

**NEUROBIOLOGICAL AND PSYCHOSOCIAL
INFLUENCES ON THE NEUROPSYCHOLOGICAL
FUNCTIONING OF CHILDREN WITH EPILEPSY**

by

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submitted in accordance with the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in the subject

PSYCHOLOGY

at the

UNIVERSITY OF SOUTH AFRICA


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NOVEMBER 2011

DECLARATION

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I, Saraswathie Govender, declare that **Neurological and Psychosocial Influences on the Neuropsychological Functioning of children with Epilepsy** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



Signature

(Mrs. S. Govender)

30 November 2011

Date

ACKNOWLEDGEMENTS

The success of this study would have not been possible without the continued support and inspiration from many sources:

- Prof. Kate Grieve, my promoter, for her patience, support, and critical insights that helped to shape my thinking. I am grateful for her thoroughness which has taught me to set higher standards for myself in the pursuit of knowledge.
- Prof. Anneke Meyer, my colleague for her valuable input on statistical analysis and research methodology.
- All the children and their mothers who participated in the study and so willingly gave up their valuable time to make this study possible. Their co-operation is greatly appreciated.
- My husband, Kevin Ramdharie, and my daughter, Akila Ramdharie, who unselfishly gave me time to complete this project. You have shown me patience and forbearance throughout the completion of this project. I thank you both for your support.
- My parents and family, for the nurturance over the years, and their support and encouragement that have sustained me.
- The financial assistance of the National Research Foundation and the University of Limpopo towards this research is hereby acknowledged.

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ABSTRACT

The aim of the study was to investigate the neurobiological and psychosocial factors that influence neuropsychological test performance in children with epilepsy from a non-Western rural background. The sample comprised 100 children with tonic-clonic seizures and 100 children with simple partial seizures between the ages of eight to twelve years. A third group of 100 children with chronic renal problems was used as a comparison to control for the effects of having a chronic illness.

The findings of the present study indicate that in the epilepsy groups, seizure variables such as the age of onset, frequency of seizures and duration of seizures have an impact on self-esteem, adjustment and NEPSY scores. However, psychosocial and emotional factors appear to have a greater impact than neurobiological variables on the measured neuropsychological domains (attention/executive, language, sensory-motor and learning/memory functions). These findings are consistent with the theoretical perspectives used, combining the view of Piaget (1955) that cognitive development proceeds as a result of the child's own activities, with Luria's (1973) model of brain functioning and the stance of Vygotsky (1978) that development is a socially mediated process. The findings regarding the influence of neurobiological and psychosocial factors on neuropsychological test performance in children with epilepsy from non-Western backgrounds are similar to those of Western studies.

Epilepsy presents with unique problems relative to other chronic illnesses. The three groups are separated according to differences in psychosocial (maternal attitudes), emotional (adjustment and self-esteem) as well as neuropsychological functioning (attention/executive, language and visual-spatial skills). The renal group is characterised by the highest levels of psychosocial, emotional and neuropsychological functioning, while the simple partial seizure group have lower levels of psychosocial and emotional functioning, and the tonic-clonic seizure group have the lowest levels of neuropsychological functioning and adjustment.

CHAPTER ONE

GENERAL INTRODUCTION AND BACKGROUND

1.1. Introduction and background to study

There is strong evidence to suggest that neurological diseases are accompanied by psychological disturbances (Billard, Motte & Farmer, 2002; Binnie 2003; Dodrill, 1992a; Dodrill & Ojemann, 2007). One such neurological disorder is epilepsy, which is the disturbance of the nervous system that abruptly interferes with ongoing behaviour, perception, movement, consciousness and other brain functions. Epilepsy is one of the world's most prevalent non-communicable diseases affecting approximately 50 million people in the world with no age, racial, social class, and national or geographical boundaries (Aldenkamp, Van Donselaar, & Flammah, 2003; Baskinda & Birbeck, 2005; Spangenberg & Lalkhen, 2006). It has to be acknowledged that more than 80% of people with epilepsy live in developing countries, where the condition remains largely untreated (WHO, 2002; WHO, 2006). Moreover, epilepsy is considered by several researchers (Buelow & Mc Nelis, 2002; Dodrill, 1992a; Hermann & Seidenberg, 1994) to represent the most common chronic neurological disorder in childhood. It is a rather unique neurological disorder in that the clinical presentation, progression and underlying etiology appear to vary across clinical cases.

The various aspects of epilepsy such as classification of epileptic seizures, neuropsychological sequelae, treatment and prevention of psychosocial problems which often accompany epilepsy have stimulated research for several decades (Binnie 2003; De Boer, Mula & Sander, 2008; Trimble & Reynolds, 1998). However, while

earlier research made remarkable strides in understanding several aspects of epilepsy there is a compelling need to understand how neurobiological and psychosocial factors influence neuropsychological functioning in children with epilepsy.

Over the past half century, neuropsychology has played an increasingly important role in the assessment of people with epilepsy. Advances in our understanding of brain-behaviour relationships have mirrored the rapidly expanding technologies of diagnostic neurophysiology and structural and functional neuro-imaging, resulting in a more accurate understanding of the effects of seizures on higher cortical functions (Kolb & Whishaw, 2003). Furthermore, behaviour does not only become altered in the presence of organic variables that alter the structure and functioning of the central nervous system, but also in the presence of psychological and social variables that are mediated through the nervous system (Lezak, Howieson & Loring, 2004; Luria, 1980). Thus, since the organ of pathology in epilepsy is the brain, epilepsy has been implicated as a cause of impaired behavioural, emotional and cognitive functioning in children suffering from this disorder (Berg, Langfitt, Testa, Levy & Di Mario, 2008).

According to Ben-Ari and Holmes (2006), the vast majority of people with epilepsy begin the seizure attacks before the age of twenty, with more than fifty percent of cases beginning in childhood, and in many instances the seizures last for several years. Thus, it is apparent that most people experience their first epilepsy attack at a time that is critical for the acquisition and development of basic cognitive and social competencies that are crucial for long term academic, interpersonal and vocational adjustment. Thus, the presence of recurrent seizures could possibly interfere with the normal developmental process through a number of means, including negative social

reactions, parental anxieties and apprehensions, learning difficulties and altered brain functions. Moreover, it is evident that there are a great many factors that impinge on children suffering with epilepsy and as well as on their psychological development. It would therefore appear that these variables are mediating influences in the neuropsychological performances of children with epilepsy.

Investigations of the neuropsychological correlates of the epilepsies have provided useful information in the treatment and management of adults with epilepsy (De Boer, 2002). Knowledge of the nature, degree and determinants of neuropsychological performance of children with epilepsy is perhaps more crucial, as they are in the process of acquiring skills which will be necessary for future academic achievement and subsequent social adjustment. Impairments in the development of these skills arising from a compromise in psychological functions could clearly have far-reaching effects for the child. Thus, identification of the factors responsible for neuropsychological impairment in children enables clinicians to identify children at risk and provide appropriate remediation services at the time when these services are likely to have their greatest impact.

The study of neuropsychological sequelae in epilepsy has been guided by the findings of neurological and psychiatric studies of these clinical conditions. Most of the studies on the neuropsychological functioning in children with epilepsy have examined a range of psychological skills such as memory, learning and attention (Berg, et al., 2008; Bigler & Turkheimer, 1999; Hermann, Jones, Sheth, Koehn & Seidenberg, 2006; Rantanen, Timonen, Hagstrom, Eriksson & Nieminen, 2009; Schoenfield, Seidenberg & Woodard, 1999). These international investigations have provided

valuable insight into brain-behaviour relationships and neuropsychological correlates of epilepsy in children.

However, there is a paucity of research on the neuropsychological aspects of children suffering with epilepsy, particularly within the African context. Most of the African studies reported focussed on issues related to epidemiology, attitudes towards epilepsy and cultural beliefs (Cristiansen, Zwana & Manga, 2002; Cristianon, Zwana, Manga, Rosen & Venter, 2000; Verstteg & Carter, 2003). There are numerous reported international studies. These findings have little relevance for many of the developing countries in Africa, since most of the assessments and interventions used are based on sophisticated technology such as fMRI and electroencephalography biofeedback techniques.

