowed, or if contextual clues are provided. Second, lexical processing matches the phonological input with recognized words or sounds in the individual's memory. Lexical processing determines whether a sound is a word or not. Recent evidence has localised lexical processing to the left temporal lobe, where the representations of lexical data are organized according to a semantic category. Third, semantic processing connects the words to their meaning. Persons with an isolated defect in semantic processing may retain the ability to repeat words in the absence of an ability to

understand or to spontaneously generate speech. Semantic processing activates the middle and superior gyri of the left temporal lobe, whereas the representation of the conceptual content of the words is widely distributed in the cortex. Language direction proceeds in the opposite direction, from the cortical semantic representations through the left temporal lexical nodes to either the oro-motor phonological processing area (for speech) or the graphomotor system (for writing). Each of these areas can be independently or simultaneously damaged by stroke, trauma, infection, or tumour, resulting in a specific type of aphasia (Kaplan & Sadock's, 2007). The garbled word salad or illogical utterance of an aphasic patient leave little uncertainty about the diagnosis of left-sided cortical injury, but the right hemisphere contributes a somewhat more subtle, but equally important, affective quality to language. For example, the phrase "I feel good" may be spoken with an infinite variety of shadings, each of which is understood differently. The perception of prosody and the appreciation of the associated gestures, or "body language," appear to require an intact right hemisphere. Behavioural neurologists have mapped an entire pathway for prosody association in the right hemisphere that mirrors the language pathways of the left hemisphere. Patients with right hemisphere lesions, who have impaired comprehension or expression of prosody, may find it difficult to function in society despite their intact language skills (Kaplan & Sadock's, 2007).

Developmental dyslexia is defined as an unexpected difficulty with learning in the context of adequate intelligence, motivation, and education. On the other hand, speech consists of the logical combination of 44 basic phonemes of sounds; reading requires a broader set of brain functions and, thus, is more susceptible to disruption. The awareness of specific phonemes develops about the age of 4 to 6 years and appears to be prerequisite to acquisition of reading skills. Inability to recognize distinct phonemes is the best predictor of a reading disability. Functional neuroimaging studies have localized the identification of letter to the occipital lobe adjacent to the primary visual cortex. Phonological processing occurs in the inferior frontal lobe, and semantic processing requires the superior and middle gyri of the left temporal lobe. A recent finding of uncertain significance is that phonological processing in men activates only the left inferior frontal gyrus, whereas phonological processing in women activates the inferior frontal gyrus bilaterally (Kaplan & Sadock's, 2007).

In children, developmental non-verbal learning disorder is postulated to result from right hemisphere dysfunction. Non-verbal learning disorder is characterized by poor fine-motor control in the left hand, deficits in visuo-perceptual organization, problems with mathematics, and incomplete or disturbed socialization (Kaplan & Sadock's, 2007).

Broca (1863) suggested that an area of the left frontal lobe, just in front of the primary motor cortex, played a key role in processing language. Specifically, he noted that damage to this area left-handed people are able to understand speech but with reduced capacity to produce it. Broca (1863) concluded that this area of the brain contained memories for the sequence of muscular movements needed for fluent speech.

Wernicke (1874) suggests that a second area, located in the left temporal lobe just behind the primary auditory cortex, also played a key role in language. Wernicke (1874) noticed that damage to this region left-handed people are able to speak but with reduced understanding of spoken or written words. In other words, such persons could speak fluently, but they could not readily understand what was said to them. Hundred years later, Geschwind (1972) combined these suggestions, plus other data, into a unified model known as the Wernicke-Geschwind theory. According to this model, both areas of the cortex identified by Broca (1861) and Wernicke (1874) which are pathways connecting them and several other regions, including the primary visual cortex and the primary motor cortex, function together in the production and comprehension of language (Geschwind, 1972; Wernicke, 1874).

Studies by Naeser, Zimmermann and Cebula (1981) state that brain-imaging devices that have been used to scan the brains of individuals suffering from language-related problems consistently reveal damage to either Broca's or Wernicke's area. These results provide support for the view that language is localized in specific brain regions, as predicted by this model (Wernicke-Geschwind model). However, the inconsistencies noted earlier raise the possibility that individual differences in language localization may exist.

Baron (1998) states that a large and rapidly growing body of evidence suggests that the cerebral hemispheres of the human brain are quite different with respect to their function. In other words, the brain shows a considerable degree of lateralization of function. Each hemisphere seems to be specialized for the performance of different tasks. Speech is one of the most important of these. For a large majority of human beings, this crucial process is located primary in the left hemisphere (Benson, 1985). In many persons, though by no means all, the left hemisphere specializes in verbal activities like speaking, reading, and writing and in logical thought and the analysis of information. The right hemisphere specializes in the control of certain motor movements, in synthesis (putting isolated elements together), and in the comprehension and communication of emotion. According to Baron (1998), many studies employing diverse methods and procedures support these basic conclusions.

2.3 Theoretical framework

2.3.1 Luria's theory

There are a variety of theories dealing with how the brain is organized and how it operates. For example, Hebb's (1949) cell assembly theory and MacLean's (1978) theory of the triune brain attempt to explain brain function from both a micro-and a macroscopic perspective. However, no theoretical account of brain function is as complete as that proposed by Luria (1973). Luria's views on brain functions are widely quoted and have been useful in conceptualizing both research and clinical work. He derived his ideas from investigations of adults with brain pathology (D'Amato & Hartlage, 2008).

Rather than advocating a strict location view of brain structure and function, Luria proposed a more dynamic conceptualization. He calls this complex composition of brain activities a "Functional System". In other words, a function such as speaking or writing is mediated by a coordinated set of brain activities. An inability to speak or write would indicate a breakdown somewhere within the functional system. Luria also suggests that no specific brain area completely controls a given function. Therefore, if a particular brain area is damaged, a variety

of behavioural disruptions may result; similarly non-damaged brain areas may be able to assume some of the function that is compromised. Consequently, any given brain area may be involved with a variety of behaviours. This phenomenon is referred to as “pluri-potentiality,” and it highlights the interdependence and communication between various brains structures (D’Amato & Hartlage, 2008).

However, Luria (1973) suggests that in order to understand his theory of the functional organization of the brain, the first task should be to discover the basic functional units from which the human brain is composed and the role played by each of these in complex forms of mental activity.

2.3.1.1 Functional units of the brain

Luria proposed that the human brain is made up of three main blocks, or functional units, and that all mental activity draws from these units. He describes functional systems that operate along a vertical organization (lower or higher), a longitudinal organization of the brain (frontal-back), and a lateral organization (left-right D’Amato & Hartlage, 2008).

Luria’s three principal functional units

Luria posited that human mental processes represented complex functional systems that involved groups of brain areas working in concert, each making a unique contribution to the organization of a functional system.

Thus, Luria designated three principal functional units of the brain necessary for human mental processes in general and conscious activity in particular (Luria, 1973):

- A) The unit for regulating tone or waking;
- B) The unit for obtaining, processing and storing information; and
- C) The unit for programming, regulation and verifying mental activity.

Each of these three units appears to have a hierarchical structure comprising three cortical zones based one upon the other: the primary (projection) area, which receives impulses from or sends impulses to the periphery, the secondary (projection-association) area, where incoming information is processed and programs are prepared, and the tertiary (zones of overlapping) areas—the latest systems of the cerebral hemispheres to develop, which are responsible for the most complex forms of mental activity requiring the concerted involvement of many cortical areas (Luria, 1973).

2.3.1.1.1 Unit 1 – The unit for regulating tone or waking and mental states

Luria argued that the organized course of mental activity (when one is receiving and analysing information) and the mental processes are checked by mistake correction and cannot be obtained without the waking state. Luria mentioned Magoun and Moruzzi (1949) who, in 1949, showed that the reticular formation in the brain stem, with the structure of a nerve net, gradually modulates the whole state of the nervous system (Luria, 1973).

This finding showed that the structures maintaining and regulating cortical tone are located in the sub-cortex and brain stem, and have a double relationship with the cortex. Specifically, the ascending reticular system activates the cortex and regulates the state of activity, while the descending reticular system subordinates the lower structures to the control of the cortex. Luria claimed that this discovery was suggestive of a vertical organization to all structures of the brain, with the first functional unit of the brain maintaining cortical tone and the waking state, thus regulating these states in accordance with the conditions confronting the organism. Importantly, the reticular formation had both activating and inhibiting portions (Luria, 1973).

A) Metabolic processes

According to Luria (1973), the reticular system had certain qualities of differentiation or “specificity” in regards both to its anatomical structure and its sources and manifestations. The first of three principle sources of activation of the reticular formation was the metabolic

processes leading to the maintenance of homeostasis. The reticular formation of the medulla (bulbar) and mesencephalon (mesencephalo-hypothalamic), closely related to the hypothalamus, played a significant part in this “vital” form of activation (Luria, 1973). The higher nuclei of the mesencephalic, diencephalic, and limbic reticular formation also took part in more complex systems of instinctive or unconditioned-reflex food-getting, sexual and defensive behaviour. These two subdivisions of activation sources were similar in that they occurred in the body, but are different in their level of complexity.

B) Stimuli and the orienting reflex

The second source of activation related to the arrival of stimuli from the outside world and represented an orienting reflex (Luria, 1973). Here, Luria referred to the experiments of Hebb (1955) and the human need for incoming information. He further elaborated on the investigative activity of humans as well as the need for increased alertness as a form of mobilization in a constantly changing environment. It is important to emphasize that the tonic and generalized forms of the activation that Luria allocated to the lower regions of the reticular formation, while the phasic and local forms (“more complex, vital or conditioned-reflex in character”), were allocated to the higher structures such as the non-specific thalamic region and limbic system (Luria, 1973).

C) Intentions and plans by forecasts and programs

The third source of activation was represented by “intentions and plans, by forecasts and programmes” (Luria, 1973) that were social in their motivation and formed consciously with the help of speech. It is noteworthy that Luria viewed these highest forms of organizational activity as subject to the vertical principle of construction in the functional systems of the brain.

Observing the medial zones of the cortical zones in this unit, Luria claimed that they played a role in the “regulation of the general state, modification of the tone and control over the inclinations and emotions” (Luria, 1973).

In summarizing his findings concerning this first functional unit, Luria asserted that impairments showed the relation between disturbances of memory and disturbances of consciousness (Luria, 1973).

The first unit described by Luria is the Arousal Unit. This unit is comprised of a network of diffuse structures at the brain stem and thalamic levels, also referred to as the reticular activating system. The arousal unit is primarily involved in filtering sensory input and adjusting the arousal level or tone of the cortex. It is crucial to one's ability to attend or respond to stimuli. Dysfunction in this unit can cause disorders of sleep or consciousness, difficulties in screening incoming stimuli, hyper- or hypo-responsiveness to situations, and lack of attention or concentration. Structures in the arousal unit are linked hierarchically to other brain areas, particularly the pre-frontal cortex. Ontogenetically, this first brain unit develops very early. Damage to this unit in adults may greatly affect vegetative functions and the ability to attend and adapt sufficiently to the environment. Developmental disturbance to this unit within the first year of life may have less drastic effects on the individual but seem to cause problems of attention, hyper activity, and inadequate filtering of information. This lower brain unit is often on the front end of functional systems, managing the early information process such as attending to, detecting, filtering, and acquiring sensory input (D'Amato & Hartlage, 2008).

2.3.1.1.2 Unit 2 – The unit for receiving, analysing and storing information

The brain regions of Luria's second principal functional unit are in the neo-cortex on the convex surface of the hemispheres—the posterior regions including the visual (occipital), auditory (temporal) and general sensory (parietal) regions. Importantly, this unit consists of isolated neurons, working in accordance with the “all or nothing” rule (Luria, 1973). In general, the unit represents the “cerebral mechanisms of modally specific forms of gnostic processes” (Luria, 1973).

This unit is characterized by high modal specificity of the primary and projection areas. Those modally-specific zones are built in accordance with a single principle of hierarchical

organization articulated by Campbell (as cited in Luria, 1973), where each of the cortical structures is seen as the central cortical apparatus of a modally-specific analyser.

The primary zones of the cortical regions of this unit also have “multimodal” cells that can respond to several types of stimuli, and cells that do not respond to any modally specific type of stimuli. The core projection areas of this unit are surrounded by systems of secondary (or gnostic) cortical zones that contain more associative neurons to implement the synthetic function of converting the somato-topic projection of impulses into their functional organization. The tertiary zones of this brain system—the “zones of overlapping”—are responsible for the combined work of several groups of analysers and hypothetically respond to general features of stimuli. They mostly occupy the inferior parietal region that after fleshing was seen as the “posterior associative centre” typical particularly of humans (Luria, 1973). These zones enable the “transition from direct, visually represented syntheses to the level of symbolic processes” and also play a role in the “memorizing of organized experience” (Luria, 1973).

Luria defined three fundamental laws of the work structure of the cortical zones of the second and the third brain units (Luria, 1973).

A) Law of the hierarchical structure of the cortical zones: The primary, secondary and tertiary cortical zones are engaged in the complex synthesis of information and change in the course of ontogenetic development.

According to Vygotsky (as cited in Luria, 1973), the interaction between the cortical zones goes “from below upward,” meaning that defects of the lower zones in infancy must lead to incomplete development of the higher zones. By contrast, among adults, the interaction goes “from above downward,” and the tertiary zones then have a compensatory influence if the secondary zones are damaged (Luria, 1973, p.74).

B) Law of diminishing specificity of the hierarchically arranged cortical zones of the second brain unit (starting from the primary zones with maximal modal specificity).

Luria emphasized that the secondary and the tertiary cortical zones show more “functional properties” than the primary ones and play an “organizing, integrative role in the work of the more specific areas” which is necessary for more complex gnostic processes (Luria, 1973).

C) Law of the progressive lateralization of functions (progressive transfer from the primary cortical areas to the secondary and tertiary respectively).

With the occurrence of right-handedness in humans, due to processes such as work and speech, some degree of lateralization of functions takes place (Luria, 1973). Thus, the left and dominant hemisphere in right-handers begins to lead in the “cerebral organization of all higher forms of cognitive activity connected with speech” (p.78). However, this dominance of the left hemisphere is relative in character (Luria, 1973).

This unit coordinates activity of cortical brain areas posterior and inferior to the central sulcus (temporal, parietal, and occipital lobe function). Within this second unit, Luria (1973) describes a sub-organization that is applied to each of the parietal, temporal and occipital lobes. The foundation of this unit is the primary zone, or primary projection area, within each of these three lobes in both hemispheres. The primary zone of the parietal lobe, for example, is located along the post-central gyrus and is chiefly responsible for the reception of somatosensory input, including touch, pain, temperature, and proprioception. The primary zone of the temporal lobe is located along the superior temporal gyrus. This is the primary projection area for auditory information. The primary zone of the occipital lobe is located in the posterior portion of each hemisphere. This zone is the primary projection area for incoming visual stimuli. These primary zones within each lobe are modality-specific. The specificity of cells in these primary zones has been well detailed elsewhere (Hubel & Wiesel, 1963). Interestingly, stimulation to these primary cortical areas induces rather meaningless sensory experiences (e.g. hearing sounds) or uncoordinated movements. More complicated and coordinated behaviours within each lobe are sub-served by association areas (D’Amato & Hartlage, 2008).

The secondary zone within each lobe is located adjacent to the primary zone. Here, there is less modal specificity (e.g. the association areas of the temporal lobe are involved with vision as well as hearing), and the structure is composed of neurons that associate with other brain areas, including homologous areas of the contralateral hemisphere. In general, these secondary zones, or association areas, are involved in the analysis, coding, and storing of information. For example, within the function of vision, the secondary (association) area in the occipital lobe seems to be involved in temporal, spatial, and feature-related analysis of the visual stimulus. In the parietal lobe, the secondary (association) area is involved in Gnostic tactual functions (e.g. knowing what an object is by feeling it, and also knowing where one's arm is located in space from the perception of moving it). Similarly, the associations are in each. At this secondary zone level, one begins to see an increase in hemispheric differentiation. The secondary zone of the left temporal lobe is more involved in the perception of speech sounds, while the right hemisphere appears to be more involved in the analysis on non-speech sounds, particularly aspects of rhythm, pitch, and tone. In general, these secondary zones or association areas are involved with the ability to recognize incoming stimuli, detect and analyze the information, and associate the information to previous experience (D'Amato & Hartlage, 2008).

Another zone within this second unit is the tertiary zone, located at the juncture of the parietal, occipital, and temporal lobes in each hemisphere. In this zone, data from different sensory sources are integrated. There is much less modal specificity. In fact, this zone has been identified as multimodal (Pandya & Yeterian, 1990) or cross-modal in function. The principal role of the tertiary zone is information organization, particularly as it relates to the simultaneous processing of information. It is in this zone that one achieves a high degree of analysis of incoming information. Here, information from a particular modality, such as visual information, can be related to tactual or auditory input and all information can be converted to symbolic representations (D'Amato & Hartlage, 2008).

Disruption of the tertiary zone in either hemisphere tends not to produce overt sensory deficits but, instead, yields deficits in high levels of perceptual and cognitive functions, such as those associated with reading, writing, mathematics, and spatial behaviour. It should be pointed out

that, the three zones within this second brain unit are both developmental and hierarchical in nature. Whereas, the primary zones develop early in life and deal with the reception of modality-specific information, the secondary and tertiary zones nature later in life and is involved in more complex, less modality-specific mental operations (D'Amato & Hartlage, 2008).

2.3.1.1.3 Unit 3 – The unit of programming, regulation and verification of activity

The third principal functional unit is responsible for human intentions, the formation of plans and programs of actions, inspection of performance, verification of conscious activity, and regulation of behaviour (Luria, 1973).

The motor cortex and the parts of the great pyramidal tract are core brain structures of the unit (this cortical area is projectional in character). However, a tonic background is also required, delivered by the basal motor ganglia and the fibers of the extra-pyramidal system.

Luria referred to the third unit of the brain, essentially the left and right frontal lobes, as the execution or output unit, or the unit that is involved with programming, regulation, and verification of activity. While this brain unit receives orienting and sensory information from the other two brain units, it is essentially involved with motor out, planning, and evaluation of behaviour. It, too, is described in terms of a sub-organization. The primary zone of this unit is the motor cortex, located anterior to the central sulcus. This area of the brain is known to exert major control over motor impulses sent to the contralateral side of the body. The secondary zone, or premotor area, lies anterior to the motor strip. It is involved with preparing motor programs by analysing, organizing, and sequencing motor acts and then applying spatial and temporal analysis to on-going movement. The tertiary zones of this third brain unit lie in the most anterior part of the brain, the prefrontal cortex, and are also modality non-specific. In fact, the pre-frontal cortex has many efferent and afferent connections with the other brain areas (D'Amato & Hartlage, 2008).

