

https://dspace.org/

Gender differences in neuropsychological test performance among people with negative schizophrenia

Roberts, Kathrine Ashley

2014-03-26
http://hdl.handle.net10539/14341

Downloaded from a DSpace repository. https://dspace.org/

GENDER DIFFERENCES IN NEUROPSYCHOLOGICAL TEST PERFORMANCE AMONG PEOPLE WITH NEGATIVE SCHIZOPHRENIA.

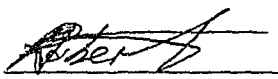
Kathrine Ashley Roberts

A research dissertation submitted to the Faculty of Medicine (Health Sciences), University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Science in Medicine

Johannesburg, 1999

DECLARATION

I, Kathrine Ashley Roberts, declare that this research dissertation is my own, unaided work. It is being submitted for the degree of Master of Science in Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university, nor has it been prepared under the aegis or with the assistance of any other body or person outside the University of the Witwatersrand, Johannesburg.



Kathrine Ashley Roberts

29th Day of April, 1999

ABSTRACT

Gender differences in certain frontal lobe functions were assessed in 40 people (20 men and 20 women) with negative Schizophrenia and 40 people (20 men and 20 women) without any history of psychiatric illnesses. The results indicated that there were few statistically significant differences for certain frontal lobe functions for the men and the women in the Schizophrenic group. One explanation that was provided for these results was that the lack of sex differences in certain frontal functions may be pathognomonic to Schizophrenia, as statistically significant gender differences were found in the Control group on particular tasks that measure frontal lobe functions. The second component of this research compared the results of certain frontal lobe functions in the negative Schizophrenic cohort (N = 40) and the Control group (N = 40). It was found that on most of the measures of frontal lobe functioning the negative Schizophrenic group, displayed greater impairment in these functions than the Control group. Such results provide further evidence that many people with negative Schizophrenia have deficits in frontal lobe functioning. The results of this research are preliminary, as there appears to be no other study of its kind that has been conducted in South Africa. Thus, it is suggested that this research should be replicated in order to determine whether such differences do exist for men and women with Schizophrenia, as such results have implications for aetiology, prognosis and treatment.

ACKNOWLEDGEMENTS

I wish to extend my sincere thanks to the following people without whom this research could not have been possible.

Mr Marc Goldstein, my supervisor. Thank you for all of your invaluable help.

Professor Michael Berk, my co-supervisor. Thank you for all of your words of encouragement, advice, and wisdom. Thank you for encouraging me to always "chug along".

Ms. Celeste Joyce, thank you for all your encouragement in my current venture, and for all the hours you spent in editing my dissertation.

Ms. Marilyn Lukas, thank you for all of your assistance and support.

The people who participated, both those of you with Schizophrenia and those without. Without all of your participation none of this research could have been conducted.

The staff at Sterkfontein Hospital, Gordonia, and Wards 6, 7 and 8 at Tara, H. Moross Centre. In particular I would like to thank Ms. Emmy Jackson, Sister Linda, Sister Sheila, and Sister Blackwood at Tara, and Meghan, Koruna and Tammy at Gordonia.

The staff at the Psychiatry Department, Wits University, Professor Allwood, Alta, Serah, Chantel, and Louise, thank you all for your enduring encouragement and support.

I would also like to thank Mr Peter Fridjon and Esther Viljoen for their help in the statistical analysis of my data.

Thank you to Laura van de Merwe and Rudi Jonker, for laying down the foundation for the path that I have chosen to follow.

I also wish to extend my thanks to my mother, father, my sisters, Samantha and Natalie, my brother-in-law, Rob, and my nieces Daryl-Leigh and Kate-Lynn. Thank you for all of your love, support and encouragement throughout my current venture.

Finally, I wish to thank my friends Greg, Laila, Darren, Sue, Sara, Aunty Yvonne, Inna and Wayne. Thank you for providing me with all of your support.

DEDICATION

I wish to dedicate this dissertation to the people who have been diagnosed with Schizophrenia. Too often in this world we tend to label people. Consequently, the label tends to proceed the person, the individual. Initially when I started this research I too fell victim to this labeling process. However, once the assessments commenced, the labels fell away and all I saw was people, people who, despite their illness, were struggling with life, just as many of us. You all have given me so much and I sincerely thank you. Thank you for the privilege of allowing me to step into your world.

I wish to quote from Oliver Sacks' book *Awakenings* in the hope that researchers, who endeavor to tread the same path as I have, will see you as the individuals that you are.

"There evolved a new concern, a new bond: that of commitment to the patients, the individuals under my care. Through them I would explore what it was like to be human, to *stay* human, in the face of unimaginable adversities and threats. Thus, while continually monitoring their organic nature – their complex, ever-changing pathophysiologies and biologies – my central study and concern became *identity* – their struggle to maintain identity – to observe this, to assist this, and finally, to describe this" (Sacks, 1990, p xxviii-xxvix).

TABLE OF CONTENTS

DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	vii
LIST OF TABLES	xii
INTRODUCTION	1
1.0 **THE FRONTAL CORTEX**	4
1.1 Neuroanatomy of the Frontal Lobes	4
1.2 Luria's Functional Units	6
1.3 Functions of the Frontal Lobes	10
1.3.1 Executive Functions	10
1.3.1.1 Planning	10
1.3.1.2 Abstract Thinking/Reasoning	11
1.3.2 Attention	12
1.3.3 Memory	13
1.3.4 Affect	15
1.3.5 Movement	15
1.3.6 Language	16
1.3.6.1 Spoken Language	16

2.0 **SCHIZOPHRENIA** 18

2.1 The Neuropsychology of Schizophrenia 20

2.1.1 The 'Split' in the Functions of the Frontal Cortex 21

2.1.2 Memory 21

2.1.3 Executive Functions 22

2.1.4 Attention 23

2.1.5 Movement 24

2.1.6 Language 25

3.0 THE POSITIVE-NEGATIVE DICHOTOMY in SCHIZOPHRENIA 29

3.1 The Positive Syndrome 29

3.2 The Negative Syndrome 30

3.3 The Neuropsychology of the Negative Syndrome 31

4.0 SCHIZOPHRENIA AND SEXUAL DIMORPHISM 34

4.1 Normative Sex Differences in the Brain 34

4.2 Sex Differences in Schizophrenia 36

4.3 Gender, Neuroanatomy and Schizophrenia 39

4.4 Gender, Neuropsychology and Schizophrenia 41

5.0 RATIONALE FOR THE PRESENT STUDY

5.1 Hypotheses 49

6.0 METHODOLOGY 50

6.1 Research Design 50

6.2 Subjects 50

6.2.1 Schizophrenic Group 51

6.2.2 Control Group 51

6.3 Procedure 52

6.4 Neuropsychological Test Battery 54

6.4.1 The Rey Complex Figure Test 54

6.4.2 The Modified Card Sorting Test 55

6.4.3. The Tower of London 57

6.4.4 Block Counting 58

6.4.5 Stroop Colour and Word Test 59

6.4.6 Trail Making Test 60

6.5 Statistical Analysis 60

7.0 RESULTS 62

7.1 Introduction 62

7.2 Within-group Analysis 62

7.2.1 Rey Complex Figure 63

7.2.2 Modified Card Sorting Test 65

7.2.3 Tower of London 66

7.2.4 Block Counting Task 68

7.2.5 Stroop Colour and Word Test 69

7.2.6 Trail Making Test 71

7.3 Statistical Analysis Between-groups 72

7.3.1 Rey Complex Figure 72

7.3.2 Modified Card Sorting Test 74

7.3.4 Tower of London Test 75

7.3.5 Block Counting Test 76

7.3.6 Stroop Colour and Word Test 77

7.3.7 Trail Making Test 79

8.0 DISCUSSION 80

8.1 Discussion of Within-group Results 80

8.1.1 Introduction 80

8.1.2 Rey Complex Figure 81

8.1.3 The Modified Card Sorting Test 82

8.1.4 Tower of London 83

8.1.5 Block Counting Test 84

8.1.6 Stroop Colour and Word Test 85

8.1.7 Trail Making Test 85

8.1.8 Conclusions for Within-group Analysis 86

8.2 Discussion of Between-group Analysis 91

8.2.1 Introduction 91

8.2.2 Rey Complex Figure 91

8.2.3 Modified Card Sorting Test 92

8.2.4 Tower of London Test 94

8.2.5 Block Counting Test 94

8.2.6 Stroop Colour and Word Test 95

8.2.7 Trail Making Test 96

8.2.8 Conclusions for Between-group Analysis 97

8.3 Limitations 99

8.4 Recommendations 100

8.5 Conclusions 101

APPENDICES

APPENDIX A: Consent form and subject information sheet 103

APPENDIX B: Types of Medication for the Schizophrenic group 107

REFERENCES 108

LIST OF TABLES

Table 1 DSM-IV criteria for diagnosing Schizophrenia. 19

Table 2 Mann-Whitney Test of Within-Group Analysis for the Rey Complex Figure. 63

Table 3 Means and Standard Deviations for the Rey Complex Figure. 64

Table 4 Mann-Whitney Test of Within-Group Analysis for the Modified Card Sorting Test. 65

Table 5 Means and Standard Deviations for the Modified Card Sorting Test. 65

Table 6 Mann-Whitney Test of Within-Group Analysis for the Tower of London Test. 66

Table 7 Means and Standard Deviations for the Tower of London Test. 67

Table 8 Mann-Whitney Test of Within-Group Analysis for the Block Counting Test. 68

Table 9 Means and Standard Deviations for the Block Counting Test. 68

Table 10 Mann-Whitney Test of Within-Group Analysis for the Stroop Colour and Word Test. 69

Table 11 Means and Standard Deviations for the Stroop Colour and Word Test. 70

Table 12 Mann-Whitney Test of Within-Group Analysis for the Trail Making Test. 71

Table 13 Means and Standard Deviations for the Trail Making Test. 71

Table 14 Mann-Whitney Test of Between-Group Analysis for the Rey Complex Figure. 72

Table 15 Means and Standard Deviations for the Rey Complex Figure. 73

Table 16 Mann-Whitney Test of Within-Group Analysis for the Modified Card Sorting Test. 74

Table 17 Means and Standard Deviations for the Modified Card Sorting Test. 74

Table 18 Mann-Whitney Test of Within-Group Analysis for the Tower of London Test. 75

Table 19 Means and Standard Deviations for the Tower of London Test. 75

Table 20 Mann-Whitney Test of Within-Group Analysis for the Block Counting Test. 76

Table 21 Means and Standard Deviations for the Block Counting Test. 76

Table 22 Mann-Whitney Test of Within-Group Analysis for the Stroop Colour and Word Test. 77

Table 23 Means and Standard Deviations for the Stroop Colour and Word Test. 78

Table 24 Mann-Whitney Test of Within-Group Analysis for the Trail Making Test. 79

Table 25 Means and Standard Deviations for the Trail Making Test. 79

INTRODUCTION

A number of variables appear to modify the clinical expression of schizophrenia, resulting in it being seen as a heterogeneous disorder. Some of these modifying variables include symptomatology and sex. There have been very few studies that have investigated sex differences in neuropsychological test performance in people with negative symptom schizophrenia. Furthermore, in those few studies that have focused on this area, little consensus has been reached as to whether men and women with schizophrenia do differ in certain neuropsychological functions.

There were two main aims of the current research. The first aim was to determine whether sex differences exist in certain frontal functions among people who predominantly display the negative signs and symptoms in schizophrenia. There were three reasons for looking at this line of research. Firstly, previous research has shown that men with schizophrenia tend to have a more debilitating form of the disorder, in that they develop schizophrenia at an earlier age, they generally have a poorer prognosis, and are often less receptive to neuroleptic medication. Secondly, to determine whether the sex differences (or lack thereof) that are found in schizophrenia are pathognomonic to this disorder, or whether such sex differences are found in all populations, reflecting the sexual differentiation and specialisation of the brain, in certain neuropsychological functions. Finally, the author believes that by determining whether sex differences exist in people with schizophrenia, may expand on current theoretical ideas concerning the aetiology, prognosis and treatment of this disorder.

The second aim of this research was to compare the same specific frontal lobe functions in the same group of people with negative schizophrenia and the control group. The reason for investigating this area was to determine whether people with schizophrenia were more impaired than a normative sample on these tasks, and thus provide further evidence that people with schizophrenia tend to be predisposed to displaying greater deficits in frontal lobe functions, than a normative sample.

Thus, the chapter outline is as follows:

Chapter One discusses information regarding the frontal cortex, the gross neuroanatomy, and some of the functions that have been ascribed to this area. In addition to this, Luria's model with regards to brain organisation and functioning, with particular emphasis on Unit III (the frontal cortex) is also discussed in this chapter.

Chapter 2 opens with a brief synopsis of some of the characteristics that have been associated schizophrenia. The main focus of this chapter is to consider some of the findings from previous studies that have found frontal lobe impairments in some people with schizophrenia.

The central focus of Chapter 3 is to discuss previous research which has focused on the Negative syndrome of schizophrenia, and the neuropsychological deficits that have been associated with the Negative syndrome.

Chapter 4, the focal point of the entire research, gives an in depth account of sex differences in the brain. The chapter commences with one theory that has been proposed as to why normative sex differences occur in the brain. Following on from this, a discussion of previous studies that have focused on sex differences in neuroanatomical and neuropsychological in people with schizophrenia will be discussed.

Chapter 5 provides the rationale and hypotheses for the present research.

Chapter 6, the Methodology, focuses on the research design, subjects, and procedures that will be used in the current research. It also gives an in-depth account of the neuropsychological tests that will be used, and the statistical tests that will be used to analyse the current results.

Chapter 7 provides the results that were found in the current research.

Chapter 8 is an in-depth discussion of the results of the current research and corroborates these findings with the results from previous studies. It also discusses some of the limitations of the current research, and proposes some recommendations for future research in this area.

1.0 THE FRONTAL CORTEX

The frontal cortex assumes the position as one of the most highly functioning structures in the human brain. Not only is this area one of the most recently developed cortical structures phylogenetically (Walsh, 1987; Luria, 1973), but it is also one of the last cerebral areas to mature ontogenetically, which according to Luria (1973), usually occurs between the ages of 4 to 7 years of age.

The following discussion will primarily review current opinions regarding the functions of the frontal lobes. However, before proceeding to discussing some of these functions, a brief overview of the gross neuroanatomy of the frontal lobes, and one of the models that have been proposed, will be considered first.

1.1 Neuroanatomy of the Frontal Lobes

The frontal cortex is one of the largest components of the human brain, comprising approximately one third of the cerebral matter. It is located anterior to the central sulcus and dorsal to the lateral fissure (Damasio and Anderson, 1993; Fuster, 1989; Stuss and Benson, 1986).

Neuroanatomists have divided the frontal lobes into three distinct areas. The first is the motor area, which is found anterior to the central fissure, (that is, it occupies the region of the precentral gyrus). The motor area is the site that has been associated with the integration of motor skills. The second component of the frontal lobes, is the premotor area, which is located anterior to the motor area. The premotor area is

linked to the motor area, both in terms of function and anatomy (Barr, 1979; Damasio and Anderson, 1993; Fuster, 1989; Lezak 1995; Stuss and Benson, 1986; Walsh, 1994).

Finally, the third area of the frontal lobes, the prefrontal cortex, is situated anteriorly to the premotor and the motor areas. This area comprises the greater part of the frontal lobe, and is one of the most important structures of the brain. The reason for its importance is that it is an area of the brain that has extensive connections with virtually every other part of the brain. That is, both efferent and afferent fibers carrying information from the posterior cortex, and information about the internal states from the limbic system, converge at the prefrontal cortex (Barr, 1979; Chute, 1998; Damasio and Anderson, 1993; Fuster, 1989; Lezak 1995; Stuss and Benson, 1986; Walsh, 1994). Consequently, the nature of the frontal cortex is complex, both in terms of anatomy, and in terms of its functioning.

Because of its anatomical complexity, and its extensive connections with other structures of the brain, the functioning of the frontal lobes remains somewhat elusive. A number of functions of the frontal lobes have been identified through observing and testing the behaviours, in individuals who have sustained frontal lobe injuries (Lezak, 1995; Stuss and Benson, 1986; Walsh, 1994).

However, one of the main criticisms with studying brain-behaviour relationships is that it is sometimes impossible to localize a specific area of the brain with a particular function. Thus, some researchers have discarded the localization of certain functions, and have rather focused on a more holistic approach involved in brain-behaviour

relationships. One such researcher, who combined both the localization and holistic approaches for studying brain-behaviour relationships, was Alexander Luria.

1.2 Luria's Functional Units

Luria proposed a functional unit approach to study brain functioning. He divided the brain into three principal functional units, these being, Unit I, Unit II and Unit III.

Luria (1973) asserted that, Unit I, the most 'primitive' component, is the unit for regulating arousal and tone. The structures that are associated with Unit I are located in the medial surfaces of the cerebral hemispheres and in the brain stem. The most important component in the brain stem, is the reticular activating system (both ascending and descending), whereas many of the structures that make up the limbic system are important for the medial cerebral component. According to Luria (1973), the activity of Unit I (that of regulating tone and arousal), is a prerequisite for all other forms of cognitive functioning. However, there is a reciprocal relationship between the cortex and the lower cerebral structures, whereby Unit I influences and is influenced by the cortex (Kagan and Saling, 1988; Luria, 1973).

Both Units II and III occupy the neocortical areas and are positioned on the lateral surfaces of the cerebral hemispheres. Unit II is located in the region of the occipital, temporal and parietal lobes, whereas Unit III consists of the frontal lobes (Kagan and Saling 1988; Luria, 1973).

Luria (1973) contended that the task of Unit II is for receiving, processing, and storing information. He identified three modes of input (analyzers) for Unit II these being audition, vision and tactile-kinaesthetic. Once again, Luria (1973) argued that it is imperative that Unit I is fully functional, prior to Unit II being able to operate adequately. Furthermore, Unit II has to be functional before Unit III can carry out its cognitive tasks (Kagan and Saling, 1988).

The unit that is directly pertinent to this study is Unit III. According to Luria (1973), this functional unit is located in the frontal lobes, and appears to be the "directive controlling force" of the brain (Luria, 1973 cited in Stuss and Benson, 1986, p.237). Luria (1973) argued that Unit III is responsible for, the formulation of plans, programs and intentions. It is also the area that is responsible for ensuring that behaviour is regulated so that it conforms to these plans and programs. One of the final tasks of Unit III, is to validate conscious activity, comparing the effects of the actions, with the original intentions (Luria, 1973). Thus, Unit III appears to function at the apex of brain functioning.

Luria (1973) asserted that the functions of the frontal lobes (Unit III) have to act in collaboratic with other cerebral structures to which they are connected, in order to function adequately. Furthermore, the current researcher believes that there are certain cognitive tasks, (for example, memory), that require other cognitive operations, such as attention, in order to be performed. A more in-depth account of some of the other functions that are governed by the frontal lobes will be considered in the following section.

According to Luria (1973), there are three zones that are associated with Units II and III, the primary, secondary and tertiary zones, and these zones are hierarchically arranged. The primary zone of Unit II, is the most rudimentary, and receives neural impulses from the sense organs via projection pathways. Thus, the task of the primary zone of Unit II is to mediate awareness of basic physical changes that occur in both the external and internal environments. Furthermore, each of the three analyzers of Unit II (vision, audition and tactile-kinaesthetic) has its own primary zone (Kagan and Saling 1988; Luria, 1973).