In developing countries there are numerous variations in cultural, economic and political practices, religions, level of education and literacy and rural versus urban lifestyles. Thus, the management of epilepsy in developing countries requires cultural knowledge and understanding beyond the usual practices of western medicine. The issue of the cultural understanding of epilepsy has been largely ignored by western studies. This is an important issue, since in African communities there are widespread beliefs that epilepsy is due to possession or bewitchment by evil spirits or the devil, and in some cultures the spirit is believed to be that of ancestors (Govender, 1999; Nubukyo, 2002). Thus, many people in rural communities in Africa perceive epilepsy as a feared and dreaded disease and as a result of these traditional beliefs and superstitions, the person with epilepsy in Africa suffers not only psychologically but also from social deprivation and prejudice.

It is within this context that the present study was planned to determine the factors that influence the neuropsychological functioning of South African children with epilepsy that come from a non-Westernised rural background.

1.2. Objective of the study

This research proposes to study the factors that influence the epilepsy group's neuropsychological test performance. This implies looking at factors such as demographics, medical history, home environment, emotional status and behavioural adjustment. And in addition, in order to control for the effects of having a chronic illness, a comparison will be made between children with epilepsy and those with a chronic renal condition.

1.3 Significance of the study

Epilepsy is considered a major health problem, which globally affects 50 million people of all races, geographic localities, gender and culture (Cristianson, Zwane & Manga, 2002). It is the most common neurological disorder affecting children in the developing world (WHO, 2002). However, children with epilepsy differ from one another on a variety of dimensions. The impact of childhood epilepsy has been studied and reviewed by many authors across the world (Austin, 2000; Bailet & Turk, 2000; Camfield, Breau & Camfield, 2001; Camfield, Breau & Camfield, 2003; Cowan & Baker, 2004; Ellis, Upton & Thompson, 2000; Perera & Rodrigo, 2004). Although there are numerous studies reporting on the psychological aspects of epilepsy in children, most of these studies are based on samples from westernised middle-class communities (Sackellares & Berent, 1999; Schoenfeld et al., 1999; Versteeg & Carter, 2003). While these findings are valuable indicators in

understanding a child with epilepsy, generalising these findings and making inferences about the neuropsychological functioning from non-Westernised disadvantaged communities becomes problematic.

According to Guerrini (2006) it is estimated that worldwide 10.5 million children under 15 have active epilepsy representing about 25% of the global epilepsy population. Epilepsy in children is regarded as one of the most common childhood neurological disorders in Africa (Chomba, Haworth, Atadzhanov, Mbewe & Birbeck, 2008; WHO, 2006) and certainly warrants further investigation as relatively little is known about epileptic children in these population groups. To date there are no reliable documented epidemiological statistics on the prevalence of epilepsy in South Africa, but it is estimated that 1 in every 100 South Africans suffer from epilepsy, with more than 50% developing the condition before the age of 15 (Spangenberg & Lalkhan, 2006). The World Health Organization has emphasised that epilepsy has its origins in childhood and is a major contributor to the “global burden of disease”. Primary and secondary prevention in child and adolescent mental health is of the utmost importance (Costello, Egger & Angold, 2005).

There are a number of etiological factors that have been identified as correlates in childhood epilepsy, especially with regard to interpreting neuropsychological test performance. The features of chronicity and early age of onset in epilepsy have important implications for the acquisition and development of basic cognitive and academic abilities. Epilepsy can affect other areas of development by impacting on motor, psychosocial, emotional and social competence (Tse, Hamiwka, Sherman & Wirrell, 2007). Social competence refers to the means for achieving the major

developmental tasks expected of a child of a given age and gender in the context of his or her own culture and time (Jakovljevic & Martinovic, 2006). Although many of these factors are only of conceptual or theoretical interest to researchers in the field of epilepsy, they are a reality to the child with epilepsy.

Some of the factors, such as epileptogenic foci, extent and type of seizures, age of acquisition, alterations in neurotransmitter systems and resultant seizure manifestations have implications for how the child's adaptive behaviour could be affected. There are also several associated psychosocial factors such as reactions of the child's parents, peers and teachers, perceived stigma and discrimination that impact in being reflective of a child's neuropsychological functioning. Although many of these factors can be interactive, the impact of each one cannot be underestimated when evaluating a child with epilepsy. Moreover, most of the studies reported (Aldenkamp, Overwag-Plandsoen & Arens, 1999; Binnie, 2003; Staden, Isaacs, Boyd, Brandi & Neville, 1998) have focussed on the effects of specific variables on epilepsy and have not provided an integrated explanation of the various interactive factors that influence the neuropsychological test performance of children with epilepsy.

The present study aims to determine the neurobiological and psychosocial predictors that impact on the neuropsychological functioning of children with epilepsy, from a South African perspective.

1.4. Delineation of the study

Research interests in epilepsy are broad and there is an array of possible outcomes: medical/physiological, neurological, cognitive, academic, motor, neuropsychological, psychosocial, social competency and emotional/behavioural (Aylward, 2002). However, the focus for the present study is to determine how neurobiological, psychosocial and emotional factors influence performance on neuropsychological tests in children with epilepsy.

The first two chapters presents a discussion of the history, classification and diagnosis of epilepsy. Chapter three focuses on a brief overview of chronic renal disease in children. Childhood epilepsy is a chronic condition, and consideration must be given to the constraints derived from any chronic illness before any inferences are made about factors that may influence neuropsychological test performance. Thus, the group of children with chronic renal disease serve to control for the chronicity of illness features. Chapter four begins with a consideration of neuropsychological development in children. This topic will be examined from various theoretical viewpoints-firstly, the neuropsychological approach proposed by Luria, (1973; 1980); secondly, the socio-cultural view of Vygotsky (1978); and thirdly the cognitive-developmental model of Piaget (1955). Chapter five reflects on available research on neuropsychological deficits in children with epilepsy. This chapter also attempts to explore the influence of neurobiological and psychosocial factors on neuropsychological test performance. Chapter six focuses on the methodology of data collection, while chapter seven reports on the results of the study. In chapter eight, the interpretation of the results, limitations of the study and suggestions for future research will be discussed.

CHAPTER TWO

HISTORY, CLASSIFICATION AND DIAGNOSIS OF EPILEPSY

2.1 Introduction

Epilepsy is a complex neurological disorder, which should not be viewed as a homogeneous condition. The relationship between epilepsy, behaviour and mental functions has always been a matter of great interest, debate and controversy. Before discussing contemporary views on this contentious subject, it is therefore appropriate to consider some of the views regarding the historical aspects of epilepsy, which have shaped the understanding and attitude of researchers and different cultures towards epilepsy.

The chief aim of this chapter is to provide an overview on both the historical aspects and the nature of epilepsy, with specific reference to the classification and diagnosis of the condition.

2.2 Historical understanding of the phenomenon of epilepsy

The history of epilepsy is both fascinating and complex and extends over 4000 years. Epilepsy is one of the oldest neurological conditions known to man. The term epilepsy is derived from a Greek word meaning “to take hold of”, hence the use of the term to describe its effects (Baddeley & Ellis, 2002). Epilepsy has been regarded as both a natural disorder and as due to some sort of supernatural visitation. Historically, various eras have had different cultural understandings of the phenomenon. The management and treatment for epilepsy has always been greatly influenced by cultural attitudes and beliefs, which vary widely (Govender, 1999).

2.2.1 The Graeco-Roman Period

During this era, epilepsy was initially regarded as a sacred disease. It was believed that only a god could deprive a healthy man of his senses, throw him to the ground, convulse him and then restore him to the former self again. The historical milestone of this period was set by Hippocrates who claimed that epilepsy was not a sacred disorder, but rather that the brain was the seat of this disorder (Trimble & Reynolds, 1998). This was the first scientific hypothesis regarding the understanding of the disorder. However, this hypothesis was only widely accepted twenty five centuries later.

Later in this period, epilepsy was associated with some form of lunar influence. Hence the word lunatic was applied to sufferers of epilepsy. In contrast, insane people were considered to be maniacs, whose insanity was the result of an invasion of the body by devils or evil spirits. However, this distinction soon became blurred and epileptic patients were regarded as both lunatic and maniacal. The association of epilepsy with mental disturbance persisted in the public mind until the nineteenth century (Trimble & Reynolds, 1998).