The primary projective motor cortex is seen as the “outlet channel” (Luria, 1973) for motor impulses. The impulses should be well prepared with the help of superposed secondary areas of the motor cortex, and only after that can they be sent out to the pre-centorial gyrus and then to the giant pyramidal cells. Other structures responsible for preparation of motor programs include the upper layers of the cortex and the extra-cellular grey matter of dendrites and glia that control the giant pyramidal cells of Betz.

Luria (1973) and others suggest that this brain region plays an important role in the formation of intentions and programs, as well as in planning and regulating the most complex forms of human behaviour. In addition to planning, executing, and evaluating behaviour, the pre-frontal lobes are involved with selective attention, concentration, mental flexibility, and personality functioning, such as the regulation of mood, judgment and drives. Once again, this brain unit has both a hierarchical and developmental organization. The primary motor cortex is fully functional quite early in life, while the tertiary zones in the frontal lobe sub-serve much more complex functions and seem to develop gradually throughout childhood and adolescence (D’Amato & Hartlage, 2008).

Luria’s (1973) theoretical formulation is rather macroscopic in nature. For example, he does not describe the functions of the nerve cell or the specific pathways and projections that comprise a particular functional system. Luria’s theory, although dated and imperfect, still provides us with a useful heuristic for understanding much of brain functioning. His approach relies heavily on the notion of serial processing in a hierarchical manner, with each level (arousal unit – primary zone of reception unit – secondary and tertiary zone of reception unit – output and planning unit) thus adding functional complexity. Brain science, over the past 30 years, has informed us that brain activation is much more dynamic and parallel in real time than Luria described. We now have a greater appreciation for more widely distributed patterns of neural connectivity in the brain, including feedback mechanisms within functional systems and processing streams (D’Amato & Hartlage, 2008).

This unit, therefore, as an efferent system, runs in the descending direction, starting from the highest levels of the tertiary and secondary zones where the motor plans are formed, to the structures of the primary motor area and periphery (Luria, 1973). Importantly, the pre-motor areas can be allocated to the secondary divisions of the cortex. These areas play an organizing role for movements.

The second distinctive feature of this unit is that it works under the influence of the second or afferent brain unit and consists entirely of systems of efferent zones.

Finally, the pre-frontal cortex region of this unit “plays an essential role in regulating the state of activity” in accordance with complex intentions and plans formulated with the help of speech (Luria, 1973). Luria also claims that the pre-frontal regions have “two-way connections,” both with the lower structures of the brain stem and diencephalon, and with all other parts of the cerebral cortex (Luria, 1973).

Thus, Luria (1973) concluded that the “tertiary portions of the frontal lobes are, in fact, a super-structure above all other parts of the cerebral cortex” and that they “perform a far more universal function of general regulation of behaviour” than other tertiary regions (Luria, 1973). Luria further elaborated that the frontal lobes are “responsible for the orientation of an animal’s behaviour not only to the present, but also to the future,” and, therefore, to the most complex forms of active behaviour (Luria, 1973).

The final important feature of the frontal lobes is seen in the feedback mechanism or “reverse afferentation” as the necessary component of any organized action (Luria, 1973, p. 91), which has been described by the famous Russian physiologist Anokhin (1935) in his theory of functional systems as the “action acceptor” apparatus. Luria concluded that the frontal lobes also had the function of “allowing for the effect of the action carried out and verification that it has taken the proper course” (Luria, 1973).

2.3.1.2 Interaction between the three principal functional units of the brain

Luria asserted that complex psychological processes have a systemic structure and that each form of conscious activity represents a complex functional system and takes place through the concerted working of all three brain units (Luria, 1973).

Citing Leontiev (1959), Luria (1973) described the modern understanding of the structure of mental processes as having moved on from isolated faculties, being based, instead, on the model of “a reflex ring or self-regulating system” with afferent and effector components so that “mental activity assumes a complex and active character” (Luria, 1973).

In conclusion, perception takes place through the combined action of all three functional units of the brain. The first provides the necessary cortical tone; the second carries out the analysis and synthesis of incoming information, and the third provides for the necessary searching movements which give perceptual activity its active character. Additionally, voluntary movement and more especially, manipulations of objects are based on the combined working of different parts of the brain. The first unit of the brain supplies the necessary muscle tone, without which coordinated movements would be impossible. The second unit provides the afferent synthesis within which the framework of movement takes place. The third unit subordinates the movement and the action to the corresponding plans, produces the programmes for the performance of motor action, and provides the necessary regulation, thereby checking the course of movement without which the organized and purposive character would be lost (Luria, 1973).

In addition, Luria’s work is greatly under-appreciated in neuroscience. While his compatriots, Vygotsky and Pavlov, received much recognition and many accolades for their contributions in the fields of psychology and the biology of behaviour, Luria remained relatively unknown (Kostyanaya & Rossouw, 2013).

2.3.2 Vygotsky's theory on child language development

Vygotsky (1978) saw the child as embedded in a social context and focused on what she could do with the assistance of adults or older, more skilled children. For Vygotsky, cognitive development was the result of collaboration in a particular socio-cultural setting. In effect, the child is an apprentice. Vygotsky also measured development in terms of the child assuming more important social roles and responsibilities, not the child's use of logic. Finally, Vygotsky (1978) saw cognitive development as continuous, not as distinct stages.

2.3.2.1 Zone of proximal development

At the heart of Vygotsky's theory was an idea called the Zone of Proximal Development (ZPD) which is the area between what a child can do alone and what a child can do with assistance. The ZPD is made up of skills, ideas, and understanding that are just beyond the child's reach, that the child is beginning to perform and can do with support or assistance from adults or more skilled peers. During "Cognitive Development in Infancy," the parent or older children's role is to support the child's effort with scaffolding, that is, to provide learning opportunities, materials, hints and clues when the child gets stuck (Bruner, Jolly, & Sylvia, 1976). A key feature of effective scaffolding is that the parent provides only as much support as the child needs; once skills are mastered, the parent withdraws the "scaffolding" or support (because that particular support is not needed Spink, 2010).

Another approach to cognitive development was developed by Vygotsky (1962, 1978, 1982) who asserted that humans learn in the context of culture and social interaction that influences thinking, behaviour and knowledge levels. Social agents, such as parents, teachers or peers, also affect a human's learning. Vygotsky (1962) saw humans as having lower level functions that are genetically inherited and higher level functions acquired by social interaction (Spink, 2010).

Vygotsky's (1967) Zone of Proximal Development (ZPD) is the difference between independent problem solving by a child compared to problem solving guided by an adult through mediated

learning and social interaction. The universal aspect of different cognition development approaches the idea of an incremental increase in specific skills and domain-specific knowledge (Goswami, 2007; Morra, 2007), for example, learning to ride a bicycle. When a young child is a whiz on a tricycle, parents introduce a two-wheeler with training wheels. The parent walks alongside as the child learns to apply familiar skills to a somewhat less stable vehicle. The parent will provide a push to help the child get started and may provide a hand to stabilize a wobbly rider.

When he has learned to steer and pedal, it is time to take off the training wheels. The parent still walks alongside, though, providing balance when the child needs it until one day, the parent lets go, and the child is on his own, for a short time at least. Once he has learned to ride the bike confidently, a new zone of development opens: racing and performing stunts that older and/or more skilled children show him. Parental guidance, like training wheels, bridges the gap between what is easy for the child (riding a two-wheeled bike), while new skills lead to a new ZPD or new competencies to be mastered with assistance (Spink, 2010). When reading picture books, parents (ideally) adjust their prompts to the child's ZPD. With fifteenth-month-olds, parents point to illustrations and ask leading questions that supply the answer: "is that an elephant?" When the child is able to label familiar objects, parents begin to ask for information that is not visible on the page ("What does Winnie-the-Pooh like to eat?" "Honey, that is right. Bees make honey. You know.").

Through these interactions in the ZPD, parents scaffold early literacy activities. Helping the child to come up with the right answer herself, providing assistance when it is needed and allowing the child to "do it herself" when she can, are part of the scaffold. Vygotsky (1967) held that children learn their culture's "intellectual tools" language, number system, reading and writing, religion and science, as well as ways to remember and plan through social interaction in the ZPD (Rogoff, 2003).

Vygotsky (1967) saw pretend play as another Zone of Proximal Development. In make-believe, children try on different roles (actual and fictional), imitating adults and experimenting with

rules. As he explains, “In play, a child is always above his average age, above his daily behaviour; in play, it is as though he were a head taller than himself” (Vygotsky, 1967, p. 522).

2.3.2.2 Guided participation

Rogoff (2003) has reported that Vygotsky’s (1967) socio-cultural theory and the idea of the ZPD to include guided participation or the varied ways children learn their society’s values and practices through participation in family and community activities. Guided participation goes beyond actions intended to be instrumental. It includes time when children watch adults going about their business and listen to adults talking among themselves, participate in cultural rituals and everyday activities, listen to family stories or their culture’s mythology, play traditional games, and so on. When adults or older children praise, shame, or laugh about a child’s behaviour, they are guiding participation by providing a frame of how to behave and how not to behave. For example, middle-class Euro-American families (directly and indirectly) prepare children for their future roles as students. With toddlers, parents combine play with vocabulary lessons. They often ask known-answer questions, such as “what is this?” (Holding up a toy) or “where is your belly button?” Both the parents and the children know the answer, so the question is not a request for information. Rather, parents are teaching the format used for test questions in school. At the dinner table, parents ask children to talk about their day and, as in school, each child gets a turn. When a child hesitates, they prompt the child with questions such as “What did you do?” “Who was there?” “And then...” “And after that...” providing a scaffolding for the narrative format used in school (When, where, what, who, and why). Even before they learn to “talk like a book”, children need to imitate their parents (Gauvain, 2001; Rogoff, 2003).

Children learn some social and cultural lessons on their own simply by observing. In one example, a United States (US) mother was working at home, spending hours every day transcribing tape-recorded conversations onto her computer for a research project while her three-year-old daughter played nearby. One day, the little girl set up her own “office” (Wolf & Heath, 1992). She had pulled her small director’s chair up to her bed which served as a desk. It held her “computer” (really a toy typewriter) as well as her small plastic tape recorder. She

would play a section of star wars and then stop the recording to bang out a message on the plastic keys of her typewriter. Back and forth, she went between the recorder and her “computer,” playing and typing, playing a new section and typing again, in a way more than a little reminiscent of her mother’s efforts at transcription (Wolf & Heath, 1992, pp. 11-12).

According to Rogoff (2003), guided participation is seen in other cultures. In a Mayan Village in Guatamala, for example, a young child watched her mother make tortilla each morning. One day, the mother rolled a small ball of dough, flattened it a little, and gestured to her daughter to continue. After the child seemed to be doing her best, the mother began demonstrating techniques to make the play tortilla thinner and more even, which is an example of scaffolding. Emulating adults is one way children activity sees knowledge and skills. Just as the content of guided participation varies, so do the rules for participation.

In some cultures, children are expected to learn by listening and holding their tongues. For example, in Native-American communities, due to their cultural beliefs, asking direct questions often is considered rude because it obliges the other person to reply. Since is the appropriate response when a person does not have a reply or wish to make one, the person choses to keep quite in order to show respect to the elders. Inuit of Arctic Quebec say, “The more intelligent children are, the quieter they become” (Freeman, 1978, p. 21). Euro-American teachers find these children’s silence unnerving, even disrespectful. To some degree, these children must unlearn the manners they acquire at home to succeed in school where Euro-American standards prevail and where how children talk can be as important as what they say. In classrooms, non-Inuit teachers ask children to speak up, in contrast to their parents’ expectations. This clash surfaced in a parent-teacher conference:

Non-inuit teacher: your son is talking well in class. He is speaking up a lot.

Inuit parent: I am sorry (Crago, 1992, p. 496).

In Vygotsky’s developmental (or ‘genetic’) view, language (‘speech’) has a pivotal role to play in the emergence of distinctively human forms of thinking and action in the child. Through a

process of 'internalization', 'external', or 'social', speech is transformed from a directly interpersonal, communicative means of regulating and directing the child's behaviour into 'inner speech', the medium of the child's own personal consciousness and will and of his or her capacity for purposeful and independent action. The halfway house in this internalization process is 'egocentric speech' or, the term preferred nowadays (Wertsch, 1979), 'private speech'. In more prosaic terms, Vygotsky is attempting to account for our ability to do things 'mentally' or 'in our head'. Roughly speaking, the main idea is that we have to first learn to do things publicly 'externally' with others before being able to do them 'internally'. Having first learnt to do sums in the classroom with the teacher using pen and paper, we later find ourselves able to do 'mental' arithmetic. Similarly, we learn to read out loud and then 'silently'. More broadly, the capacity to think to ourselves, to inwardly reflect on what we are doing, to guide our own actions purposefully and self-consciously, depends on 'inner speech', a specially adapted 'inner' form of language use which, according to his premise, must derive from the 'external' practice of using language in dialogue with others.

In themselves, these claims were not original or unique to Vygotsky's theory. However, Vygotsky bolstered his own speech internalization hypothesis with detailed claims about the linguistic properties of his different speech forms. In particular, drawing heavily on contemporary linguistic ideas, he argued that utterances in 'egocentric speech' (and, by extrapolation, those of 'inner speech') had a peculiar elliptical structure which must be the result of clipping, abbreviating or reducing the expanded and complete utterance forms of 'external speech'. In other words, Vygotsky's psychological theory – a whole conception of what it means to be human, no less – is built around a particular conception of language (Spink, 2010).

According to Vygotsky (1962), inner speech is "a dynamic, shifting, unstable thing, fluttering between word and thought" (Vygotsky, 1962, p. 149). Its true nature and place can be understood only after examining thought itself. "Every thought creates a connection, fulfils a function, and solves a problem. The flow of thought is not accompanied by a simultaneous unfolding of speech. The two processes are not identical, and there is no rigid correspondence between the units of thought and speech" (Vygotsky, 1962, p. 149).

Inner speech, by contrast with outer speech, essentially reflects a clearly different, new and independent function of speech, poetry-like silent speech for oneself. Inner speech is also “simplified” and compressed as it “opens up” with difficulty to others and is hardly intelligible without context. It consists of apparent fragmentariness, which makes it elliptic, including “open” gaps, so inner speech deviates by its syntax from written speech by being predicative and often even idiomatic, like a dialect (Spink, 2010).

Vygotsky (1962) moves further and claims that “thought itself is engendered by motivation, i.e. by our desires and needs, our interest and emotions. A true and full understanding of another’s thought is possible only when we understand its affective—volitional basis” (Vygotsky, 1962, p. 150). It seems that metaphors are one of the most salient formulations that manifest this affective-volitional basis. Any metaphor may be regarded as an expressed form of inner speech which reveals itself in the form of external speech. However, it differs from usual or “literal” forms of speech in some features (Spink, 2010). One of these features concerns the role of imagery in the metaphors. Most folk metaphors are mainly based on images which play a very important role in the “liveliness” and vividness of metaphors. The second feature is related to the fact that metaphors are generated and expressed in encapsulated forms. In contrast to extended speech, which is elaborated and descriptive in nature, metaphors are condensed and imaginative in their structure. Metaphors, therefore, follow the general rule of generation of an utterance which starts from a motivation and ends up with a statement. It is, in general, a form of an utterance; therefore, it obeys the rules of linearity and sequentiality which are evident in any verbal expression. However, at the same time, it reflects the reality in a special way, which is not necessarily always linear and sequential, but grounded in imagery (Spink, 2010).

From Vygotsky’s (1962) point of view “man is a social creature, and social cultural conditions profoundly change him/her, developing a whole series of new forms and techniques in his/her behaviour: a conscientious study of these characteristics constitute the specific task of the science of psychology” (Vygotsky & Luria, 1993, p. 213).

Three major points may be outlined regarding this change process: (1) the child is born to an already existing cultural–industrial environment, and this fact constitutes the crucial, critical difference between the child and the “primitive” man (Vygotsky & Luria, 1993, p. 171); (2) a very complicated interaction occurs between the child and the socio-cultural environment which shapes the whole process of development in the child; and (3) in the process of such an active interaction, internalization takes place, which is mostly based on signs, signification, and generalized meaning. The implication of these processes is that the whole system of information processing, including communication, perception, memorization, concept formation, and volition work according to the rules and patterns which have been evolved in the society in the course of history (Spink, 2010).

Words are considered by Vygotsky (1962) as the most powerful social means. The origin of volition, for example, is intimately related to the child’s mastering the speech. As children gradually master speech, they will learn to use speech for the planning and control of their own actions. The fact that words (as a system of signs and signification) are particularly effective in this respect is, again, attributable to their social origin. Vygotsky (1962) subscribed to the view that words are originally (both phylogenetically & ontogenetically) commands. The power of the word for the regulation of our own behaviour (i.e. in inner speech form) finds its origin in the power of words to command others (Van Der Veer & Valsiner, 1988, p. 55). This point leads us to one of the most important aspects of Vygotsky’s mediational psychology, that is, as Cole and Wertsch (2002) have stated “mind is no longer to be located entirely inside the head”, but persons are a part—an active part—of a complicated network including biological variables, cultural artefacts, natural environments, and “culturally structured social environment.” An outstanding element of mediation from a Vygotskian perspective relates to the last part of this network i.e. “culturally structured social environments” which are created by sign system (i.e. mostly by speech) in humans (Spink, 2010).

Mediation, then, becomes instrumental in the context of social activities and organizations leading to specific patterns of behaviour which relate every person both to the community and

himself/herself. Culture evolves in this process and acts as a context on one hand, and as a regulator of behaviour on the other (Spink, 2010).

In recent Vygotskian literature, mediation has been defined and interpreted in different ways. Wertsch (1979, 1983, 1985), for example, has mainly stressed on semiotic mediation. Mediation, in this sense, is based on signs as a means of controlling human behaviour. Minick (1987) has explained the concept of mediation in relation to the origin of the higher mental functions. According to Vygotsky (1962), higher mental functions rely on the mediation by signs and sign systems, the most important of which is speech. Signs, in this context, are special type of stimuli which function as “psychological tools”, and are directed toward the mastery or control of behaviour processes (Spink, 2010).

Karpov and Haywood (1998) have distinguished two major types of mediation: (1) meta-cognitive or the acquisition of semiotic tools of self-regulation which can be named in the contemporary literature as executive processes; and (2) cognitive mediation based on school learning and systematic instruction. The authors have tried to develop an instructional procedure that incorporates both of Vygotsky’s types of mediation. However, mediation possesses another aspect which deals with the primary function of speech as one of the most important sign systems, and that is a means of social interaction and communication. From this perspective, higher mental functions are not only mediated, meaning that they are established with the help of psychological tool, but they are social in origin. As Fernyhough (1996) states, the higher mental functions are dialogic and have evolved in the process of communication.

2.3.2.3 Language and thought

Vygotsky (1986) argues that thought and language develop together. He held that the child’s first attempts to speak are efforts to establish and maintain social contact. When an infant says, “Bow-wow,” the mother responds, “Yes! That is a dog.” using a word elicits and maintains social interaction, which is the child’s primary goal (though she may be expressing excitement,

too). These interactions served to place the child in a Zone of Proximal Development. So called social speech is all important at this stage.