According to Luria (1973), there is a specific secondary zone that is associated with each primary zone, which is located adjacent to the primary zone. The main function of the secondary zone of Unit II is for synthesising the sensory information, which is obtained from the primary zone, and organising this information into perceptual wholes (Kagan and Saling, 1988). The information that has been organised from the second zone, is then fed into a common tertiary zone, and it is at this zone where the information is integrated, a process which Luria (1973) termed 'intermodal synthesis'. This then forms the basis of certain cognitive processes, such as concrete spatial synthesis and complex linguistic functions (Kagan and Saling, 1988).

Luria (1973) contended that there are also three zones that are associated with Unit III: primary, secondary and tertiary zones. However, unlike Unit II, which has three input channels (visual, auditory, and tactile-kinaesthetic), Unit III has a single output channel. Furthermore, the direction of information flow for the two units is also different. Since Unit II essentially deals with the input of information, the direction of information flow in Unit II will be such that information will flow from the periphery

to the tertiary cortex. In contrast to this, Unit III is concerned with information output, thus information will flow from the tertiary cortex, through the secondary and primary cortices to the effectors, that is information flows from Unit III, to Unit II and then finally to Unit I (Kagan and Saling 1988).

Luria (1973) regarded the tertiary zone of Unit III, as the most intricate regulatory mechanisms of the brain, as it has afferent connections with almost every other part of the brain. The function of the tertiary zone involves assembling the information necessary for actions, plans the broad framework within which action is realized, and finally establishes its effectiveness (Kagan and Saling, 1988; Luria, 1973).

The secondary zone of Unit III receives information from the tertiary zone and programs this information into specific details of action. Thus, the secondary zone of Unit III determines the sequential structure, or what Luria (1973) termed the "kinetic melody" of movement. (Kagan and Saling, 1988; Luria, 1973).

Finally, once the particular sequence of movement has been worked out, the primary zone of Unit III will initiate contractions of the individual muscle apparatus, and thus the sequence is complete (Kagan and Saling, 1988).

Having discussed one of the theories that have been proposed with regards to the neuroanatomical substrates, and some of the functions that have been ascribed to these areas, some the specific functions that have been attributed to the frontal lobes will now be discussed.

1.3 Functions of the Frontal Lobes

One of the main methodologies which researchers have used in order to determine some of the functions of the brain, is through assessing the types of behaviour that is displayed in people who have sustained brain injuries. It has been through such in-depth neuropsychological investigation that a number of important cognitive functions have been associated with the frontal cortex.

1.3.1 Executive Functions

Traditionally, theorists have included a number of components that were ascribed to "executive functions". These components of the executive functions included: planning, goal selection, abstract reasoning, anticipation, monitoring behaviour and the use of feedback (Lezak, 1995; Luria, 1973; Stuss and Benson, 1986). However, for the purposes of the current research, the author will only focus planning and abstract reasoning, as these two components of executive functions, may be measured quantitatively.

1.3.1.1 Planning

One of the main executive functions that have been identified is planning. Planning involves the identification and the organisation of behaviour into stages, in order to carry out, and to reach the intention or to achieve a goal (Lezak, 1995). According to Luria (1973) damage to the frontal cortex leads to a profound disturbance of complex behavioural programmes and to a "marked disinhibition of immediate responses to

irrelevant stimuli" making it impossible in the forming of complex behavioural programmes (Luria, 1973, p.91). It appears that such patients do not perform any preliminary analysis of the given situation. Such an inability, to efficiently integrate cognition and action into an organised pattern of behaviour, results in a patient being unable to successfully complete an orientating activity in complex tasks (Luria, 1973).

However, as with most cerebral functions, planning ability cannot be seen in isolation. Therefore, many theorists have posited that there appears to be a strong link between deficits in planning ability, attention, memory, affect and abstract reasoning (Duncan, 1986; Kimberg, 1997; Luria, 1973; Stuss and Benson, 1986).

1.3.1.2 Abstract Thinking/Reasoning

It has been found that people with damage to the frontal lobes often show deficits in abstract thinking. Abstract reasoning involves "making complex associations between semantic elements and identifying super-ordinate categories, reasoning by general rules and formulating hypotheses" (Chute, 1998, p.2). Such an operation enables the individual to transcend the current situation that is presented to him/her. In addition to this, it often affords the individual the ability to have initiative and for[illegible]nto his/her behaviour. This inability in abstract thinking has been observed through a person's failure to shift cognitive set, while performing certain neuropsychological tasks, such as the Wisconsin Card Sorting Test (Stuss and Benson, 1986; Walsh, 1987).

One common response, which is indicative of this failure to shift cognitive set, and hinders abstract thinking, is perseveration. Perseverative errors appear to reflect a broader cognitive inability to inhibit dominant schemas or central sets (Kimberg, 1997; Shallice, 1988;), and is considered to be a general reflection of behavioural rigidity (Goldberg and Bilder, 1987). Furthermore, patients with frontal lobe injuries often display deficits in response suppression and initiation (Burgess and Shallice, 1996; Cockburn, 1995, Kimberg et al., 1997; Luria, 1973). These types of responses, not only affect abstract reasoning, but will also impede other cognitive processes.

1.3.2 Attention

The frontal cortex, notably the prefrontal area, is one of the many structures that are involved in attention. Its main role is in the regulation and arousal of attentional states. According to Luria (1980), the medio basal area is an important component in setting the level of activation of the brain, and is therefore involved in attention. In addition to this, the frontal cortex maintains connections with important subcortical structures, such as, the limbic system and the reticular system, all of which play a specific role in states of attention. Such extensive connections with these areas, enables the prefrontal cortex to monitor arousal states elicited by extrinsic and intrinsic stimuli and to exert a regulatory influence over a number of cortical functions (Benson and Miller, 1997; Pandya and Barnes, 1987; Pribram, 1987). Two criteria appear to be involved in attention: the direction of concentration and the selection of material. Thus, not only are the frontal lobes involved in monitoring arousal states, but they also play a role in directing and selecting information that needs to be processed (Stuss and Benson, 1986).

According to Lezak (1995), patients who have sustained frontal lobe injuries will be susceptible to distractibility, whereby the individual will be drawn towards irrelevant stimuli. In addition to this, Fuster (1989) contends that such patients may have a lowering of general awareness in his/her immediate environment, and/or may even experience sensory neglect. Finally, frontal lobe patients, may display disorders of visual search and gaze control, whereby they may show an inability to actively direct and sustain attention and have difficulty in concentration (Fuster, 1989).

Therefore, it may be seen that, impairments to the frontal lobes often lead to an inability to regulate and sustain attention. In addition to this, impairments in attention may affect an individual's ability to plan, select and monitor their performance on certain tasks, and impair other cerebral functions, such as memory.

1.3.3 Memory

The hippocampus, amygdala (both of which are sub-cortical structures and form part of the limbic system) and the temporal lobes tend to be designated as the sites for memory functioning. However, memory, and the functions associated with it, is heterogeneous. Consequently, the nature of the memory impairments that have been observed in patients who have sustained brain damage, depends largely on the site and the extent of the lesion(s). For example, "associative" memory (Damasio and Anderson, 1993), and "declarative" memory (Giovannetti, 1998) are usually left intact following frontal lobe lesions. However, it is possible that injuries to the frontal lobes may indirectly lead to disruptions to these types of memory. The reason for this proposition is that the frontal lobes are closely interconnected with the limbic-

diencephalic neuronal pathways, which are involved in the processing of these types of memory. Thus, the impairments that have been associated with these two types of memory may be due to "impaired search strategies and a weak ability to organise information" (Giovannetti, 1998, p2), two functions which are directly related to the frontal lobes.

There are particular memory impairments that have been associated with damage to the frontal lobes. For example, disturbances in working memory (short-term memory) have been found in patients following frontal lobe lesions (Cockburn, 1995; Damasio and Anderson, 1993; Fuster, 1989; Kimberg, 1997) However, it has been argued that this particular type of defect in short-term memory, is strongly dependent on attention (Fuster, 1989). Therefore, it has been difficult to ascertain whether the deficit constitutes a "pure" memory problem, or whether the impairment in memory is a secondary consequence of disorders in attention.

Furthermore, some theorists have actually questioned whether the dysfunctions associated with working memory (short-term memory) following frontal lobe lesions do in fact exist. For example, Stuss and Benson (1986) suggest that "the prefrontal cortex has a directive, organisational, controlling role in the process of memory"(Stuss and Benson, 1986, p.151). They propose that deficits in short-term memory (working memory) are products of a general inability to respond to the information at the required time, rather than an inability to learn and remember.

As may be seen from the above, the deficits in memory may constitute a "pure" deficit in memory, that is an inability to "learn and remember". Alternatively,

impairments in other neurocognitive functions, such as attention, may lay down the foundation for subsequent memory impairments. The point quite simply is this, memory impairments have been found in many people who have sustained injuries to their frontal lobes, the nature of such impairments to memory, depend on the site(s) and the extent of the lesion(s).

1.3.4 Affect

Two main types of affective disorders, namely apathy and euphoria, have been noted in patients who have sustained damage to the frontal lobes (Fuster, 1989; Stuss and Benson, 1986). Apathy is "characterised by low awareness, lack of initiative and hypokinesis" (Fuster, 1989, p.142). In contrast to this, emotions of euphoria have also been observed in people who have damage to the frontal lobes. This abnormal elevation of mood, is often accompanied by disorders of attention and motility, these being distractibility and hyperactivity (Fuster, 1989). The disorders of hyperactivity and hypokinesis will be explicated below.

1.3.5 Movement

The motor and the premotor areas are located in the frontal cortex. Thus, damage to the frontal cortex often results in certain impairments in motility. It has been found that lesions to the posterior frontal regions, adjacent to the motor cortex lead to disturbances in the organisation of movement (Damasio and Anderson, 1993). Such dysfunctions in movement include motor neglect, hypokinesis, and hyperactivity (hyperkinesis). In hypokinesis there is a general decrease of spontaneous motor

activity. In contrast, hyperkinesis refers to excessive and aimless (Fuster, 1989). Both hyperkinesis and hypokinesis have been observed in a person's everyday functions, and have also been detected during certain neuropsychological tests which are known to measure visuo-constructive abilities, such as the Rey Complex Figure and the Block Design test, whereby people with hypokinesis tend to have slowed responses, whereas those with hyperkinesis tend to display impulsivity (Lezak, 1995; Stuss and Benson, 1986).

1.3.6 Language

The relationship between the frontal lobes and language is two fold. Firstly, certain speech centres (for example, Broca's area) are situated in the frontal lobes, and are primarily involved in spoken language. Secondly, language has a supervisory role on various cognitive and motor tasks, and this too, it has been argued, is mediated by the frontal lobes. Such deficits in the supervisory role of language often appear as a dissociation between language and motor behaviour, which may reflect a general dysfunction in planned and goal directed behaviour (Kimberg, 1997; Luria, 1973; Shallice, 1988). For the purposes of the current research, the current author will only discuss the role of the frontal cortex involved in spoken language.

1.3.6.1 Spoken Language

Dysfunctions in language production have been associated with damage to the speech centres of the dominant hemisphere of the brain. However, as with other cognitive impairments, the nature of the dysfunctions in language depends on the site and the

extent of the lesion. For example, injury involving the inferior area of the premotor frontal gyrus may lead to either Broca's aphasia, where verbal fluency is impaired, or transcortical motor aphasia, where speech is reduced (Alexander, 1997; Benson, 1979, 1988; Chute, 1998; Lezak, 1995). Furthermore, lesions involving the motor association area (including the cingulate gyrus) of the frontal lobe, often result in a disruption of speech production, whilst comprehension remains intact. In such cases, there is usually either a total lack of speech, or speech is dramatically reduced. The quality of speech may also be impaired and is often indicated by poor or monotonous tone (Damasio and Anderson, 1993; Lezak, 1995). Finally, various parts of the left dorsolateral frontal lobe have connections with subcortical structures and posterior cortices that provide the substrate for linguistic production and comprehension. Therefore, like many of the other functions that have been discussed above, the characteristic deficits that are associated with the language impairment are dependent upon the locus of the lesion, as well as its severity.

Some of the functions of the frontal lobes have been discussed above. As may be seen, the frontal lobes are involved in a complex array of cerebral functions, some of which act independently, while other functions work in collaboration with each other. All of the functions discussed above are open to neuropsychological investigation. In the proceeding chapter, the primary focus will be on the frontal deficits that have been found in people with schizophrenia.

2.0 SCHIZOPHRENIA

Schizophrenia is a pervasive disorder marked by a number of deficits that affect all areas of functioning. The DSM-IV presents a number of criteria for diagnosing schizophrenia: 1) The presence of characteristic psychotic symptoms for at least one week duration; 2) deterioration in social and occupational functioning and self-care; 3) the ruling out of a major mood syndrome, or if present, the mood syndrome is brief in duration relative to the duration of the Schizophrenic disturbance; 4) continuous signs of the disturbance for at least 6 months; 5) ruling out of an organic mental disorder and 6) if there is a history of autistic disorder, the additional diagnosis of schizophrenia is made only if prominent delusions and hallucinations are also present. Table 1 below provides additional criteria for diagnosing schizophrenia.

Table 1. DSM-IV criteria for diagnosing schizophrenia

A. Characteristic symptoms: Two (or more) of the following, each present for a significant portion of time during a 1-month period (or less if successfully treated):

1) Delusions

2) Hallucinations

3) Disorganised speech (e.g. frequent derailment or incoherence)

4) Grossly disorganised or catatonic behaviour

5) Negative symptoms, i.e. affective flattening, alogia or avolition

B. Social, occupational dysfunction: For a significant portion of the time since the onset of the disturbance, one or more major areas of functioning, such as work, interpersonal relations, or self care are markedly below the level achieved prior to the onset (or when the onset is in childhood or adolescence, failure to achieve expected level of interpersonal, academic, or occupational achievement).

Duration: Continuous signs of the disturbance persist for at least 6 months. This 6-month period must include at least one month of symptoms (or less if successfully treated) that meet Criterion A (i.e. active phase symptoms) and may include periods of prodromal or residual symptoms. During these prodromal or residual periods the signs of the disturbance may be manifested by only negative symptoms or two or more symptoms listed in Criterion A, present in an attenuated form (e.g. odd beliefs, unusual perceptual experiences).

C. Schizoaffective and Mood Disorder exclusion: Schizoaffective Disorder and Mood Disorder with Psychotic Features have been ruled out because either (1) no Major Depressive, Manic, or Mixed Episodes have occurred concurrently with the active-phase symptoms, their total duration has been brief relative to the duration of the active and residual periods.

D. Substance or general medial condition exclusions: The disturbance is not due to the direct physiological effects of a substance (e.g. a drug abuse, a medication, or a general medical condition.

E. Relationship to a Pervasive Developmental Disorder: If there is a history of Autistic Disorder or another Pervasive Developmental Disorder, the additional diagnosis of schizophrenia is made only if prominent delusions are also present for at least a month (or less if successfully treated).

(APA DSM-IV, 1994, pp285-286)

As can be seen from the above table, the diagnosis of schizophrenia encompasses an array of criteria. Once a diagnosis of schizophrenia has been made, the clinical picture may become more tangible. One result of this will include, cognitive deficits, which affect all domains of functioning.

2.1 The Neuropsychology of Schizophrenia

The neuropsychological deficits that have been observed in schizophrenia are global in nature, and thus cannot be restricted to one specific cognitive domain. Furthermore, there are no signs and symptoms that are pathognomonic for schizophrenia, and very often such disorders, like schizophrenia, do not exist in a "pure" form, but rather have comorbidity with other disorders, such as the mood disorders. Like many psychiatric illnesses, the diagnosis of schizophrenia is relatively fluid. Consequently, a person's diagnosis may change over time, depending on the signs and symptoms that they may exhibit (Comer, 1995; Kaplan and Saddock, 1994). Finally, it should be borne in mind that many neurocognitive functions may either operate in a synergistic manner, or may represent different neurocognitive constructs, which act independently. Consequently, a deficit in one cognitive process, for example, attention (Fuster, 1989), may affect the functioning of another cognitive process, for example, visual-spatial memory (Pantelis, et al., 1997). However, the converse is not always true. The following sections will primarily focus on some of the neuropsychological deficits that have been found in people with schizophrenia.

2.1.1 The 'Split' in the Functions of the Frontal Cortex

Many people with schizophrenia often manifest clinical symptoms suggestive of frontal lobe dysfunction. It was Emile Kraepelin who, at the turn of the century, first suggested that dementia praecox was a disease of the frontal lobes (1919/ trans. Barclay, 1971). With the increase in the utilisation of neuropsychological tests, advances have been made in the measurement of cognitive deficits that have been associated with schizophrenia, particularly with regards to those functions that implicate the frontal lobes. Some of these dysfunctions will be explicated below.

2.1.2 Memory

As discussed in the section on the functioning of the frontal cortex, certain types of memory have been linked to the frontal lobes. The types of memory impairment that have been found in schizophrenia, usually resembles the memory dysfunctions of people who have sustained frontal lobe injuries. Specific studies which have focused on memory functioning in schizophrenia have found deficits in sequential memory, (Dickerson et al, 1991); verbal memory, (Nathaniel-James, et al., 1996; Saykin et al., 1991); auditory working memory (Gold, et al., 1997) and visual-spatial working memory (Pantelis, et al., 1997). It may therefore be proposed that, the memory deficits that have been found in schizophrenia may reflect the involvement of many different memory systems, rather than reflect an unspecific, global deficit in memory. Furthermore, the memory impairments that have been observed in people with schizophrenia appear to be primarily subserved by the frontal lobes.

It has been argued that the memory deficits in schizophrenia may be related to anticholinergic medication, rather than to the disease itself (Saykin, et al 1991). However, not all theorists are in concordance with this view (Cassens, Inglis, at al, 1990; Verdoux, Magnin and Bourgeois, 1995)

Some theorists have proposed that there may be a strong correlation between aspects of memory (and the deficits associated with it) and certain components of the executive functions. Thus, they argue that the deficit that is seen in people with schizophrenia, may be a result of dysfunctions in components of the executive functions rather than the memory system, per se (Nathaniel, Brown and Ron, 1996; Nestor, Shenton, Wible, et al., 1998).

Despite these criticisms, many cognitive processes, such as memory, and the corresponding impairments, cannot be seen in isolation. Such operations sometimes require additional cognitive processes, such as the executive functions, in order to function adequately.

2.1.3 Executive functions

Many neuropsychological tests, which are thought to tap into some of the components of the executive functions, such as abstract thinking and planning, have been found to be impaired in people with schizophrenia. Three of the main tests, that primarily assess planning and abstract abilities, are the Wisconsin Card Sorting Test, the Rey Complex Figure and the Tower of London task. A number of studies have shown impaired performance in these three tests in some people with schizophrenia (for

example, Blachard and Neale, 1994; Butler et al 1992; Dickerson, et al, 1991; Goldberg, et al., 1988; Kolb and Whishaw, 1983; Morice, 1990; Morice and Delahunty, 1996; Morrison-Stewart, Williamson, Corning, Kutcher, Snow, and Merskey, 1992; Saykin et al., 1991; Seidman, et al., 1994; Taylor, and Abrams, 1984; Williamson, et al., 1989).