2.2.2 The Early Nineteenth Century

The process of distinguishing epilepsy from insanity began in the early nineteenth century and was linked to the development of neurology as an independent and new discipline. Epilepsy still remained an integral part of the psychiatric nosology. However, neurologists began to challenge the deeply entrenched concepts used in the psychiatric diagnosis, since they encountered several cases of epilepsy without mental disturbances (Reynolds, 1861). Subsequently, Morel (1962, as cited in Haymaker &

Schiller, 1970), a prominent psychiatrist, proposed a classification system wherein epilepsy was seen as a psychiatric disorder. Moreover, this classification system was based on the hypothesis that new and obscure forms of epilepsy such as “larval”, “masked” and epileptic “equivalent” embrace vaguely paroxysmal forms of psychological behaviours in the absence of any overt seizures (Falret, 1862, as cited in Haymaker & Schiller, 1970). This trend is still with us today, but following the discovery of the electroencephalography by Berger (1929 as cited by Temkin, 1994), there has been a revision of the above terms to new terminology such as “subclinical”, “subictal” and “interictal”.

2.2.3 The Mid Nineteenth Century

During the latter half of the nineteenth century, views on the understanding of epilepsy were radically changed by Jackson (1931), who suggested that epilepsy should be re-defined in neurophysiological rather than clinical terms. He accordingly defined epilepsy as a condition with occasional, sudden, excessive, rapid and local discharges of grey matter. This was the first neuronal theory of epilepsy that set the cornerstone for modern understanding of the phenomenon. Another prominent psychiatrist’s contribution to the understanding of epilepsy, was that of Berger (1934). He made the remarkable discovery of the electroencephalograph, a device which measures brain wave rhythms. According to Trimble and Reynolds (1998), although Berger did not understand English and had not learnt of Jackson’s (1931) theory, a later generation of clinical neurophysiologists were convinced that the “spikes” and epileptiform tracings that Berger and his successors discovered, corresponded with Jackson’s intuitive neurophysiological definition of epilepsy. Subsequently, by using

Jackson's (1931) definition of epilepsy, it was then possible to classify the mental manifestations of epilepsy into ictal and interictal states.

2.2.4 The Twentieth Century

At the beginning of this century the psychiatrists' views regarding epilepsy still dominated the literature. Guerrant, Anderson and Deskins (1962) describe three phases in the evolution of thinking since then. Firstly, in the early part of this century the concept of the epileptic character was predominant. According to this view, epileptic patients could be identified by their vulnerability to certain personality traits. These traits were mostly of an unfavourable and antisocial nature. Later, from the studies of Lennox in the 1930's and 1940's (as cited in Guerrant et al., 1962), it became more widely accepted that most epileptic patients had normal mental states. However, according to Hill (1981), the culmination of this process was that only in the last thirty years has the diagnosis of epilepsy been removed from international classifications of psychiatric illness.

Secondly, the publication of a paper by Gibbs and Fuster (1948) ushered in the era of "psychomotor" peculiarity. They found that in their electrophysiological study of patients with psychomotor seizures, there was an association between abnormalities in the anterior temporal area and severe disturbances in personality. Subsequently, this study has challenged several researchers to investigate the specific type of personality disturbances manifested by an epileptic attack. However, controversial literature has evolved associating temporal lobe epilepsy not only to personality disorders, but also to aggression and schizophrenia-like psychosis (Guerrant et al., 1962). Perhaps this personality debate was an indirect focus of the early twentieth century controversy

surrounding the epileptic character, but during this era it referred only to patients with a specific type of epilepsy.

Thirdly, the latter period of this century was characterized by the steady increase in the scientific study of the relationship between epilepsy and the different types of mental disturbances. Epidemiological studies by Pond (1981) have shown that more than one third of the patients with active epilepsy have significant psychological problems ranging from cognitive impairment to behaviour disorders and emotional disturbances. In recent years, there has been a remarkable growth of and interest in research into the influence of epilepsy on the various psychological correlates in children, adolescence and adults. These studies include the effects of different types of seizures, the age of onset of the disorder, the degree of maturation of the nervous system, the site and the degree of the brain damage, the amount and the duration of the anticonvulsant therapy and its metabolic consequences, genetic factors, electroencephalographic abnormalities and a wide range of environmental, social and psychosocial factors such as mother-child relationships, levels of adjustment and self-esteem (Berent & Sackellares, 1998; Berg et al., 2008; Chomba, Haworth, Atadzhanov, Mbewe & Birbeck, 2008; Cowan, 2002).

2.2.5 Traditional beliefs about epilepsy in Africa

Throughout the African continent there exists a history of numerous beliefs about the causes of epilepsy and its treatment. In many African communities there are widespread beliefs that epilepsy is due to possession or bewitchment by evil spirits or the devil, and in some cultures the spirit is believed to be those of the ancestors. There are also beliefs that the transmission of the disease is through physical contact, such

as saliva. In central Uganda, epilepsy is attributed to the presence of a lizard in the brain, and epileptic episodes are believed to occur when the lizard moves (Nubukpo, 2002). Hence, some people in rural communities in Africa perceive epilepsy as a feared and dreaded disease because of its alleged association with evil spirits and witchcraft. However, as a result of these traditional beliefs and superstitions, the person with epilepsy can suffer from social deprivation and prejudice.

2.3 The Nature of Epilepsy

2.3.1 Definition

Neurologists regard epilepsy to be the most complex neurological disorder. Thus, it has always been difficult and problematic to offer a completely satisfactory definition of this condition. The term seizure disorders, convulsive disorders or fits are often used interchangeably to refer to this syndrome.

Although epilepsy has been recognized as a clinical syndrome for centuries, it was only in the late nineteenth century that an adequate definition was introduced by Jackson (1931). He defined the phenomenon of epilepsy as occasional, excessive and disorderly discharge of neurons in various parts of the brain.

Glaser (1979) added to this definition by stating that epilepsy is a paroxysmal and transitory disturbance of the functions of the brain which develops suddenly, ceases spontaneously and exhibits a tendency to recur. The World Health Organization has adopted a definition of epilepsy as “a chronic brain disorder of various etiologies due to excessive discharge of cerebral neurons” (WHO, 2002).

However, the definition used most frequently by clinicians is in accordance to the one proposed by the International Classification of Seizure Disorders of the International League against Epilepsy (Dreifuss, 1989). Epilepsy is defined as an intermittent disorder of the nervous system due to abnormal paroxysmal discharge of cerebral neurons resulting in almost simultaneous disturbance of sensation, loss of consciousness, or some combination thereof (Dreifuss, 1989; Wolf, 1997).

Hence, from these definitions it appears that physiologically excessive and disorderly discharges arise in neurons, especially when their threshold for firing is decreased beyond the capacity of their membrane threshold stabilizing mechanism to prevent firing.

While the physiological event underlying seizures at a cellular level may appear uniform, the disease process of epilepsy is not. Epilepsy may arise as a result of a variety of pathological brain conditions. The excessive neuronal discharges may be restricted to a localized brain region, or spread through several areas of the brain. When the discharges from these hyperexcitable neurons propagate along neural pathways, various clinical manifestations can occur in the form of the seizure, including sudden alterations in the motor, sensory, affective, cognitive or autonomic functions.

Thus, the symptoms accompanying a particular seizure could be a direct function of the presumed brain region(s) interrupted by the excessive neuronal discharges (Dodrill, 1992). For example, a loss of consciousness reflects involvement of the upper brainstem and the nuclei of the different thalamic projection system, while

some somatic muscular contractions are associated with involvement of the frontal motor area.

Furthermore, another critical distinction in the definition of epilepsy is a continuing tendency to recurrent seizures. A single seizure does not constitute epilepsy. There are certain conditions such as alcohol and drug excess, sleep deprivation, fatigue, high fevers, hypoglycaemia and other conditions that may produce transient physiological and biochemical alterations of the central nervous system functions. The term epilepsy implies chronicity. Hence a diagnosis of epilepsy is generally made only after a history of seizures is substantiated. This has led to an operational definition of epilepsy as the occurrence of transient paroxysms of excessive or uncontrolled neurons, which may be caused by different etiologies and lead recurrently to epileptic seizures for the present study. This definition supports Appleton and Gibbs (1998) claim that epileptic seizures are considered as intermittent, paroxysmal, stereotyped disturbances of consciousness, behaviour, emotion, motor function, perception or sensation, that may occur singly or in combination.