According to Vygotsky (1986), around age three or four, children begin to use the language they developed for social purposes as a tool to organize their thoughts and actions. Faced with a problem, they talk out loudly to themselves. Thus, language facilitates problems solving and thought. The self-directed talk helps children to recall what they know and to plan and organize what they want to do. "I want to draw a tree. I need the green pencil for the leaves. But I need a brown pencil, too, for the tree trunk," and so on. Gradually, self-directed talk becomes silent inner speech. Instead of talking out loud, Vygotsky (1986) held that adults' thought are an advanced version of inner talk. Of course, adults also talk to themselves out loud, usually when no one else is around. "Great! I got it. Now, what next?" (Spink, 2010). Although in both cases (in the existing classifications vs. the one which was introduced here) mediation plays a crucial role, it enters the whole system of processing as an instrument, in the first case, and as a mechanism, in the second. Vygotsky (1986) believed that these two aspects merge together in the course of development. A child's conception of the world becomes mediated when he/she uses speech, on the one hand, and his/her representation becomes culturally structured reconstruction, on the other. It is in this process that "inter-mental" world of the child becomes "intra-mental". Vygotsky calls this internal reconstruction of the external operations as internalization (Spink, 2010).

For Vygotsky (1986), language has a particular role in learning and development by acquiring a language, a child is provided the means to think in new ways and gains a new cognitive tool for making sense of the world. Language is used by children as an additional device in solving problems, to overcome impulsive action, to plan a solution before trying it out and to control their own behaviour (Jones, 1995). Nevertheless, the main purpose of language for children is social. They use the language to obtain the help of others and to solve problems. The child, in its process of development, begins to practice the same forms of behaviour that others formerly practice with respect to the child. The significance of such behaviour is only understood in a social context (Spink, 2010).

Language is also crucial and inter-related with the action, providing an additional tool used both to reflect on and direct behaviour. Vygotsky's work is, therefore, viewed as particularly relevant to those who are concerned with the use of language. Both Piaget and Vygotsky viewed pre-school children in problem-solving situations talking to themselves. When Piaget labeled the self-directed behaviour as egocentric and believed it only minimally relevant to children's cognitive growth, Vygotsky (1986) referred to it as a private speech. He argued that private speech grows out of the children's interaction with parents and other adults, and through such interactions, they begin to use their parent's instructional comments to direct their own behaviour (Jones, 1995).

Vygotsky (1978) states that every function in the child's cultural development appears twice: first, between people (inter-psychological) and then inside the child (intra-psychological). This applies equally to voluntary attention, to logical memory, and to the formation of ideas. All the higher functions originate as actual relationships between individuals.

According to Vygotsky (1986), intellectual abilities are much more specific to the culture in which the child was reared (Vasta, Haith, & Miller, 1995). Culture makes two sorts of contributions to the child's intellectual development. First, children acquire much of their thinking (knowledge) from it. Second, children acquire the processes or means of their thinking (tools of intellectual adaptation) from the surrounding culture. Therefore, culture provides the children with the means to, what to think and how to think.

2.4 Conclusion

In this chapter, terms and the concepts used in the study were defined and explained in terms of how these apply to the current study and the difference they bring between both genders (male & female children) and their handedness (being left-handedness & right-handedness). Furthermore, theoretical perspectives and the theoretical framework which support the understanding of the current study were discussed. The next chapter discusses the literature review of the study.

CHAPTER 3

3. Literature review

3.1 Introduction

In this chapter, an overview of the literature review to this study is given. The relationship between handedness and language is explained. The difference between left-hemisphere and the right-hemisphere, and the difference between left-handed and right-handed people is also explained. The cerebral asymmetry is also outlined. Research with intact persons and the research with split-brain participants isolating the two hemispheres is also provided.

3.2 The relationship between handedness and language

Handedness has been widely studied in disciplines ranging from psychology to medicine, as well as in certain Social Sciences such as Anthropology. Maccoby and Konrad (1966) states that there are several reasons why the relationship between handedness and language remains the centre of attention for so many years. First, there are considerable differences between girls and boys in the development of language abilities. When speaking first begins, girls generally articulate better than boys and produce longer sentences. Perhaps as a consequence of this advantage, girls tend to have larger working vocabularies and better use of grammar than boys (Sommer, Aleman, Somers, Boks, & Kahn, 2008). Some years later, girls typically have superior reading abilities than boys. Part of this verbal advantage for females survives into adult age, especially in the domain of verbal fluency and the use of grammar. Furthermore, language disabilities, both of severe and mild type, affect boys more frequently than girls, with reported sex ratio between 3:1 and 7:1 (Sommer et al., 2008). If females, indeed, have more bilateral language lateralization than males, this could provide an explanation for all these observed sex differences.

For a long period, hand preference in performing tasks was taken into account as an indicator of brain lateralization of the subjects of experiments. However, Rogers (2007) proposed that such

an approach has been proven to work only for certain complex tasks and not for simple ones. In fact, it is claimed that for simpler tasks such as picking up the food items, the procedure is vice versa, that is, in such cases brain lateralization is the index of hand preference and the hemisphere which is most likely to be used to do the task determines which hand is to be used by the animal (Rogers, 2007).

According to Bishop (2001), handedness is often seen as a by-product of brain lateralization in human beings, which is also at work in the development of language among them (Humans). Nevertheless, what remains ambiguous is the fact that why it does not affect all the human beings. In fact, a minor group of the population of every culture (5%–15%) is found to be left-handed (Bishop, 2001). For long, it has been proven that in humans, the two concepts of brain lateralization for language and handedness are interconnected to a large degree. The relationship is in such a way that right-hemisphere dominance for language is found more in case of left-handers than in right-handers. Springer and Deutsch (1989), for example, assert that for the thirty percent of left-handers whose speech is in the right-hemisphere, because of proximity of the brain parts which are at work for verbal and non-verbal abilities, these two types of skills are more interconnected and interwoven (Field, 2004).

Handedness is often assessed through subjective self-reporting and surveys (Oldfield, 1971) and has been defined using a variety of terms and measures across fields of study. Handedness is commonly considered to be the hand that is preferred for a specific task, regardless of performance, however, it can also reflect hand efficiency with respect to speed and accuracy (Healy, Liederman, & Geschwind, 1986). Handedness can be categorized as right, left or mixed along a gradient that ranges from strongly left-handed to strongly right-handed (Hopkins, 1999; Beaton, 2003). It is generally established that children typically develop handedness by the time they start school (Annett, 1970; Gudmundsson, 1993; Ingram, 1975). As in adult populations, associations have been drawn between hemispheric asymmetries associated with language and hand biases in children (Hervé, Crivello, Perchey, Mazoyer, & Tzourio-Mazoyer, 2006).

Some investigations of child handedness suggest that left-handedness can be an indicator of decreased cerebral lateralization (Dane & Balci, 2007; Lewin & Kohen, 1993; Satz, Soper, Orsini, Henry, & Zvi, 1985; Soper, Satz, Orsini, Henry, Zvi, & Schulman, 1986). However, other studies involving children suggests that stronger hand dominance (left or right) correlates with both earlier language acquisition (Leask & Crow, 2001) and the successful hemispheric specialization for language (Toga & Thompson, 2003). For example, hand dominance (left or right) for manipulative tasks such as drawing has been associated with typical neuro-development, whereas inconsistent hand dominance has been associated with significantly lower developmental assessment scores in children, using the Viennese Development Test (WET) (Kastner-Koller, Deimann, & Bruckner, 2007).

Hand dominance has, traditionally, focused on school-aged children and left hemisphere dominant functions (e.g. object manipulation, right-handedness). In general, these studies have identified putative associations between hand dominance and cognitive performance on the basis of subjective parent-report, self-report or surveys for handedness. However, observational studies of naturalistic hand actions have demonstrated that hand dominance can be objectively revealed much earlier than pre-school age (Gudmundsson, 1993). For example, right-handed dominance for manual tasks has been observed in typically developing infants between 6 months and 18 months of age (Fagard & Marks, 2000; Hinojosa, Sheu, & Michel, 2003; Potier, Meguerditchian, & Fagard, 2013). Studies of observed naturalistic hand dominance in children have observed actions such as pointing gestures, unimanual grasping of objects and bimanual tasks. However, hand dominance for different functional behaviours (for example, communicative and non-communicative) has not been previously shown to be correlated in young children (Cochet & Vauclair, 2010; Esseily, Jacquet, & Fagard, 2011; Fagard & Marks, 2000; Jacquet, Esseily, Rider, & Fagard, 2011). In fact, a disparate range of experimental paradigms for assessing handedness in children has resulted in a variety of patterns of asymmetries depending hand action function (Cochet, Jover, & Vauclair, 2011). These studies showcase an opportunity for broader investigations of handedness across ages, revealing more complex patterns of handedness across development than previously found employing traditional reporting approaches. However, these studies also highlight the possibility that differences in

handedness patterns across studies may be, in part, due to the vast range of paradigms and measurement techniques employed (Hopkins, 1999).

In addition to early handedness evaluation, observing naturalistic handedness behaviours allows for the exploration of a more comprehensive range of hand behaviours. For example, the study of three pre-literate cultures, using methods developed in ethology, revealed that the only condition under which spontaneous hand actions were preferentially lateralized across a pooled dataset of naturalistic hand actions was for object manipulation during tool use. Handedness for non-tool-use actions, pooling a range of hand actions to both social partners (for example, embrace) and to the self (for example, nose wipe), demonstrated a propensity toward mixed-handedness (Marchant, McGrew, & Eibl-Eibesfeldt, 1995). The authors noted that traditional studies of handedness were narrowly defined and did not represent the naturalistic actions of daily life.

A recent study of children also found that hand dominance varied across targets, even in those who are otherwise considered right-hand dominant by parent report (Forrester, Quaresmini, Leavens, Mareschal, & Thomas, 2013). The authors demonstrated that while developing, right-handed boys (aged 4–5 years) expressed a significant right-hand dominance for object manipulation, and no hand preference was found for hand actions directed toward social partners and the self. The authors proposed that in typically developing children, hand actions to object and hand actions to the self/social partners are functionally different behaviours and, thus, are associated with different patterns of hemispheric specialization. Specifically, the authors posited that while object manipulation revealed the expected left hemisphere/right hand dominance, hand actions directed to social partners and the self (pooled) incorporated additional right-hemisphere resources for processing social-emotional content. This interpretation is consistent with prevailing theories of social-emotional processing in humans. In humans, the right-hemisphere hypothesis considers the right hemisphere to be dominant in all forms of emotional expression and perception (Borod, Caron, & Koff, 1984), while the valence theory posits that the left-hemisphere dominance is dominant for positive affect and right-hemisphere dominance for negative affect (Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Davidson, 1995).

3.3 The cerebral asymmetry

Brain asymmetry or cerebral asymmetry refers to anatomical, physiological or behavioural differences between the two cerebral hemispheres. The hemisphere that is larger, more active, or superior in performance is dominant. The scientific study of cerebral dominance is recent and dates back to Paul Broca's discovery in 1865, based on observing acquired language deficit (aphasia) following left hemisphere (LH) stroke, that the left cerebral hemisphere of right-handed people is dominant for language. Until the mid-1940's, the general neurological consensus was that the LH of right-handers is dominant for all higher functions and that the RH is dominant in left-handers. European neurologists and neuropsychologists such as Hecaen (1969), McFie, Piercy, and Zangwill (1950) then noted that the LH is dominant for language and planned movements (praxis), whereas the right hemisphere (RH) is dominant for visuo-spatial functions. This led to replacing the dogma of exclusive LH specialization by the theory of complementary hemispheric specialization (Denes & Pizzamiglio, 1999, Heilman & Valenstein, 1993).

Rasmussen and Milner (1977) and Knecht, Dräger, Deppe, Bobe and Lohmann (2000b) state that asymmetry is a common phenomenon in higher organisms. It can be found, for instance, in the development of cortical functional asymmetries. In humans, hemispheric asymmetry is most pronounced for language, for which the left hemisphere is generally dominant. Handedness is correlated with language dominance in that left-handed persons are more likely than right-handed individuals to be atypically (bilateral or right-hemispheric) lateralized for language (Pujol, Deus, Losilla, & Capdevila, 1999; Szaflarski, et al., 2002).

In other words, the brain shows a considerable degree of lateralization of function. Each hemisphere seems to be specialized for the performance of somewhat different tasks. Speech is one of the most important of these. For a large majority of human beings, this crucial process is located primarily in the left hemisphere (Benson, 1985). In fact, taken as a whole, research on lateralization of brain functions points to the following conclusions in many persons, though by no means all, the left hemisphere specializes in verbal activities like speaking, reading, and

writing and in logical thought and the analysis of information; the right hemisphere specializes in the control of certain motor movements, in synthesis (putting isolated elements together), and in the comprehension and communication of emotion. Many studies employing diverse methods and procedures support these basic conclusions (D'Amato & Hartlage, 2008).

The co-occurrence of hemispheric language dominance to the left hemisphere and right-hand dominance has led researchers to believe that the two are jointly inherited and, therefore, they are intricately related. To support this view, Josse and Tzourio-Mazoyer (2004) conducted a review and found that individuals who are on the left-handed end of the continuum are more likely to have atypical hemispheric specialization for language. This atypical hemispheric specialization has been observed in a number of disorders, including dyslexia and schizophrenia. For example, dyslexia, a reading disorder which is thought to be due primarily to a phonological processing deficit (Kovelman, Norton, Christodoulou, Gaab, Lieberman, Triantafyllou, et.al., 2010; Temple, Deutsch, Poldrack, Miller, Tallal, Merzenich, & Gabrieli, 2003), has a higher rate of left-handedness (Eglinton & Annett, 1994; Geschwind & Behan, 1982) as well as increased right hemisphere activation during language tasks (Temple, 2002). Additionally, some studies have found that non-disordered left-handed individuals perform poorer on phonological processing tasks (Annett, 1992; Annett, 2002; Smyth & Annett, 2006). Similar language/handedness findings have been observed in schizophrenia in that there is a greater incidence of left-handedness and atypical language lateralization (Dollfus, Razafimandimby, Delamillieure, Brazo, Joliot, & Mazoyer, 2005) that may be related to the language deficits observed (Michell & Crow, 2005). While the language deficits associated with these two disorders are quite different, together, they illustrate a potential link between direction of handedness and language processing differences (Annett, 1992; Annett, 2002; Smyth & Annett, 2006).

3.3.1 Anatomic and Functional differences

Perhaps the most popular area of research in neuropsychology has to do with the investigation of anatomic and functional differences between the hemispheres. Studies involving split-brain subjects, hemispherectomy patients, sodium amytal testing, blood-flow analysis, evoked-

potential recording, magnetic resonance imaging, dichotic listening, visual half-field presentation, localized lesions, and simple sensory and motor functions (handedness) have all yielded converging evidence regarding certain aspects of hemispheric functioning (D'Amato & Hartlage, 2008).

In the most general sense, the left hemisphere is the speech-producing hemisphere for most people, while the right hemisphere has been linked to certain non-speech functions such as visual ideation and visual-spatial organization. It is important to keep in mind that lateralization of functions is a relative, not an absolute concept (D'Amato & Hartlage, 2008).

It appears that both hemispheres are, to a large extent, capable of handling functions that may be better executed by a particular hemisphere. In fact, there are some who think that the hemispheres of the brain start out as equipotential and that left hemispheric language specialization is imposed on brain organization (Moscovitch, 1977).

Some investigators such as Lenneberg (1967) and Bryden and Allard (1978) argue that increasing development in hemispheric specialization occurs as a child ages. Others such as Kinsbourne and Hiscock (1977) suggest that hemispheric specialization is essentially determined at birth and only changes qualitatively with age. Despite these controversies, few people would argue that anatomic and functional differences do exist between the hemispheres (D'Amato & Hartlage, 2008).

3.3.2 Functional Hemispheric Specialization

Many of the asymmetries found between the right and left hemisphere are subtle and not particularly relevant to the clinicians. These include anatomical differences in cell organization and the size of a brain area, as well as individual difference related to one's gender or handedness. Of greater interest are functional differences between the hemispheres that emerge in research studies and in patients with cerebral lesions. Sperry (1968) was a pioneer in demonstrating the virtual independence in functioning of the cerebral hemispheres. As indicated

above, the left hemisphere is the language-producing side of the brain. It is logical and analytical in nature. In most people, it is involved in sequential solutions to problems, and it seems to be more concerned with detail and more directly associated with skilled fine motor movements (D'Amato & Hartlage, 2008).

In contrast, the right hemisphere is more ideational and more pictorial than verbal in nature. It prefers a mode of simultaneously synthesizing and integrating information. The right hemisphere seems to be less concerned with details than it is with getting the big picture. The right hemisphere is more musically inclined and more apt to take governance in gross motor activities, particularly how the body arranges itself in space. Its approach to problems tends to be more impulsive and holistic (D'Amato & Hartlage, 2008).

Obviously, these cognitive styles of each hemisphere are exaggerated. It is doubtful that even individuals with only one hemisphere would manifest all the above-mentioned characteristics to a great degree. However, studies have indicated that people vary in terms of these hemisphere styles and present custom finds clinicians referring to people as self-hemisphere and right-hemisphere individuals (D'Amato & Hartlage, 2008).

3.3.3 Effects of lateralization lesions

In addition to the summary of lateralized functions shown above, it may be beneficial to provide some of the clinical findings that results from unilateral lesions. At the level of primary zones, the two hemispheres are relatively symmetrical in structure and functions. The neurological design in these primary zones is highly specific, such as that a stroke or similar trauma to the left hemisphere motor strip will result in a right-sided hemi-paresis. In a similar manner, trauma to the right hemisphere motor strip will result in a left-sided hemi-paresis. Damage to the entire primary zone of the left occipital lobe will result in a right visual field loss, while damage to the entire primary zone of the right occipital lobe will result in a left visual field loss. Damage to the primary zones in the parietal lobe will result in sensory loss (i.e. disturbance in touch, numbness, temperature sensation) on the right side of the body, while damage to the right parietal primary

zone will result in sensory loss on the left side of the body. Impairment to the primary auditory cortex in either temporal lobe, however, will only result in a mild sensory hearing loss in the contra-lateral ear. The sparing of the auditory function under these conditions is due to a greater degree of bilateral neural representation for audition (D'Amato & Hartlage, 2008).

The secondary zones in the four lobes of the brain are more diffusely organized neurologically. Because of this diffuse organization, there is more functional asymmetry between the hemispheres. These secondary zones are still, for the most part, modality specific; thus, the secondary zone of the occipital lobe receives information from the primary zone of the occipital lobe. The function of this secondary zone includes the perception of visual into a recognizable whole. Disturbances in this part of the brain have been known to result in visual agnosia, that is, an inability to recognize such things as simple objects, colours, or faces (William, 1970). Such agnosias usually involve damage to the sub-cortical white matter and/or corpus callosum in addition to the occipital cortex.