2.1.4 Attention

The deficits in attention that have been found in schizophrenia resemble those deficits that have been observed in people who have sustained injuries to the frontal lobes. Thus, people with schizophrenia will generally be susceptible to distractibility, display a lowering of general awareness to their immediate environment, and they may even show an inability to actively direct and sustain attention, and have difficulty in concentration (Fuster, 1989).

One theory that has focused on these deficits in attention in schizophrenia, is the defective filter theory (Corcoran and Frith, 1993). This theory posits, that people with schizophrenia, are unable to inhibit irrelevant information. As the attention system is thought to have limited capacity, the person will attend to this irrelevant information, and is left with a sense of being flooded with information. Thus, a resultant deficit in attention will be observed, and this will lead to a decrease in the performance of the task.

2.1.5 Movement

One of the main disturbances in movement and that is believed to be pathognomonic for schizophrenia, is tardive dyskinesia (Fenton, Blyler, Wyatt and McGlashan, 1997). This involuntary, stereotyped movement usually manifests itself as grossly disorganised movement in certain regions of the body. One example of tardive dyskinesia is facial grimacing (Comer, 1995).

Other deficiencies in the motor functions of people with schizophrenia appear to be more abstruse. For example, they may display slower movement times whilst completing certain visuo-constructive tasks, such as the Tower of London test (Pantelis, Barnes, Nelson, et al., 1997).

These disturbances in movement cannot be entirely attributed to the adverse reactions of neuroleptic medication. In a recent study it was found that, patients with schizophrenia still displayed tardive dyskinesia, even though they had never been administered neuroleptic medication, or they had been on medication for a limited period of time (less than a month) (Gervin, Browne, Lane, et al., 1998). In addition to this, in the classic cases of schizophrenia (that is, prior to the administration of neuroleptics), catatonic behaviour was a common feature in some individuals with schizophrenia. However, with the introduction of neuroleptics, the prevalence of this motor dysfunction diminished (Comer, 1995). Therefore, it appears to be the disease process itself, which may account for such disorders in movement. Another neurocognitive feature that has been found to be dysfunctional in schizophrenia, and is linked to motor functioning, is language.

2.1.6 Language

It is well established that many people with schizophrenia display a variety of language impairments. These disturbances in language seem to take on two forms, whereby they are either excessive or deficient in nature.

The excessive nature of their verbal expression in some individuals with schizophrenia, is reflected by their idiosyncratic language style, and may include neologisms, echolalia, clanging, and loose associations[1]. Consequently, their speech may be perceived as being tangential, with little coherence and/or meaning (Comer, 1995; APA, DSM-IV, 1994). These types of dysfunctions in language tend to be more predominant in people who display the positive syndrome.

A number of studies have also indicated deficits in the domain of language, in some people with schizophrenia (for example, Blachard and Neale, 1994; Crawford, Obonsawin and Bremner, 1993; Dickerson et al., 1991; Morrison-Stewart, Williamson, Corning, et al., 1992). The predominant dysfunction appears to be poverty of speech (alogia), whereby the individual with schizophrenia displays "a decreased command and productivity of speech characterised by brief and empty replies" (Comer, 1995,p527). Such deficits in language functioning tend to be more characteristic of those people who display negative signs and symptoms.

[1] Neologisms – made-up words that only have meaning to the individual using them. Loose associations/derailment – rapidly shift from one topic to another; statements are incoherent and inconsequential. Clanging – use rhyme throughout speech. Echolalia/parroting – repetition of words.

However, not all studies that have been conducted concur that people with schizophrenia have language impairments. Some studies have found few differences between the language abilities between people with schizophrenia and those without schizophrenia (Goldberg, et al., 1988; Goldstein, Beers and Shemansky 1996; Hoff et al., 1992; Morrison-Stewart, Williamson, Corning, Kutcher, Snow and Merskey, 1992). These discrepancies in the literature may be due to a number of reasons. Firstly, there may have been a bias in the selection of the sample. For example, men are known to be more impaired than women on tasks that require linguistic abilities (Lezak, 1995). Consequently, if there were more men in a sample, this may account for the reduced performance in a particular language task. Secondly, the type of neuropsychological tests (for example, the Stroop Colour and Word Association Test and the Category Generation Test) that have been used to assess certain language functions may also confound the results. Thirdly, language ability is subserved by a multitude of other functions. Thus, impairment in one of these functions, for example, motor functioning, may lead to impairments in the domain of language. This has been demonstrated recently in a study conducted by Goldstein, Beers and Shemansky (1996).

Goldstein, Beers, and Shemansky (1996) compared people with schizophrenia, who performed poorly on the Wisconsin Card Sorting Test (WCST), and those who performed well on this test. They found language impairments only in the poor WCST performer group. From this study, they concluded that, poor performance on the WCST could not be seen in isolation. Rather, they asserted that such poor performance on the WCST was indicative of a pervasive cognitive impairment in the poor-performing group. Similarly, Goldman (1994) proposed that the fundamental

impairment, which may lead to, formal thought disorder in schizophrenia, is a defect in working memory, rather than being an isolated deficit in the realm of language. The fourth reason for the disparities in the literature with regards to language impairments in schizophrenia relates to medication. Once again, it has been postulated that, medication status may affect language functioning in people with schizophrenia.

In one study it was demonstrated that mean verbal score of unmedicated subjects was lower than the verbal mean score of medicated subjects (Crawford, Obonsawin and Bremner, 1993). From this study it appears that medication may actually increase performance on certain cognitive tasks, rather than hinder performance. Finally, the nature of the dysfunctions in language (in addition to the other deficits in certain neuropsychological processes) that have been observed in people with schizophrenia, appear to be synchronous with symptomatology. For example, echolalia and neologisms appear to be more prevalent in people with the positive type of schizophrenia, whereas poverty of speech is more often associated with people with negative symptomatology (Comer, 1995). This will be elaborated on in the following chapter. All of these factors need to be taken into account not only when one is researching linguistic abilities, but also when one is measuring other neurocognitive functions.

As can be seen from the above chapter, people with schizophrenia often display a number of pervasive impairments in the functions that have been ascribed to the frontal cortex. However, there are a number of factors that may lead to a greater propensity of displaying such deficits. Two constituents, which may influence the nature of the neuropsychological impairments that are displayed in schizophrenia, are

symptomatology and sex. These two factors will be discussed in the subsequent chapters.

3.0 THE POSITIVE-NEGATIVE DICHOTOMY IN SCHIZOPHRENIA

As stated in the previous chapter, *The Neuropsychology of schizophrenia*, one of the factors that appear to determine the types of cognitive impairments displayed in schizophrenia, is symptomatology.

Historically schizophrenia was subdivided into Paranoid, Catatonic, Disorganised and undifferentiated types (Comer, 1995). More recently, some theorists have reassessed this method of classification, and now subdivide schizophrenia into positive and negative syndrome groups (Andreasen, 1982, 1985; Kay, et al, 1987, 1989). It has been argued that, both of these syndromes are important in terms of aetiology, pharmacology and prognosis of schizophrenia (Andreasen, 1982).

3.1 The Positive Syndrome

The positive syndrome is characterised by delusions, disorganised thinking and hallucinations. Patients with these symptoms usually have a relatively acute onset, and a prognosis that is often exemplified by exacerbations and remissions (Kay, Fisbein and Opler 1987; Kay, 1989). Andreasen (1985) has proposed that, the positive signs and symptoms that are displayed in schizophrenia are not due to an underlying structural deficit in the brain, as indicated by their good response to neuroleptic medication. Rather, the positive syndrome in schizophrenia, implicates a neurochemical dysfunction of the brain in the manifestation of these signs and symptoms (Johnstone, 1989).

3.2 The Negative Syndrome

In contrast to the positive syndrome, the negative syndrome represents an absence of normal functions, such as deficits in cognition, affect and social realms. These signs and symptoms include, blunting of affect, alogia, avolition and apathy, impairments in attention, asociality and anhedonia. The underlying symptoms are deficit in nature and "represent a diminution of function rather than an excess" (Andreasen, 1985, p.382). Negative symptoms are inclined to have an insidious onset and have more widespread dysfunctioning for the individual (Kay, Fisbein and Opler 1987; Kay, 1989).

Unlike the positive syndrome, which appears to be related more to dysfunctions in neurochemistry, the negative syndrome, is often marked by structural changes in the underlying cerebral matter. Through observing brain scans, such as Computerised Tomography, Positron Electron Tomography and Magnetic Resonance Imaging scans, some patients with negative symptomatology have displayed such structural changes in the brain (Andreasen, Nasrallah, Dunn et al., 1986; Pantelis, Barnes and Nelson, 1992; Turetsky, Cowell, Gur, et al., 1995).

Furthermore, individuals who primarily present with negative signs and symptoms have been found to fair more poorly on certain neuropsychological tests, than those people who display predominantly positive signs and symptoms. Some of these studies, which have focused on the relationship between the negative syndrome and the resultant neuropsychological deficits, will be discussed in the proceeding section.

3.3 The Neuropsychology of the Negative Syndrome

Braff, Heaton, Kuck, Cullum, Moranville, Grant, and Zisook (1991), not only found that people with schizophrenia were impaired on a number of the neuropsychological measures, which included the Category test, Trail Making Test and the Wisconsin Card, Sorting Test (WCST), but that such impairment on these tests was related to negative symptoms. Similarly, Addington, Addington and Maticka-Tyndale (1991) found a correlation between negative symptoms and neuropsychological deficits on tests of general intellectual ability, the Wisconsin Card Sorting Test and on the Newcombe verbal fluency test, both at the initial testing and at 6-month follow-up.

Buchanan, Strauss, Kirkpatrick, Holstein, Breier and Carpenter (1994) found that patients with predominantly negative symptoms performed more poorly than those with positive symptoms, on the Stroop test, the Trail-Making-part B test, and on the Mooney Faces Closure Test. However, one of the main criticisms with this study is that the number of men in the two groups greatly outnumbered the number of women. Thus, these results may have been due to sex differences, rather than due to positive and/or negative symptomatology.

Capleton (1996) compared positive and negative symptom Schizophrenic sub-groups and a normal control group. He used a word-fluency test, a word-generation test and the Coglab Card Sorting Test[2]. The results indicated that the group with negative symptom schizophrenia displayed more perseverative errors on the Coglab card Sort

[2] This is a computerised version of the Wisconsin Card Sorting Test.

Test than the control group. When comparisons were made within the schizophrenia group, that is, between the negative and positive subgroups, it was found that the negative group made more perseverative errors than the positive symptom group.

Allen, Liddle, and Frith (1993) used a Category Generation verbal fluency task in their study, comparing the results of Schizophrenic patients, depressed and 'normal' controls. They found that the schizophrenia group produced fewer words than the controls, generated fewer clusters of related words and more words outside the specified category. Those people with negative symptoms in the Schizophrenic group showed more impairment on these tasks than the control groups.

Similarly, Brown and White (1991) found a significant positive relationship between negative symptoms and impairment on the Trail Making Test, WCST and Word Fluency tests, whereby people with predominantly negative signs and symptoms performed more poorly on these tests.

Nelson, Pantelis, Carruthers, Speller, Baxendale, Barnes (1990) found that a chronic Schizophrenic in-patient group performed significantly below average in intellectual functioning than the normal population. People with predominantly positive symptoms were found to score higher on tests of intelligence, than those people with negative symptoms. With regards to tests of motor and cognitive speed, it was found that the people with schizophrenia were slower on these tasks, and that the negative symptom group was slower on these tasks than the positive symptom group.

Thus, it may be seen from the above studies, that there does appear to be a relationship between neuropsychological impairment, especially of the frontal lobes, and the negative syndrome in schizophrenia. However, one of the main criticisms of the above studies, is that most of these studies have failed to take sex differences into account. Therefore, one of the possibilities that does exist, is that the discrepancies that have been found between the positive and negative syndrome groups may have been due to differences in sex, rather than symptomatology. In the final chapter, sex differences in some neuropsychological studies in people with schizophrenia, will be explored.

4.0 SEXUAL DIMORPHISM in the BRAIN[3]

The final chapter, of this literature review, forms the focal point of the current research. It will focus on some of the sex differences that have been found in certain neuroanatomical structures, and in some domains of neuropsychological functioning. The chapter begins with a brief overview of one of the theories that have been proposed as to why normative sex differences occur in the brain. Proceeding this, a synopsis will be given of some of the theories that have been presented regarding why sexual dimorphism occurs in schizophrenia. The chapter concludes with the results from previous studies that have focused on sex differences in some neuroanatomical structures and in certain neuropsychological functions in people with schizophrenia

4.1 Normative Sex Differences in the Brain

It is well established that men and women's brains are different. Not only has it been found that there are morphological differences, but such sex differences, have also extend to neuropsychological functioning (De Lacoste, Horvath and Woodward, 1991; Kimura, 1987; Lezak, 1995; Weekes, 1994).

One of the leading theories that have been proposed as to why sexual dimorphism occurs in the brain relates to the differing amounts of hormones that are released *in utero.* It has been proposed that differing amounts of testosterone that are released *in utero,* may promote the development of the right hemisphere or delay the

[3] Because the topic of sex differences is such an extensive field, I will only discuss certain neurobiological aspects that have been related to sex differences. But the interested reader is referred to the following references that have focused on the impact of socialisation on some neurocognitive abilities. Andersson, H.W. Sonnander, K. and Sommerfelt, K. (1998); Bjorklund. D.F. and Brown R.D. (1988); Brosnan, M.J. (1988); Delgado, A.R. and Prieto, G. (1996); Collaer, M.L. and Hines, M. (1995); Pellegrini, A.D. and Smith, P.K. (1988). Full references of these articles are provided in the reference list.

utero, may promote the development of the right hemisphere or delay the development of the left hemisphere. The result being that males would be more adept at tasks involving visuospatial skills, governed by the non-dominant hemisphere (usually the right hemisphere), and females would display better verbal skills, which are under the control of the dominant hemisphere (generally the left hemisphere) (Damasio and Geschwind, 1984).

De Lacoste, et al. (1991) hypothesized that sex differences in the degree of gross anatomical asymmetries may be influenced by these circulating levels of testosterone. In their study they found that in the developing brain, the " occipital area appear [ed] to be more symmetrical in female than in male brains" (De Lacoste, et al., 1991, p839). They also found that there was a tendency for the male developing brain to have a larger right hemisphere in comparison to the female developing brain, which displayed a more symmetrical neuroanatomical structure, or they tended to have a slightly larger left hemisphere.

It has also been found that men, who are deficient in the hormone androgen early in life, tend to perform worse than 'normal' men on tasks that require spatial abilities. However, the males who were deficient in androgen did not perform better than their 'normal' male counterparts on tasks that required verbal ability (Kimura, 1987). Thus, there does appear to be an optimal level of hormone required, in order for sexual differentiation and specialisation of the brain to occur.

Parsons (1980) found that female children tend to be more neurologically mature, achieve developmental milestones earlier and reach sexual maturity earlier than their

male counterparts. He proposed that such differences in the rates of maturation (which is governed by the release of hormones), might influence behaviour and experiences, and subsequently result in males and females developing different cognitive skills.

Thus, it appears that the hormones that are released during the development of the brain, affects both neuroanatomical sexual differentiation, as well as seems to determine sexual differentiation and specialisation in certain neuropsychological functions, such as verbal ability and visuo-spatial functions (De Lacoste, et al., 1991; Kimura, 1987; Parsons, 1980).

Following on from these studies, a number of researchers are now trying to correlate the findings from the normative studies on sex differences in neurodevelopment, in an attempt to explain the sex differences that have been found in people with schizophrenia. A few of these studies will be briefly explicated below.

4.2 Sex Differences in Schizophrenia

The importance of studying neuroanatomical and neuropsychological sex differences in people with schizophrenia is three fold. Firstly, by establishing whether sex differences do exist in people with schizophrenia has implications for theories of aetiology. For example, it has been proposed that the sex differences that have already been found in people with schizophrenia may indicate that there are different routes through which men and women develop schizophrenia, that is, that there may be different subtypes of schizophrenia, which are based on sex (Castle and Murray,

1991; Cowell, Kostianovsky, Ruben, et al., 1996; DeLisi, Dauphinais and Hauser, 1989; Jacobsen, Giedd, Vaituzis, et al., 1996). Secondly, through studying neuro-morphological and neuro-functional differences between men and women with schizophrenia, may help to explain why men with schizophrenia tend to be more impaired (cognitively and socially), have an earlier onset, and are more resistant to neuroleptic medication, than women. (Andia, Zisook, Heaton, Hesselink et al., 1995; Goldberg, Gold, Torrey and Weinberger, 1995; Lewine, Walker, Shurett, Caudle and Haden, 1996). Finally, the current researcher believes that by studying sex differences in people with schizophrenia may expand on theories of prognosis, as well as of treatment. It is possible that schizophrenia will follow a different course in men and women. Consequently, they will then require different types of treatment, not only pharmacologically, but also therapeutically. Some of the theories that have been proposed as to why such sex differences in schizophrenia have been found will now be discussed.

Cowell, Kostianovsky, Ruben, et al. (1996) have argued that "(g)iven evidence of sex differences in normal development, it is plausible that sex differences found in the neurobiology of schizophrenia are caused in part by interactions among environmental, genetic, and hormonal influences during brain maturation"(Cowell, et al., 1996, p803). The possibility therefore exists that men and women may develop schizophrenia via different neurodevelopmental routes. A number of theorists are in concordance with this view (Castle and Murray, 1991; Cowell, et al., 1996; DeLisi, Dauphinais and Hauser, 1989; Jacobsen, Giedd, Vaituzis, et al., 1996; Nasrallah et al., 1991; Norman et al., 1997a).

Castle and Murray (1991) have reviewed a number of studies that have focused on sex differences in people with schizophrenia. They argue that one of the most plausible explanations for the sex differences that have been found in people with schizophrenia, is that men with schizophrenia have a form of disease that is due to a neurodevelopmental anomaly. They provide three reasons for this assumption. Firstly, men tend to develop schizophrenia earlier than women. Secondly, men tend to show a greater number of impairments than women, both socially and cognitively. Finally, women tend to be on less neuroleptic medication than men, and women are more likely to respond more favourably to neuroleptic medication. Most of the studies that Castle and Murray (1991) reviewed posited that the anomalies that have been associated with men with schizophrenia occur *in utero*. Furthermore, most of these studies found that males are more likely to have a history of obstetric complications, are more susceptible to neurodevelopmental disorders and tend to have neural deficits.

Lewine (1981) examined two models that attempted to explain why sex differences develop in schizophrenia. The 'timing model', proposes that schizophrenia is essentially the same in men and women, but men have an earlier onset, whereas women have a later onset. Thus, it is the age at onset which appears to be affecting functioning, i.e. the earlier the onset, the greater the impairment, rather than sex. The second model that Lewine (1981) reviewed is the 'sub-type model'. This model posits that there are two different types (or dimensions) of schizophrenia. The one sub-type is characterised by early onset, poor premorbid competence, typical symptoms, and the other sub-type, has a late onset, atypical symptoms, and good premorbid proficiency. The former subtype is usually found in men, and the latter is

generally found in women. Therefore, sex appears to be the variable that affects functioning in this second model.