2.3.2 Classification of Seizures

In the last three decades the need for a unanimous classification of epileptic seizures has been realized. This need has been emphasized by the continuing growth in the volume of publications concerned with several aspects of epilepsy. Hence, this has undoubtedly led to a considerable increase in knowledge and understanding of epilepsy, but has simultaneously posed an inevitable demand for increased precision in terminology (Engel, 2003).

Epilepsy can be classified on the basis of several features, such as the presumed site of abnormal activity within the brain, electroencephalographic (EEG) patterns, clinical manifestations of the seizures, or the etiology of the disorder. However, at the present time, there is no single or comprehensive classification system that has proven to be entirely satisfactory.

The International League Against Epilepsy (1970, as cited in Gaustaut, 1970) tried to standardize a grouping system of seizures, which is based on clinical and EEG manifestations. The International Classification of Epileptic Seizures (ICES) (Dreifuss, 1981; 1989) has evolved over a long period of time and is the most widely accepted classification scheme of seizures in use today.

The ICES (1989) classification scheme is based on three factors:

(1) clinical seizure manifestations, (2) EEG ictal (during seizure) patterns and (3) EEG interictal (between seizure) patterns. Consistent with the ICES system, the majority of all seizures can be classified as either partial or generalized seizures (Dreifuss, 1989). In partial seizures (also known as focal seizures) the epileptogenic activity usually begins in a circumscribed brain area. The abnormal EEG activity is restricted to an area of the scalp corresponding to the cortical region involved. The symptomatology of a partial seizure can be limited to the elementary sensory or motor processes without an accompanying loss of consciousness. It may also include more complex disturbances of consciousness, behaviour, cognition or affect.

The epileptogenic focus of generalized seizures however, involves both cerebral hemispheres, and the subcortical connections and structures simultaneously. In these

seizures, the abnormal EEG patterns are bilateral, synchronous and symmetrical over the two hemispheres. The clinical presentations are often consistent with impaired consciousness that is frequently accompanied by abnormal bilateral activity.

Table 2.1: Classification of Seizures

1. Partial seizures (seizures beginning locally):

- Simple (consciousness not impaired):
 - With motor symptoms
 - With somatosensory or special sensory symptoms
 - With autonomic symptoms
 - With psychic symptoms
- Complex seizures (with impairment of consciousness):
 - Beginning as simple partial seizures (progressing to complex seizures)
 - Impairment of consciousness at the onset
 - Partial seizures becoming secondarily generalized

2. Generalized seizures:

- Absence seizures
 - Typical (petit mal)
 - Atypical
- Myoclonic seizures
- Clonic seizures
- Tonic seizures
- Tonic-clonic seizures
- Atonic seizures

3. Unilateral seizures

4. Unclassified seizures

Adapted from Dreifuss, 1989

2.3.3 Clinical features of the major types of seizures

2.3.3.1 Partial Seizures

Partial seizures can be classified into two types: (1) those with elementary symptomatology (simple), and (2) those with complex symptomatology (complex). A major distinguishing feature of the two types of partial seizures is the extent of the

impairment of consciousness. Impaired consciousness is defined as the inability to respond normally to external stimuli by virtue of altered awareness and/or responsiveness.

2.3.3.1.1 Simple partial seizures

In this type of seizure there is no loss of consciousness. These seizures are classified in accordance to manifestations as motor, sensory, autonomic, psychic and compound seizures (mixed simple partial seizures). In children these seizures are often followed by rapid generalized activity, thus the focal onset may not be easily recognized. Very often the young child does not give an accurate account of the initial sensory and autonomic symptoms and the parents seldom make precise observations of the early motor manifestations. Nevertheless, the neurological examination taken during the EEG may reveal a focal abnormality.

Distinctive epileptiform EEG abnormalities may appear during sleep. According to a study on Computerized Tomography (CT) scans in focal seizures by Okuno and Konishi (1990), it was reported that 63% of children with partial seizures had abnormal CT scans, with focal abnormalities in 78% and diffuse abnormalities in 22% of the cases. The external manifestations of simple partial seizures vary, but the most typical and frequent type consists of a sudden flexion of the head with simultaneous extension of the upper limbs and flexion of the thighs and the abdomen. This type of convulsion is preceded by a short cry, laugh or giggle. Other manifestations are: sudden nod of the head or an abrupt loss of all muscle control with consequent falls forward.

2.3.3.1.2 Complex partial seizures (CPS)

This type of seizure is characterized by an impairment of consciousness. CPS occur less frequently in children than in adults (Cowan, 2002). Although these seizures often originate in the temporal lobe, there is ample evidence that they can originate in other regions of the brain (Dodrill, 1992b). Complex partial seizures are also referred to as temporal lobe epilepsy or psychomotor seizures.

The presumptive causes of CPS in children include perinatal complications, postnatal head trauma, congenital malformations, inflammatory diseases, severe or prolonged seizures in early life and neoplasms. However, very often no definitive cause can be established. The ictal clinical manifestations of these seizures are legion. Hence, in children the symptoms must be carefully distinguished from migrainous events. Some of the overt manifestations of complex partial seizures are: an arrest or suspension of the activity, for example, staring or dazed expression; repetitious, automatic, stereotyped and poorly coordinated movements; repetitious, automatic reflections of disordered and confused psychic functioning, such as incoherent and irreverent speech, rages and tantrums. Hence complex partial seizures are associated with several mental disturbances such as psychoses.

2.3.3.2 Generalized seizures

These seizures are primarily generalized from onset. There are different types of generalized seizures, which are: absence, myoclonic, tonic, clonic, tonic-clonic and atonic. Although the ictal EEG manifestations vary across the different type of attacks, the electroencephalographic manifestations are bilaterally synchronous at onset.

2.3.3.2.1 Absence seizures

Absence seizures are also referred to as petit mal seizures. Neuronal maturation plays an important role in the expression of this seizure (Cowan, 2002). The onset of absence seizures is rare before the age of three and is most common between the ages of four and eleven. These seizures are of a very short duration. During these spells the child is in a state of unconsciousness for a brief period. The overt manifestation of this seizure is that the child stares blankly into space. In other instances, the eyes may roll upward or there may be slight jerky movements of the head, eyes or upper limbs. Occasionally, there may be smacking movements of the lips or urinary incontinence. The spell usually lasts for about ten seconds, but rarely longer than a minute.

Due to the innocent and subtle appearance of most absence attacks, which consist essentially of just staring into space, this condition is frequently overlooked or neglected by parents and teachers. Very often children are reprimanded and punished for day dreaming in class or being inattentive at times. It is possible that these children are experiencing absence attacks during these times and are not responsible for their actions.

2.3.3.2.2 Myoclonic seizures

Myoclonic seizures or myoclonic jerks are sudden brief shock-like contractions that may be generalized or confined to the face and limbs, to individual muscles, or to groups of muscles. These seizures may be rapidly repetitive or isolated. These seizures occur predominantly during or on awakening, and may be stimulated by volitional movement.

2.3.3.2.3 Tonic-clonic seizures

The tonic-clonic seizure is also known as the grand mal seizure or the big “fits”. This seizure is the most prevalent among all the other types of seizures and the most common type in children (Cowan, 2002). The onset of tonic-clonic seizures may occur at any age, except in neonatal life. The duration of the attack varies from less than one minute to as long as thirty minutes.

A typical attack consists of a sudden loss of consciousness and generalized tonic and clonic movements. The tonic phase is characterized by rigidity of muscles, which changes to very rapid generalized jerky movements of the muscles. The latter typifies the clonic phase. During the convulsive phase the child may bite his/her tongue or may present with laboured breathing movements.

When the seizure is brief, the child is usually able to resume normal activity within several minutes after the seizure has subsided. However, at the end of a protracted seizure, the child usually falls into a deep sleep. Upon recovery from this post-convulsive sleep, the child may present with numerous post-convulsive phenomena. Some of the common symptoms are: generalized weakness, restlessness, nausea, vomiting, severe headaches, sore muscles, fatigue, increased irritability, impaired speech, confusion and transient paralysis of the muscles.

Generalized seizures may include specific disorders with major tonic or clonic features without the presence of the other. Atonic seizures may also occur in which there is a sudden diminishing in muscle tone with slumping to the ground. These

attacks may be brief and are often known as “drop attacks”. If there is loss of consciousness, it is extremely brief.