It appears that the inability to name objects, colours, or people is more likely to result from a left occipital lesion, whereas difficulty in pictorial recognition is related to right occipital damage. Lesions involving the secondary zones of the parietal lobes tend to produce an inability to recognize objects from touch. In terms of the right parietal secondary zone, a lesion will tend to produce astereognosis with the left hand; tactile recognition errors, particularly with the left hand (Semmer, Weinstein, Ghent, & Teuber, 1960), constructional apraxia and loss of knowledge or sense of one's own body. In addition, right parietal lesions are known to cause contralateral neglect of the left side of the body or left space. Left parietal lesions are associated with deficits in right-side tactile errors, right-hand astereognosis, ideomotor apraxia and handwriting (D'Amato & Hartlage, 2008).

Damage to the secondary zones of the temporal lobes tends to result in disorders of auditory perception. These disorders include disabilities in differentiating acoustic stimuli and in processing different combinations of sound. The left hemisphere seems to be more involved with the synthesis of speech sounds and the linguistic aspects of auditory input, such as phonemic and

semantic qualities, whereas the right temporal association areas seem to be more involved in the acoustic properties of music, as well as nonverbal memory (Luria, 1973). Both temporal lobes have been shown to be involved in aspects of visual perception as well as emotion. The most discussed function of the temporal lobes involves the language processing ability of the left hemisphere. Damage to the association areas of the left hemisphere may produce a variety of auditory-language problems, including verbal memory loss, poor comprehension, and certain aphasic conditions (D'Amato & Hartlage, 2008).

The area of the temporal, parietal and occipital lobes that border one another are referred to as tertiary zones. Information of all forms is synthesized in these cross-modal areas. In the left hemisphere, damage to the posterior tertiary zone could impair reading, writing, calculating, visual-motor construction, and language processing. Damage to the right tertiary zone is likely to result in visual-spatial difficulties in drawing, building, dressing, and spatial awareness. In addition, disturbances of memory and personality are found frequently with tertiary-zone damage (D'Amato & Hartlage, 2008).

The pre-motor region of the frontal lobes includes an area known as Broca's area. Broca's area has been identified as the principal site of the motor control for speech. Other areas of the pre-motor region are involved in complex body movement. These areas that generate motor programs are refined by the extra-pyramidal system. Lesions to the prefrontal regions, or tertiary zones of the frontal lobes, will affect motor programming and inhibit complex motor behaviour. Damage to the left side may induce rigid, inflexible, or stereotypic behaviour, as well as problems with verbal fluency and attention. Damage to the pre-frontal regions has also been related to personality changes; specifically, lesions of the left pre-frontal lobe have been linked to symptoms of depression, apathy, reduced sexual interest, and decreased verbal output, while lesions to the right pre-frontal lobe have been related to such symptoms as immature behaviour, lack of tact and social judgment, coarse language, inappropriate sexual behaviour, and increased motor output (D'Amato & Hartlage, 2008).

One must not assume that the frontal lobes exclusively serve the most complex aspects of human behaviour. In fact, higher level mental functions such as memory, thoughts, reasoning, and emotion have been difficult to pinpoint from a neuroscience perspective. Since these functions are so easily disrupted with lesions in any part of the brain, it is safe to say that elaborate networks or “functional systems” as Luria would call them, are involved in the execution of complex functions (D’Amato & Hartlage, 2008).

3.4 The difference between the left-hemisphere and the right-hemispheric functions

Functional differences between the two cerebral hemispheres represent a basic characteristic of the human brain (Hervé, Zago, Petit, Mazoyer, Tzourio-Mazoyer, 2013). In healthy participants these differences have been traditionally studied using behavioural paradigms which are constructed to selectively assess the processing abilities of each hemisphere. One of the most frequently used paradigms is dichotic listening, which is commonly used to behaviourally assess hemispheric asymmetries for speech and language processing (Bryden, 1963; Hugdahl, 2011; Kimura, 1961; 2011). The paradigm typically consists of the presentation of two slightly differing verbal stimuli (such as consonant–vowel syllables) whereby one stimulus is presented to the left ear and the other one is simultaneously presented to the right ear. Instructed to report the syllable that was perceived best, participants, more often, report the right- than the left-ear stimulus.

This behavioral auditory laterality effect is widely accepted to be a non-invasive indicator of left-hemispheric dominance for speech and language processing (Della Penna, Brancucci, et al., 2007; Kimura, 1967; Tervaniemi & Hugdahl, 2003; Toga & Thompson, 2003); an interpretation which has been validated in studies on patients with hemispheric or callosal lesions (Eslinger & Damasio, 1988; Hugdahl Wester, 1992; Pollmann, Maertens, von Cramon, Lepsien, Hugdahl, 2002; Spierer, Meuli, Clarke, 2007) as well as in clinical studies using the invasive sodium-amytal procedure (Hugdahl, Carlsson, Uvebrant, Lundervold, 1997; Kimura, 1961; Zatorre, 1989).

At the same time, functional neuroimaging studies in healthy participants also indicate that the task is more complex since both hemispheres are usually reported to be significantly activated when performing a dichotic-listening task. More specifically, bilateral frontal and temporal brain regions are found to be activated, irrespective of whether the dichotic-listening condition was contrasted with silence (Dos Santos Sequeira, Specht, Moosmann, Westerhausen, Hugdahl, 2010; Stefanatos, Joe, Aguirre, Detre, Wetmore, 2008; van den Noort, Specht, Rimol, Ersland, Hugdahl, 2008), binaural verbal (Jäncke & Shah, 2002; Lipschutz, Kolinsky, Damhaut, Wikler, Goldman, 2002; Thomsen, Rimol, Ersland, Hugdahl, 2004), or non-verbal control condition (Hugdahl, Bronnick, Kyllingsbaek, Law, Gade, Paulson., 1999). However, significant activation of both hemispheres does not exclude that one hemisphere is more strongly activated than the other, that is, showing a relative asymmetrical activation pattern. To date, no study has systematically analyzed both symmetries as well as relative and absolute asymmetries in brain activation in response to the dichotic-listening paradigm.

This would allow distinguishing between symmetrically engaged brain networks that, possibly, are responsible for processing of basic acoustic features of the stimulus and response execution, and asymmetrically engaged brain areas that are possibly responsible for the observed behavioral laterality effects. Annett (1985) and McManus (1985) stipulated that it has been known for some decades that the two most important kinds of asymmetry which fluctuate over different members of the human species, cerebral dominance for language and handedness, are linked in their distributions, with a greater proportion of right-hemisphere dominance for language found among left-handed than among right-handed people. However, the introduction of non-invasive methods such as functional magnetic resonance imaging (fMRI) and functional transcranial Doppler ultrasonography (fTCD) have transformed the situation (Abou-Khalil, 2007). The fTCD method, in particular, now makes it practically accurate to ascertain cerebral dominance in experimental studies (Hunter, Brysbaert, & Knecht, 2007; Krach & Hartje, 2006). Measurements are made of possible increases in blood flow velocity in left and right cerebral arteries in response to the performance of a language task.

It has long been suggested that the distribution of handedness has a genetic basis (Annett, 1985; McManus, 1985), and in recent years, two major qualitative characteristics of handedness inheritance have emerged. First, Klar (1996) has provided evidence that the tendency to left-handedness is inherited recessively because he observed that among the offspring of two right-handed parents, if one of those parents, in turn, is the offspring of two left-handed grandparents, then the likelihood of left-handedness is increased above the usual level for the offspring of two right-handed parents to approximately the level for one left-handed and one right-handed parent.

Despite some substantial investigations of handedness relations among children, parents and grandparents (Warren, 2006), the scarcity of pairs of left-handed grandparents means that the observations of Klar (1996) appear, at present, to remain unique. Second, McKeever (2000) has provided evidence that control of handedness is situated on the X chromosome. If this is the case, then, since a son's X-linked allele must derive from his mother, a son's chance of being left-handed should not be affected by whether or not his father is left-handed, and this is what McKeever (2000) observed. Of course, for an approach that does not embrace X-linkage, such as the right shift theory of (Annett, 1985; Annett, 2002), McKeever's finding appears as an anomalous shortage of left-handed sons in the families of left-handed fathers (Annett, 2008).

These two major qualitative characteristics of handedness inheritance have been combined by Jones and Martin (2000; 2001) in a recessive X-linked theory of handedness. Due to the hypothesised X-linkage, the theory of Jones and Martin predicts the occurrence of a higher rate of left-handedness among males than among females. Many sets of data bearing on this issue have been accrued over the decades, and meta-analysis of the results of a very large number of studies demonstrates that there is, indeed, a reliable sex difference in handedness (Papadatou-Pastou et al., 2008).

As for the general differences between the two hemispheres, considering their asymmetry, it is generally believed that “the left brain is analytical, logical and calculating, while the right brain is holistic, visual, spatial, and emotional” (Bosman, 2004). However, this claim has to be treated with caution since drawing a border line between the functions of the two halves is a complex

task, and evidence abounds that there are a vast number of individuals in whom the organization of the brain is atypical from that of the majority.

According to Bosman (2004), the functionality of the two hemispheres is categorized into separate parts. "The right hemisphere mostly works with the whole concepts, similarities, images and meaning, emotions and intuition, rhythm and flow, humour and mood, and farsightedness". On the other hand, he argues that the "left hemisphere takes care of logic differences, numbers and letters, reasoning and analysis, sequentiality, literal focus, and details" (Bosman, 2004).

3.5 The difference between left-handed and right-handed people

A number of theories predict differences in the cognitive abilities of left-handed and right-handed individuals. Annett (1985) proposed a genetic model of handedness, stating that handedness is determined by one gene with two alleles (i.e. two alternate forms). One allele is dominant (RS+) and selects for right-handedness, while the other is recessive (RS-) and selects for both right-handedness and left-handedness. Annett theorized that the recessive trait is maintained because of a cognitive advantage for individuals with both alleles (RS+ RS-) relative to lefthanders (RS- RS-) and individuals who are very strongly right-handed (RS+ RS+). For strong right-handers, a cognitive deficit, particularly for spatial processing, was observed by Annett (1992), but not by other researchers (Cerone & McKeever, 1999; McManus, Shergill, & Bryden, 1993).

McManus and Mascie-Taylor (1983) reported evidence for a general cognitive disadvantage for non-right-handers compared with right-handers. Resch, Haffner, Parzer, Pfueller, Strehlow, and Zerahn-Hartung (1997) also reported lower levels of achievement in left-handers: individuals on the left side of the handedness continuum had lower scores in spelling, educational success, and nonverbal intelligence. Resch et al. (1997) noted, however, that the effect of handedness on cognitive ability is small, especially when sex and age are controlled.

In addition to genetic effects, reduced cognitive performance in left-handers could be the result of brain pathology. Bakan, Dibb, and Reed (1973) proposed that in a perfect world, everyone

would be right-handed. In reality, however, a proportion of individuals suffer some minor brain insult either prenatally or perinatally, and this causes a cognitive decline as well as a shift toward right-hemisphere dominance-leading to left-handedness. More recent and moderate models now have acknowledged that pre- or perinatal brain insult accounts for only a proportion of left-handers (Satz, et. al, 1985). In support of this more moderate model, an elevated incidence of left-handedness has been reported in children who have suffered severe bacterial meningitis (Ramadhani, Koomen, Grobbee, van Donselaar, van Furth, & Uiterwaal, 2006) and for females with early neurologic insult (Miller, Jayadev, Dodrill, & Ojemann, 2005). There is also evidence that chances of having a left-handed child are increased for older mothers (Bailey & McKeever, 2004) and for infants who experienced birth asphyxia (Fox, 1985). The pathological model predicts lower academic achievement in a sub-group of left-handers not as a result of their hand preference per se, but because of the brain insult that caused a shift in hand preference and decreased cognitive ability. It is interesting to note that the link between brain pathology and handedness may have a genetic component whereby mothers pass on a susceptibility to problematic births and hence left-handedness (Pipe, 1987).

While Annett's (1985) and Bakan's (1973) theories propose that left-handers are generally disadvantaged relative to right-handers, McManus (2002) suggested that left-handedness bestows a cognitive advantage. Once again, this proposition is grounded on a genetic theory suggesting that handedness is controlled by a gene with two alleles, one dominant and the other recessive. In this case, however, McManus (2002) argues that the recessive gene, which causes left-handedness, persists because it is cognitively advantageous. In support of a left-handed advantage, Benbow (1986) found an excess of gifted children among individuals who are left-handed. Halpern, Haviland, and Killian (1998) also found that left-handers have higher scores on verbal reasoning tests and that left-handers are over-represented in the upper tail of the distribution. Piro (1998), however, found no difference in mean handedness scores between 657 gifted and non-gifted children.

Besides general cognitive ability, left-handedness may be advantageous for specific activities because it brings about a shift of dominance toward the right hemisphere, enhancing visuo-

spatial functioning carried out on that side of the brain (Heilman, 2005). In the scientific and popular literature, there are consistent reports that left-handers are overrepresented among populations of creative artists (Preti & Vellante, 2007) and architects (Peterson & Lansky, 1977), though Wood and Aggleton (1991) have contested the latter finding. In relation to musical ability, a slight over-representation of left-handers is observed among accomplished musicians (Aggleton, Kentridge, & Good, 1994), but this effect is not observed among children (Good, Aggleton, Kentridge, Barker, & Neave, 1997). Enhanced mathematical ability, which involves a high level of visuo-spatial ability (Hermelin & O'Connor, 1986), may also show an effect of hand preference. However, Annett and Kilshaw (1982) reported an increase in the prevalence of left-handedness among mathematicians; they noted that this effect may be due to a spatial/mathematical deficit for strong right-handers rather than an advantage for left-handers. Benbow (1988), however, reported an unusually large percentage of left-handers among those scoring in the top 1% of 10,000 people tested on the Scholastic Aptitude Test. Field, (2004) used Scholastic Aptitude Tests to determine whether left-handers have a superior visuo-spatial ability have yielded mixed results. Although elevated levels of spatial ability (Annett, 1992) and divergent thinking (Coren, 1995) are reported in left-handers, Snyder and Harris (1993) found no difference between left- and right-handers for tests of mental rotation and 3D drawing ability, and McKeever (1986) reported that left-handers performed worse on a test of spatial visualization.

In contrast to theories that centre on the relative abilities of left-handers and right-handers, some researchers have focused on individuals with mixed, or no, hand preference. The idea that mixed-handedness and weak laterality are related to learning disabilities has a long history first proposed by Orton (1937). More recently, Crow, Done, and Leask (1998) argued that the evolution of laterality is the key characteristic that allowed language and higher cognitive functions to develop. Individuals without a strong hand preference are thought to suffer from "hemispheric indecision," which reduces academic ability and makes the individual more prone to psychotic disorders. Once again, evidence is mixed, with some researchers finding support for this theory (Crow et al. 1998; Nettle, 2003) while others did not (Heinz & Heinz, 2002). Recent large-scale studies, however, found lower levels of cognitive ability in mixed-handers. Corballis,

Hattie, and Fletcher (2008) used data from an IQ test administered in New Zealand as part of a nationwide television program. Data from 1,355 respondents revealed no difference in IQ between left- and right-handers. Mixed-handers, however, performed more poorly, especially on sub-scales measuring arithmetic, memory, and reasoning. Another large-scale study by Peters, Reimers, and Manning (2006) collected data from 250,000 respondents using the internet. Individuals who reported no hand preference for writing had significantly lower spatial ability and a higher prevalence of dyslexia, hyperactivity, and asthma than individuals with a strong hand preference.

Some researchers report anatomical differences in the form and size of the corpus callosum in left-handers versus right-handers. Such studies suggest that the corpus callosum tends to be larger in left-hand individuals. Beside the behavioural differences as well as physiological ones as reported by the literature, there are some studies that suggest left-hand individuals show less left hemisphere involvement in language tasks compared to right-hand ones (Thilers, MacDonald, & Herlitz, 2007). Such findings have resulted in the hypothesis that the organization of the brain in left hand individuals is different from that of right-handers, with left-handers having a right hemisphere or bilateral dominance with regard to language functions (Thilers et al, 2007). Such a conclusion is the line of reasoning for what Thilers et al. (2007) examined with regard to sex differences in terms of cognitive skills in left-hand and right-hand individuals.

Their findings revealed that right-handed women outperformed men in tasks assessing episodic memory and verbal fluency, while the right-handed men have higher degrees of cognitive ability in performing visio-spatial tasks. In case of left-handers, however, they found out that such sex differences are smaller in magnitude. In reasoning for such findings, they assumed that greater right-hemisphere involvement in language functions in left hand individuals could be the cause of such less differences. Their data supports the fact that right-hemisphere dominance or even a more bilateral pattern in language functions, a phenomenon which is more typical to women, can enhance the cognitive ability of the individuals in performing verbal tasks such as verbal episodic memory and verbal fluency. According to Thilers et al. (2007), brain organization of the left-handed men is more similar to women, considering language functions. This conclusion is

based on the claim that females have lower degrees of language lateralization compared to men (Thilers et al, 2007).

It is worth mentioning here that just like many other aspects of lateralization and handedness among individuals, there are some studies that came across the opposite results about sex differences in lateralization of language. Using different methods of observation, such reviews failed to detect any sex differences among individuals, considering lateralized linguistic functions (Thilers et al, 2007). Therefore, again, we can easily observe the lack of agreement among scholars, even after years of investigation (Thilers et al, 2007).

Cognitive styles, rather than cognitive skills, are also regarded as the difference point between the two groups of individuals in some studies. Coren (1995) for instance, introduces the two thinking styles, the convergent style versus the divergent one, and draws a connection between handedness and these two thinking styles. The first one has to do with the bottom-up style of using the details to come up with a single answer, while the latter is a more top-down process of moving from a whole in order to discover the existing associations. He relates the divergent style to left-handedness. This is in accordance with the dominance of the right hemisphere, which is reported as to be more holistic than the left one (Ruebeck, Harrington, & Moffitt, 2006).

In fact, considering the cognitive functions and information-processing among the left-handers, evidences are a lot that the approaches taken by the two hemispheres are different in a way or the other. For example, there is a tendency to relate the right hemisphere to visualization. Despite all these, the existing findings of the literature on the superiority of right-handers versus left-handers do not give consistent results. Some studies such as the work of Orton (1937) for example, suggest that “reading disability and speech problems might be more prevalent in those lacking consistent cerebral asymmetry, as reflected in mixed or left-handedness” (Corballis, Hattie, & Fletche, 2009). Such claims, however, are challenged by the results of other researches such as that of McManus and Mascie-Taylor (1983), which has reported no difference between the left- and right-hand individuals in terms of their IQ (as cited in Corballis et al., 2009). Moreover, the results of the study by Corballis et al. (2009) indicate that in spite of the intellectual deficits

among ambidextrous, probably due to their lack of cerebral dominance, there is no evident difference between left- and right- hand individuals in terms of their intellectual abilities, and their IQ, in particular.