As was discussed in the previous section, the release of hormones *in utero* seems to affect sexual specialisation and differentiation of the brain. Flor-Henry (1990) and Seeman and Lang (1990) have proposed that the levels of oestrogen that are released, both *in utero* and during later maturational stages (for example, during puberty) may account for the sex differences that are found in schizophrenia. However, the release of oestrogen at different stages of life is also found in 'normal' populations, and therefore this hypothesis does not seem to fully account for the differences that are found in men and women with schizophrenia.

Having briefly discussed some of the theories that have been suggested to account for the sex differences in schizophrenia, the author will now discuss findings from some studies that have focused on sex differences in people with schizophrenia, both in terms of neuroanatomy, as well as neuropsychological functioning.

4.3 Sex, Neuroanatomy, and schizophrenia

A number of studies have been conducted with regards to neuroanatomy, schizophrenia and sexual dimorphism (for example, Flaum, Arndt and Andreasen, 1990; Flaum Swayze, O'Leary, et al 1995; Nopoulos, Flaum, and Andreasen, 1997). However, it is beyond the scope of the present paper to present a detailed analysis of these studies. Therefore, a brief overview of some of the findings will be given below.

Flaum, Arndt and Andreasen (1990) found in their study that males with schizophrenia had significantly larger ventricle brain ratios than male control group, whereas, females with schizophrenia, were found not to differ from the female control subjects in ventricle brain ratios. Similarly, Flaum, Swayze, O'Leary et al (1995) found that the cranium, cerebrum, superior temporal gyrus and third ventricle, were larger in the male subjects, even after height was controlled for. They also found greater differences between the female patients and female comparison subjects, than between the male patients and male control subjects.

In contrast to these studies, Nopoulos, Flaum, and Andreasen (1997) found that men with schizophrenia had significant differences from the men in the control group, on all measures of total tissue, frontal lobe and temporal lobe tissue, and greater total cerebro-spinal fluid (CSF). Furthermore, the female patients were found to have significantly less frontal lobe tissue, greater total CSF and a trend toward smaller temporal lobes compared with the female control group.

From the studies outlined above, it does appear that schizophrenia affects the neuroanatomy of men and women differently. From these results, the question arises: If such sex differences exist in the neuroanatomy of people with schizophrenia, then is it possible that there are sex differences in neuropsychological functioning among people with schizophrenia? The following section explores this question more thoroughly, by reviewing some of the previous research that has been conducted in this area.

4.4 Sex, Neuropsychology and schizophrenia

A limited number of studies have been conducted with regards to sex differences, neuropsychology and schizophrenia. Most of the research that has been conducted in this area has postulated that men with schizophrenia would be more impaired on tests of neuropsychological functioning than women with schizophrenia (for example, Goldberg, James, Gold, Torrey and Weinberger, 1995; Lewine, Walker, Shurett, Caudle, and Haden, 1996). One of the reasons for this hypothesis is that men tend to have an earlier onset than women (Andia, Zisook, Heaton, et al., 1995; Lewine, Walker, Shurett, et al., 1996). Thus, it may be inferred that men have been exposed to schizophrenia for a longer period of time, compared with women, possibly leading men to experience more deficits in cognitive functioning. Furthermore, it has been observed that once schizophrenia has been diagnosed, there has been a trend for men to be more impaired socially, and are frequently on higher doses of neuroleptic medication, in comparison to women. A number of theorists have also posited that 'normal' neurodevelopment may account for some of the sex differences that have been observed in people with schizophrenia, and some of these studies will be discussed in the final section of this chapter. However, the results from these previous studies that have focused on sex, neuropsychology and schizophrenia, are antagonistic and in some cases have been inconclusive. Thus, it has been difficult to ascertain whether such differences, in neuropsychological functioning, do in fact exist between men and women with schizophrenia. Some of these studies will be discussed in the following section.

In their study, Goldberg, James, Gold, Torrey and Weinberger (1995) proposed that women with schizophrenia would have less cognitive impairment than men with schizophrenia, because schizophrenia appears 'milder' in women. They found that in all four Schizophrenic cohorts, women and men performed the same on a neuropsychological test battery. The only difference that was found between men and women were on tests that were spatial or attentional in nature, where men outperformed women. However, such a finding is indicative of normative findings, whereby men in 'normal' populations tend to be more proficient than women on tasks that require visuo-spatial functioning (Damasio and Geschwind, 1984; Kimura, 1987; Lezak, 1995).

There are a number of criticisms with regards to this study. One of the main criticisms, is that each Schizophrenic cohort that participated in this study was administered a different test battery. This implies that the lack of sex differences may have been due to differences in the tests. That is, the tests may have been measuring different cognitive characteristics. Furthermore, the authors acknowledged that the number of men greatly exceeded the number of women. Thus, the results that were found may have been skewed due to a selection bias.

Andia, Zisook, Heaton, Hesselink, Jernigan, Kuck, Morganville, Braff (1995), have also found no significant differences in neurocognitive functioning between men and women, who have schizophrenia. The differences that were found in this study, were that women were more educated than men, women were on less neuroleptic medication, and women were more likely to have better social functioning than men. That is, women were more likely than men to be married, to be living independently

and to be employed. These results cannot be explained in terms of age at the time of the study, age at which psychiatric treatment was received, total number of hospitalisations, neuroanatomy and symptomatology, as these were all comparable between men and women (Andia, et al., 1995).

Lewine, Walker, Shurett, Caudle, and Haden (1996), hypothesised that men would show more global impairment than women in neuropsychological functioning, because men have earlier age at onset, poorer premorbid development, and poorer response to treatment. They found that women were more impaired than men on tasks of verbal memory, spatial memory and visual processing. However, it has been found that in general, men perform better than women on tasks that require visual and spatial skills (Lezak, 1995). They also found discrepancies with regards to age at first hospitalisation, where men were younger than women, and more men with schizophrenia, were single compared with women. No significant differences were found in this study, between men and women in years of education, duration of illness, symptomatology and dosage of medication. In this study, the authors combined the findings for the people with schizophrenia and those that had Schizoaffective disorder. Although they state that the effects of diagnosis afforded no significant differences between the two groups, it is possible that the groups may have differed with regards to mood, and this has been shown to affect neuropsychological performance (Lezak, 1995). As in the previous study (Andia, et al., 1995), the number of men greatly outnumbered the number of women, and this may have lead to a sampling bias. Furthermore, approximately 30% of the patient's who were participating in this study, were involved in trials of new medication, and as the

authors acknowledge their sample may have been drawn from a more treatment-resistant pool of individuals.

Perlick, Mattis, Stastny and Teresi (1992) used the Dementia Rating Scale (DRS), which provides a measure of attention, memory, initiation and perseveration, conceptualisation and construction. They found a significant main effect of sex in people with schizophrenia for DRS conceptualisation, and a near-significant trend of sex for the DRS Attention Scale, whereby it was observed that women were more impaired on these two scales. For the DRS construction scale, women scored lower in the inpatient sample, whereas in the outpatient sample, women scored slightly higher than men. No sex differences were found on the DRS memory or initiation and perseveration scales. In addition to these differences, women were found to be more impaired on verbal and non-verbal abstracting ability, concept formation, visual scanning, sustained attention and self-monitoring, than men with chronic schizophrenia. However, in this research there was a sampling bias, in that there were a greater number of severely ill women in their Schizophrenic groups.

Lewine, Haden, Caudle, and Shurett (1997) investigated both sex differences in neuropsychological performance and brain morphology in Schizophrenic subgroups (late versus early onset). They discovered that there were a greater number of men who experienced earlier onset, and were significantly younger at first hospitalisation, and were more likely to be single. Medication was comparable across the groups. On measures of neurocognitive functioning, men in this study were found to have a significantly higher mean full-scale IQ than the women for both verbal IQ and performance IQ. Furthermore, it was found that men performed better than the

women on four measures of memory: Immediate memory; Delayed Logical Memory; Immediate Visual Reproduction and Delayed Visual Reproduction. Within group differences were also found in this study, whereby early-onset men and late-onset women had higher scores than early-onset women and late-onset men on the number of perseverative errors on the Wisconsin Card Sorting Test. The early-onset men and late-onset women also had lower scores on the Dichotic Listening Test right ear advantage, Finger tap left, Finger Tap right and Handstrength right hand bias (Lewine, et al., 1997).

In addition to the criticisms that have already been mentioned for the above studies, the current researcher believes that there are three main reasons that may account for the inconsistencies in the above studies. Firstly, the number of women and men in the groups differed. Secondly, many of the studies that have been discussed used the Scale for the Assessment of Positive Symptoms and the Scale for the Assessment of Negative Symptoms, and these scales do not give a composite score for the entire symptomatological profile of the individual. Finally, many of the studies combined both positive and negative syndrome groups, and as was discussed in Chapter 3, *The Positive-Negative Dichotomy in schizophrenia,* people who display predominant negative symptomatology, tend to be more impaired on tests of neuropsychological functioning. Thus any sex differences, or the lack thereof, that were found in these previous studies may have been to symptomatology, rather than being due to sex differences.

Therefore, as can be seen from the above discussion, there appears to be little consensus as to whether sex differences do in fact exist in neuropsychological test

performance in people with schizophrenia. Such contradictions and limitations of the previous research have provided the framework, on which the current study is based.

5.0 RATIONALE for the PRESENT STUDY

The present study sought to address some of the shortcomings of previous research. Both within-group and between-group comparisons were made.

Firstly, some of the previous research that has focused on sex differences in neuropsychological test performance among people with schizophrenia have used more than one test battery, either for comparing negative and positive syndrome groups, or between people with schizophrenia and a normative sample. The present study used one neuropsychological test battery for all subjects, (that is, in the negative Schizophrenic group and the Control group). Thus, the same neurocognitive functions were measured in both groups.

Secondly, the tests that were chosen have been found to tap into frontal lobe functions, and most of them have been devised, to alleviate any possible sex differences. For those tests where sex differences have been found (for example, the Rey Complex Figure), norms have been created for both males and females.

Thirdly, the Schizophrenic group comprised only of people who presented with predominantly negative signs and symptoms. The reason for this is that people with predominantly negative schizophrenia have been shown to be impaired on many neuropsychological tests. Consequently, by testing only those people who have negative symptomatology, should alleviate any possible biases, whereby, any differences that are found, within this group, may be seen as being due to sex, rather than symptomatology. Furthermore, many previous studies have not differentiated between positive and negative syndrome groups. Rather, these researchers have

studied schizophrenia as a homogeneous disease, which may have confounded their results. Furthermore, current perceptions hold that schizophrenia is a heterogeneous disorder.

Finally, both within-group and between-group comparisons were made between the Schizophrenic cohort and the 'normal' Control group. For the within-group, comparisons were made between the men and women in the Schizophrenic group, and between the men and women in the Control group. Between group comparisons were between the Schizophrenic group and the Control group. The reasons for doing this were two-fold: Firstly, it was postulated that if sex differences were found in the Control group and the same differences were found in the Schizophrenic group, that such sex differences were normative, rather than being pathognomonic to schizophrenia. However, if sex differences were found only for the Schizophrenic cohort, it was proposed that this will add further support for theories on aetiology, prognosis and/or treatment for people with schizophrenia, and provides further evidence, that there are subgroups of schizophrenia, which are based on sex. In addition to this, although not directly pertinent to the current research, it was hypothesised that if sex differences were found only for the Control group, this would add credence to the existing literature regarding sexual dimorphism in the developing brain. Secondly, comparisons between the two groups will also enable us to determine the types of frontal functions that are impaired in schizophrenia.

5.1 Hypotheses

1a) Null hypothesis: No significant differences will be found between men and women with negative symptom schizophrenia on tests of frontal neuropsychological functioning.

1b) Alternate hypothesis: A significant difference will be found between men and women with negative symptom schizophrenia on tests of frontal neuropsychological functioning.

2a) Null Hypothesis: There will be no difference between the people with negative symptom schizophrenia and the control group on neuropsychological tests that measure frontal lobe functioning.

2b) Alternate Hypothesis: A significant difference will be found between the negative symptom Schizophrenic cohort and the Control group, on tests that measure frontal lobe functioning. Furthermore, it is proposed that people with negative symptom schizophrenia will display more deficits on these tests than the Control group.

6.0 METHODOLOGY

6.1 Research Design

This was a non-experimental research design, whereby there was no manipulation of the independent variables. The independent variable for within-group analysis was sex, and the dependent variable was neuropsychological functioning. For between-group analysis, the independent variable was group (that is, Schizophrenic group and Control group), and the dependent variable was neurocognitive functioning. Therefore, both within-group and between-group comparisons were made.

6.2 Subjects

All subjects had to meet several criteria prior to participation in the current research. These criteria included: Subjects had to be between the ages of 18-55 years. They had to have no previous history of head injury, where they lost consciousness for longer than half an hour. They had to have no abuse of narcotic substances within 30 days prior to the assessment. They had to have no history of epileptic seizures. Subjects had to have had at least 8 years of education. Finally, subjects had to be fluent in either English and/or Afrikaans. 80 people met these inclusion criteria and were assessed.

6.2.1 Schizophrenic Group

A qualified psychiatric registrar made the Axis I diagnosis for schizophrenia prior to the assessment. Only people who met DSM-IV criteria for schizophrenia, and who displayed predominant negative signs and symptoms, and who met the criteria given above were included for assessment. 40 subjects who met these inclusion criteria were then assessed. Of the 40 people who were assessed, 20 were men and 20 were women. The people in this group were recruited from Tara, H. Moross Centre (6 women and 11 men), Gordonia (11 women and 3 men), and Sterkfontein Hospital (3 women and 6 men). The mean age for the men in this group, was 30.63 years (SD = 7.35), and the mean years of education was 10.78 years (SD = 2.69). The mean age for the women in this group was 38.1 (SD = 11.06), and the mean years of education was 10.63 (SD = 2.79). There was 1 left handed man, 1 ambidextrous man, and the remaining people in this group, were right-handed. There were no left handed or ambidextrous women. With regards to marital status, 2 men were married, 16 were single and 2 were divorced. In the female group, 2 were married, 14 were single and 4 were divorced. The length of illness was also calculated for this group and was found to be M = 6,94 (SD = 4.42) for men, and M = 14.77 (SD = 9.81) for women. A list of medications that each person in this group was currently taking is provided in Appendix B.

6.2.2 Control group

The Control group comprised volunteers from the general population. 40 subjects in total (20 men and 20 women) were considered for inclusion in the current study, and

were subsequently assessed. The mean age for the men in this group was 30.05 (SD = 8.82), and the mean years of education was 13.3 years (SD = 2.36). The mean age for the women in this group was 34.4 (SD = 10.87), and the mean years of education was 12.40 (SD = 2.43). There were 4 left handed men, and the rest were all right-handed. There were no left handed or ambidextrous women. With regards to marital status, 7 men were married, 13 were single, and none were divorced. In the female group, 10 were married, 9 were single and 1 was divorced.

6.3 Procedure

Informed consent was obtained from all of the subjects who participated, and a copy of the consent form and the subject information sheet, for both groups, has been included in Appendix A. For the Schizophrenic group, a qualified examiner had made an Axis I diagnosis for schizophrenia, prior to the assessment. Only those subjects, who met DSM-IV criteria, and who displayed predominant negative symptoms, were included in the Schizophrenic group.

Prior to the administration of the neuropsychological tests all of the participants were asked several questions. All subjects were asked questions related to their age, sex, home language, highest level of education, current occupation, marital status, handedness, previous psychiatric illnesses, current medication, head injury, and substance abuse. In addition to these questions, people with schizophrenia, were asked questions related to their current symptoms, the age at which their symptoms began and the age at which they were diagnosed with [illegible]renia. The reason for asking these questions is that many of these [illegible]n found to affect

neuropsychological functioning. Furthermore, subjects had to be matched on as many of these variables as possible. A copy of these questions is provided in Appendix A.

For most of the people who participated in this research, the average time for the administration of the test battery was one hour. However, in severe cases of schizophrenia, the time taken to complete the test battery increased to an hour and a half. This was one of the main advantages of using a small battery of tests, as it decreased the possibility of fatigue and boredom among the subjects. People with schizophrenia were administered the battery in a private room at the hospitals, whereas people in the Control group were administered the tests at a private house.

The neuropsychological tests that were used in the current research encompassed a battery of tests that have been found to be reliable and valid tests for tapping into some of the functions of the frontal lobes. Furthermore, most of the tests have been found to have no sex biases (for example, the Modified Card Sorting Test, the Tower of London test, the Block Counting Task, the Stroop Colour and Word test and the Trail Making Test).

Following the administration of these tests, statistical analysis was carried out, and this will be discussed in the final section of this chapter (Section 6.5 Statistical Analysis).

6.4 Neuropsychological Test Battery

The tests that were administered in this research included, the Rey Complex Figure, the Modified Card Sorting Test, the Tower of London Test, the Block Counting test, the Stroop Colour and Word Test, and the Trail Making Test (Trails A and B). The battery was administered in the sequence that has been presented above. Each of these tests, and the scoring procedures that were used, will be explicated in the proceeding section.

6.4.1 The Rey Complex Figure Test (RCF)

This test measures planning, visual memory (immediate and delayed) and visuospatial constructional abilities (Lezak, 1983; 1995; Spreen and Strauss, 1991). Failure on the Rey Complex Figure indicates, impairments in visuospatial constructive ability (Spreen and Strauss, 1991), visual memory (immediate and delayed) (Lezak, 1983; 1995), and an inability for the subject to organise or integrate components into a whole (that is, planning) (Walsh, 1987). All of these functions have been found to be predominantly governed by the frontal lobes.

In the current research standardised instructions were given. Initially, the subject was instructed to copy the figure that was presented to him/her. The examiner closely observed the way in which the subject copied the drawing, and noted the sequence in which the drawing was reproduced. The time taken to copy the drawing was recorded.

The original drawing and the copy were then removed from the subject, and the subject was then asked to re-draw the figure from memory. Once again the time taken to re-draw the figure was recorded. After a delay of approximately 50 minutes the subject was asked to recall the figure.

The scoring for the RCF was based on both the standardised scoring systems offered by Lezak (1983; 1995) and Spreen and Strauss (1991), both of which are adapted from the scoring system developed by Rey and Osterreith.

6.4.2 The Modified Card Sorting Test (MCST)

The Modified Card Sorting Test (Nelson, 1976) is based on the Wisconsin Card Sorting Test (WCST) devised by Grant and Berg (1948). Both of these tests are used as a measure of the ability to identify abstract behaviour, shift of cognitive set (Lezak, 1995), memory and non-verbal intellectual functioning (Goldman, Axelrod and Tandon 1991). The MCST, like the WCST, requires several complex cognitive operations, including concept formation, hypothesis testing and set shifting. Successful performance requires the subject to remember his/her prior response associated feedback and to use this information to select a new response, which may be seen as a form of working memory (Gold, et al., 1997). Thus, the MCST may be used as a measure of frontal lobe functioning.