2.4 Revision of the International Classification of seizures

The International League Against Epilepsy (Dreifuss, 1985; 1989) responded to the numerous criticisms of the ICES by revising certain terminologies proposed in the earlier classifications in 1970 and 1981. It was noted that the seizure is an observed phenomenon of epilepsy. However, there are specific epileptic syndromes which are not accounted for in the earlier classification systems. An epileptic syndrome is defined as an epileptic disorder characterized by a cluster of signs and symptoms customarily grouped together (Dreifuss, 1985). The signs and symptoms may be clinical (e.g., case history, seizure type, modes of seizure recurrence, neurological and psychological findings) or evident in findings detected by an EEG or CT scan. The seizure therefore is only a small part of the condition, while the seizure type determines the specific type of anticonvulsant as the drug of choice for the management of the seizure. The syndrome will determine as to whether or not medication is necessary and will also determine the consideration of other treatment modalities as well as the influence of genetic implications. Hence, assigning a child's epilepsy to an epilepsy syndrome may help to select the best type of treatment, give some insight into the prognosis and help to establish what might have caused the epilepsy.

A syndrome does not necessarily have a common etiology and prognosis. Epilepsy syndromes are classified according to etiology. There are three types of etiologies: (1) symptomatic, where a known cause is found, example, head injury; (2) cryptogenic,

where no cause is found but an underlying abnormality is found and (3) idiopathic, where no cause is found but a genetic causal link is suspected. Hence, the ILAE revision (1992 as cited in Dreifuss, 1998) makes provision for a number of varying syndromes associated with any epileptic attack. The following table is a modified version of the ILAE revision (1989).

Table 2.2: Classification of epilepsies, epileptic syndromes and related seizure disorders

1. Localisation-related (focal, local, partial) epilepsies and syndromes
1.1 Idiopathic (with age related onset)
○ benign childhood epilepsy with centro-temporal spikes
○ childhood epilepsy with occipital paroxysms
○ primary reading epilepsy
1.2 Symptomatic
○ chronic progressive epilepsia partialis continua of childhood (Kojewnikow's syndrome)
○ syndromes characterized by seizures with specific modes of presentation
1.3 Cryptogenic (presumed symptomatic but aetiology unknown)
2. Generalised epilepsies and syndromes
2.1 Idiopathic (with age-related onset, listed in order of age)
○ benign neonatal familial convulsions
○ benign neonatal convulsions
○ benign myoclonic epilepsy in infancy
○ childhood absence epilepsy
○ juvenile myoclonic epilepsy
○ epilepsy with grand mal (generalized tonic-clonic on awakening)
○ other generalized idiopathic epilepsies not defined above
○ epilepsies with seizures precipitated by specific modes of activation (reflex and reading)

Table 2.2 continued on page 25

Table 2.2 continued

2.2 Cryptogenic

- West's syndrome
- Lennox-Gastaut syndrome
- epilepsy with myoclonic-astatic seizures
- epilepsy with myoclonic absence

2.3 Symptomatic

2.3.1 Non-specific etiology

- early myoclonic encephalopathy
- early infantile epileptic encephalopathy with suppression burst
- other symptomatic generalized epilepsies not defined above

2.3.2 Specific syndromes/aetiologies

- cerebral malformations
- inborn errors of metabolism including pyridoxine dependency and disorders frequently presenting as progressive myoclonic epilepsy

3. Epilepsies and syndromes undetermined, whether focal and generalized

3.1 With both focal and generalized seizures

- neonatal seizures
- severe myoclonic epilepsy in infancy
- epilepsy with continuous spike-waves during slow wave sleep
- acquired epileptic aphasia (Landau-Kleffner syndrome)
- other undetermined epilepsies not defined above

3.2 Without unequivocal generalized or focal seizures.

4. Special syndromes

- situation related seizures
- isolated seizures or isolated status epilepticus
- seizures occurring only when there is an acute metabolic or toxic event due to factors such as alcohol, drugs, eclampsia, non-ketotic hyperglycaemia
- reflex epilepsy

Adapted from Dreifuss, (1998)

2.4.1 Definition of the major syndromes in children

There are two important dichotomies in the classification of the epileptic syndromes. The first distinguishes seizures that have a localization-related or focal element from those that are generalized. The other distinction is made between seizures that are idiopathic or primary and those that are symptomatic, secondary and lesional.

2.4.1.1 Localization-related epilepsy

In this type of epileptic disorder there is a bilateral origin for the seizures. Patients with this type of seizure have small constant circumscribed epileptogenic lesions. In most symptomatic localization-related epilepsies, the epileptic lesion can be traced to one part of the cerebral hemispheres, but in idiopathic age-related epilepsies corresponding regions of both hemispheres may be involved (Dreifuss, 1998).

2.4.1.2 Benign childhood epilepsy with centro-temporal spikes

This is a syndrome of brief partial, hemifacial motor seizures, that are frequently associated with somatosensory symptoms, and has a tendency to evolve into tonic-clonic seizures (Dreifuss, 1998). Furthermore, this seizure type is often related to sleep disorders and onset is between three and thirteen years. The EEG pattern shows blunt high-voltage centro-temporal spikes, which are often followed by slow waves that are activated by sleep.

2.4.1.3 Childhood epilepsy with occipital paroxysms

Clinical presentation of this syndrome indicates that this seizure starts with visual symptoms and is followed by a period of automatisms. The EEG pattern has paroxysms of high amplitude-spike waves recurring rhythmically on the occipital and

posterior of one or both hemispheres, but only when the eyes are closed. During the seizures, the occipital discharge may spread to the central or temporal regions.

2.4.1.4 Benign neonatal convulsions

These are frequently repeated clonic or apneic seizures occurring during the fifth day after birth without known or concomitant metabolic disturbances. The interictal EEG pattern often shows alternating sharp theta waves. There is no recurrence of seizures and the psychomotor development of the child is not affected.

2.4.1.5 Childhood absence epilepsy (pyknolepsy)

This syndrome is common among school children, with a strong predisposition in otherwise normal children. There is a higher prevalence of this form of epilepsy among girls than boys (Dreifuss, 1998). The EEG reveals bilateral, synchronous, symmetrical spike-waves, usually three spike-waves, on normal background activity.

2.4.1.6 Juvenile absence epilepsy

The absence attacks of this syndrome are similar in clinical presentation to the pyknolepsy attacks. Onset is common during puberty (Dreifuss, 1998). Seizure frequency is lower than in pyknolepsy. The absence seizures could develop into generalized tonic-clonic seizures.

2.4.1.7 Juvenile myoclonic epilepsy (impulsive petit mal)

This syndrome occurs during puberty and is characterized by seizures with bilateral single or repetitive, arrhythmic, irregular myoclonic jerks, predominantly in the arms. Some children may fall from a jerk. There is no disturbance of consciousness. The

seizures usually occur shortly after awakening, and are often precipitated by sleep deprivation. Interictal and ictal EEG patterns have rapid, generalized and irregular spike and polyspike waves (Dreifuss, 1998).

2.4.1.8 West Syndrome (infantile spasms)

This syndrome usually consists of a characteristic triad: infantile spasms, arrest of psychomotor development and hypsarrhythmia. Spasms may be flexor, extensor or nodal but are generally mixed. Onset is between four and seven months. There seems to be a higher prevalence among boys. West syndrome may be classified into two groups. The symptomatic group is characterized by the previous existence of brain damage signs (psychomotor retardation, neurological signs, radiological signs or other types of seizures) or by a known etiology. The idiopathic group is characterized by the absence of previous signs of brain damage and known etiology (Dreifuss, 1998).

2.4.1.9 Lennox-Gestaut Syndrome

In this condition children between the ages of one and eight years are affected. The most common seizure types are tonic axial, atonic and absence seizures, but other types such as myoclonic, generalized tonic-clonic or partial seizures are frequently associated with this syndrome. The EEG syndromes usually show abnormal activity interspersed with multifocal abnormalities (Dreifuss, 1998).

2.4.1.10 Epilepsy with myoclonic-astatic seizures

This syndrome may manifest between seven months and six years. Generally there is a hereditary predisposition with a normal developmental background. The EEG

patterns may appear normal except for four to seven second rhythms or irregular spike or polyspike waves (Dreifuss, 1998).