Handedness is one of the most salient traits of cerebral asymmetry. Ninety percent of the human population could be classified as right-handed in that they tend to favour this hand for a range of tasks such as writing and using tools. In the case of more “basic” behaviours, such as reaching out and picking up an object, however, it would make sense (from an ecological and biomechanical perspective) to use the hand closer to the object rather than the preferred hand. However, few studies have actually compared hand preference for visually guided grasping in left- and right-handers and these have asked to pick up tools or objects one by one (Brown, Roy, Rohr, & Bryden, 2006; Calvert & Bishop, 1998; Mamolo, Roy, Bryden, & Rohr, 2004; Mamolo, Roy, Bryden, & Rohr, 2005; Mamolo, Roy, Rohr, & Bryden, 2006).

Recently however, Claudia, Gonzalez, Melvyn and Goodale (2009) measured spontaneous hand preference in a ‘natural’ grasping task. They asked right- and left-handed participants to put a puzzle together or to create different models, as quickly and as accurately as possible, without any instruction about which hand to use. They found that right-handers showed a marked preference for their dominant hand when picking up objects; as a population, left-handers, however, did not show this preference for the dominant hand and, instead, used their right hand 50% of the time (Gonzalez, Whitwell, Morrissey, Ganel, & Goodale, 2007). Closer examination of the left-handers’ behaviour suggested that rather than using both hands equally often, some left-handers simply preferred to use their right hand whereas others preferred to use their left. But, why would some left-handers use their non-dominant right hand more often when picking up objects? It certainly did not seem to be related to the degree of left-handedness as all the left-handers in this earlier study, including those who used their right hand to pick things up, were strongly left-handed as measured by the self-reported handedness questionnaire. Indeed, even in the right-handed population, there was variability in the hand that participants used to pick up the small objects. Some right-handed participants used their right hand nearly 100% of the time

whereas others used it less, closer to 50% of the time (Claudia, Gonzalez, Melvyn & Goodale, 2009).

In neuropsychology, hand preference or handedness indirectly indicates cerebral laterality (Van der Elst, et al. 2011), and it is the most representative example of specialized function or activity on one side of the body. It has a strong hereditary basis (McKeever, 2000; McManus, 1991; Ocklenburg, et al., 2010; Scharoun & Bryden, 2014) and has been essential in the development of higher kinaesthetic and cognitive functions that have their basis on fine motor skills (Gutwinski, et al., 2011). Hand preference is most commonly assessed via questionnaires and less frequently using observational protocols. However, its assessment has not been standardized due to differences in classification of individuals and the lack of a common format for hand preference measurement (Papadatou-Pastou, et al., 2013).

The different instruments of measuring handedness in conjunction with gender differences possibly affect the way individuals and groups complete questionnaires. For example, males have been less prone to provide extreme answers, which, consequently, results in heightened laterality scores for females (Bryden, 1977). Papadatou-Pastou, et al., (2013), on the other hand, argued that reaction to extreme responses in such questionnaires is not due to gender as the phenomenon is equally observed among right-handers and left-handers. Other studies, which employed questionnaires revealed that right-handed individuals consistently report right-hand preference from childhood to adulthood, but the same is not true for left-handed individuals (Scharoun & Bryden, 2014). Other studies give prominence to the trend that both right-handers and left-handers are more likely to replace an “either/no preference” response by the preferred hand response than the non-preferred hand response (Peters, 1998).

According to Bosman (2004) the left-handers have a negative orientation of the history toward left-handedness. He browsed the history in order to refer to the negative connotations that have been attached to the notion of left-handedness. To do so, he starts with the etymology of the word “left” in different languages and comes up with negative sides of meaning in a number of world languages (Bosman, 2004). He further draws attention to some other “anthropological

examples of right/left symbolism” that prove the unkindness of the history to left-handers. He also brings some examples from different religions as to look down on the left hand as well as some anecdotes, which equate left-handedness with evil (Klar, 1999). When we take a look at our background knowledge, such negative connotations are discernable for the word “left” and we easily can find superstitions that have a bias toward the right/ left distinction. Further, in his discussion on the view of societies upon left-hander, however, Bosman (2004) continues with some positive instances of the left-handed elites of the world among artists and geniuses such as Einstein and Picasso (Bosman, 2004).

In spite of all these differences reported above, nevertheless, it is also to be mentioned that in most of the investigations carried out so far, little evidence has been found that suggests the superiority of right-handers over left-handers in terms of cognitive skills. There are however, differences between the two groups in terms of cognitive skills. The results of the studies are complex, in that some report higher cognitive achievements on the part of right-handers while on the contrary there is evidence of left-handedness as being a favour (Thilers et al., 2007).

3.6 Gender differences in cognitive abilities

The evidence teaches us that men and women perform similarly on tests of both general intelligence (IQ) and problem-solving ability. As former American Psychiatric Association (APA) president Diane Halpern points out, “There is no evidence that one sex is smarter than the other” (Halpern, 2004, p. 139). However, girls do hold an edge in verbal skills such as reading, writing, and spelling. Boys are more likely to problems in reading that range from reading below grade level to more severe disabilities such as dyslexia (American Psychiatric Association, 2000).

Boys have traditionally held an advantage in math skills. However, the gender gap in math has narrowed so much in recent years that there is now essentially no difference in the average math score of boys and girls (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). A worldwide study of math abilities across 69 countries showed girls tended to have less confidence in their math skills

but no less ability than boys (Else-Quest, Hyde, & Linn, 2010). An important lesson from this study, according to the lead researcher, psychologist Nicole Else, is that “girls are likely to perform as well as boys when they are encouraged to succeed” (Else-Quest, Hyde, & Linn, 2010).

On average, males continue to outperform females in some visual-spatial skills such as map reading and mental rotation of three-dimensions, namely (i) verbal fluency, (ii) object displacement, (iii) mental rotation of geometric shapes and finding the hidden figure (for example of gender-based differences) (Halpern & LaMay, 2000; Liben, Bigler, & Krogh., 2002). The male advantage in mental rotation is even observed in infants (Moore & Johnson, 2008; Quinn & Liben, 2008). The ability to perceive relationships among three-dimensional objects may explain why boys and men tend to excel in certain skills such as playing chess, solving geometry problems, and finding embedded shapes within geometric figures.

Women, on average, are better skilled at remembering where objects are located, which may explain why women tend to be better at finding lost keys (Azar, 1996). But notice the qualifying term on average. Many individuals exhibit abilities in which the opposite gender tends to excel: many women excel in math and science, and many men shine in writing and verbal skills. In fact, greater variations in cognitive abilities exist within genders than between genders. Thus, it is important to avoid using traditional stereotypes to limit the interests and vocations that boys and girls may pursue.

Some researchers believe that the brains of boys and men may be more highly specialized for certain kind of visual-spatial skills. Male fetuses are exposed to high levels of testosterone, which scientists suspect may facilitate the development of neural connections in the brain responsible for performing certain spatial tasks (McGuffin & Scourfield, 1997).

Other researchers believe that psychological factors may account for differences in cognitive skills. Parents who hold the stereotypical view that “girls are not good at math and science” may not encourage their daughters to develop math skills or take science courses. Negative

expectations may then become self-fulfilling prophecies, as they may lead girls to doubt their abilities in math or science and discourage them from developing interests in these areas. Our culture appears to train women to perform a simple deduction based on a faulty premise that math is “masculine” (Nosek, Banaji, & Greenwald, 2003). The narrowing of gender differences in math and science in recent years lends further credence to the influence of social or cultural factors. In all likelihood, both biological and psychological factors account for gender differences in cognitive abilities (Nevid, 2011).

3.7 Research with non-injured people

According to Baron (1998), the most convincing evidence for lateralization of function in the cerebral hemisphere is provided by research employing the drug sodium amytal. When sodium amytal is injected into an artery on one side of the neck, this drug quickly anesthetizes the cerebral hemisphere on that side, allowing researchers to investigate how the other side of the brain works. Studies using these procedures indicate that for most individuals, the left hemisphere possesses much more highly developed verbal skills than the right hemisphere. For example, when the right hemisphere is anesthetized, participants can, through the functioning of their left hemisphere-recite letters of the alphabet or days of the week, name familiar objects, and repeat sentences. In contrast, when the left hemisphere is anesthetized and only the right hemisphere is available, participants experience considerably more difficulty in performing such tasks. Furthermore, the more complex the tasks, the greater the deficits in performance (Milner, 1974).

Additional evidence for lateralization of brain function is provided by studies using positron emission tomography (PET) scan procedures. The PET scan is an imaging technique that reveals which brain structures are active when people perform specific tasks. These studies indicate that when individuals speak or work with numbers, activity in the left hemisphere increases. In contrast, when they work on perceptual tasks-for instance, tasks in which they compare various shapes-activity increases in the right hemisphere. Additional research suggests that while individuals are making up their minds about some issues, activity is higher in the left than in the

right hemisphere (Cacioppo, Petty & Quintanar, 1982). However, once logical thought is over and a decision has been made, heightened activity occurs in the right hemisphere, which seems to play a larger role in global, non-analytic thought.

A third line of evidence points that the difference between the left and right hemispheres relates to the ability to recognize and communicate emotions. Several studies (Bryden, Ley, & Sugarman, 1982) suggest that the right hemisphere is faster than the left hemisphere at recognizing signs of emotional arousal, such as facial expression, in others. In addition, some findings indicate that the two hemispheres themselves may even play different roles in different emotional experiences (Springer & Deutsch, 1985). Apparently, the left hemisphere is more active during positive emotions, whereas the right hemisphere is more active during negative ones (Miller, 1987). Thus, individuals suffering from depression (intense negative feelings) often show higher activity in the frontal lobes of their right hemisphere than do persons not suffering from depression.

3.8 Research with split-brain participants: isolating the two hemispheres

Beginning in the 1960's, research on Vogel and Bogen's split brain patients in Sperry's lab at Caltech confirmed dramatically the model of complementary hemispheric specialization by comparing the positive competencies of the two hemispheres instead of inferring them from deficit. More importantly, split brain research showed that each disconnected cerebral hemisphere constituted a complete cognitive system with its own sensations, perceptions, memory, even language, personality and consciousness (Zaidel, Zaidel, & Bogen, 1990). The two hemispheres can process information simultaneously and independently. This is the thesis of hemispheric independence (Zaidel, et al., 1990).

Hoptman and Davidson (1994) states that under normal conditions, the two hemispheres of the brain communicate with each other primarily through the corpus callosum, a wide band of nerve fibers that passes between them. Sometimes it is necessary to sever this link-for example, in order to prevent the spread of epileptic seizures from one hemisphere to the other. Careful study

of individuals who have undergone such operations provides intriguing evidence on lateralization of function of the brain (Gazzaniga, 1984, 1985; Sperry, 1968). For example, a man whose corpus callosum has been cut is seated before a screen and told to stare, with his eyes as motionless as possible, at a central point on the screen. Then simple words such as *tenant* are flashed across the screen so that the letters 'ten' appear to the left of the central point and the letters 'ant' appear to the right (to the right side of the field). If a simple word such as *tenant* is shown to a person whose corpus callosum has been severed, the letters 'ten' stimulate only the right hemisphere while the letters 'ant' stimulate only the left hemisphere. The person then reports seeing 'ant' (to the left side). This is because only the left hemisphere can respond to the verbal question "what do you see?" (Left) if shown a list of words and asked to point to the one seen previously, however, the split-brain person can do so correctly; he or she points to the tenant with the left hand (right side). This indicates that the right hemisphere recognizes this word and can respond to it in a non-verbal manner (that is, by pointing) (Baron, 1998).

According to Metcalfe, Funnell and Gazzaniga (1995), the two hemispheres differ in the way they encode memories. Previous research has revealed that the left hemisphere not only records the details of specific events it experiences, but also constructs an interpretation of these events. In contrast, the right hemisphere is not so equipped in storing a more direct representation of the to-be-remembered information. To test their ideas, the researcher first presented a set of stimuli (e.g. children's faces) to both hemispheres of a split-brain patient. Next, the man viewed a second set of stimuli consisting of the original faces, similar faces (composites constructed from combinations of the originals), and new faces he had not seen previously. The patient's task was to indicate whether or not he had seen each face before. Because of the left hemisphere's tendency to "interpret" stored information, the researcher predicted that this hemisphere would tend to confuse similar faces (the composite faces) with the originals. The results of their predictions were that both hemispheres performed equally in correctly identifying the original faces, and the left hemisphere tended to incorrectly classify the composite faces as ones they had seen before (Baron, 1998).

4. Conclusion

This chapter explained the relationship between handedness and language, the difference between left-hemisphere and the right-hemispheric functions, the difference between the left-handed and the right-handed people, gender differences in cognitive abilities and also outlines the cerebral asymmetry, research with non-injured people and the research with split-brain procedures in isolating the two hemispheres. The next chapter discusses, explains, and provides research methodology of the study.

CHAPTER 4

4. Research Methodology

4.1 Introduction

This chapter deals with the methodological aspects used in the research. The rationale for the methods chosen is provided. The manner in which the participants were selected is discussed, as well as the instruments used. Thereafter, the procedure followed in collecting and analysing data, as well as the statistical methods employed, are elaborated upon.

4.2 Research Design

According to Gorard (2013), a research design is the framework that has been created to seek answers to research questions. The research used a quantitative approach which is quasi-experimental in design. Quasi-experimental design can be utilized to provide preliminary support for verifying potentially important group differences (Bless, Higson-Smith & Kagee, 2006). In this study, the groups are different in terms of their gender (male & female) and handedness (left-handed & right-handed).

4.3 Description of population of the study

For the purpose of this study, the age range of the sample was limited to primary school learners only from the Department of Education, Capricorn District, Mankweng Circuit, and the age range estimated was from 8 to 12 years of age.

4.4 Sampling procedure

It was difficult to find left-handed participants in the primary schools. It was made possible with the help from Mankweng Education Circuit Manager of the Department of Education, Capricorn

District who provided the list of primary schools attached to the circuit. At school level, the school principals also made it possible for the researcher to find 60 left-handed learners and 60 right-handed learners from various primary schools in the Mankweng area who participated in this study.

The study adopted a purposive sampling method for the selection of participants. Purposive sampling is a type of non-probability sampling method; it is a deliberate selection of specific individuals, events or settings because of the crucial information they can provide, which cannot be obtained as adequately through other channels (Carpenter & Suto, 2008). The targeted sample for the study was primary school learners from Mankweng area. In purposive sampling, the researcher hand-picks subjects on the basis of specific characteristics, building up a sample of sufficient size having the desired traits.

The sample consisted of two groups (male & female children). The first group consisted of 60 male children – 30 left-handed and 30 right-handed, and the second group respectively consisted of 60 female children – 30 left-handed and 30 right-handed. All participants were South African children between the ages of 8 to 12, thus making a total of 120 participants residing in Mankweng area in Limpopo Province. The reason why the sample included participants from the Mankweng area is because of its easy reach, identifiable and most effective use.

In this study, the participants approached for participation consisted of parents/guardian who lives with children who agreed to sign the consent forms in order to allow their children to participate in this study. All parents and the children consented, and children between the ages of 8 to 12 who were in grade 4, 5 and 6 respectively participated in the study. In total, one hundred and twenty (120) questionnaires were administered, and all of them were completed in full.

4.5 Instrument

The Developmental Neuropsychological Assessment (NEPSY) was published in the United States (U.S.) in 1998. It contained five domains and 27 subtests and could be administered with

children between the ages of 3, 0 months to 12-years, and 11-months (Korkman, Kirk, & Kemp, 2007b). The General Assessment for preschool-aged children consists of seven sub-tests and takes approximately 45 minutes to administer; whereas, for school-aged children, ten sub-tests are administered in approximately one hour (Korkman, et al., 2007a). The current study has utilised only the domain tests for language to assess language functions of the participants. All the participants were school-aged children, and it took the researcher approximately 30 minutes to administer the tests to each child.

The current study has utilised the following sub-tests: Comprehension of Instructions, Phonological Processing, and Speeded Naming tests, which are included in the NEPSY-II for Language domain. The sub-components of language that are assessed include phonological processing; the ability to repeat nonsense words; name or identify body parts; quickly name stimuli on a page, display verbal semantic fluency and produce rhythmic oral sequences; and comprehension of oral instructions.

4.5.1 Demographic data

All participants provided demographic details such as learner's name, grade, age, sex, home language and their date of birth. All participants were located in Limpopo Province, South Africa, at the time when the study was conducted.

4.5.2 Phonological processing

This test is designed to assess phonemic awareness. It is composed of two types of phonological tasks. The first part is more basic, requiring identification of words from word segments. The second part is more complex. It assesses phonological segmentation at the level of word segments (syllables) and of letter sounds (phonemes). The child is asked to create a new word by omitting a syllable or a phoneme, or by substituting one phoneme in a word for another (Korkman, Kirk & Kemp, 1998).

Phonological Processing is composed of two tasks designed to assess phonemic awareness. Word Segment Recognition begins with the child pointing to the picture that represents a word and then requires the child to identify pictures that represent words formed from orally presented word segments. In Phonological Segmentation, the child is asked to repeat a word and then to create a new word by omitting a syllable or a phoneme, or by substituting one phoneme in a word for another. The age range of Phonological Processing has been extended upward and includes ages 3-16. Easier items have been added to Word Segment Recognition, and items have been added to Phonological Segmentation to increase the range of difficulty covered. Administration modifications include changes to age-dependent start points and reverse rules. The *discontinue* rule has been increased from five to six consecutive scores of 0. Other revisions include minor changes to recording procedures, as well as slight modifications to the administration directions read to the child (Korkman, Kirk & Kemp, 1998).

Current theories on the development of reading in English stress that phonological processing is the most significant underlying cognitive process used in the acquisition of reading skills (Stanovich, 1986). With respect to reading acquisition, phonological processing involves two major skills: phonological awareness and phonological decoding. Phonological awareness is the ability to identify and manipulate syllables and phonemes in oral language, whereas phonological decoding is the association of sounds with letters or combinations of letters (McGuinness, 2005).

Phonological processing exists on a continuum of difficulty, beginning with the awareness of whole words as units of sound through to the linking of sounds to letters. As implied above, phonological awareness is, generally, used to refer to oral language, whereas phonological decoding involves print. Thus, phonological awareness skills are especially attractive to researchers studying children's early literacy skills before reading instruction occurs. On the other hand, phonological decoding refers to the understanding of grapheme-phoneme conversion rules. Both phonological awareness and phonological decoding have been identified as necessary precursors to successful reading acquisition and are critical skills in predicting the speed and efficiency of reading acquisition for native speakers of English (Korkman, et al., 2007a). In fact,

there is a consensus in the reading literature that a core deficit in phonological processes underlies reading disorder (Siegel, 1993).