The MCST consists of 4 stimulus cards each of which is unique in terms of colour (i.e. red, green, yellow, or blue), shape (i.e. star, cross, triangle, or circle) and number of items (that is, one, two, three, or four). The subject is given a pack of 48 response

cards that have similar attributes to the stimulus cards. The MCST di[illegible]n the WCST, in that no ambiguous cards are in the pack. For example, all those cards that share more than one attribute with the stimulus cards are removed from the pack. The task of the subject is to sort the response cards underneath the stimulus cards wherever it appears to match best, that is, according to a particular rule. Whichever category the subject initially chooses, is scored as being "correct", and subsequent responses are scored accordingly. The examiner tells the subject whether his/her subsequent responses are correct or incorrect. After six correct consecutive responses the examiner informs the subject that the rule has changed, and is told to find another rule. Again, after six correct consecutive responses the subject is told that he/she must find another rule. The test is completed once all six categories (by repeating the categories: number, colour and shape twice) have been achieved, or when all 48 of the cards have been exhausted (Nelson, 1976). These standard instructions were used in the present research. However, in certain cases, where the subject did not understand the instructions, the examiner modified them. For example, the word 'way' was used instead of the word 'rule'. Furthermore, in some cases where it was clear to the examiner that the subject did not understand that he/she had to find a new sorting category, the examiner placed a card underneath one of the stimulus cards and asked the subject why he/she thought this to be correct. If the subject responded correctly, the examiner told the subject that this was correct and to continue sorting according to this rule. Modifying the instructions in this way did not appear to confound the results.

Scoring of the MCST was based on the standard scoring system that Nelson (1976) has formulated, that is, the Number of Perseverative Errors made, the Number of Non-perseverative Errors made, and the Number of correct Categories Achieved.

6.4.3 Tower of London

The neuropsychological functions that this test measures, include planning, shifting of set, sequencing behaviour, motor programming (Dehaene and Changeux, 1997), flexibility (Walsh, 1987), and attention (Lezak, 1995). In addition to this, this task has also been found to assess both spatial and non-spatial working memory (Baker, et al., 1996). This ability to plan, shift set and sequence behaviour in an orderly fashion, depends in part on the functioning of the frontal cortex (Dehaene and Changeux, 1997; Morice, 1990; Morris, Ahmed, Syed, and Toone, 1993). Thus, certain impairments of the frontal lobes may be indicated by poor performance on the Tower of London test.

In this task the subject is required to plan a strategy to move three coloured beads (blue, green and red) that are placed on three sticks, of differing lengths, short medium and long, to achieve a predetermined alignment. The initial position of the beads is always the same: The red bead lies above the green bead on the tallest pole, and the blue bead on the middle pole. The subject is required to move the beads from the original position to the target position, in the allocated number of moves, which are provided on each of the cards (Baker, Rogers, Owen, et al., 1996; Lezak, 1995; Morice and Delahunty, 1996).

In the current research, the participant was given a number of instructions prior to commencing the task, these included: Only one bead could be moved at a time; once a bead had been moved from a stick, it had to be placed on another stick; he/she could only use one hand to move the beads; and finally, the subject was told that he/she had 60 seconds in which to complete each card, and that he/she had to use the time well to plan what he/she was going to do to reach the target position.

Scoring was based on the time to make the first move, the total time taken to reach the target position, and the number of errors made.

6.4.4 Block Counting Test

This test focuses on non-verbal spatial reasoning processes of the frontal cortex. The subject is given a piece of paper on which is printed a series of two-dimensional drawings of three-dimensional block piles. The subject has to count the number of blocks that are presented in each diagram, and must also take into account the blocks that are hidden from view. Before the task commences, subjects are given a trial task in which three pictures of blocks are presented and he/she is asked to count the number of blocks including those that are hidden from view (Lezak, 1983; 1995). In the present study, where it was evident that a subject did not understand the instructions, help was given during the trial task, whereby the examiner counted the number of blocks with the subject. The examiner also coloured in the blocks for those subjects who still did not understand the instructions. Once the subject had correctly counted the number of blocks that were presented in the trial task, the task

commenced. Scoring was based on the total number of errors and the time taken to complete this task (Lezak, 1983; 1995).

6.4.5 Stroop Colour and Word Test

Stroop (1935) formulated this test. It examines the subjects' ability to change perceptual set, according to the demands of the situation. It is also used as a measure of verbal competence, that is, both reading ability and spoken language, and has been found to be effective in differentiating between brain damaged and non-brain damaged individuals (Golden, 1978; Lezak, 1983; Spreen and Strauss, 1991).

This test consists of three white cards, each containing 10 rows of five items. On card A, randomised colour names - blue, green, and red are printed in black. Card B is identical, except that each colour name is printed in another colour other than the colour that it names. Card C displays coloured crosses of the three colours (Golden, 1978; Lezak, 1983; Spreen and Strauss, 1991).

For Trial I, the task of the subject is to read the names of the colours on the card. For Trial II, the subject reads the words on card B, while ignoring the colour in which the word is printed. For Trial III he/she names the colours of the crosses that are printed on card C. Finally, for Trial IV, the subject names the colours of the print that appear on card B, while ignoring the actual word. The subject is timed during each trial and the number of errors that are made, are recorded (Lezak, 1983; Spreen and Strauss, 1991). These standard instructions and scoring procedures were used in the current research.

6.4.6 Trail Making Test

Both parts A and B of the Trail Making Test measures, visual scanning, motor speed, problem solving ability, co-ordination, attention, and mental flexibility. In addition to these skills, Part B also measures mental double tracking (Goldberg, Kelsoe, Weinberger, Pliskin, Kirwin, and Berman, 1988; Lezak, 1983; 1995; Spreen and Strauss, 1991).

This is a timed paper and pencil test. In Part A, 24 numbered circles are distributed randomly on the page. The task of the subject is to join the numbered circles with lines, in ascending order while being timed. Part B consists of 25 circles. 13 of the circles are numbered 1 to 13, and the other 12 circles are lettered A to L. The subject has to connect the numbers and the letters in ascending order, alternating between the two sequences. For example, the subject has to draw a line from 1 to A; from A to 2, 2 to B, etc. Both parts of this test have a sample page, which is used to practice and to aid the subject in understanding the instructions. The examiner points out any errors that the subject makes during the test. Timing is not stopped while the errors are brought to the subject's attention (Spreen and Strauss, 1991). The present research used these instructions and scoring was based on the time taken to complete this task.

6.5 Statistical Analysis

Following the administration and scoring of the aforementioned neuropsychological tests, data was analysed using a standard statistical package. Mann-Whitney U tests will be used in order to evaluate whether a significant difference exists in the

neurocognitive functioning between (1) men and women in the Schizophrenic group, and between men and women in the Control group, and (2) between the Schizophrenic and Control groups. The reasons for using this non-parametric statistical test are, firstly, due to the inequality of variance of the sample, and secondly, due to the small sample size per group (n = 20 people/group). Proceeding this analysis, the means and standard deviations of each of the tests will be calculated, in order to compare the statistically significant scores between men and women, and between the two groups. The results of each of the tests that were administered for both the within-group and between-group analyses are provided in the following chapter.

7.0 RESULTS

7.1 Introduction

Statistical analyses were carried out for each of the neuropsychological tests that were administered, and were further subdivided into within-group and between-group comparisons. Several Mann-Whitney U-tests were calculated, in order to determine whether a significant statistical difference existed, for both within-groups and between-groups. As was stated in the previous chapter there were two main reasons for using this non-parametric technique (1) due to the inequality of variance of the sample, and (2) due to the small sample per group (N = 20/group). Means and standard deviations for each of the tests were also computed. The results of each of the neuropsychological tests will be dealt with separately. The results for the men and women in each group (within-group) will be considered first, followed by the results that were obtained for the Control group and for the Schizophrenic group (between-group).

7.2 Statistical Analysis Within-Groups

Several Mann-Whitney statistical tests were performed in order to determine whether a significant difference existed in the test scores between men and women in the Schizophrenic group, and between men and women in the Control group. The means and standard deviations for each of the tests were also calculated.

The ages and years of education were also calculated for the men and women in the two groups in order to determine whether a significant difference existed for the groups. A statistically significant difference was found between the men and women in the Schizophrenic group for age (p = 0.0339*), whereby women with Schizophrenia (M = 38.00, SD 11.09) tended to be older than men with schizophrenia (M = 30.63, SD = 7.35). No statistically significant differences were found for years of education for this group (p = 0.5740). The length of illness for the men and women in the Schizophrenic group was also calculated, but was found to be non-significant (p =0.3798). For the men and women in the Control group, no statistically significant differences were found for both age (p = 0.3648) and for years of education (p = 0.2914). The results of each of the tests are tabulated below and the statistically significant results are highlighted in each case.

7.2.1 Rey Complex Figure

Table 2. Mann-Whitney Test for Within-group Analysis for the RCF

TRIAL	SCHIZOPHRENIC	CONTROL
COPY	P = 0.6456	P = 0.6359
IMMEDIATE RECALL	P = 0.2616	**P = 0.0033***
DELAYED RECALL	P = 0.3104	**P = 0.0029***

* P = 0.05

The results indicated no significant differences between men and women in both groups for the Copy of the RCF. No significant differences were established between men and women in the Schizophrenic group for both Immediate Recall and Delayed

Recall. These results support the null hypothesis. In contrast to these results, significant differences were found between men and women in the Control Group for both Immediate Recall and Delayed Recall.

Table 3. Means and Standard Deviations for Within-group Analysis for the RCF

TRIAL	MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
COPY	27.30 (8.03)	27.40 (5.96)	33.02 (3.38)	32.97 (2.85)
IMMEDIATE RECALL	13.97 (8.06)	11.70 (6.94)	**23.87*** (5.24)	**17.62*** (6.39)
DELAYED RECALL	12.97 (10.57)	8.11 (7.49)	**23.12*** (17.47)	**17.47*** (5.87)

* P = 0.05

For both Immediate Recall and Delayed Recall trials of the RCF, men in the Control group obtained a higher mean score than women in the Control group.

7.2.2 Modified Card Sorting Test (MCST)

Table 4. Mann-Whitney Test for Within-group Analysis for the MCST

	SCHIZOPHRENIC	CONTROL
CATEGORIES ACHIEVED	P = 0.4989	P = 0.7251
ERRORS	P = 0.6359	P = 0.7150
PERSEVERATIVE ERRORS	P = 0.1404	P = 0.4903

* P = 0.05

No significant differences were found in the scores for men and women in both groups for the number of Categories Achieved, the Number of Errors and the Number of Perseverative Errors for the MCST. The means and standard deviations are provided below.

Table 5. Means and Standard Deviations for Within-group Analysis for the MCST

	MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
CATEGORIES ACHIEVED	4.35 (1.81)	4.75 (1.61)	5.45 (1.43)	5.30 (1.42)
ERRORS	12.85 (10.70)	12.85 (7.70)	8.95 (7.51)	8.15 (6.60)
PERSEVERATIONS	9.05 (6.70)	6.65 (6.08)	6.35 (3.86)	8.05 (5.88)

* P = 0.05

The results above indicate that the means between men and women in the Schizophrenic group and between the men and women in the Control group did not differ significantly.

7.2.3 TOWER OF LONDON

Table 6. Mann-Whitney Test for Within-group Analysis for the Tower of London test

	SCHIZOPHRENIC	CONTROL
TIME TO FIRST MOVE	P = 0.5791	P = 0.9353
TOTAL TIME	**P = 0.0343***	P = 0.5428
ERRORS	P = 0.6721	**P = 0.0248***

* P = 0.05

No statistical significant differences were established for the men and women in the Schizophrenic group for both the time taken to make the first move, and the number of errors. A statistical significant difference was found for the total time taken to complete the Tower of London for the men and women in the Schizophrenic group. For the men and women in the Control group, no significant differences were found between men and women in the Control group for both the time to the first move and the total time taken to complete the Tower of London test. However, a statistical significant difference was found between men and women in the Control group for the number of errors made.

Table 7. Means and Standard Deviations for Within-group Analysis for the Tower of London Test

	MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
TIME TO 1ST MOVE	35.15 (22.50)	29.15 (15.77)	36.67 (18.77)	36.60 (20.70)
TOTAL TIME	181.26* (69.88)	141.00* (45.91)	143.30 (47.88)	130.90 (31.76)
ERRORS	3.05 (2.65)	2.94 (1.74)	0.85* (1.38)	1.70* (1.08)

* P = 0.05

From table 7, it may be seen that men obtained a higher mean score than women in the Schizophrenic group for the total time taken to complete the Tower of London. Women in the Control group acquired a higher mean score than the men in the control group for the number of errors made.

7.2.4 Block Counting Test

Table 8. Mann-Whitney Test for Within-group Analysis for the Block Counting Task

	SCHIZOPHRENIC	CONTROL
ERRORS	P = 0.5058	**P = 0.0483***
TIME	P = 0.6573	P = 0.0499

* P = 0.05

No statistical significant differences were found for the men and women in the Schizophrenic group for both the number of errors made and the time taken to complete the Block Counting Task. A significant difference was found for the number of errors made for the men and women in the Control group. No significant difference was found for the men and women in the Control group for the time taken to complete this task.

Table 9. Means and Standard Deviations for Within-group analysis for the Block Counting Task

	MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
ERRORS	6.63 (4.15)	5.70 (3.85)	**0.65*** (0.67)	**2.45*** (2.99)
TIME	148.74 (133.07)	119.06 (47.44)	58.75 (31.14)	79.05 (47.41)

* P = 0.05

The results for the means and standard deviations indicated that men in the Control group obtained a lower mean score than women in the Control group for the Number of Errors made in the Block Counting Task.

7.2.5 Stroop Colour and Word Test

Table 10. Mann-Whitney Test for Within-grou 'nalysis for the Stroop Colour and Word Test

		SCHIZOPHRENIC	CONTROL
TRIAL I	TIME	P = 0.5262	P = 0.6750
	ERRORS	P = 0.1131	P = 0.7972
TRIAL II	TIME	P = 0.5366	P = 0.4171
	ERRORS	P = 0.8245	P = 0.7557
TRIAL III	TIME	P = 0.4857	P = 0.6652
	ERRORS	**P = 0.0086***	P = 0.6554
TRIAL IV	TIME	P = 0.3835	P = 0.2914
	ERRORS	P = 0.9621	P = 0.6359

* P = 0.05

No significant differences were found on most of the trials of the Stroop for men and women in both groups. The only statistical significant difference that was found was between men and women in the Schizophrenic group for Trial III of the Stroop.

Table 11. Means and Standard Deviations for Within-group Analysis of the Stroop

		MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
TRIAL I	TIME	68.47 (32.07)	58.35 (16.72)	47.50 (10.45)	48.95 (16.47)
	ERRORS	1.68 (2.98)	0.35 (1.22)	0.00 (0.00)	0.05 (0.22)
TRIAL II	TIME	70.05 (29.93)	59.23 (14.41)	49.75 (10.55)	48.90 (10.60)
	ERRORS	3.52 (9.2.)	0.94 (1.67)	0.25 (0.63)	0.10 (0.30)
TRIAL III	TIME	103.16 (43.36)	92.58 (35.10)	59.10 (13.43)	60.90 (14.79)
	ERRORS	**1.52*** (1.80)	**0.27*** (0.46)	0.30 (0.57)	0.50 (0.82)
TRIAL IV	TIME	169.11 (81.74)	154.06 (64.04)	93.50 (19.53)	105.00 (26.79)
	ERRORS	10.63 (22.25)	5.35 (6.69)	1.20 (1.57)	1.95 (2.64)

* P = 0.05

From the above table it may be seen that for the statistically significant result, men in the Schizophrenic group obtained a higher mean score than women on the number of errors in Trial III of the Stroop Colour and Word Test.

7.2.6 Trail Making Test

Table 12. Mann-Whitney Test for Within-Group Analysis for the Trail Making Test

TRAILS	SCHIZOPHRENIC	CONTROL
A	P = 0.9888	P = 0.5250
B	P = 0.7254	P = 0.7764

* P = 0.05

No significant differences were established for Trails A and for Trails B for the men and women in both groups.

Table 13. Means and Standard Deviations for Within-group Analysis for the Trail Making Test

TRAILS	MALE SCHIZOPHRENIA	FEMALE SCHIZOPHRENIA	MALE CONTROL	FEMALE CONTROL
A	96.00 (81.61)	73.78 (40.56)	33.90 (12.75)	36.50 (13.58)
B	176.35 (132.45)	124.89 (46.89)	70.75 (43.08)	58.70 (20.84)

* P = 0.05

As can be seen from table 9 above, there is not a great discrepancy in the means of the men and women in both groups.

7.3 Statistical Analysis Between-group

Several Mann-Whitney U-tests were performed in order to determine whether a significant difference existed between the Schizophrenic group and between the Control group. The means and standard deviations of the results were also calculated for the two groups. A non-significant result was found for age ($p = 0.1729$), whereas a statistically significant result was found for years of education ($p = 0.0037$*), whereby the people with schizophrenia had less years of education ($M = 10.703$, $SD = 2.79$) compared with people in the Control group ($M = 12.60$, $SD = 2.38$). The statistical analysis for each of the neuropsychological tests provided below.

7.3.1 Rey Complex Figure

Table 14. Mann-Whitney Test for Between-group Analysis for the RCF

TRIAL	P
COPY	0.000*
IMMEDIATE RECALL	0.000*
DELAYED RECALL	0.000*

* P = 0.05

Significant differences were found between the Schizophrenic and Control group on all three trials of the RCF, viz. Copy, Immediate Recall and Delayed Recall.

Table 15. Means and Standard Deviations for Between –group Analysis for the RCF

TRIAL	SCHIZOPHRENIA	CONTROL
COPY	27.35* (6.98)	33.00* (3.09)
IMMEDIATE RECALL	12.83* (7.52)	20.75* (6.58)
DELAYED RECALL	11.77* (7.80)	20.30* (6.07)

* P = 0.05

By comparing the means it was found that, the Control group obtained a higher mean score than the Schizophrenic group, for the Copy, Immediate Recall and Delayed Recall trials of the RCF.

7.3.2 Modified Card Sorting Test

Table 16. Mann-Whitney Test for Between-group Analysis for the MCST

	P
CATEGORIES ACHIEVED	0.2181 *
ERRORS	0.0087*
PERSEVERATIVE ERRORS	0.91

* P = 0.05

No significant differences were found between the Control group and the Schizophrenic group for the number of Categories Achieved, and the Number of Perseverative Errors of the MCST. A significant difference was found between the two groups for the Number of Errors made.

Table 17. Means and Standard Deviations for Between-group Analysis of the MCST

	SCHIZOPHRENIA	CONTROL
CATEGORIES ACHIEVED	8.60 (8.71)	5.37 (1.40)
ERRORS	**12.85*** (9.20)	**8.55*** (6.99)
PERSEVERATIVE ERRORS	7.85 (1.01)	7.20 (0.78)

* P = 0.05

From the above table it may be seen that people with schizophrenia obtained a higher score for the Number of Errors made than people in the Control group.

7.3.3 Tower of London Test

Table 18. Mann-Whitney Test for Between-group Analysis for the Tower of London Test

	P
TIME TO FIRST MOVE	0.2096
TOTAL TIME	0.0659
ERRORS	0.0002*

* P = 0.05

No statistical significant differences were found for both the time to make the first move and the total time taken to complete the Tower of London task. However, a statistical significant difference was found between the two groups for the number of errors made.