2.4.1.11 Epilepsy with myoclonic absences

Clinically, this syndrome is characterized by absences accompanied by severe bilateral rhythmical jerks, which are often associated with tonic contraction. The common age of onset is seven years with a higher incidence rate in males. These seizures may occur several times a day. The EEG patterns reveal bilateral, synchronous and symmetrical three-per-second spike and wave patterns, which are similar to absence seizures (Dreifuss, 1998).

2.4.1.12 Neonatal seizures

These seizures differ from the seizures of older children and adults. The most frequent neonatal seizures are described as subtle because the clinical manifestations are frequently overlooked. These include tonic movements, horizontal deviation of the eyes with or without jerking, eyelid blinking or fluttering, sucking, smacking or other bucal-lingal oral movements, swimming or paddling movements and occasionally apneic spells. Neonatal seizures are particularly seen in premature babies. The EEG pattern is similar to suppression burst activity (Dreifuss, 1998).

2.4.1.13 Acquired epileptic aphasia (Landau-Kleffner Syndrome)

This syndrome is a childhood disorder associated with an acquired aphasia. Epileptic seizures with behavioural and psychomotor disturbances occur in two thirds of the patients. Often there is a condition of verbal agnosia and rapid reduction of

spontaneous speech. Seizures manifest as generalized convulsions or partial motor convulsions (Dreifuss, 1998).

2.4.1.14 Kojewnikou's Syndrome

Kojewnikou's syndrome occurs as a result of a lesion in the motor cortex and manifests as a Rolandic partial epilepsy. The EEG background activity shows asymmetrical and slow delta waves with numerous ictal and interictal discharges that are not strictly limited to the Rolandic area (Dreifuss, 1998).

2.4.1.15 Situation-related seizures

These seizures are characterized by specific modes of seizure precipitation and are also known as reflex epilepsies. The more simple forms of these seizure types are precipitated by simple sensory stimuli for example, flickering/flashings lights. The intensity of the stimuli is decisive but the latency of the response is short, for example, the child may experience a myoclonic jerk. In complex forms, the triggering mechanisms are elaborate, for example, listening to a certain piece of music. In the latter, the specific pattern of the stimulus is the decisive factor (Dreifuss, 1998).

2.4.2 General comments on classification of epileptic syndromes

It is apparent that there are two major distinctions that can be applied to all the childhood syndromes. These are the idiopathic and symptomatic epilepsies. The idiopathic epilepsies are free of underlying lesional pathology, there is often a positive family history of similar seizure types and the child makes normal progress until the development of the seizures. The seizures are controllable and the prognosis is quite good for a favourable response to treatment. The symptomatic epilepsies tend to have

some anatomical pathology whereby a lesion is frequently the basis of the problem and there is often a biochemical abnormality that is detectable. Seizures are more frequent and are not always of the same variety and are more difficult to control than the idiopathic epilepsies.

2.5 Diagnosis of epilepsy

The diagnosis of epilepsy is clinical and is usually done by a medical practitioner. It is based on a detailed description of events experienced by the child before, during and after a seizure and, more importantly on an eye witness account. Results from tests and medical investigations such as the medical history, observation of the seizure, physical examination and blood tests will confirm, support or question a diagnosis. However, ultimately it would be the seizure description that would provide evidence for the classification of the seizure type or epilepsy syndrome. Additional tests such as the EEG, CT scan, MRI scan or ambulatory monitoring will help to determine the cause of the episode or series of episodes (seizure events).

2.5.1 EEG as a diagnostic aid

The EEG provides valuable information that may (a) support the clinical diagnosis; (b) aid the classification of epilepsy; and (c) show changes that may increase the suspicion of an underlying structural lesion. Routine interictal EEG recordings are performed to either exclude or prove a diagnosis of epilepsy. About 20 per cent of the people with epilepsy will have a normal EEG, while others will have an inconclusive result unless they actually experience a seizure while their brainwave activity is being measured.

One way of overcoming the problem of seizure capture is for the child to wear an EEG monitor for a period of time, called an ambulatory EEG. This kind of monitoring is useful if the effect of behaviours, mood swings and changes in level of concentration or exposure to stressful situations needs to be documented. The child may take psychological tests or do school work while attached to the EEG, with simultaneous video activity carried out. In this way more subtle seizures such as absences, which have a distinctive tracing on an EEG recording, can be mapped both visually and electronically. The doctor can also determine from which part of the brain a seizure starts, how and where its effects spread, its duration and how quickly the brain recovers afterwards. Aldenkamp, Overwag-Plandsoen, Arens (1999) claimed that an analysis of paroxysmal events by prolonged video EEG monitoring helps clarify seizure type and site of onset, and may uncover differential diagnoses such as cardiac arrhythmias or psychogenic seizures.

EEG recordings can also help to pinpoint certain epilepsy syndromes, for example there is a distinctive EEG pattern associated with primary generalized epilepsy, which is one of the more common epilepsies of childhood. Standard EEG recordings are more useful in children than adults with epilepsy. Wolf (1997) reported that in eighty percent of children with epilepsy below the age of ten, there will be positive EEG findings, but the yield declines with age to less than forty percent after the age of forty.

Moreover, it should be noted that between ten and fifteen percent of the general population may have an “abnormal” EEG recording and yet not have either symptoms of epilepsy or any neuropathology. However, if the evidence is inconclusive or the

EEG recording shows focal slow-wave abnormalities, which may be indicative of the presence of a structural lesion as a cause of epilepsy, the child may be referred for some form of neurological imaging.

2.5.2 Neurological brain imaging in the diagnosis of epilepsy

The advent of brain imaging techniques has largely revolutionized the diagnostic process of many neuropathologies, including epilepsy. However, the exorbitant cost of some of these tests precludes their routine employment in most developing countries. On the other hand, others have been discarded because of their dubious predictive value. Thus, the two brain imaging techniques that are routinely used in the diagnosis of epilepsy are cranial computed tomography (CT) and magnetic resonance imaging (MRI).

The CT scan is based on the principle of the attenuation of x-rays as they pass through the body (Tanabe, Grant, Cosgrove, Hoch & Cole, 2000). The authors note that with CT the calibrated x-ray beam is passed through the patient, and the degree of attenuation varies with the type of tissue. X-rays emerging from the patient are recorded by detectors and several x-ray beams are passed in various directions through the patient yielding attenuation data for a three-dimensional slice of the region being studied.

Several findings with respect to the use of CT scans in the diagnosis of epilepsy have been reported. According to Wolf (1997), the frequency of abnormalities in CT scans of patients with epilepsy varies greatly. Other researchers (Sackellares & Berent, 1999) reported that from surveys of patients with established epilepsy from specialist

centers, 60 to 80% of these patients have abnormal CT scans, but many of these abnormalities are atrophic in nature. They also indicated that abnormalities on CT scans are very strongly predicted by the presence of focal rather than generalized seizures, focal neurological signs and focal EEG abnormalities. It was also reported that among children with epilepsy, abnormalities are detected less than 20 percent of the time. Hence, it is apparent that CT scans are most useful as a diagnostic tool in older patients with focal seizures.

With regard to the MRI technique, the underlying principle involves establishing a baseline condition in a system and obtains measurements as the system returns to normal. The advantage of magnetic resonance imaging over computed tomography is that the former has higher resolution capabilities, thereby generating cerebral matter sections which enable superior visualization.

The use of MRI in understanding epilepsy has become increasingly important. According to Wolf (1997) the MRI is sensitive in detecting hippocampal and mesial temporal atrophy and sclerosis, which are important causes of drug resistant temporal lobe epilepsy. It can also show dysplastic and developmental extratemporal lesions. Hence, it is apparent that the MRI would be a useful tool for patients whose epilepsy is unresponsive to anticonvulsant drug treatment, rather than for general use with all persons with epilepsy. However, both CT scans and MRI imaging are costly diagnostic procedures and therefore do not readily allow their deployment in many diagnostic settings, particularly in most rural areas of South Africa.

2.6. Conclusion

It is apparent that throughout human history the nature of epilepsy has been shrouded in superstitions. Despite present day advances in the understanding of epilepsy, there are many cultures that believe in mystical origins for epilepsy. The last few decades have seen an upsurge of interest on issues related to the classification and diagnosis of epilepsy. While each seizure type has a distinctive form of presentation, the unpredictable and spontaneous nature of the attacks makes diagnosis difficult. Furthermore, the etiologies of various types of seizures differ between children and adults and the impact of seizures may vary in different stages of cognitive development.