Phonological skills such as phoneme segmentation and phonological (letter-sound) decoding would carry greater weight as determinants of success in beginning reading than would visual skills, but as children acquire a high degree of proficiency in word identification and other word-level skills, language comprehension and the underlying oral language processes would, likely, become the primary sources of variability because individual differences in word identification and, phonological decoding diminish as a source of such variability (Neuman & Dickinson, 2011). Very young infants can discriminate phonemic contrasts in tasks that do not require attention to meaningful aspects of speech, such as phonological detail when tasks require processing spoken words (that is meaningful units; White & Morgan, 2008).

Bonte and Blomert (2004) examined electro-physiological responses for 5 – to 6-year-old's and 7 – to 8-years-old's performance on spoken word recognition tasks, and came to similar conclusions. They suggest that “the lexical system undergoes substantial restructuring at the level of phonological representations and processing” and that “vocabulary growth and the acquisition of reading may critically contribute to the formation of a fully segmental lexical system” (Bonte & Blomert, 2004, p. 409).

4.5.3 Speeded naming test

According to Korkman et al. (1998), this timed sub-test is designed to assess speed-naming ability-rapid access to and production of names of recurring colours, size, and shapes. This test lasts for only 30 minutes when administered, after the given time limit, the test will discontinue.

In Speeded-Naming, the child is shown an array of colours and shapes; letters and numbers; or colours, shapes and sizes. The child is then asked to name them in order as quickly as possible. The age range of Speeded-Naming has been extended upward and includes ages 3–16. Items have been added to cover the lower and upper ends of the ability range. Easier items added for

younger children require naming of colour only, shape only or both colour and shape. The stimuli for these items include a line connecting each shape for the young child to follow as he or she completes the task. The 1998 NEPSY stimulus was retained as the second section of the test, in which the child names the size, colour, and shape of each shape in an array. Difficult items require older children to name letters and numbers. Item format has been modified so that each stimulus page now comprises one item, and recording procedures have been changed accordingly. Age-dependent start and stop points have been added to ensure only age-appropriate items are administered (Korkman, Kirk & Kemp, 1998).

Early processing ability and related language have long-term effects because language processing speed and receptive vocabulary size, at age 25 months, are predictive of vocabulary when children are 8 years old (Marchman & Fernald, 2008). A meta-analysis of pre-school predictors of later reading ability also found that speed of processing reliably predicts later reading skills (NELP, 2008).

4.5.4 Comprehension of instructions test

This test is designed to assess the ability to process and respond quickly to verbal instructions of increasing complexity. This test is administered to all ages (Korkman et al., 1998). In Comprehension of Instructions, the child points to appropriate stimuli in response to oral instructions. Simple items involve pointing to rabbits of different sizes, colours, and facial expressions. More complex items involve pointing to shapes by colour, position, and relationship to other figures. The age range of Comprehension of Instructions has been extended upward and includes ages 3–16, and items with increased difficulty have been added to cover the upper end of the ability range. Administration revisions include minor changes to age-dependent start points and resulting modifications to the reverse rule. The *discontinue* rule has been increased from four to seven consecutive scores of 0. To facilitate the recording of responses, the orientation of reduced stimuli in the record form has been rotated to match the examiner's upside-down view of the stimulus book pages during administration (Korkman et al., 1998).

The language comprehension ability of 14-month-old toddlers predicts their subsequent expressive and receptive vocabulary (Watt, Wetherby, & Shumway, 2006). This evidence of continuity between pre-linguistic communication efforts and later language suggests that early encouragement to communicate may have beneficial effects. Additional evidence of the importance of the earliest phases of language acquisition to later learning comes from the finding that very young children's capacity to interpret language quickly is related to early vocabulary and language acquisition (Fernald, Perfors, & Marchman, 2006).

In comprehension of instruction, children have considerable knowledge available for analysis at the time they enter school. Non-English speakers have much less basis for knowing whether their reading is correct because the crucial meaning-making process is short-circuited by lack of language knowledge. Giving a child initial reading instruction in a language that he or she does not yet speak, thus, can undermine the child's chance to see literacy as a powerful form of communication, by knowing the support of meaning out from underneath the process of learning (Neuman & Dickinson, 2011, p. 237).

4.5.5 Reliability and Validity of the NEPSY scales

There are a few studies on cultural influences and performance on the NEPSY. A study by Mulenga, et al. (2001) found that literate Zambian children performed better than children in the United States (standardization sample) on visual spatial tasks but worse on some measures of attention/executive functions and language. Overall, however, they concluded that the NEPSY was relatively unaffected by language and cultural factors that often limit the use of such psychometric tests in other cultures. Furthermore, a recent study by Govender (2012) conducted in children with epilepsy in Limpopo Province reported that the NEPSY is a culture fair test.

4.6 Procedure

The researcher approached the principals of various schools in Mankweng area, Capricorn District. The researcher obtained a written letter of permission to collect data at the Primary

Schools from the Department of Education Mankweng Circuit (Limpopo Province) in South Africa. Secondly, the researcher forwarded the permission letters from the Department of Education (Mankweng Circuit) to the Primary Schools. Thirdly, the researcher contacted the schools concerned above and verified whether his request has been permitted or not, and the request for permission was granted. Fourth, after the permission was granted, the researcher made an arrangement with the School principals to go and hand in (administer) the consent forms to the learners concerned (involved) to give the consent forms to their parents, guardians or any elderly persons who live with them in their respective homes to sign the consent form in order to officiate the agreement with the researcher to interview their children; the learners (school children) returned the signed consent forms to the researcher from their parents and guardians. Following that, the researcher arranged again with the school principals and they agreed to utilise the free periods where the research would not interfere with the learning of the children and specified the dates and time in which the research was to be conducted in the schools. Lastly, the researcher then went to the schools on the specified and agreed upon date time and venue to conduct (administer) the questionnaires to the learners (school children). The instructions and tests were conducted in English. Data was collected in schools provided by the Department of Education, Mankweng Circuit. The NEPSY questionnaire was administered and completed within the time frame of 30 minutes per learner.

4.7 Data analysis

Data were analysed by utilizing the Statistical Package for Social Sciences (SPSS). Kelinger and Lee (2000) affirm that data analysis is a complex process that follows three basic steps which involve (i) organizing the data, (ii) summarizing the data, and then (iii) interpreting the data. Data collected was captured using the Statistical Package for Social Sciences (SPSS). As determined by the study design, the main statistical measure employed was the ANOVA-test (Bless, Higson-Smith, & Kagee, 2006). The quasi experimental design was used to compare gender role and handedness on the functions of language between male and female school children. The following variables were compared: gender and handedness on language functions. The ANOVA method was used when comparing the two independent variables, and in this

study, the variables were 8 to 12 years old in relation to age group, the ANOVA – test was used for the four variables such as male and female, left-handed and right-handed.

4.8 Ethical considerations

In this study, the following ethical measures were adhered to:

4.8.1 Confidentiality:

All participants received written assurance that only the professionals such as researcher and the research supervisor were involved in the research process and would examine the questionnaire. They were also informed that all the relevant information was to be kept in a safe place after the research has been completed, with no public access to such documentation.

4.8.2 Voluntary participation:

The researcher verbally communicated the aim and the objectives of the study to the participants so that they can understand how the data will be used. The researcher informed the participants that they will not be forced to participate and that they are free to withdraw at any time if they feel uncomfortable.

4.8.3 Anonymity:

Participants were assured in writing that their identities would remain anonymous in the questionnaire answer sheets, research reports, and in the publication of the study itself as is commonly suggested in literature (McMillan & Schumacher, 2006; Pilot & Hungler, 1991).

4.8.4 Informed consent:

Before the study began, the participants were made adequately aware of the type of information that would be required from them, and also the reason why the information was being sought, and the purpose it would be put to, how they were expected to participate and how the research could directly or indirectly affect them. Such information was also provided in written form and attached to the actual questionnaire. It was also indicated in the consent form that participants were free to stop the process at any time they so wished if they feel uncomfortable about the whole process.

4.8.5 Feedback:

The participants were assured that after the completion of the research (this study), the findings (results) of the study would be shared with them on request. In addition, the names and contact details of various professionals (School principals and the teachers) who have made it possible for this study to be successful were made available should the participants require such expertise or assistance.

4.8.6 Aftercare

The After-School Program for school-aged early education for 5 to 12 years old children is a program which involves youth and young children to participate outside of the traditional school day, some programs are run by a primary or secondary school, and some by externally funded non-profit or commercial organizations. During after school out for the day, children need to be engaged in a comfortable, yet stimulating child care environment. The after-school child care program allows kindergarten school-age children to balance learning and fun through a variety of experiences from homework help to fun physical activities. This program is designed so that everyone goes home happy. It gives children endless opportunities to learn and grow. It helps children develop effective communication skills. Children learn language and communication skills through literacy, drama, and music. It provides experience that develops the child's ability

to problem-solve, observe, predict, and explore cause-and-effect relationships; provide opportunities to explore math relationships such as classification; and provide support and time to complete homework and school projects.

KinderCare supports the child in developing healthy peer relationships. It uses the club activities, the Classroom Council, group games and events to develop leadership, planning, organizing, and team-building skills. They build stamina through small-and large-group games; focus on endurance, balance, and strength during daily fitness activities; and promote the link between physical activity and proper nutrition in creating a healthy lifestyle. It motivates the child to express creativity. It helps them to experiment with colour, shape, texture, design, and music; it also provides opportunities to build abstract concepts and problem-solving skills and stimulates creative writing and expression through poem-and story-writing, performance, and word games.

4.9 Conclusion

In this chapter, the methodological aspects used in the research study were explained, and the rationale for the methods chosen was provided. The manner in which the participants were selected was discussed, as well as the instruments used. Thereafter, the procedure followed in collecting and analyzing the data, as well as the statistical methods employed was elaborated upon. The next chapter presents the research results.

CHAPTER 5

5. Research results

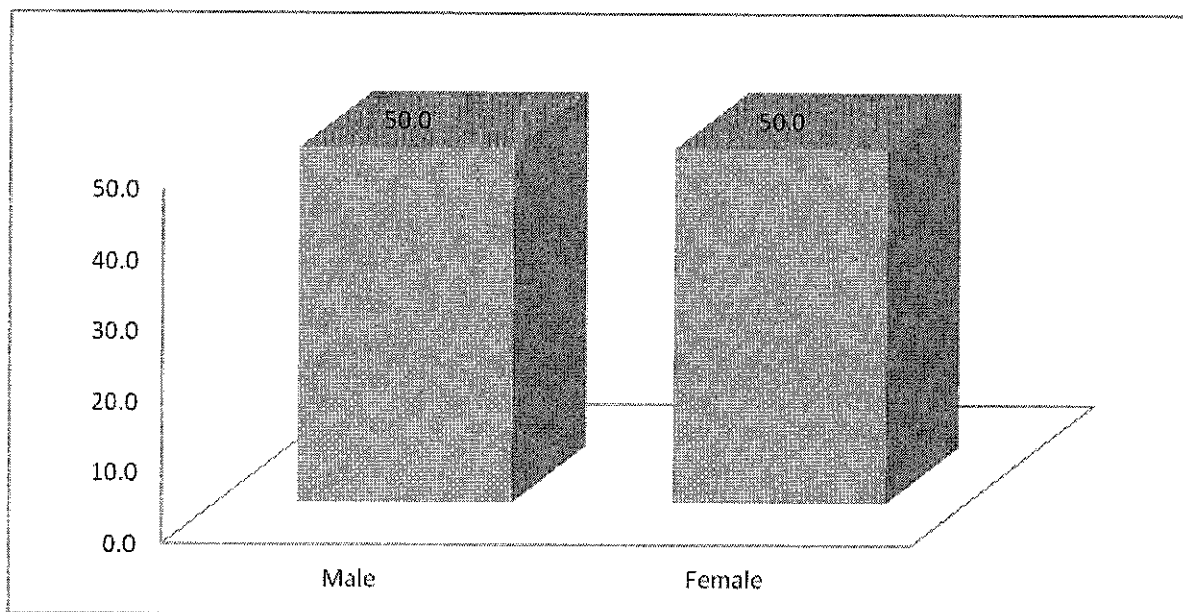
5.1 Introduction

This chapter focuses on the presentation of the findings of the research study. Data is presented in the form of graphs, descriptive statistics and ANOVA-tables.

5.2 Sample characteristics

A brief overview of the main sample characteristics is presented.

5.2.1 Graph showing gender characteristics of the sample



Graph 5.2.1 shows that the sample comprised of two groups of children, 60 (50%) male children and 60 (50%) female children.

5.2.2 Table showing children's handedness

	Frequency	Percent
Left Hand	60	50.0
Right Hand	60	50.0
Total	120	100.0

Table 5.2.2 shows that the sample comprised of two groups of hand preferences, 60 left-handed children and 60 right-handed children.

5.2.3 Table showing grades of children from the School

	Frequency	Percent
Grade 4	40	33.3
Grade 5	40	33.3
Grade 6	40	33.3
Total	120	100.0

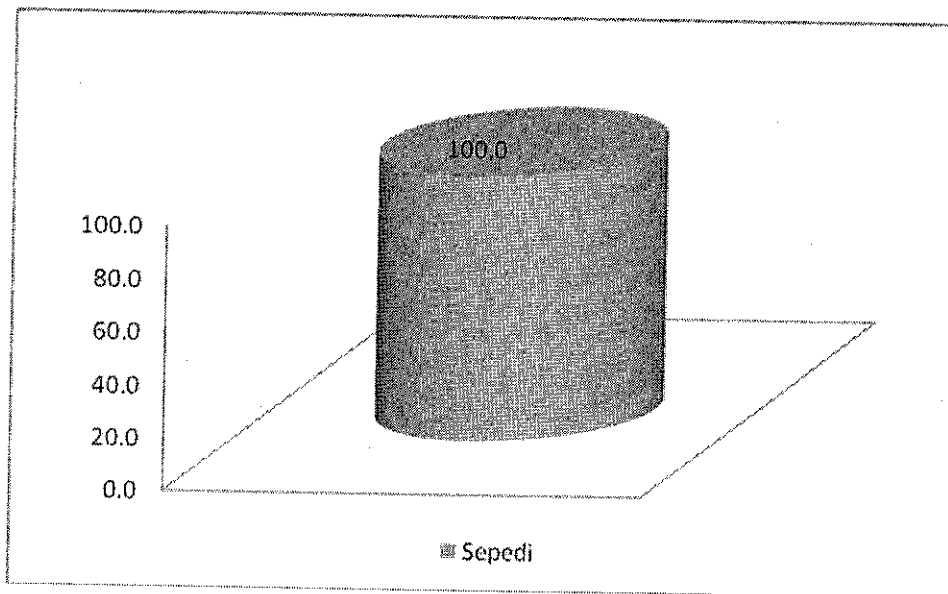
Table 5.2.3 shows that one hundred and twenty children participated in the study; forty of these children were from grades 4, 5 and 6 respectively.

5.2.4 Table showing ages of the participating children

	Frequency	Percent
9.00 Years	20	16.7
10.00 Years	39	32.5
11.00 Years	44	36.7
12.00 Years	16	13.5
Total	120	100

Table 5.2.4 shows that the sample comprised one hundred and twenty participants. 20 were nine years old, 39 were ten years old, 44 were eleven years old, and 16 were twelve years old during the time when the study was conducted.

5.2.5 Graph showing home language of the participating children



Graph 5.2.5 shows that all participating children used *Sepedi* as their home language.

5.3 The role of gender and handedness on language functions in children

5.3.1 Table showing descriptive statistics for NEPSY subscales, Phonological Processing, Speeded Naming, and Comprehension of Instruction subscales for gender

Source of variation	Gender	Mean	Std. Deviation
Phonological Processing	Male	13.97	1.727
	Female	14.47	1.712
	Total	14.22	1.731
Speeded Naming	Male	17.60	2.546
	Female	17.72	2.059
	Total	17.66	2.306
Comprehension of Instructions	Male	12.53	2.004
	Female	12.93	1.716
	Total	12.73	1.869

It is apparent, from the above table, that the average score for males was ($\bar{X} = 13.97$; $SD = 1.727$) and ($\bar{X} = 14.47$; $SD = 1.712$) for females on Phonological Processing Test while the average scores for males were ($\bar{X} = 17.60$; $SD = 2.546$) and ($\bar{X} = 17.72$; $SD = 2.059$) for females on Speeded Naming Test; the average scores for males were ($\bar{X} = 12.53$; $SD = 2.604$) and ($\bar{X} = 12.93$; $SD = 1.716$) for females on Comprehension of Instruction Test.

5.3.2 Table showing results of the ANOVA-test for children's gender

ANOVA

Source of Variance	Sum of Squares	Deference of Variance	Mean Square	Freque ncy- Value	P - Value
Phonological Processing	7.500	1	7.500	2.537	.114
	348.867	118	2.956		
Speeded Naming	356.367	119		.076	.783
	.408	1	.408		
	632.583	118	5.361		
Comprehension of Instructions	632.992	119		1.379	.243
	4.800	1	4.800		
	410.667	118	3.480		
	415.467	119			

It is apparent from the above table that there are no significant difference according to gender on phonological processing and speed-naming and comprehension of instruction tests of the NEPSY.

5.3.3 Table showing descriptive statistics for NEPSY subscales, Phonological Processing, Speeded Naming, and Comprehension of Instruction subscales for handedness

Source of Variance	Gender	Mean	Std. Deviation
Phonological Processing	Left Hand	14.17	1.796
	Right Hand	14.27	1.676
	Total	14.22	1.731
Speeded Naming	Left Hand	17.38	2.505
	Right Hand	17.93	2.074
	Total	17.66	2.306
Comprehension of Instructions	Left Hand	13.05	1.534
	Right Hand	12.42	2.118
	Total	12.73	1.869

It is apparent from the above table that the average score for left-handed children was ($\bar{X} = 14.17$; $SD = 1.796$) and ($\bar{X} = 14.27$; $SD = 1.676$) for the right-handed children on the Phonological Processing Test while for the Speed-Naming Test, the average for left-handed children was ($\bar{X} = 17.38$; $SD = 2.505$) and ($\bar{X} = 17.93$; $SD = 2.074$) for the right-handed children; the average score for the left-handed children was ($\bar{X} = 13.05$; $SD = 1.534$) and ($\bar{X} = 12.42$; $SD = 2.118$) for the right-handed children.

5.3.4 Table showing results of the ANOVA-test for children's handedness

ANOVA

Source of Variance	Sum of Squares	Deference of Variance	Mean Square	Freque ncy- Value	P - Value
Phonological Processing	.300	1	.300	.099	.753
	356.067	118	3.018		
Speeded Naming	356.367	119			
	9.075	1	9.075	1.716	.193
Comprehension of Instructions	623.917	118	5.287		
	632.992	119			
	12.033	1	12.033	3.520	.063
	403.433	118	3.419		
	415.467	119			

It is apparent from the above table that there are no significant differences according to handedness on phonological processing, speed-naming and comprehension of instruction tests.