Table 19. Means and Standard Deviations for Between-group Analysis for the Tower of London Test

	SCHIZOPHRENIA	CONTROL
TIME TO FIRST MOVE	32.15 (19.50)	36.63 (19.50)
TOTAL TIME	161.13 (61.78)	161.13 (40.59)
ERRORS	**3.00*** (2.21)	**1.27*** (1.30)

* P = 0.05

It was found that people with schizophrenia obtained a higher mean score than the Control group for the number of errors made while performing the Tower of London task.

7.3.4 Block Counting Task

Table 20. Mann-Whitney Test for Between-group Analysis for the Block Counting Test

	P
ERRORS	0.000*
TIME	0.000*

* P = 0.05

Significant differences were found for both the Number of Errors and the Time Taken for the Block Counting test. In order to determine which groups achieved higher and/or lower scores for this test, the means and standard deviations were calculated.

Table 21. Means and Standard Deviations for Between-group analysis for the Block Counting Test

	SCHIZOPHRENIA	CONTROL
ERRORS	6.19* (3.98)	1.55* (2.33)
TIME	134.72* (101.79)	68.90* (40.90)

* P = 0.05

The people in the Control group obtained a lower mean score for the time taken and the number of errors made, than the people in the Schizophrenic group.

7.3.5 Stroop Colour and Word Test

Table 22. Mann-Whitney Test for Between-group Analysis for the Stroop

		P
TRIAL I	TIME	0.0006*
	ERRORS	0.0488*
TRIAL II	TIME	0.0024*
	ERRORS	0.0753
TRIAL III	TIME	0.000*
	ERRORS	0.1094
TRIAL IV	TIME	0.0000*
	ERRORS	0.0191*

* P = 0.05

Statistically significant differences were found for times taken to complete Trial I, Trial II, Trial III, and Trial IV. Significance was also established for the number of errors made for Trial I and for Trial IV.

Table 23. Means and Standard Deviations for Between-group Analysis for the Stroop

		SCHIZOPHRENIA	CONTROL
TRIAL I	TIME	61.25* (21.98)	48.22* (13.63)
	ERRORS	1.08* (2.41)	0.025* (0.15)
TRIAL II	TIME	63.88* (23.69)	49.32* (10.45)
	ERRORS	2.34 (6.94)	0.17 (0.50)
TRIAL III	TIME	95.05* (35.30)	60.00* (13.97)
	ERRORS	0.91 (1.46)	0.40 (0.70)
TRIAL IV	TIME	162.00* (73.27)	99.61* (24.06)
	ERRORS	8.13* (16.80)	1.58* (2.20)

* P = 0.05

In each case, where significance was established, it was found that the people in the Schizophrenic group obtained a higher mean score than the people in the Control group.

7.3.6 THE TRAIL MAKING TEST

Table 24. Mann-Whitney Test for Between-group Analysis for the Trail Making Test

TRAILS	P
A	0.0000*
B	0.0000*

* P = 0.05

The results from the Mann-Whitney U test revealed that a statistically significant difference existed between the two groups for both Trails A and for Trails B.

Table 25. Means and Standard Deviations for Between-group Analysis for the Trail Making Test

TRAILS	SCHIZOPHRENIA	CONTROL
A	85.17* (68.08)	35.20* (13.07)
B	172.66* (155.21)	64.72* (33.95)

* P = 0.05

The results from the means and standard deviations indicated that the subjects in the Schizophrenic group obtained higher mean scores, than the subjects in the Control group for both Trails A and B.

An in-depth discussion of the results that were found in the current research will be provided in the following chapter.

8.0 DISCUSSION

In this final chapter, an in-depth discussion of the results of each of the tests will be provided. Firstly, the results from within-group analysis will be discussed, followed by a discussion of the results of the between-group analysis. Following this discussion, general conclusions and limitations of the current research will be provided. Finally, recommendations for future research will then be explored.

8.1 Discussion of Within-Group Results

8.1.1 Introduction

The results indicated that there tended to be a lack of sex differences for the negative Schizophrenic group for most of the neuropsychological tests that were administered. This result was unexpected, as it was hypothesized that men with negative syndrome schizophrenia would show more impaired performance than women, on all of the neuropsychological functions that were measured, as previous research has demonstrated this. Some sex differences were found for two of the tests that were administered for the schizophrenic cohort. This result is in concordance with previous studies that have found sex differences for certain neuropsychological functions in people with schizophrenia. For the Control group, most of the sex differences that were found, tended to be indicative of the normative position. Thus, such results add credence to the vast amount of literature that has demonstrated that men and women have a different proficiency with regards to certain

neuropsychological functions. An in-depth discussion of the current results, and those of previous studies, will be considered for each of the tests below.

8.1.2 Rey Complex Figure

No significant differences were found between the men and women in the negative Schizophrenic group on all three trials of the RCF, namely Copy ($p = 0.64$), Immediate Recall ($p = 0.26$) and Delayed Recall ($p = 0.31$) trials. This result is in concordance with the null hypothesis, which proposed that no statistically significant differences would be found between men and women in the negative Schizophrenic group. This finding suggests that men and women with negative schizophrenia may experience similar deficits in tasks that require planning, visual memory (immediate and delayed), visuospatial functions, and visuoconstructive abilities, all of which implicate damage to the frontal cortex (Lezak, 1995; Spreen and Strauss, 1991). The current results are in contrast to those found by Goldstein et al. (1994), who found that men with schizophrenia were more impaired than women, on all three trials of the RCF.

The results of the RCF for the men and women in the Control group were statistically significant for both Immediate Recall ($p = 0.0033$*) and Delayed Recall ($p = 0.0029$*). In both of these recall trials men performed better than women ($p = 0.05$). However, as stated in the Methodology section and in Chapter 4, men are generally more skilled than women, in tasks that require visuoconstructive and visuospatial ability (Lezak, 1995). One of the reasons that have been proposed as to why such sex differences exist in certain cognitive functions, is related to the type and amounts of sex

hormones (for example, oestrogen, testosterone) that are released during the development of the brain *in utero*, (Flor-Henry, 1990; Kimura, 1987).

8.1.3 The Modified Card Sorting Test (MCST)

No significant differences were found between men and women in the negative Schizophrenic group for all measures of the MCST, these being Categories Achieved ($p = 0.49$), the number of Errors ($p = 0.63$) and the number of Perseverative Errors ($p = 0.14$). This finding is in concordance with the results obtained by Goldberg, Gold, Torrey and Weinberger (1995). Similarly, Lewine, Haden, Caudle and Shurett (1997), demonstrated no significant differences between men and women for the number of Perseverative Errors made during the performance of the MCST ($p < 0.01$). Such a result supports the null hypothesis of the current research.

The results for the men and women in the Control group also yielded no statistically significant differences, for the number of Categories Achieved ($p = 0.72$), the number of Errors ($p = 0.71$) and the number of Perseverative Errors ($p = 0.49$). Similarly, Yeudall, Fromm, Reddon, and Stefanyk (1986) also found no sex differences in the performance of the MCST for a normative sample. It may therefore be inferred from these results, that no sex differences exist in neuropsychological functions that require abstract abilities, shift of cognitive set, hypothesis testing and/or visual memory, in a normative sample.

8.1.4 Tower of London Test

A significant main effect was found for the men and women in the negative Schizophrenic cohort, for the total time taken to complete this task ($p = 0.03^*$), whereby men with negative schizophrenia took longer to complete this task than women with negative schizophrenia. This finding supports the alternate hypothesis. This result may indicate that men with schizophrenia may be more impaired than women with schizophrenia, on one or more of the following functions, these being planning, attention, psychomotor functions, visuo-constructive abilities and/or working memory (Baker, et al 1996; Dehaene and Changeux, 1997; Lezak, 1995; Walsh, 1994). No statistically significant differences were established for both the time taken to make the first move ($p = 0.57$) and for the number of errors made ($p = 0.67$), for the negative Schizophrenic cohort.

No statistically significant differences were found between men and women in the Control group for both the time taken to make the first move ($p = 0.93$), and the total time taken to complete this task ($p = 0.54$). These findings support the null hypothesis of this study. This result suggests that it is possible that men and women in a normative sample may have a similar aptitude for tasks that require psychomotor abilities, and/or working memory. However, Lezak (1995) has argued, that women would be more proficient at tasks that require motor functioning.

It was found that a statistically significant difference existed for the number of errors made ($p = 0.02^*$), whereby women in the Control group made more errors than men in the Control group. This may indicate that women may be less adept than men, in

visuo-spatial functions. Such a finding supports the alternate hypothesis of this study, and is in concordance with previous research that has demonstrated that women are less proficient than men in tasks that require visuo-spatial ability (Lezak, 1995; Weekes, 1994)

8.1.5 Block Counting Test

No statistically significant differences were established for the men and women in the negative Schizophrenic group, for both the number of errors made ($p = 0.50$) as well as for the time taken to complete this task ($p = 0.65$). This result may indicate that both men and women with negative schizophrenia may experience similar cognitive impairments, in tasks that require non-verbal reasoning ability. Unfortunately, the current researcher was unable to find previous studies that have focused on sex differences in the Block Counting task, and thus no collaboration with previous studies could be made.

A significant difference was established between men and women in the Control group, whereby it was found that women made more errors than men, in this task ($p = 0.04$*). This result was expected, as it has been proposed that men are more proficient in tasks which involve non-verbal spatial reasoning ability (Lezak, 1995), and should therefore make fewer errors than women, on tasks that require spatial reasoning abilities.

8.1.6 Stroop Colour and Word Test

The only statistically significant result that was found was for the number of errors made for Trial III, for the men and women in the Schizophrenic cohort ($p = 0.0086^*$). A comparison of the means indicated that men with negative schizophrenia made more errors than women with negative schizophrenia, on Trial III of the Stroop. Goldberg, Gold, Torrey and Weinberger (1995) found similar results, to the ones found in the current research. Such findings may indicate that men with schizophrenia may have an inability to change perceptual set, which is one of the main functions that is measured by Trial III of the Stroop.

The lack of sex differences for the control group on this test was anticipated, as this test was specifically devised taking the affects of sex into account (Golden, 1978).

8.1.7 Trail Making Test

No significant differences were established between men and women with negative schizophrenia for both Trails A and B. This finding is in contrast to the results found by Goldberg, Gold, Torrey and Weinberger (1995) and Goldstein, et al. (1994). Goldberg, Gold, Torrey and Weinberger (1995) found that women with schizophrenia took longer than men with schizophrenia on both Trails A and Trails B. In contrast, Goldstein, et al. (1994) found that men with schizophrenia were more impaired than women with schizophrenia, on Part B of the Trail Making Test.

The results for the Control group indicated no significant differences between men and women for both Trails A and B. These results are in concordance with Bornstein's (1985) research, and may suggest that there is a general lack of sex differences in visual scanning, motor speed, attention, and mental double tracking.

8.1.8 Conclusions for Within-group Analysis

As can be seen from the above discussion for most of the neuropsychological tests that were administered, the control group displayed a number of sex differences for certain neuropsychological tests, for example the immediate and delayed recall trials of the Rey Complex Figure. Two possible reasons may account for these sex differences. Firstly, most of these tests have taken sex differences into account during their development, for example the Stroop (Golden, 1978), thus reducing the effects of sex differences in neurocognitive functioning. And secondly, most of the sex differences that were found are generally regarded as being normative. For example, men performing better than women on tasks that require visuospatial memory (Lezak, 1995; Spreen and Strauss, 1991). Such sex differences in neuropsychological functions have been attributed to sex hormones that are released *in utero* (De Lacoste, Horvath and Woodward, 1991; Kimura, 1987; Weekes, 1994), and/or to sociocultural practices (for example, Andersson, et al., 1998; Collaer and Hines, 1995).

In contrast to the results for the control group, the results from the people in the schizophrenic group revealed few sex differences in the performance of the neuropsychological tests that were used. This result was unexpected, given that most of the previous research has suggested that men would display more impairments than

women, as they have a more debilitating form of the disease, due to dysfunctions that occurred during neurodevelopment (Castle and Murray, 1991; De Lisi, et al., 1991 Flor-Henry, 1990; Lewine, Walker, Shurett, et al., 1996; Seeman and Lang, 1990;). The reasons for this general lack of sex differences in the current research may be manifold, but for the purposes of the current research the author will propose four possible explanations.

Firstly, the development of sex differences in schizophrenia is often regarded as having a large neurodevelopmental basis (Castle and Murray, 1991; De Lisi, et al., 1991; Flor-Henry, 1990; Lewine, Walker, Shurett, et al., 1996; Seeman and Lang, 1990). It has been suggested in these previous studies, that certain sex hormones, such as oestrogen, may act as modifying variables in schizophrenia. It has been inferred that oestrogen may act as protective factor in women with schizophrenia, and consequently this may help to explain why women often develop a less debilitating form of schizophrenia, are more responsive to neuroleptic medication, and are generally more functional than men with schizophrenia (Andia, et al., 1995; De Lisi, et al., 1991; Flor-Henry, 1990; Lewine, Walker, Shurett, et al., 1996; Seeman and Lang, 1990). Thus, from these studies it appears that differences in hormonal levels, may account for certain sex differences in the clinical expression of schizophrenia. Weinberger (1987) has suggested that a " 'fixed' structural defect [possibly in the dorsolateral prefrontal cortex] occurs long before the diagnosis [of schizophrenia] is made" (Weinberger, 1997, p.660) and this may interfere with hormonal brain maturation, and account for the sex differences that have been shown.

However, in the current research there were few differences between men and women with schizophrenia in neuropsychological functions. The present researcher therefore suggests that there may have been a hormonal anomaly. That is, it is possible that some type of disruption has occurred during neurodevelopment, either *in utero* or during puberty, whereby women with schizophrenia in this sample did not have an adequate amount of oestrogen to act as a protective factor. The result being that, woman would function at the same neurocognitive level as men. This proposition requires further investigation.

Secondly, related to this 'neurodevelopmental hormonal anomaly' hypothesis are the side effects of medication. It has been documented that certain types of neuroleptics may interfere with normal gonadal hormone levels (Andia, et al., 1995; Murray, 1991; Seeman and Lang, 1990). It is therefore possible that the types of medication that were administered to the people in the schizophrenic cohort affected their hormonal functioning, resulting in them functioning at the same neurocognitive level. Thus, no sex differences would be found, because the normal hormonal systems had been disrupted by medication. Andia, et al (1995) have suggested, and the current researcher is in concordance with this view, that more research is required to determine the effects of neuroleptics on hormone levels.

Thirdly, the types of medication that the participants were taking could not be controlled. It is possible that there was a bias in the sample with regards to the types of medication that were administered. Previous research has shown that the newer forms of neuroleptic medication, such as Clozapine, may improve certain neuropsychological functions (Fujii, Ahmed, Jokumsen and Compton, 1997), whereas

the older forms, such as Haloperadol, may impair performance (Medalia, Gold and Merriam, 1988). It is therefore possible, if one accepts the neurodevelopmental hypothesis, that more women than men were on the older forms of medication, and therefore were functioning at the same level as men. Therefore, women and men were not functioning at the same neurocognitive level due to similar impairments. Rather they were functioning at the same level due to the side effects of the neuroleptic medication. It was beyond the scope of the present research to investigate this, but this could be an area for future research.

Finally, a significant difference was found between the men and women with regards to age, whereby women with negative syndrome schizophrenia were found to be older than the men. It has been reported that with advancing age certain neuropsychological functions may become impaired, for example memory and psychomotor functions (Lezak, 1995; Spreen and Strauss, 1991). However, in the current research if age was to act as a confounding variable, and because women were older, one would expect sex differences in the performance of these tests, with women faring more poorly than men. This was not found for all of the tests that were administered. Thus, while age may account for differences in performance of most of these tests in general, it did not appear to affect the current findings.

Where significant differences were found for the negative symptom Schizophrenic group, (that is, for the Tower of London, and Trial III of the Stroop), it was initially presumed that men were more impaired than women on tasks that require a shift of cognitive set and psychomotor speed. However, once a holistic analysis of the entire test battery was made, whereby each of the tests and the functions that each test

measures was taken into account, it was established that this assumption did not hold any weight. For example, it was found that men with negative symptom schizophrenia had impairments in shift of cognitive set, as they were found to make more errors than women, in Trial III of the Stroop. However, no difference was found between men and women with negative schizophrenia on the MCST, which also measures, shift of cognitive set (Nelson, 1976; Spreen and Strauss, 1991).

One explanation that the current researcher can propose for this discrepancy, is that the nature of shifting of cognitive set for the two tests is different. That is, it may be possible that in the Stroop the shift in set occurs between colour recognition and verbal ability, whereas the MCST deals more with visuo-spatial abilities, such as shape, number and colour. Other reasons for this discrepancy may have been distractibility, poor concentration, and/or fatigue whilst performing the Stroop. These responses to the Stroop have been reported previously (Lezak, 1995) and need to be taken into account.

Similarly, it was initially proposed that men with negative syndrome schizophreni were impaired on psychomotor tasks, as it was found that they took longer to complete the Tower of London task. However, no difference was established for men and women in the schizophrenic cohort on the performance of the Trail Making Test, which also measures psychomotor functioning (Lezak, 1995; Spreen and Strauss, 1991). One possible explanation that the current author can propose for this difference is that the Trail Making Test is a pencil and paper test, and therefore requires fine motor functioning, as opposed to the Tower of London, which focuses on larger psychomotor movements. Furthermore, it is possible that medication may

have an impact on large motor functioning, and has little or no impact on fine motor functioning.

Therefore, in conclusion, the results for the men and women in the control group were expected, as it is well documented that men and women show different proficiency for different neuropsychological functions. In contrast, the results for the people in the schizophrenic group were unexpected, as it was hypothesized that men with negative syndrome schizophrenia would display greater impairments than women on these measures of certain frontal lobe functions. One reason that was given for this lack of sex differences relates to the side-effects of neuroleptics, which may have an adverse affect on sex hormones. It was suggested that future research should be done to investigate this.

In the following section the between-group results will be discussed.

8.2 DISCUSSION OF BETWEEN-GROUP ANALYSIS

8.2.1 Introduction

For most of the neuropsychological tests that were administered, it was found that people in the Control group performed better than people in the Schizophrenic group. A discussion of the results for between-group analysis for each of the tests will be provided below.

8.2.2 Rey Complex Figure

The control group tended to achieve higher mean scores than the negative symptom schizophrenic group, on all three trials of the RCF, these being Copy ($p = 0.000$*), Immediate Recall ($p = 0.000$*), Delayed Recall ($p = 0.000$*). This result is in concordance with the results found by Kolb and Whishaw (1983), who found that people with schizophrenia were more impaired than a 'normal' control group on all trials of the RCF.

Furthermore, the current findings for the performance on the RCF, adds credence to the already existing literature, which has compared neuropsychological functioning in people with schizophrenia and a control group. Many of these studies have indicated that many people with schizophrenia tend to be more impaired on a number of frontal lobe functions, which include visuo-spatial memory (immediate and delayed) (Pantelis, et al., 1997), visuo-constructive abilities and planning (Lezak, 1983,1995; Spreen and Strauss, 1991; Walsh 1994).