In the next chapter, an overview of chronic renal diseases in children is presented because a comparison of children with epilepsy is made with these children in order to control for the effects of having a chronic illness.

CHAPTER THREE

CHRONIC RENAL DISEASES IN CHILDREN

3.1 Introduction

Literature in the field of neuropsychology has reported extensively on the evaluation of neurological conditions that result in impairment in cognitive, emotional and behavioural functioning. Accordingly, most of the research in child neuropsychology has focussed on the brain itself and views most problems of concern as occurring within the brain or some other portion of the central nervous system. However, there is recognition that there is a need to study children suffering from diseases that affect any part of the body. This is supported by the recent advance in the field of school neuropsychology which has a keen interest on children with health related difficulties.

Thus in the assessment of a child with medical problems, it is important that multiple causes for any noted neuropsychological disturbance is considered. Berg and Linton (1997) maintain that the determination of the presence and severity of any brain effects thus requires knowledge of the possible contribution of a variety of factors including the disease itself, those organ systems directly or indirectly affected, the specific phase of illness, any current medical treatment, pre-morbid personality, the coping capacity of the child, and the child's estimated functional level prior to the illness.

In many chronic conditions, the neuropsychological sequelae have only been assumed to clinically report mental or behavioural changes of some children with the disease. There is comparatively little research on the neuropsychological effects of individuals

suffering from a number of non-neurological and medical diseases. Even in cases when central nervous system effects are reported as possible or frequent, there is little understanding of the type of neuropsychological deficit likely to occur with the different disease processes, as well as about recovery patterns and residual effects.

In this chapter, children with chronic renal problems will be discussed. A chronic condition is defined as one that has the following elements: the presence of a disorder with a biological, psychological, or cognitive basis of twelve months or more duration (including prognosis) that is likely to require special services, limit functioning and require supportive services, medication or technology (Roberts, 2005; Stein & Silver, 2002). Thus, these conditions affect children for an extended period of time with an age of onset for the condition at varying ages. Examples of chronic disorders in children are asthma, cerebral palsy, congenital heart disease, cystic fibrosis, diabetes, sickle cell disease, and renal diseases.

The renal group was used in the present study to control for the effects of chronicity of illness features. The renal group was compared to children with epilepsy on various biographical, neurobiological and psychosocial/emotional factors influencing neuropsychological functioning.

3.2 Renal structure and function

The kidneys are a pair of bean-shaped organs located against the posterior wall of the abdomen. Their principal function is to assist in the maintenance of water balance, blood pH level, and balance of electrolytes in the body, such as sodium, potassium and phosphorous. The kidneys play an important role in a child's growth. In addition

to removing wastes and extra fluid from the blood, the kidneys produce hormones that promote red blood cell production. The kidneys also help regulate the amounts and interactions of nutrients from food, including minerals such as calcium, phosphorous and vitamin D, which are necessary for growth.

Blood enters the kidney through the arteries that branch inside the kidneys into tiny clusters of looping blood vessels. Each cluster is called a glomerulus, which comes from the Greek word meaning filter. There are approximately one million glomeruli in each kidney. The glomerulus is attached to a opening of a small fluid collecting tube called a tubule. Blood is filtered in the glomerulus, and extra water and wastes pass into the tubule and become urine. Eventually, the urine drains from the kidneys into the bladder through the larger tubes called the ureters. Each glomerulus and tubule unit is called a nephron which is actually the functional unit of the kidney. Thus, each kidney is composed of about one million nephrons. In healthy nephrons, the glomerular membrane that separates the blood vessel from the tubule allows waste products and extra water to pass into the tubule while keeping blood cells and protein in the blood stream (Montagnino & Hockenberry, 2007.)

A secondary function of the kidney is the production of certain humoral substances. One such substance is an enzyme, erythropoietin, which acts on the plasma globulin to form erythropoietin, which in turn stimulates erythropoiesis in the bone marrow. Its production is increased in the presence of hypoxia and androgens. Few red blood cells are formed in the absence of erythropoietin, which accounts for the anemia associated with advanced kidney disease. Another enzyme, renin, is also secreted by the kidney in response to reduced blood volume, decreased blood pressure, or increased secretion

of catecholamines. Renin stimulates the production of the angiotensins, which produce arteriolar constriction and an elevation in blood pressure and stimulates the production of aldosterone by the adrenal cortex (Montagnino & Hockenberry, 2007).

Kidney damage is referred to as nephrosis. Infections of the kidney system (nephritis) may impair the functioning of the kidneys. When kidney functioning is impaired and urine functioning is reduced, the waste products typically excreted are retained in the body and can lead to a number of childhood kidney diseases. A brief overview of some of the common childhood kidney diseases are discussed next.

3.3 Classification of childhood kidney diseases (CKD)

3.3.1 Introduction

There is limited information on the epidemiology of childhood kidney diseases. This is especially true for less advanced stages of renal impairment that are potentially more susceptible to therapeutic interventions aimed at changing the course of the disease and avoiding end stage renal disease. Because childhood chronic renal disease is often asymptomatic in its early stages, it is both under diagnosed and under reported. This is in part the result of the historical absence of a common definition of childhood chronic renal disease and a well defined classification of its severity. However, the most widely reported classification of chronic renal diseases distinguishes those that have dysfunctions due to birth defects or systemic diseases such as diabetes and lupus (Chadha & Warady, 2005).

3.3.2 Birth Defects

Birth defects are the most common cause of kidney diseases in children. They include:

3.3.2.1 Posterior urethral valve obstruction

This narrowing or obstruction of the urethra affects only boys. It can be diagnosed before a baby is born or just afterward and treated with surgery.

3.3.3.2 Foetal hydronephrosis

This enlargement of one or both of the kidneys is caused by either an obstruction in the developing urinary tract or a condition called vesicoureteral reflux in which urine abnormally flows backward from the bladder into the ureters. Foetal hydronephrosis is usually diagnosed before the child is born and treatment varies widely. In some cases the condition only requires ongoing monitoring, while in others, surgery must be done to clear the obstruction from the urinary tract.

3.3.3.3 Polycystic kidney disease (PKD)

This is a condition in which many fluid-filled cysts develop in both kidneys. Most forms of PKD are inherited. The condition can be diagnosed before a child is born. In some cases there are no symptoms, in others PKD can lead to urinary tract infections, kidney stones, and high blood pressure. Treatment for PKD also varies widely. In some cases, PKD can be managed with dietary changes; in others, it requires a kidney transplant or dialysis, which is a medical treatment that helps the body filter waste when the kidneys are not able to function.

3.3.3.4 Multicystic kidney disease

This is when large cysts develop in a kidney that has not developed properly, eventually causing it to stop functioning. While PKD affects both kidneys, multicystic kidney disease usually affects only one kidney. It is usually diagnosed before a baby

is born and can lead to kidney failure. Currently, there is no cure, but doctors can manage it by preventing and treating infections, maintaining blood pressure, and addressing any issue that arise with surgery.

3.3.3.5 Renal tubular acidosis

This is a condition in which the kidneys do not properly regulate the amount of acid in the body. It can cause kidney stones and affect a child's growth, but usually can be treated with medication.

3.3.3.6 Glomerulonephritis

This is an inflammation or infection of the glomeruli, which are parts of the nephrons that contain tiny blood vessels. It can affect the kidney's ability to properly filter out waste and can lead to swelling, blood in the urine, and a reduced amount of urine production. Some cases can be treated with medication, while others require dialysis or a kidney transplant.

3.3.3.7 Nephrotic syndrome

This occurs when the body loses large amounts of protein through the urine, typically because of some sort of change in the nephrons. It is usually diagnosed after the child is one year old. Swelling of the face, abdomen, and extremities are among the main symptoms, and are often relieved with medication.

3.3.4 Systemic diseases

Sometimes a child can have other health problems that affect how well the kidneys function. For example, systemic diseases such as diabetes and lupus can affect many

parts of the body including the kidneys in some people. In lupus, the immune system becomes overactive and attacks the body's own tissue. Diabetes leads to high levels of blood glucose that damages the glomeruli. Thus the child's kidney functioning may be compromised by hypertension, kidney stones and nephritis.