5.4 Summary of research findings

Based on the research results, the following conclusions about the research hypotheses can be made:

- (i) Confirmation was not found for hypothesis 1 as there was no significant difference of performance in language functions between male and female children on phonological processing, speeded-naming and comprehension of instructions; and
- (ii) Confirmation was not found for hypothesis 2 as there was no significant difference of performance in language functions between left-handed and right-handed children on phonological processing, speeded-naming and comprehension of instructions.

5.5 Conclusion

In this chapter, research findings were presented in graphs, descriptive statistics, and ANOVA-tables. The next chapter discusses these findings.

CHAPTER 6

6. Discussion of research results

The aim of this study was to investigate the role of gender and handedness on the ability to speak using language functions in children aged 8 to 12. *Gender* refers to the attitudes, feelings, and behaviours that a given culture associates with a person's biological sex (APA, 2012). *Handedness* is the preferred use of the right hand, the left hand, or one or the other hand, depending on the task (Annett, 2002). *Language functions* refer to the purposes in which we use language to communicate. We use language for a variety of formal and informal purposes, and specific grammatical structures and vocabulary are often used with each language function. Some examples of language functions include asking questions and summarizing. *Gender role* refers to a set of expectations held by society about the ways in which men and women are supposed to behave based on their gender. Therefore, the difference between gender and the handedness of children were expected to be significant, but with the current study, no difference between children's handedness and their gender was found.

6.1 Introduction

In the current chapter, research results are discussed in terms of the stated hypotheses and with regard to the literature reviewed. The meaning, the implication of the results, and their congruence (or lack thereof) with the results of other studies, is explained. The limitations of the study are also outlined, and the recommendations are made to assist and direct the future research on the topic.

6.2 Children's gender and its findings on the NEPSY for language

Thirty years after the first review on sex differences in lateralization, there is still no consensus about sex differences in lateralization, and it remains a much debated topic (Clements, Rimrodt,

Abel, Blankner, Mostofsky, Pekar, Denckla, & Cutting, 2006; Plante, Schmithorst, Holland, & Byars., 2006).

The current study found no significant gender difference between both genders (male and female). Graph 5.2.1 shows that one hundred and twenty of the participating children participated in the study and showed no difference of performance in gender and language. The results of the study, from Graph 5.2.1, are supported by the study conducted by the former American Psychiatric Association (APA) President Halpern who points out that, “there is no evidence that one sex is smarter than the other” (Halpern, 2004, p. 139). However, girls do hold an edge in verbal skills such as reading, writing, and spelling. Boys are more likely to experience problems in reading that range from reading below grade level to more severe disabilities such as dyslexia (American Psychiatric Association, 2000).

Boys have, traditionally, held an advantage in math skills. However, the gender gap in math has narrowed so much in recent years that there is now, essentially, no difference in the average math score of boys and girls (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). A worldwide study of math abilities across 69 countries showed girls tended to have less confidence in math skills but no less ability than boys (Else-Quest, Hyde, & Linn, 2010). An important lesson from this study, according to the lead researcher, psychologist Nicole Else, is that “girls are likely to perform as well as boys when they are encouraged to succeed” (Else-Quest, Hyde, & Linn, 2010).

Thus, according to the findings of this study, gender did not influence performance on the Phonological Processing, Speeded-Naming, and Comprehension of Instruction Tests.

Hyde and Linn (1988), for example, conducted a meta-analysis of 165 language studies involving both children and adults and included a broad range of language tests (vocabulary, analogies, anagrams, reading comprehension, speaking or other verbal communication, essay writing, the Scholastic Aptitude Test (SAT)-Verbal, and general verbal ability tests). Results were mixed: forty-four (27%) of the studies reported that females outperformed males, 109 (66%) found no significant gender differences and 12 (7%) found males outperforming females.

The authors concluded that “the magnitude of the sex difference in verbal ability is currently so small that it can effectively be considered to be zero” (Hyde & Linn, 1988, p. 64).

Nichelli, Bulgheroni and Riva (2001) presented developmental data for verbal and spatial memory tasks (Corsi's block-tapping test and Luria's verbal learning test) for 275 children aged from 5 years-4 months to 13 years-6 months. No significant sex difference was found, though a slight trend in verbal span favouring female subjects was present. Ardila and Rosselli (1994) used a neuropsychological battery (Boston Naming Test, Token Test, verbal fluency, Wechsler Memory Scale, Rey-Osterrieth Complex Figure, and recognition of superimposed Poppelreuter-type figures) in a study of 233 normal children aged 5 to 12 years. No evident gender differences were reported.

Studies conducted by Lebel and Beaulieu (2009) show that children aged 5 – 13 years underwent cognitive assessment. They found that age and gender effects on lateralization were not significant. Scores on the NEPSY Phonological Processing task differed significantly among groups, with left-only subjects outperforming the right-lateralized group, and the left-lateralized children scoring significantly better than the right-lateralized group on phonological processing. Lateralization index was not significant between males and females and also produced no significances in gender (Lebel & Beaulieu, 2009).

Other studies conducted by Kaushanskaya, Maria and Yoo (2011) examined gender differences in word-learning within the Declarative/Procedural framework and demonstrated that women outperform men on a lexical learning task, but only when the novel words were constructed using native-language phonological categories (Kaushanskaya et al., 2011). These findings were interpreted to suggest that when learning can be supported by the declarative memory system, namely, long-term linguistic knowledge, women outperform men.

The presence of gender difference on linguistic tasks is not a uniform finding. While many studies have suggested that adult women tend to outperform adult men on linguistic processing tasks (Herlitz et al., 1999; Kimura & Harshman, 1984; Larsson et al., 2003; Loonstra et al., 2001;

Maitland et al., 2004), a similar number of studies documented a lack of difference between adult males and females on language tasks (Allendorfer, Lindsell, Siegel, Banks, et al., 2012; Jackson & Rushton, 2006; Kimura, 1999; Ryan, Kreiner, & Tree, 2008). Similarly, in children, some studies show evidence of lack of gender differences on cognitive tasks that include language measures (Ardila, Rosselli, Matute, & Inozemtseva, 2011) while others demonstrate consistent and stable gender difference in language development over the first six years of life (Bornstein, Hahn, & Haynes, 2004).

According to Kaushanskaya, Yoo, and Van Hecke (2013), studies that do document gender differences on language measures in children generally find that girls outperform boys (Bornstein et al., 2004, Ericson, Marschik, Tulviste, Almgren, et al., 2012). Gender difference in language acquisition appears very early in life. For example, girls have been shown to outperform boys as early as 6 months of age on measures related to sensory discrimination of speech sound (Pivik, Andres, & Badger, 2011). Gender differences in language acquisition are also largely stable, with longitudinal studies showing that when girls outperform boys at the first time point, these advantages generally sustain with age (Bornstein et al., 2004, Ericson, et al., 2012). However, patterns of increased gender difference with age (Bouer, Goldfield, & Reznik, 2002; Bouchard, Trudeau, Sutton, Bourdeault, et al., 2009; Dodd, Holm, Hua, & Crosbie, 2003; Erikson et al., 2012) and of reduced gender differences with age (Bornstein et al., 2004) have also been reported.

Comprehensive review of studies involving young children conclude that although the direction appear to be the same as found for adults, cognitive differences between the two sexes do not appear as consistently and are often smaller. Although girls do appear to have an early edge in verbal skills, somewhere between the ages of two and five boys begin to “catch up” with girls and this edge diminishes, but then reappears by adolescence and continues through middle age (Maccoby & Jacklin, 1974). Reviews of the spatial ability literature conclude that consistent and robust sex-related differences are not found until 8-12 years of age when males as a group show a clear advantage which persists through middle adulthood (Johnson & Meade, 1987; Maccoby & Jacklin, 1974; Newcombe, & Liben, 1982).

Since the magnitude of cognitive sex-related differences appears to increase over time, it has been argued that these differences are partially or entirely produced by sex-role stereotyping and other environmental influences (Kinsbourne, 1980) and should be termed gender-related differences rather than sex-related differences to reflect the strong role that culture and socialization play in the development of cognitive abilities (Denmark, Russo, Frieze, & Sechzer, 1988). It could be further argued that since girls mature physically earlier than boys (Bever, 1970; Pauly, 1951), the early cognitive differences favouring girls over boys is actually due to differential maturational rates. That is, the sex-related differences in cognition are maturationally induced differences in the scale of cognitive task performance rather than cognitive profile differences (Gottfield & Bathurst, 1983).

Babalola and Oyinloye (2012) states that male and female have equal chance of learning and acquiring tools of language of communication apart from individuals language variation (ability to use the tools of any language cannot be the same among individuals). The fact revealed here is that good or poor language performance is not as a result of gender factor. Male and female have the same range of test scores and the same range of abilities in language learning and language acquisition. The findings of their study disagrees with the claim of scholars like Kelly (1976) and Kolawole (2002). Kelly (1976) says that girls do better in languages. Kolawole (2002) equally believes that girls typically excel in English spelling, writing, and arts/subjects. The population opinion that female performs better in language and literature had no concrete empirical support. It has not been biologically proved (beyond a reasonable doubt) that female has superior organ in their system to acquire and learn language better than the male. According to the findings of this study, male and female can perform well in language task not on the basis of gender but on the pedestal of individual ability and also on the factors of prevailing environmental situation.

Studies conducted by Kraft and Nickel (1995) states that there were no significant sex-related differences found for the overall verbal ability scores ($p > 0.05$). This is consistent with Maccoby and Jacklin (1974) summary of their comprehensive review of sex-related cognitive differences that the margin of female superiority for verbal tasks appear to temporarily diminish in children between 3 and 5 years of age. Although there were also no significant results found when

analyzing children's Verbal Comprehension scores obtained during the initial testing, analysis of the data obtained at the older age revealed significant differences in these scores related to children's sex and their hand preference stability. Post hoc comparisons revealed that the regression line representing the relationship between children's hand preference stability and their Verbal Comprehension scores were not significant (Kraft & Nickel, 1995).

There were no significant sex-related differences among those children who did not show strong and stable right-hand preferences or demonstrated stable but weak right-hand or ambidextrous hand preference scores (Kraft & Nickel, 1995).

According to Boles (1984), however, failed to find a sex difference in lateralization in a meta-analysis on studies that applied visual half-field paradigms. Another review by Hiscock and Mackay (1985) also failed to find a sex difference in lateralization assessed with dichotic listening. A more recent meta-analysis on functional imaging studies applying language tasks yielded no sex differences (Sommer et al., 2004).

In summary, the results of this study indicate the existence of a large number of gender similarities than gender difference across a relatively aged range (8 – 12 years), and using a sample of 120 children. This results does not support hypothesis no.1 due to the results obtained using the Statistical Packages for Social Science (SPSS) which shows no significant difference of performance on language functions between male and female children on phonological processing, speeded naming and comprehension of instruction tests of the NEPSY for language.

6.3 Children's handedness and its findings on the NEPSY for language

Handedness is a rather stable individual characteristic, from about 7 years of age (Michel & Harkins, 1986). The researcher has included handedness data from both (male & female) children (above age 7). Subject's age may however be a factor to affect language lateralization (Holland, Plante, Weber Byars, Strawsburg, Schmithorst, & Ball., Jr. 2001). A significant interaction between age and sex has been described in studies on language lateralization (Plante

et al., 2006; Gaillard, Pugliese, Grandin, Braniecki, Kondapaneni, Hunter, Xu.;...Petrella, Balsamo, & Basso., 2001).

The researcher marked the data obtained from the participating children. An additional analysis was performed to assess possible differences in the sex difference in lateralization between male and female children.

According to the results obtained from table 5.2.2 shows that there was no significant difference found in both handedness being the left-handed and the right-handed children. Piro (1998) found no difference in mean handedness scores between 657 gifted and non-gifted children. Corballis et al. (2008) used data from 1,355 respondents revealed no difference in IQ between left-handers and right-handers. Studies conducted by Petrinovich and Goldman (2009), and the one conducted by McManus and Mascie-Taylor (1983) reported no difference between left-hand and right-hand individuals in terms of their IQ (Corballis et al., 2009).

It is difficult to find left-handed participants in a particular or given population given the fact that left-handed people are very rare to be found in our population and also the fact that majority of them are shy. A study conducted by Llaurens, Raymond and Faurie (2014) has found that Left-handedness could be favoured by negative frequency-dependent selection. Data have suggested that left-handedness, as the rare hand preference, could represent an important strategic advantage in fighting interactions. However, the fact that left-handedness occurs at a low frequency indicates that some evolutionary costs could be associated with left-handedness. In a survey of 12 000 subjects from 17 countries, 2.5–12.8% were left-handed for writing (Perelle & Ehrman, 1994), and among seven ethnic groups based on 255 100 answers to a BBC internet study 7–11.8% were left-handed (Peters, Reimers, & Manning., 2006). Studies on traditional societies tend to show a similar range of variations. Faurie, Schiefenhover, Le Bomin, Billiard, and Raymond (2005b) found a range of left-hander frequencies between 3.3 and 26.9% across eight societies. The frequency of left-handedness thus seems to be variable among human populations, left-handers being always at a lower frequency than right-handers. Moreover, in most populations studied, the proportion of left-handers among women was lower than in men

(reviewed in Raymond & Pontier, 2004), suggesting an important influence of sex in the determinism of hand preference. The current study was made possible with the assistance from the Mankweng Department of Education Circuit Manager together with the school principals who helped the researcher to hand-picks the participants from their classrooms. All participants were School children from Primary Schools in the Mankweng area which is under Department of Education Mankweng Circuit in the Limpopo Province, in South Africa.

Dellatolas, De Agostini, Jallon, Poncet, Rey, and Lellouch, (1988) observed an increase in the frequency of left hand use for writing in France ('generation' effect), showing clearly that the educational attitude towards left hand writing has significantly changed in France during the second half of the twentieth century. The same phenomenon has been observed in other countries (Italy: Salmaso & Longoni, 1985; Brazil: Berdel Martin & Barbosa Freitas, 2003). Studies of school children in China and Taiwan have found that only 3.5 and 0.7% used their left hand for writing (Teng, Lee, Yang, & Chang., 1976). This contrasts with a 6.5 per cent figure for Asian school children living in the United States, where cultural pressures have been reduced (Hardyck, Petrinovich, & Goldmann., 1976). In two African countries (Ivory Coast & Sudan), the target activity against left hand use was eating and there remains strong cultural pressure for this activity (De Agostini, Khamis, Ahui, & Dellatolas., 1997).

Left-handers have indeed smaller asymmetries in hand skills than right-handers (Peters 1989; Curt, Maccario, & Dellatolas, 1992; Judge & Stirling, 2003) and are less lateralized in language dominance (Steinmetz, Volkmann, Ja"ncke, & Freund., 1991). In fact, at the equilibrium value, the fitness of right- and left-handers is equal (although this does not mean that all fitness components are necessarily equal). In such a case, some advantages for one trait could be found for one handedness category, and other advantages for other traits for another handedness category. This could explain many discrepancies in handedness studies. What is currently lacking is a way to clearly identify the left-hander categories in order to better estimate fitness costs and benefits associated with each category. It is also pivotal to further investigate the possible current evolution of left-handedness frequencies, and to examine, in different

environments, the type of selection, particularly frequency dependent, acting on handedness Llaurens, Raymond and Faurie (2014).

Overall, it was found that there was no significant difference in strength of lateralization for boys and girls. This goes against some research conducted with adult participants, which has typically found that males are more strongly lateralized than females (Bourne, 2005, 2008; Bourne & Maxwell, 2010). However, research examining lateralization in children has tended not to find significant sex difference (Watling & Bourne, 2007). While there was no overall sex difference, sex was found to interact with strength of lateralization when predicting the ability to process facial expressions of happiness discrimination indicates that this relationship is only significant for the males. In examining the mean laterality quotients it is possible that the sex difference in boys lateralization patterns differing from those of the girls across the age groups; for instance, with the girls lateralization at 8 and 10 years appears similar, while for the boys it appears that the 10 year old are more right hemisphere dominant than the 8 year old. This could indicate that the predictive ability of laterality for boys only may be that they are delayed in their laterality and if the patterns of laterality for boys and girls were more similar there may not be a sex difference.

In spite of the differences reported by different authors, it is also to be mentioned here, that in most of the investigations carried out so far, little evidence has been found that suggests the superiority of right-handers over left-handers in terms of cognitive skills. There are however, differences between the two groups (left-handers & right-handers) in terms of cognitive skills. The results of the studies are complex, in that some report higher cognitive achievements on the part of right-handers while on the contrary there is evidence of left-handedness as being a favour (Thilers et al., 2007).

Knecht, Drager, Deppe, Bobe, Lohmann, and Floel (2000) investigated all kinds of language aspects, from language comprehension to word production, also did not find any sex difference in language lateralization. This was in alignment with meta-analyses by Sommer et al., (2004, &

2008). Studies with relatively small sample sizes, on the other hand, may have a higher chance of obtaining significant results due to chance.

6.4 Conclusion

The results of the study did support the aim of this study but did not support the study hypothesis. The support of the study aim was found in Babalola and Oyinloye (2012) who state that males and females have an equal chance of learning and acquiring tools of language of communication apart from individuals' language variation (ability to use the tools of any language cannot be the same among individuals). The fact revealed here is that good or poor language performance is not as a result of gender factors. Males and females have the same range of test scores and the same range of abilities in language learning and language acquisition.

The study hypothesis was not supported because there were no significant difference of performance in language functions between male and female children on phonological processing, speed-naming and comprehension of instruction tests of the NEPSY. It is apparent from Table 5.3.1 that gender did not influence language functions as proposed. Table 5.3.3 and table 5.3.4 also prove that there was no significant difference of performance in language functions between left-handed and right-handed children on phonological processing, speed-naming and comprehension of instruction, and it also concluded that gender did not influence language functions. However, in primary school learners this could be an important phenomenon to indicate the significant difference of performance on the functions of language using both variables gender and handedness to arrive at the required significant conclusion of a particular identifiable population which need research attention in future.

6.5 Limitations of the study

The study sample was limited to primary school learners only. The age group range estimated was from 8 to 12 years and learners from grade 4, 5 and 6 respectively. No learner above or under the ages of 8 to 12 years participated in the study.

All parents of the participating children were sent the consent forms to fill in to give their consent for participation in the current study since the participating children were minors who were still depending on their parents.

The sample consisted of two groups (male & female children). The first group consisted of 60 male children – 30 left-handed and 30 right-handed, and the second group consisted of 60 female children – 30 left-handed and 30 right-handed. All participants were South African children between the ages of 8 to 12 years old, thus making a total of 120 participants residing in Mankweng area, from primary schools under Mankweng Circuit of Education, in Limpopo Province, South Africa.

Due to the research results obtained, findings are not to be used to generalize to the population of all primary school learners in South Africa since this research was conducted on learners residing in Mankweng area, where all learners used the same language (Sepedi – Speaking – People). The researcher's hope is that future research will replicate this study using different languages.