8.2.3 Modified Card Sorting Test (MCST)

In the current research, statistical significant differences were found between the Schizophrenic and Control groups for the number of errors ($p = 0.0087$*) made while performing the MCST. By comparing the means of these two groups it was found that people with negative symptom schizophrenia tended to make more errors than people in the normative sample. No significant differences were found between the two groups for the number of Categories Achieved ($p = 0.2181$) and for the number of

Perseverative Errors made ($p = 0.91$). This result was contrary to the hypothesis that was formulated, as it was proposed that people with schizophrenia would display more deficits in tasks that require abstract thinking, shift of cognitive set and planning.

However, many other researchers have found similar results to the ones found in the current research with the performance of the MCST, although, discrepancies have been found, as to which measures people with schizophrenia are more deficient. For example, Nathaniel, Brown and Ron (1996), and Morrison-Stewart et al (1992) found that people with schizophrenia performed significantly worse than a 'normal' control group on all three measures of the WCST. In contrast, Braff et al (1991) and Butler, Jenkins, Sprock and Braff (1992), found that people with schizophrenia made more Perseverative Errors than Controls. It has been suggested that such diminished performance on the MCST may be seen as being due a deficit in working memory (Gold et al., 1997), and/or may be due to an inability to shift cognitive set, and/or an impairment in abstract ability (Lezak, 1995). All of these dysfunctions implicate impairments in the frontal lobes (Goldberg, et al., 1987; Goldberg, Kelsoe, Weinberger, et al, 1988).

One other suggestion for this finding relates to the side effects of neuroleptic medication, which may lead to impaired performance on such tasks. However, in a study conducted by Verdoux, Magnin and Bourgeois (1995), it was found that people with schizophrenia displayed deficits on the MCST with and without medication. Thus, it may be inferred that the disease process itself may account for the deficits in

the functions of the frontal lobes, rather than being a result of the side effects of neuroleptic medication.

8.2.4 Tower of London

No significant differences were found between the Control group and Schizophrenic group for both the time taken to make the first move ($p = 0.2096$) and the total time taken to complete the Tower of London task ($p = 0.0659$). However, significant differences were established for the number of errors made ($p = 0.0002$*) while completing the Tower of London task, with the people in the negative Schizophrenic cohort making more errors than the people in the control group.

The results for the times taken for the first move and the total time taken to complete this task were unexpected. It was postulated, in the current research, that people with negative schizophrenia would take longer to complete this task, as it has been documented in previous literature, that people with schizophrenia tend to be predisposed to displaying deficits in planning ability (Morice and Delahunty, 1996), and also tend to demonstrate psychomotor poverty (Pantelis, et al., 1997).

8.2.5 Block Counting

Significant differences were established between the two groups for both the number of errors made ($p = 0.000$*), as well as the time taken to complete this test ($p = 0.000$*). A comparison of the means of the two groups revealed that, people in the negative symptom Schizophrenic group made more errors and took longer to

complete this task than the people in the Control group. The current author was unable to find previous literature that has compared a Schizophrenic group to a 'normal' Control group using this task. Therefore, the only explanation that the author can offer for this result is that people with schizophrenia may be impaired on non-verbal spatial reasoning processes.

8.2.6 Stroop Colour and Word Test

Significant differences were found for the two groups for the time taken for all four trials of the Stroop. For Trial I $p = 0.0006$*, for Trial II, $p = 0.0024$*, for Trial III $p = 0.000$*, and for Trial IV, $p = 0.0000$*. For each of these trials it was found that the people in the Schizophrenic group tended to take longer to complete these trials than the Control group. Significant differences were also observed for the number of errors made for Trial I ($p = 0.0488$*), and for Trial IV ($p = 0.0191$*), with the Schizophrenic group making more errors than the Control group. Buchanan et al. (1994) found similar results, to the ones that have been found in the current research, whereby they found that people with negative syndrome schizophrenia performed more poorly than a normative control group on the Stroop.

Two possible explanations may be offered for the results that were found in the current research for the Stroop: 1) People with schizophrenia tend to be more impaired in tasks that require shift in cognitive set, verbal fluency, and/or attention. And deficits in such tasks point towards the involvement of the frontal cortex; and/or 2) the adverse side effects of neuroleptic and other psychiatric medication, which may

contribute towards the impaired performance on tasks of attention, shift of cognitive set, psychomotor functioning and verbal fluency.

With regards to the negative side effects of medication, such effects may not entirely contribute to the deficits that were found in the current research. Verdoux, Magnin and Bourgeois (1995) found that once people with schizophrenia had been stabilized on medication, their performance on the Stroop actually improved. They therefore concluded that the impaired performance on the Stroop could not be attributed to the effects of neuroleptic medication, rather they argued that impaired performance on the Stroop was due to deficits in the functioning of the frontal lobes that are ascribed to negative schizophrenia. Thus, the current author believes that the results for the Stroop, whereby the Schizophrenic group tended to show more impaired performance than the normative sample, cannot be fully attributed to the effects of neuroleptic medication. Rather, the author believes that the impaired performance that was observed, may be attributed to deficits in frontal lobe functioning, and consequently is related to the disease process itself.

8.2.7 Trail Making Test

A statistically significant difference was established between the two groups for both Trails A ($p = 0.000$*) and for Trails B ($p = 0.000$*). In both of these forms, the people with negative symptom schizophrenia took longer to complete these tasks, than the people in the Control group. Similarly, Nelson et al. (1990) found that people with schizophrenia tended to perform this test slower than a control group. Brown and White (1991), and Braff et al. (1991) also established a relationship between impaired

performance in the performance of the Trail Making Test and people with negative symptom schizophrenia. Buchanan et al (1994) found a positive correlation between negative symptomatology and a decrease in the performance of Trails B. Therefore, it may be assumed from these studies, as well as from the current one, that people with schizophrenia tend to be impaired on tasks that require psychomotor speed, shift of cognitive set and attention.

8.2.8 Conclusion for Between-Group Analysis

As was hypothesized at the outset of this research, and was found in the current research, people with negative symptom schizophrenia tend to display more impairments in neuropsychological tests than a 'normal' control group. In particular, it was found, in the current research, that people with negative symptom schizophrenia tend to display deficits in tasks that require shift of cognitive set, attention, planning, visuospatial memory, abstract thinking, mental double-tracking, spatial reasoning, and psychomotor speed. Three reasons may be proposed for these results.

Firstly, as was stated previously, such impaired performance on these tasks cannot solely be ascribed to the negative side effects of neuroleptic medication, as previous research has found that neuroleptic medication may actually improve neuropsychological test performance rather than impede it (for example, Verdoux, e al., 1995). However, as was discussed in the conclusions for the within-group differences for the schizophrenic cohort, the type of medication may impact on certain cognitive functions, whereby the older forms of neuroleptics have been found to

impair performance (Medalia, et al., 1988), whereas the newer forms may enhance certain neuropsychological functions (Fujii, et al., 1997). Thus, it is possible that most of the people in the schizophrenic cohort were taking older forms of neuroleptics and may account for their impaired performance. This requires further investigation, as it was beyond the scope of the current research.

Secondly, the above results may have also been due to differences in the years of formal education. It was found in the current research that people in the control group had significantly more years of education than people in the schizophrenic group. Previous research has shown that years of education may impact on the performance of certain neuropsychological tests, whereby people with less education displaying more impaired performance than people with more schooling (Lezak, 1995; Spreen and Strauss, 1991).

Finally, it may be the disease process itself that may account for the differences in the performance of these neuropsychological tests. This view is in concordance with previous research in this area, which has shown that people with schizophrenia, especially negative syndrome schizophrenia, are more impaired than controls on most neurocognitive functions (Braff, et al., 1991; Brown and White, 1991; Butler, et al., 1992; Buchanan et al., 1994; Gold, et al., 1997; Goldberg, et al., 1987; Goldberg, et al.,1988; Morice and Delanhunty, 1996; Morrisson-Stewart, et al., 1992; Nathaniel, et al., 1996; Nelson, et al., 1990;Pantelis, et al., 1997).

The current research has a number of limitations, and these will be discussed in the following section. It is with great hope that future researchers who wish to replicate

this research will be able to do so, taking cognizance and accounting for these limitations.

8.3 Limitations

Because of the debilitating nature of schizophrenia, it was difficult to obtain a drug-free population. As far as the current author was aware, most, if not all of the people with schizophrenia had been stabilised on medication. Thus, this should not have confounded the results in any way. However, as discussed in the previous sections, it is possible that one of the confounding variables in this research were the side-effects of medication. This may account for the lack of sex differences in the schizophrenic group, and may have had a negative impact on the performance of the people in the negative symptom Schizophrenic group.

Furthermore, many of the people with schizophrenia were on different types of medication and this too may account for the results of the current research (see Appendix B).

The second limitation of the current research was the problem of organicity. The current researcher was unable to establish whether any of the participants had atrophy or any other organic diseases, which may have accounted for the impaired performance among people with negative symptom schizophrenia.

Thirdly, the current research may also be criticized for the limited test battery that was used. However, as stated in the Methodology section, the reason for using such a

small test battery, was to avoid fatigue and boredom amongst the participants, which has been found to influence neuropsychological functioning.

Finally, a significant difference was found between the people in the negative schizophrenic cohort and the people in the control group for the number of years of formal education, and this may have confounded the results. With these limitations in mind, some recommendations for future research in this area of study will be proposed.

8.4 Recommendations

Firstly, a larger battery of tests should be used. However, one still needs to take account of the effects of fatigue and boredom. Thus, the examiner should offer breaks of a few minutes whenever a subject displays fatigue and boredom. Furthermore, although it was the aim of this study to only concentrate on some of the functions of the frontal lobes, it is possible that people with negative symptom schizophrenia may be suffering from impairments in other regions of the brain. Such impairments, in the posterior regions of the cerebrum and/or subcortical areas, may therefore be indirectly affecting the performance of the functions of the frontal lobes. Thus, it is suggested that future research should use an array of tests, which tap into various cerebral functions and should not restrict testing to the frontal lobes.

Secondly, participants should be more closely matched according to their years of formal education.

Thirdly, participants should be matched according to the types of medication that they currently are taking.

The fourth recommendation is that future research could look at the effects of hormones with regards to both neuropsychological functions and to the impact different types of psychiatric medication have on hormonal levels.

Finally, future researchers need to establish the prevalence of organicity. That is, one needs to determine whether the participant has experienced any cerebral lesions and/or is suffering from any degenerative processes such as atrophy. Such a finding may be the reasons for inferior performance in neuropsychological functions, rather than being due to schizophrenia itself. Furthermore, if such a lesion is found, one needs to establish the site and the severity of such a lesion, taking cognisance of the fact that the brain works in a concerted manner, whereby lesions to a sub-cortical structure may impact on the functioning of the higher cortical areas.

8.5 Conclusions

This research sought to address two main hypotheses. The first hypothesis set out to determine whether sex differences exist in neuropsychological test performance among people with negative symptom schizophrenia. The main premise being that if sex differences were found, this would expand on existing theories on aetiology, prognosis and/or treatment. No overall significant sex differences were found in the current research, and it was suggested that it is possible that men and women with negative symptom schizophrenia were functioning at the same neuropsychological

level, due to a neurodevelopmental hormonal anomaly and/or the effects of neuroleptic medication. Sex differences in certain frontal lobe functions were also calculated for a sample who had no previous history of psychiatric illnesses. The reasons for using a control group were, firstly, to determine whether sex differences in neuropsychological functioning were normative, and secondly due to the lack of norms for a South African sample on these neuropsychological tests. The results indicated that on most of the neuropsychological tests that were administered, the results were normative. For example, it is well established that men tend to do better than women, on tests that require visual-spatial memory. One of the reasons that have been put forward to account for this difference, and that was discussed in the current research, is the nature of sex hormones that are released during neurodevelopment.

The second hypothesis was set up to determine whether people with negative schizophrenia were more impaired than a normative sample on tests of neurocognitive functioning. The findings from the current research do suggest that people with negative symptom schizophrenia tend to display greater deficits in tasks that require frontal lobe functions, as on most of the tests that were administered the people with negative schizophrenia displayed greater impairments, compared with a normative sample.

It should be noted that the results that were found in the current research cannot be generalized. The current research was merely a preliminary analysis, and therefore it is recommended that future research should be conducted in this area, in order to determine whether sex differences do exist in neurocognitive functioning among people with negative schizophrenia.

APPENDIX A

CONSENT FORM FOR SCHIZOPHRENIC GROUP

Subject #_____

Gender Differences in Neuropsychological Test Performance among People with schizophrenia.

Good day, my Name is Kathrine Ashley Roberts. I am a Masters student at Wits University. I am currently doing research on sex differences in problem solving skills among people with schizophrenia. This involves doing several neuropsychological paper-pencil tests. It should take one hour to complete. Please would you participate.

Participation in this research is entirely voluntary, and you may withdraw your consent at any time during the assessment. Only my supervisors and myself will have access to the results of your tests, and under no circumstances will your results be disclosed to anyone without your consent. Therefore, this assessment is anonymous.

If you have any questions about the assessment, please feel free to ask me.

_____
Kathrine Ashley Roberts

I fully understand the above

SIGNATURE_____

DATE OF ASSESSMENT_____

SUBJECT INFORMATION SHEET: SCHIZOPHRENIC GROUP

SUBJECT # _____

PLACE ASSESSED_____

TIME _____

DATE_____

AGE_____

GENDER_____

HOME LANGUAGE _____

HIGHEST LEVEL OF EDUCATION _____

OCCUPATION_____

MARITAL STATUS_____

HANDEDNESS_____

MEDICATION TYPE & DOSAGE _____

CURRENT SYMPTOMS _____

AGE AT WHICH SYMPTOMS BEGAN_____

AGE DIAGNOSED WITH SCHIZOPHRENIA _____

HEAD INJURY WHEN_____SEVERITY _____

NARCOTIC DRUGS: TYPE _____ AMOUNT_____FREQ._____

ALCOHOL: FREQUENCY_____AMOUNT_____

ANY OTHER RELEVANT INFORMATION

_____

_____

_____

CONSENT FORM FOR CONTROL GROUP:

Subject # _____

Gender Differences in Neuropsychological Test Performance.

Good day, my Name is Kathrine Ashley Roberts. I am a Masters student at Wits University. I am currently doing research on sex differences in problem solving skills. This involves doing several neuropsychological paper-pencil tests. It should take one hour to complete. Please would you participate.

Participation in this research is entirely voluntary, and you may withdraw your consent at any time during the assessment. Only my supervisors and myself will have access to the results of your tests, and under no circumstances will your results be disclosed to anyone without your consent. Therefore, this assessment is entirely anonymous.

If you have any questions about the assessment, please feel free to ask me.

_____
Kathrine Ashley Roberts

I fully understand the above

SIGNATURE_____

DATE OF ASSESSMENT_____

SUBJECT INFORMATION SHEET: CONTROL GROUP

SUBJECT# _____

PLACE ASSESSED _____

TIME _____

DATE _____

AGE _____

GENDER _____

HOME LANGUAGE _____

HIGHEST LEVEL OF EDUCATION _____

OCCUPATION _____

MARITAL STATUS _____

HANDEDNESS _____

PREVIOUS MENTAL ILLNESS _____

MEDICATION TYPE & DOSAGE _____

HEAD INJURY WHEN _____ SEVERITY _____

NARCOTIC DRUGS: TYPE _____ AMOUNT _____ FREQ. _____

ALCOHOL: FREQUENCY _____ AMOUNT _____

ANY OTHER RELEVANT INFORMATION

_____

_____

_____

_____

APPENDIX B

TYPES OF MEDICATION FOR THE SCHIZOPHRENIC GROUP

SUBJECT NUMBER	MEDICATION FOR WOMEN
001	Sulpiride
002	Trial
003	Trial
004	Trial
005	Tegretol, Valium, Etomine, Fluanxol (IV)
006	Orphenadrine, Terazone
007	Clopixol
008	Stelazine
009	Fluanxol (IV), Disipal, Oxasepam, Serenace
010	Fluanxol (IV), Sulpiride
011	Sulpiride
012	Unable to establish
013	Fluanxol (IV), Eltroxin, Disipal, Lithium
014	Sulpiride, Oxasepam, Orphenadrine
015	Haloperadol, Amitryptaline, Fluanxol
016	Mellaril, Modecate
017	Lithium, Disipal
018	Stelazine, Inderal, Propranolol, Disipal, Eltroxin
019	Disipal, Oxasepam, Inderal, Stelazine
020	Fluanxol (IV), Orphenadrine

SUBJECT NUMBER	MEDICATION FOR MEN
001	Risperidone
002	Olanzapine, Aropax, Epilim
003	Convalex, Clozapine
004	Clozapine
005	Zyprexal
006	Etomine
007	Unable to establish
008	Haloperadol, Clopixol, Disipal, Lorazepam, Etomine
009	Trial
010	Trial
011	Trial
012	Trial
013	Trial
014	Trial
015	Clozapine, Lorazepam, Inderal
016	Clozapine
017	Tegretol
018	Lithium
019	Sulpiride, Olanzapine
020	Risperidone, Clozapine

REFERENCES

Addington, J., Addington, D., and Maticka-Tyndale, E. (1991). Cognitive functioning and positive and negative symptoms in schizophrenia. schizophrenia Research, 5, 123-134.

Alexander, M. (1997). Aphasia: Clinical and Anatomic Aspects. In T. Feinberg, and M. Farah (eds.) Behavioural Neurology. New York, McGraw-Hill.

Allen, H.A., Liddle, P.F. and Frith, C.D. (1993). Negative features, retrieval processes and verbal fluency in schizophrenia. British Journal of Psychiatry, 163, 769-775.

American Psychiatric Association: The Diagnostic and Statistical Manual of Mental Disorders (1994), 4th ed. pp 273-290. Washington, DC., American Psychiatric Association.

Andia, A.M., Zisook, S., Heaton, R.K., Hesselink, J., Jernigan, T., Kuck, J., Morganville, J., Braff, D.L. (1995). Gender differences in schizophrenia. Journal of Nervous and Mental Disorders, 183 (8), 522-528.

Andersson, H.W., Sonnander, K. and Sommerfelt, K. (1988). Gender and its contribution to the prediction of cognitive abilities at five years. Scandinavian Journal of Psychology, 39 (4), 267-274.

Andreasen, N.C. (1982). Negative symptoms in schizophrenia: Definition and reliability. Archives of General Psychiatry, 39, 784-788.

Andreasen, N.C. (1985). Positive vs. negative schizophrenia: A critical evaluation. schizophrenia Bulletin, 11 (3), 380-389.

Andreasen, N., Nassrallah, H.A., Dunn, V., Olson, S.C., Grove, W.M., Ehrhardt, J.C., Coffman, J.A., Crossett, H.W. (1986). Structural abnormalities in the frontal system in schizophrenia: A Magnetic Resonance Imaging study. Archives of General Psychiatry, (43), 136-144.

Baker, S.C., Rogers, R.D., Owen, A.M., Frith, C.D., Dolan,R.J., Frackowiak, R.S., and Robbins, T.W. (1996). Neural systems engaged by planning: A PET study of the Tower of London task. Neuropsychologia, 34 (6), 515-526.

Barr, M. (1979). The Human Nervous System. An Anatomical Viepoint, 3rd ed. Maryland, Harper and Row Publishers.