Further research is needed to determine if there is more significant difference of performance in language functions on phonological processing, speeded-naming and comprehension of instruction tests between left-handed and right-handed children and between males and females children on PP, SN and CI tests. This was the first study to utilize such a method using PP, SN and CI tests of the NEPSY. Although further research is needed to more strongly reflect differences in the way left- and right-handers, this study indicates that there may be a variation in responses based on an individual's classification of handedness.

Primary School teachers and Principals would not be the only beneficiaries in this study, but the Department of Education, Institution of Higher Learning and future Researchers will also benefit from this study.

6.6 Recommendations

The literature used for the current study indicates that there is a great need for further research in the field. There was not enough literature to support the NEPSY instruments used in the study, especially on the findings since this study is the first of its nature to be conducted in South Africa and Africa as a whole. The replication of this study could be carried out in other countries and with the rural and urban learners in order to enable the researcher to generate further findings on the significant differences of performance in language functions on phonological processing, speeded naming and comprehension of instruction tests in children.

More NEPSY tests to suit the African child should be constructed by specialists in order to appropriately place the level of NEPSY for the African child. The field will benefit from the studies where rural and urban samples are compared, as well as accommodating larger samples in their investigation. Comparison of the administration and the application of the NEPSY sub-tests will help in the improvement of Maths and literacy for learners at primary schools. Parents/Guardians and teachers should show much appreciation of the work done by learners at school and also show their support and encouragement. Good education leads to good grades.

7. References

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R. C. OLDFIELD

APPENDIX I

Medical Research Council Speech & Communication Unit

EDINBURGH HANDEDNESS INVENTORY

Learner's Name _____ Grade _____

Age _____ Sex _____ Home Language _____

Date of Birth _____

Please indicate your preferences in the use of hands in the following activities by ticking in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, tick twice within the column of your choice. If in any case you are really indifferent tick in both columns. Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets. Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		LEFT	RIGHT
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Spoon		
7	Broom (upper hand)		
8	Striking Match (match)		
9	Opening box (lid)		
10	Which foot do you prefer to kick with?		

L.Q.

Leave these spaces blank

DECILE

MARCH 1970

Phonological Processing

Core



Reversal Rule

For ages 7-12 after failure on either of first 2 items administered, reverse sequence of preceding items until 2 consecutive items are passed.



Discontinue Rule

3 consecutive scores of 0

Part A

Item (Say)	Correct Response	Response	Score
1. hi-ke	c		0 1
2. tele-	a		0 1
3. -indow	b		0 1
4. ki-tchen	a		0 1
5. -oar	c		0 1
6. -lip	c		0 1
7. -ake	a		0 1

Item (Say)	Correct Response	Response	Score
8. -og	a		0 1
9. -able	b		0 1
10. -ask-	c		0 1
11. -oast-	b		0 1
12. -ar-	b		0 1
13. -ap-	b		0 1
14. -ick-	c		0 1

Part A Total Score
(Maximum = 14)

Part B

Item (Say)	Say it again but don't say...	Correct Response	Child's Response	Score
15. remember	re-	member		0 1
16. meat	/m/	eat		0 1
17. tease	/z/	tea		0 1
18. coat	/k/	oat		0 1
19. ink	/k/	in		0 1
20. smock	/s/	mock		0 1
21. lip	/k/	lip		0 1
22. mistaken	mis-	taken		0 1
23. sting	/t/	sing		0 1
24. pod	/l/	pod		0 1
25. captivate	-ate	captive		0 1

Item (Say)	Change the ... to ...	Correct Response	Child's Response	Score
26. flight	/fi/ /br/	bright		0 1
27. shake	/sh/ /st/	steak		0 1
28. grain	/ā/ /ō/	groan		0 1
29. hope	/p/ /z/	hose		0 1
30. pack	/k/ /n/	pan		0 1
31. sled	/eh/ /ī/	slide		0 1
32. hiding	/ide/ /urt/	hurting		0 1
33. changing	/ang/ /omp/	chomping		0 1
34. ceiling	/ēē/ /āve/	saving		0 1
35. slumber	/lumb/ /up/	supper		0 1
36. plunder	/und/ /an/	planner		0 1

Part B Total Score
(Maximum = 22)

Qualitative Observations

Asks for Repetition (tally)

Part A + Part B = Total Score
(Maximum = 36)



Speeded Naming Core



Discontinue Rule
800 seconds

5-12

Item	Score			
	0	1	2	3
1. big red circle				
2. big blue square				
3. big yellow circle				
4. little black square				
5. big blue circle				
6. big black square				
7. little red circle				
8. big red circle				
9. big black square				
10. big blue circle				
11. little black square				
12. big yellow circle				
13. big blue square				
14. big red circle				
15. little yellow square				
16. little red circle				
17. little blue square				
18. big black circle				
19. little yellow circle				
20. little yellow square				

Time
(Maximum = 300")

Accuracy Score
(Maximum = 60)

Qualitative Observations

- Body Movement (with words produced)
- Increasing Voice Volume
- Reversed Sequences (more than two)

Total Score

Note: Total Score is determined using Table A.1



Arrows



Discontinue Rule
4 consecutive scores of 0.

5-12

Circle the child's responses.
Note: Correct responses are indicated in bold type.

Item	Score			
	0	1	2	3
1. 1 2 3 4 5 6 7 8				
2. 1 2 3 4 5 6 7 8				
3. 1 2 3 4 5 6 7 8				
4. 1 2 3 4 5 6 7 8				
5. 1 2 3 4 5 6 7 8				
6. 1 2 3 4 5 6 7 8				
7. 1 2 3 4 5 6 7 8				
8. 1 2 3 4 5 6 7 8				
9. 1 2 3 4 5 6 7 8				
10. 1 2 3 4 5 6 7 8				
11. 1 2 3 4 5 6 7 8				
12. 1 2 3 4 5 6 7 8				
13. 1 2 3 4 5 6 7 8				
14. 1 2 3 4 5 6 7 8				
15. 1 2 3 4 5 6 7 8				

Total Score
(Maximum = 30)

Qualitative Observations

<input type="text"/>	<input type="text"/>
Right Visual Field Errors	Left Visual Field Errors



Comprehension of Instructions

Core



Reversal Rule

For ages 7-12: After failure on the Prerequisite Items (identifying shape), start with Item 1. If a child aged 7-12 does not complete Items 14 and 15 correctly, reverse until 2 consecutive items are passed.



Discontinue Rule

4 consecutive scores of 0

5-6

Item	Child's Response	Score
1. Show me...a big bunny		0 1
2. ...a little bunny		0 1
3. ...a blue bunny		0 1
4. ...a happy bunny		0 1
5. ...a sad bunny		0 1
6. ...a yellow bunny		0 1
7. ...a bunny that is big and blue		0 1
8. ...a bunny that is big and yellow		0 1
9. ...a little sad bunny		0
10. ...a little happy bunny		0
11. ...a bunny that is little and blue		0
12. ...a bunny that is big and blue and happy		0
13. ...a bunny that is little and yellow and sad		0

Qualitative Observations

Asks for Repetition (tally)

Subtotal (Items 1-13)

Comprehension of Instructions (Continued)

Core

7-12

Item	Child's Response	Score
Prerequisite Items Point to...a circle. Point to...a cross.		
14. Point to...the blue cross and the yellow cross		0 1
15. ...the white one and a circle		0 1
16. ...one that is not a cross and not blue or yellow		0 1
17. ...a shape that is not a circle, but is yellow or black		0 1
18. ...a blue circle last and a black cross first		0 1
19. ...all the crosses and then to a red circle		0 1
20. ...two red ones, but first to a yellow cross		0 1
21. ...a white cross after you have pointed to a red shape under a blue one		0 1
22. ...the black circle and the third shape in the second row		0 1
23. ...the circle below the white cross and the shape above the black circle		0 1
24. ...a shape that is above one cross and beside another cross		0 1
25. ...a shape that is between two crosses and above a circle		0 1
...a cross that is to the left of a circle and underneath a cross		0 1
...the second cross in the first row, but first to a blue circle		0 1
...a cross, the black circle, and the red cross		0 1

Qualitative Observations

+ =
 Items 1-13 (from previous page) Items 14-28 (tally) Total
 Asks for Repetition

Total Score (Maximum = 28)

Note: Include points for items on previous page.

Centre for Academic Excellence
B-Block (University of Limpopo)
Private Bag X 1106
SOVENGA
0727

The Manager
Mankweng Circuit
Department of Education
Limpopo Province

Dear Sir/Madam

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH

I am hereby applying to request for your permission to conduct research to the Primary Schools attached to your circuit. Would you please notify me as soon as possible once I have been permitted to conduct research.

Currently, I am a registered student doing Masters of Arts in Research Psychology for the academic year 2010 at the University of Limpopo (Turfloop Campus). My research topic is: **The role of gender and handedness on the ability to speak in language functions in children aged 8 to 12 at Mankweng Education Circuit, Limpopo Province.** My control groups are all learners from all Primary Schools and my experimental group are learners from the designated Primary Schools between the age of 8 and 12.

The ethical issues will be bound by the ethics form attached on this letter.

I will be waiting to hear from you as soon as possible.

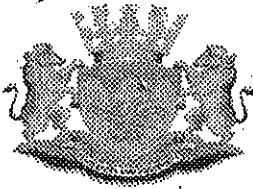
Yours faithfully



Risenga Samuel Baloyi

Cell: 076 592 6901

Email-Address: 200513481@ul.ac.za or sammyrs@webmail.co.za



LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

PRIVATE BAG X1108
SOVENGA
0727

TEL: 015 267 5641
FAX: 015 267 5243

**DEPARTMENT OF EDUCATION
CAPRICORN DISTRICT
MANKWENG CIRCUIT**

Ref No: 81413173
Enq: Modiba M.E
Tel No: 015 267 5641

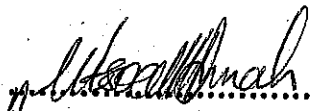
2010.09.20

Baloyi R.S
B- Block (University of Limpopo)
PRIVATE BAG X1106
Sovenga
0727

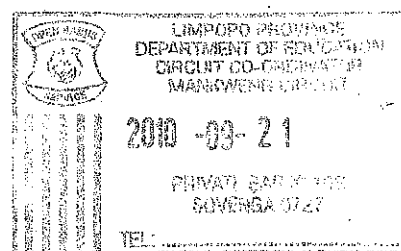
Dear Sir/Madam

**REQUEST TO CONDUCT RESEARCH BASED ON THE ROLE OF
GENDER AND HANDEDNES ON LANGUAGE FUNCTIONS IN
CHILDREN AGED 8 TO 12.**

1. The above matter has reference.
2. We acknowledge the receipt of your letter, requesting to conduct research based on the role of gender and handedness on language functions in children aged 8 to 12 at Pula-Madibogo and Dikolobe Primary School.
3. Permission is hereby granted for the above mention request.
4. Wishing you for the success.


.....
(Magagane M.D)
CIRCUIT MANAGER

2010-09-21
.....
DATE



**UNIVERSITY OF LIMPOPO
ETHICS COMMITTEE**

APPLICATION FOR HUMAN EXPERIMENTATION

(Completed forms, preferably typed, should reach the Chairperson of the Ethics Committee at least one month before the experimentation is due to start. Projects where the researcher only receives human material for analysis without actually being involved with collection from the experimental group must still register in the normal way. Researchers who are involved with projects which have been approved by Ethical Committees of other Institutions should provide this Committee with the necessary information and provide it with a shortened protocol for approval)

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: Ms. S. Govender

DECLARATION

I, the signatory, hereby apply for approval to execute the experiments described in the attached protocol and declare that:

1. I am fully aware of the contents of the Guidelines on Ethics for Medical Research, Revised Edition (1993) and that I will abide by the guidelines as set out in that document (available from the Chairperson of the Ethics Committee); and
2. I undertake to provide every person who participates in any of the stipulated experiments with the information in Part II. Every participant will be requested to sign Part III.

Name of Researcher: Samuel Risenga Baloyi

Signature: 

Date: 08/09/2010

For Official use by the Ethics Committee:

Approved/Not approved
Remarks:

Signature of Chairperson:
Date:

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: Mrs. S Govender

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

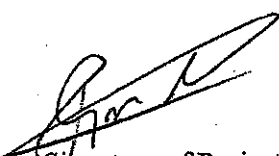
Protocol for the execution of experiments involving humans

1. Department: Department of Psychology
2. Title of project: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.
3. Full name, surname and qualifications of project leader:

Saraswathie Govender, MA (Research Psychology)
4. List the name(s) of all persons (Researchers and Technical Staff) involved with the project and identify their role(s) in the conduct of the experiment:

Name:	Qualifications:	Responsible for:
RS Baloyi	B A Honours	Researcher
5. Name and address of supervising physician: N/A
6. Procedures to be followed: Administer the Edinburg Handedness Inventory, Phonological Processing, Speed Naming Test and Comprehension of Instruction Test.
7. Nature of discomfort: None
8. Description of the advantages that may be expected from the results of the experiment:

Academic research and insight into the role of gender and handedness on language functions in children.



Signature of Project Leader:

Date: 08/09/2010

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: S Govender

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

INFORMATION FOR PARTICIPANTS

1. You are invited to participate in the following research project/experiment:

The role of gender and handedness on language functions in children.
2. Participation in the project is completely voluntary and you are free to withdraw from the project/experiment (without providing any reasons) at any time.
3. It is possible that you might not personally experience any advantages during the experiment/project, although the knowledge that may be accumulated through the project/experiment might prove advantageous to others.
4. You are encouraged to ask any questions that you might have in connection with this project/experiment at any stage. The project leader and her/his staff will gladly answer your question. They will also discuss the project/experiment in detail with you.
5. Your involvement in the project. Completion of handedness and language function tests .

This section is to be drawn up by the researcher and must be submitted together with the application form.

(it is compulsory for the researcher to complete this field before submission to the ethics committee)

1

**UNIVERSITY OF LIMPOPO
ETHICS COMMITTEE**

APPLICATION FOR HUMAN EXPERIMENTATION

(Completed forms, preferably typed, should reach the Chairperson of the Ethics Committee at least one month before the experimentation is due to start. Projects where the researcher only receives human material for analysis without actually being involved with collection from the experimental group must still register in the normal way. Researchers who are involved with projects which have been approved by Ethical Committees of other Institutions should provide this Committee with the necessary information and provide it with a shortened protocol for approval)

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PROJECT LEADER: Ms. S. Govender

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2. I undertake to provide every person who participates in any of the stipulated experiments with the information in Part II. Every participant will be requested to sign Part III.

Name of Researcher: Samuel Risenga Baloyi

Signature:

Date:

For Official use by the Ethics Committee:

Approved/Not approved

Remarks:

Signature of Chairperson:

Date:

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: Mrs. S Govender

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

Protocol for the execution of experiments involving humans

1. Department: Department of Psychology
2. Title of project: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.
3. Full name, surname and qualifications of project leader:

Saraswathie Govender, MA (Research Psychology)
4. List the name(s) of all persons (Researchers and Technical Staff) involved with the project and identify their role(s) in the conduct of the experiment:

Name:	Qualifications:	Responsible for:
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5. Name and address of supervising physician: N/A
6. Procedures to be followed: Administer the Edinburg Handedness Inventory, Phonological Processing, Speed Naming Test and Comprehension of Instruction Test.
7. Nature of discomfort: None
8. Description of the advantages that may be expected from the results of the experiment:

Academic research and insight into the role of gender and handedness on language functions in children.


Signature of Project Leader:

Date: 08/09/2010

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: S Govender

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

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2. Participation in the project is completely voluntary and you are free to withdraw from the project/experiment (without providing any reasons) at any time.
3. It is possible that you might not personally experience any advantages during the experiment/project, although the knowledge that may be accumulated through the project/experiment might prove advantageous to others.
4. You are encouraged to ask any questions that you might have in connection with this project/experiment at any stage. The project leader and her/his staff will gladly answer your question. They will also discuss the project/experiment in detail with you.
5. Your involvement in the project. Completion of handedness and language function tests .

This section is to be drawn up by the researcher and must be submitted together with the application form.

(it is compulsory for the researcher to complete this field before submission to the ethics committee)

**UNIVERSITY OF LIMPOPO
ETHICS COMMITTEE**

PROJECT TITLE: The role of gender and handedness on language functions in children aged 8-12 in Mankweng, Limpopo Province.

PROJECT LEADER: S Govender

CONSENT FORM

I, _____ hereby voluntarily consent to my child's participation in the following project: The role of gender and handedness on language functions in children.

I realise that:

1. The study deals with investigating the role of gender and handedness on language functions in children.
2. The procedure or treatment envisaged may hold some risk for me that cannot be foreseen at this stage;
3. The Ethics Committee has approved that individuals may be approached to participate in the study.
4. The experimental protocol, ie. the extent, aims and methods of the research, has been explained to me;
5. The protocol sets out the risks that can be reasonably expected as well as possible discomfort for persons participating in the research, an explanation of the anticipated advantages for myself or others that are reasonably expected from the research and alternative procedures that may be to my advantage;
6. I will be informed of any new information that may become available during the research that may influence my willingness to continue my participation;
7. Access to the records that pertain to my participation in the study will be restricted to persons directly involved in the research;
8. Any questions that I may have regarding the research, or related matters, will be answered by the researchers;
9. If I have any questions about, or problems regarding the study, or experience any undesirable effects, I may contact a member of the research team;

10. Participation in this research is voluntary and my child can withdraw participation at any stage;
11. If any medical problem is identified at any stage during the research, or when I am vetted for participation, such condition will be discussed with me in confidence by a qualified person and/or I will be referred to my doctor;
12. I indemnify the University of Limpopo and all persons involved with the above project from any liability that may arise from my participation in the above project or that may be related to it, for whatever reasons, including negligence on the part of the mentioned persons.

SIGNATURE OF RESEARCHED PERSON

SIGNATURE OF WITNESS

SIGNATURE OF PERSON THAT INFORMED
THE RESEARCHED PERSON

SIGNATURE OF PARENT/GUARDIAN

Signed at _____ this _____ day of _____ 2008



To whom it may concern:

This document certifies that the dissertation whose title appears below has been edited for proper English language, grammar, punctuation, spelling, and overall style by Rose Masha, a member of the Professional Editors' Group whose qualifications are listed in the footer of this certificate.

Title:

**THE ROLE OF GENDER AND HANDEDNESS ON LANGUAGE
FUNCTIONS IN CHILDREN AGED 8-12 IN MANKWENG CIRCUIT,
LIMPOPO PROVINCE IN SOUTH AFRICA**

Author:

BALOYI RISENGA SAMUEL

Date Edited:

11 August 2015

Signed:

A handwritten signature in black ink, appearing to read "Rose Masha".

Rose Khanyisile Masha

(040) 402 2345 or 082 770 8892