Benson, D. (1979). Aphasia. In Heilman and Valenstein, E. (eds). Clinical Neuropsychology. Oxford, Oxford University Press.

Benson, D.F. and Miller, B.L. (1997). Frontal Lobe: Clinical and Anatomical Aspects. In Feinberg, T. and Farah, M (eds.). Behavioural Neurology and Neuropsychology. New York, McGraw-Hill.

Bjorklund, D.F. and Brown, R.D. (1988). Physical play and cognitive development: Integrating activity, cognition and education. Child Development, 69 (3), 604-606.

Blanchard, J.J. and Neale, J.M. (1994). The neuropsychological signature of schizophrenia: Generalized or differential deficit? American Journal of Psychiatry, 151 (1), 40-48.

Bornstein, R.A. (1985). Normative data on selected neuropsychological measures from a non-clinical sample. Journal of Clinical Psychology, (41), 651-659.

Braff, D.L., Heaton, R., Kuck, J., Cullum, M., Moranville, J., Grant, I., Zisook, S., (1991). The generalised pattern of neuropsychological deficits in outpatients with chronic schizophrenia with heterogeneous Wisconsin Card Sorting Test results. Archives of General Psychiatry (48), 891-898.

Brosnan, M.J. (1988). Spatial ability in children's play with Lego blocks. Perceptual Motor Skills, 87 (1), 19-28.

Brown, K.W. and White, T. (1991). The association among negative symptoms, movement disorders, and frontal lobes psychological deficits in schizophrenic patients. Biological Psychiatry, (30), 1182-1190.

Buchanan, R.W., Strauss, M.E., Kirkpatrick, B., Holstein, C., Breier, A., Carpenter, W.T. (1994). Neuropsychological impairments in deficit vs. non-deficit forms of schizophrenia. Archives of General Psychiatry, 51 (10), 804-811.

Burgess, P. and Shallice, T. (1996). Response suppression, initiation and strategy use following frontal lobes lesions. Neuropsychologia, 34, 263-273.

Butler, R.W., Jenkins, M.A., Sprock, J., Braff, D.L. (1992). Wisconsin Card Sorting Test deficits in chronic paranoid schizophrenia. Evidence for a relatively discrete subgroup? schizophrenia Research, 7, 169-176.

Capleton, R.A. (1996). Cognitive function in schizophrenia: Association with negative and positive symptoms. Psychological Reports, 78, 123-128.

Cassens, G. Inglis, A.K., Appelbaum, P.S., Gutheil, T.G. (1990). Neuroleptics: Effects on neuropsychological function in chronic schizophrenic patients. schizophrenia Bulletin, 16 (3), 477-499.

Castle, D.J., and Murray, R.M. (1991). The neurodevelopmental basis of sex differences in schizophrenia. Psychological Medicine, 21, 565-575.

Chute. "Executive Function Disorder" *Behavioural Neuropsychology* (1998). http://www.nan.drexel.edu/nandistance/nanneuro/modules/mod3/mod3.html (11/9/98).

Cockburn, J. (1995). Task interpretation in prospective memory: A frontal lobe function. Cortex, 31, 87-97.

Collaer, M.L. and Hines, M. (1995). Human behavioural sex differences: A role for gonadal hormones during early development. Psychological Bulletin, 18 (1), 55-107.

Comer, R.J. (1992). Chapter 15, schizophrenia. In R.J. Comer, Abnormal Psychology, 2nd ed., New York,W. H Freeman and Co.

Corcoran, R. and Frith, C.D. (1993). Neuropsychology and neurophysiology in schizophrenia. Current Opinion in Psychiatry, 6, 74-79.

Cowell, P.E. Kostianovsky, D.J., Gur, R.C , Turetsky, B.I. and Gur, R.E. (1996). Sex differences in neuroanatomical and clinical correlations in schizophrenia. American Journal of Psychiatry,153 (6), 799-805.

Crawford, J.R., Obonsawin, M.C., and Bremner, M. (1993). Frontal lobe impairment in schizophrenia. Relationship to intellectual functioning. Psychological Medicine, 23, 787-790.

Damasio, A.R. and Anderson, S.W. (1993). The frontal lobes. In K.M Heilman and E.Valenstein (Eds.), Clinical Neuropsychology (3rd Ed.). New York, Oxford University Press.

Damasio, A.R. and Geschwind, N.W. (1984). The neural basis of language. Annual Review of Neuroscience, (7), 127-147.

Dehaene, S. and Changeux, J-P. (1997) A hierarchical neuronal network for planning behavior. The National Academy of Science (94), 13293-13298.

De Lacoste, M-C., Horvath, D.S., and Woodward, D.J. (1991). Possible sex differences in the developing human fetal brain. Journal of Clinical and Experimental Psychology, 13 (6), 831-846.

Delgado, A.R. and Prieto, G. (1996). Sex differences in visuospatial ability: Do performance factors play such an important role? Memory and Cognition, 24 (4), 504-510.

DeLisi, L.E., Dauphinais, D., and Hauser, P. (1989) Gender differences in the brain: Are they relevant to the pathogenesis of schizophrenia? Comprehensive Psychiatry, 30 (3), 197-208.

Dickerson, F.B., Rigel, N.B., and Boronow, J.J. (1991). Neuropsychological deficits in chronic schizophrenics. Relationship with symptoms and behaviour. Journal of Nervous and Mental Disease, 179 (12), 744-749.

Duncan, J. (1986). Disorganisation of behaviour after frontal lobe injury. Cognitive Neuropsychology, 3, 271-290.

Fenton, W.S., Blyler, C.R., Wyatt, R.J., and McGlashan, T.H. (1997). Prevalence of spontaneous dyskinesia in schizophrenic and non-schizophrenic psychiatric patients. British Journal of Psychiatry, Sept, 171, 265-268.

Flaum, M., Arndt,S., and Andreasen, N.C. (1990). The role of sex in studies of ventricular enlargement in schizophrenia: A predominantly male effect. American Journal of Psychiatry, 147 (10), 1327-1332.

Flaum, M., Swayze,V.W., O'Leary, D.S.,Yuh, T.C., Ehrhardt, J.C., Arndt, S.V., and Andreasen, N.C. (1995). Effects of diagnosis, laterality, and sex on brain morphology in schizophrenia. American Journal of Psychiatry, 152 (5), 704-714.

Flor-Henry, P. (1990). Influence of sex in schizophrenia as related to other psychopathological syndromes. schizophrenia Bulletin, 16 (2), 211-227.

Fujii, D.E.M., Ahmed, I., Jokumsen, M., Crompton, J.M. (1997). The effects of Clozapine on cognitive functioning in treatment-resistant schizophrenic patients. The Journal of Neuropsychiatry and Clinical Neurosciences, 9, 240-245.

Fuster, J.M. (1989). The Prefrontal Cortex: Anatomy, Physiology, and Neuropsychology of the Frontal Lobe, 2nd ed. New York, Raven Press.

Gervin, M., Browne, S., Lane, A., Clarke, M., Waddington, J.L., Larkin, C., O'Callahan, E. (1998). Spontaneous abnormal involuntary movements in first episode schizophrenia and schizophreniform disorder: Baseline rate in a group of patients from an Irish catchment area. American Journal of Psychiatry, 155 (9), 1202-1206.

Giovannetti. "Cortical Structure and Function" (1998).

http://www.nan.drexel.edu/nandistance/nanneuro/modules/mod3/mod3.html.(11/9/98).

Gold, J.M., Carpenter, C., Randolph, C., Goldberg, T.E., and Weinberger, D.R. (1997). Auditory working memory and Wisconsin Card Sorting Test performance in schizophrenia. Archives of General Psychiatry, 54, 159-165.

Goldberg, E. and Bilder, R.M., Jr. (1987). The frontal lobes and hierarchical organisation of cognitive control. In E. Perecman (Ed.), The Frontal Lobes Revisited. New York, The IRBN Press.

Goldberg, T.E. Kelsoe, J.R. Weinberger, D.R. Pliskin, N.H. Kirwin, P.D. and Berman, K.F. (1988). Performance of schizophrenic patients on putative neuropsychological tests of frontal lobe function. International Journal of Neuroscience, 42, 51-58.

Goldberg, T.E. and Weinberger, D.R. (1988). Probing prefrontal function in schizophrenia with neuropsychological paradigms. schizophrenia Bulletin, 14 (2), 179-183.

Goldberg, T.E., Gold, J.M., Torrey, E.F. and Weinberger, D.R. (1995). Lack of sex differences in the neuropsychological performance of patients with schizophrenia. American Journal of Psychiatry, 152 (6), 883-888.

Golden, C.J. (1978). Stroop Colour and Word ' .nnual for Clinical and Experimental Uses. Chicago, Stoelting Company.

Goldstein, J.M., Seidman, L.J., Santangelo, S., Knapp, P.H. and Tsuang, M.T. (1994). Are schizophrenic men at higher risk for developmental deficits than schizophrenic women? Implications for adult neuropsychological functions. Journal of Psychiatric Research, 28, (6), 483-498.

Goldstein, G., Beers,S.R., and Shemansky, W.J. (1996). Neuropsychological differences between schizophrenic patients with heterogeneous Wisconsin Card Sorting Test Performance. schizophrenia Research, 21, 13-18.

Goldman, R.P.S. (1994). Working memory dysfunction in schizophrenia. Journal of Neuropsychiatry and Clinical Neurosciences, 6 (4), 348-357.

Goldman, R.S., Axelrod, B.N., and Tandon, R., (1991). Analysis of executive functioning in schizophrenics using the Wisconsin Card Sorting Test. Journal of Nervous and Mental Diseases, 179 (8), 507-508.

Grant, D.A. and Berg, E.A. (1948). A behavioural analysis of degree of reinforcement and ease of shifting to new response in Weigl-type Card Sorting Problem. Journal of Experimental Psychology, 38, 404-411.

Halpern, D.F. (1992). Sex Differences in Cognitive Abilities. New Jersey, Lawrence Erlbaum Associates Inc.

Hoff, A.L., Riordan, H., O'Donnell, M.A., Morris, L., DeLisis, L.E.(1992). Neuropsychological functioning of first-episode schizophreniform patients. American Journal of Psychiatry, 149 (7), 898-903.

Jacobsen, L.K. Giedd, J.N., Vaituzis, A.C., Hamburger, S.D., Rajapakse, J.C., Frazier, J.A., Kaysen, D., Lenane, M.C., McKenna, K., Gordon, C.T., Rapoport, J.L. (1996). Temporal lobe morphology in childhood-onset schizophrenia. American Journal of Psychiatry, 153 (3), 355-361.

Johnstone, E.C. (19[illegible]. The assessment of negative and positive features in schizophrenia. British Journal of Psychiatry, 155 (7), 41-44.

Kagan, A., and Saling, M.N., (1988) Chapter 1. In A. Kagan and M.N. Saling, An Introduction to Luria's Aphasiology: Theory and Application. Johannesburg, Wits University Press.

Kaplan, H.I., and Saddock, B.J., (1994) Synopsis of Psychiatry, 7th ed. New York, Williams and Wilkens.

Kay, S.R., Fiszbein, A.and Opler, L.A. (1987). The Positive and Negative Syndrome Scale (PANSS) for schizophrenia. schizophrenia Bulletin, 13 (2), 261-275.

Kay, S.R., Opler, L.A. and Lindenmayer, J-P. (1989). The Positive and Negative Syndrome Scale (PANSS): Rationale and standardisation. British Journal of Psychiatry, 155 (7), 59-65.

Kimberg, D. (1997). Frontal Lobes: Cognitive and Neuropsychological Aspects, in Feinberg, T. and Farah, M. (eds.). Behavioural Neurology and Neuropsychology. New York, McGraw-Hill.

Kimura, D. (1987). Are men's and women's brains really different? Canadian Psychology, 28 (2), 133-147.

Kolb, B. and Whishaw, I.Q. (1983). Performance of schizophrenic patients on tests sensitive to left or right frontal, temporal, or parietal function in neurological patients. Journal of Nervous and Mental Disease, 171 (7), 435-443.

Kraeplin , E. (1919) Dementia Praecox and Paraphrenia. (Translated and Edited by R.M. Barclay and G.M. Robertson,1971) Edinburgh, Scotland: E and S. Livingston.

Lewine, R.R.J. (1981). Sex differences in schizophrenia: timing or subtypes? Psychological Bulletin, 90 (3), 432-444.

Lewine, R.R.J., Walker, E.F., Shurett, R., Caudle, J., Haden, C., (1996). Sex differences in neuropsychological functioning among schi ophrenic patients. American Journal of Psychiatry, 153, 1178-1184.

Lewine, R., Haden, C., Caudle, J., and Shurett, R. (1997). Sex-onset effects on neuropsychological function in schizophrenia. schizophrenia Bulletin, 23, 51-61.

Lezak (1983). Neuropsychological Assessment, 2nd ed. New York, Oxford University Press.

Lezak, M. D. (1995).Neuropsychological Assessment, 3rd ed. New York, Oxford University Press.

Luria, A.R. (1973). The Working Brain. An Introduction to Neuropsychology. (Translated by B.Haigh, 1973). New York. The Penguin Press.

Luria, A.R. (1980) Higher Functions in Man. New York, Basic Books.

Morice, R. (1990). Cognitive inflexibility and pre-frontal dysfunction in schizophrenia and mania. British Journal of Psychiatry, 157, 50-54.

Morice, R., and Delahunty, A. (1996). Frontal/executive impairments in schizophrenia. schizophrenia Bulletin, 22 (1), 125-137.

Morris, R.G., Ahmed, S., Syed, G.M., and Toone, B.K. (1993). Neural correlates of planning ability: Frontal lobe activation during the Tower of London Test. Neuropsychologia, 31, (12), 1367-1378.

Morrison-Stewart , S.L., Williamson, P.C. Corning, W.C., Kutcher, S.P. Snow, W.G. and Merskey, H. (1992). Frontal and non-frontal lobe neuropsychological test performance and clinical symptomatology in schizophrenia. Psychological Medicine, 22, 253-259.

Nassrallah, H.A. (1991) pp 3-37. In S.R. Steinhauer, J.H. Gruzelier, and J. Zubin, Handbook of schizophrenia, Volume 5: Neuropsychology, Psychophysiology, and Information Proccssing. Amsterdam, Elsevier.

Nathaniel, J.D.A., Brown, R., and Ron, M.A. (1996). Memory impairments in schizophrenia: Its' relationship to executive function. schizophrenia Research, 21, (2), 85-96.

Nelson, H.E. (1976). A modified card-sorting test sensitive to frontal lobe defects. Cortex, 12, 313-324.

Nelson, H.E., Pantelis, C., and Carruthers, K., Speller, J., Baxendale, S., Barnes, T.R.E. (1990). Cognitive functioning and symptomatology in chronic schizophrenia. Psychological Medicine, 20, 257-365.

Nestor, P.G., Shenton, M.E., and Wible, C., Hokana, H., O'Donnell, B.F., Law, S., McCarley, R.W. (1998). A neuropsychological analysis of schizophrenic thought disorder. schizophrenia Research, 29, (3), 217-225.

Nopoulos, P., Flaum, M., and Andreasen, N.C. (1997). Sex differences in brain morphology in schizophrenia. American Journal of Psychiatry, 154 (12), 1648-1654.

Norman, R.M.G. et al (1997) Neuropsychological Correlates of Syndromes in Schizophrenia in British Journal of Psychiatry pp 134 - 139.

Pandya, D. and Barnes, C. (1987). Architecture and connections of the frontal lobe. In E. Perecman, E (ed.) The Frontal Lobes Revisited. New York, The IRBN Press.

Pantelis, C., Barnes, T.R., Nelson, H.E., Tanner, S., Weatherley, L., Owen, A.M. and Robbins, T.W. (1997). Frontal-striatal cognitive deficits in patients with chronic schizophrenia. Brain, 120, (10), 1823-43.

Parsons, J.E. (1980). pp3-29. In J.E. Parsons, The Psychobiology of Sex Differences and Sex Roles. Washington D.C., Hemisphere Publishing Corporation.

Pellegrini, A.D. and Smith, P.K. (1998). Physical activity play: The nature and function of a neglected aspect of playing. Child Development, 69 (3), 577-598.

Perlick, D., Mattis, S., Stastny, P. and Teresi, J. (1992). Gender differences in cognition in schizophrenia. schizophrenia Research, (8), 69-73.

Primbram, K. (1937). The Subdivisions of the Frontal Cortex Revisited. In E. Perecman, (ed.). The Frontal Lobes Revisited. New York, The IRBN Press.

Saykin, A.J., Gur, R.C., Gur, R.E., Mozley, D., Mozley, L.H., Resnick, S.M. Kester, B., Stafiniak, P., (1991). Neuropsychological function in schizophrenia. Archives of General Psychiatry, 48, 618-624.

Seeman, M.V. and Lang, M. (1990). The role of estrogens in schizophrenia: Gender differences. schizophrenia Bulletin, 16 (2), 185-194.

Seidman, L.J., Yurgelun-Todd, D., Kremen, W.S., Woods, B.T., Goldstein, J.M., Faraone, S.V. and Tsuang, M.T. (1994). Relationship of prefrontal and temporal lobe MRI measures to neuropsychological performance in chronic schizophrenia. Biological Psychiatry, 35, 235-246.

Shallice, T. (1988). From Neuropsychology to Mental Structure. Cambridge: Cambridge University Press.

Spreen, O. and Strauss, E. (1991). A Compendium of Neuropsychological Tests. New York, Oxford University Press.

Stuss, D.T. and Benson, D.F. (1986). The Frontal Lobes. New York: Raven Press.

Taylor, M.A. and Abrams, R. (1984). Cognitive impairment in schizophrenia. American Journal of Psychiatry, 141 (2), 196-201.

Turetsky, B.T., Cowell, P.E., Gur,R.C., Grossman, R.I., Shtasel, D.L and Gur, R.E. (1995). Frontal and temporal lobe brain volumes in schizophrenia. Archives of General Psychiatry, 52, 1061-1070.

Verdoux, H., Magnin, E., and Bourgeois, M (1995). Neuroleptic effects on neuropsychological test performance in schizophrenia. schizophrenia Research, 14 (2), 133-139.

Walsh, K. (1987). Neuropsychology. A Clinical Approach, 2nd ed. Edinburgh: Churchill Livingstone.

Walsh, K. (1994). Neuropsychology. A Clinical Approach, Edinburgh: Churchill Livingstone.

Weekes, N.Y. (1994). Sex Differences in the Brain, pp293-315, in D.W.Zaidel (ed.) Neurospychology. San Diego, Academic Press Inc.

Williamson, P.C., Kutcher, S.P., Cooper, P.W., Snow, W.G., Szalai, J.P., Kaye, H., Morrison, S.L., Willinsky, R.A., and Mamelak, M. (1989). Psychological, topographic EEG, and CT scan correlates of frontal lobe function in schizophrenia. Psychiatry Research, (29), 137-149.

Yeudall, L.T., Fromm, D., Reddon, J.R. and Steanyk, W.O. (1986). Normative data stratified by age and sex for 12 neuropsychological tests. Journal of Clinical Psychology, 42, 918-946.

Author Roberts K A
Name of thesis Gender Differences In Neuropsychological Test Performance Among People With Negative Schizophrenia Roberts K A 1998

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.