3.3.4.1 Hypertension

The kidneys control blood pressure by regulating the amount of salt in the body and by making the enzyme rennin that is one of the substances that controls the constriction of blood vessels. The many causes of high blood pressure include any of the kidney diseases mentioned above.

3.3.4.2 Kidney stones

Kidney stones are the result of build-up of crystallized salts and minerals such as calcium in the urinary tract and can also form after an infection. If kidney stones are large enough to block the kidney or ureter, they can cause severe abdominal pain. The stones usually pass through the urinary tract. In some cases, they need to be removed surgically, or treated with medication or modifications to the diet.

3.3.4.3 Nephritis

This is any inflammation of the kidney. It can result due to an infection, an autoimmune disease (such as lupus), or an unknown reason. The first symptoms of nephritis are usually high levels of protein and blood in the urine.

3.4 Psychological impact of chronic kidney disease in children

Understanding of the psychological aspects of chronic kidney disease in children has grown rapidly over the past decade (Slickers, Duquette, Hooper & Gipson, 2007). This increased understanding has resulted in the opportunity for mental health care workers to offer informed psychological support as an integral part of the management of children with chronic renal diseases. The course and outcome of many chronic illnesses are decisively affected by social, psychological and emotional variables. However, like most chronic diseases of childhood, chronic kidney disease may seriously affect children's lives as they negotiate the stress and responsibilities associated with disease management (Slickers et al., 2007). In addition, these illnesses have varying impact on family life. Clinicians generally conclude that factors such as age of onset, family structure, and the disease's clinical features influence psychosocial adjustment and outcome (Slickers et al., 2007; Soliday, Kool & Lande, 2000; Tong, Lowe, Sainsbury & Craig, 2008).

The way in which one responds to chronic illness has implications for adjustment. One framework which has been used to outline these reactions and explain how people adjust to chronic illness is the cognitive adaptation theory (Taylor, 1983). Specifically, a chronic illness may challenge an individual's sense of self-worth, invulnerability and optimism about the future. Heffer, Prevatt, Miner and Young-Saleme (1998) reported that chronically ill children have difficulty returning to school after diagnosis of a chronic illness or prolonged hospitalizations. This difficulty is frequently not due to medical conditions, but rather the ill child is anxious about being able to keep up with work and may feel isolated from their peers. Healthy peers who are uncertain about the sick child's physical adequacy, may reject the child as a

friend. Thus, instead of receiving security and support from friends, the ill child may experience increased stress due to social isolation.

It is important to view the effects of chronic illness on the child from a developmental context. For example, young children are dealing with issues of competition, self worth (Erikson, 1968), mastery and self efficacy (Bandura, 1986), and ego development (Freud, 1966). Adolescents experience a very turbulent period in terms of their social-emotional development. Developmental challenges that must be dealt with include establishment of emotional independence, peer group acceptance, development of a comfortable body image, sexual role identity, separation from parental value systems, as well as future goal orientation and career planning (Christensen & Antoni, 2002). The presence of a chronic disease can have a negative impact on the child's ability to meet developmental demands.

Moreover, a developmental approach must also consider the child's cognitive stages and abilities (Flavell, 1985; Piaget, 1955). Developmental theory provides insight on how children obtain, process and use information, for example, whether a particular child has the ability to conceptualize and think hypothetically. This is important for children with chronic illness as it enables the clinician to evaluate the child's ability to engage in and think about their illness and future ramifications.

For parents, having a chronically sick child generates extra work, chronic anxiety and unresolved grief, which may produce patterns of parenting which eventually affect personality development (Govender, 2005). Soliday et al. (2000) examined family environment, levels of parenting stress and child behaviour problems in children with

chronic renal disease compared to healthy children. Their findings reported general similarity between the kidney disease and healthy groups on child behaviour problems, parenting stress, and family environment variables. This finding is consistent with previous kidney disease research by Heffer et al. (1998) indicating positive associations between family environment and children's adjustment. Moreover, earlier research by Soliday, Grey and Lande (1999) proclaimed that positive family relationships can buffer stress, including that caused by childhood chronic illness. Earlier findings reported by Holden, Chmielewski, Nelson, Kage and Foltz (1997) claim that academic concerns such as low motivation for or poor attitude towards school places children with chronic kidney diseases at risk for educational problems.

3.5 Conclusion

Thus, it is important to perform neuropsychological evaluations on children with chronic renal diseases to ascertain if there are underlying neuropsychological deficits. Slicker et al. (2007) examined the clinical predictors of neurocognitive deficits in children with chronic kidney disease and found that increased disease severity, longer duration of disease and younger duration of onset of kidney disease potentially placed children with chronic kidney diseases at increased risk of neurocognitive deficits. It is difficult to attribute better or poorer life course and outcome solely to the nature of the disease and its treatment when many additional psychological, social and societal factors play an important role in a child's cognitive development. Health care professionals have begun to recognize that "well-being" is not synonymous with biomedical status or disease improvement alone, and are increasingly incorporating the assessment of psychosocial factors on development in children with chronic

illnesses. Thus, these investigations are necessary to understand the contributions of a variety of biomedical and psychosocial risk factors that may impact on neuropsychological development in children with chronic illnesses.

The next chapter provides an overview of the major theoretical approaches in understanding neuropsychological development in children.

CHAPTER FOUR

THEORETICAL APPROACHES TO NEUROPSYCHOLOGICAL DEVELOPMENT IN CHILDREN

4.1 Introduction

Attempts to understand the relationship between the disorders of the central nervous system, such as epilepsy, and neuropsychological functioning focused predominantly on adults. The past two decades have witnessed a relative explosion of interest in and awareness that neurological disorders in children incorporate developmental issues, which need to be considered in brain-behaviour studies (Dodrill, 1992; Golden, 1987). The discipline of child neuropsychology encompasses brain-behaviour relationships as they apply to the developing child. Although the downward extension of adult neuropsychological theories have broken ground in this regard, the adult models have provided inadequate information on the basic understanding of the neuropsychological functioning of the developing child. The central nervous system of the child undergoes rapid change, thus both quantitative and qualitative differences should be expected. Research has shown that a number of factors have been implicated as significant in the development of cognitive, emotional and behavioural problems in children suffering with recurrent seizures (Bennet, 1994; Hermann, Bell & Seidenberg, 2001).

Human learning and behaviour are reliant upon the ability to pay attention to important aspects in the environment, retain and retrieve information, and select, deploy, monitor and manage cognitive strategies to learn, remember and think (Barkley, 1996). Without these abilities, people would not have the ability to use

language, plan or solve problems. Barkley (1996) argued that the lack of this capacity to concentrate, remember, organize and structure information within the world would result in the inability to modify one's behaviour when confronted with new situations. It is therefore logical to conclude that attention, memory and executive functions play a crucial role in thinking, problem solving, and other symbolic tasks involved in speaking, reading, writing, mathematics and social behaviour.

At the present time, there are few theories that attempt to incorporate the principles of both brain organization and that of psychological development in children. Luria's, (1973, 1980) theory of brain organization has as been one of the cornerstone of neuropsychology for nearly forty years. Other important contributions were made by Vygotsky (1978), who advocated that a culture provides the context in which a child develops and thus is a source of many important influences on development throughout childhood and adolescence. Moreover, Piaget's (1955) theory of cognitive development in children has shown that there are distinct neurodevelopmental periods in which qualitative rather than quantitative changes in skills occur.

The lack of a sound developmental neuropsychological theory has severely curtailed the documentation and the interpretation of neuropsychological difficulties among children with neurological conditions. However, in recent years there has been a growing awareness that neurological disorders among children incorporate developmental issues, which need to be considered in brain-behaviour studies. Two scholarly attempts at addressing this issue have been the work of Golden (1987) and Korkman, Kirk and Kemp (1998).

In this chapter, three major approaches to understanding neuropsychological development in children will be discussed. These are, firstly, the neuropsychological tenets of brain organisation proposed by Luria, (1973; 1980); secondly the socio-historical view of Vygotsky (1978); and thirdly the cognitive-developmental model of Piaget (1955). While these approaches are seemingly disparate, influenced as they are by the individual background of the authors, there are many overlapping ideas that can be interwoven in order to contribute to a more holistic explanation of the neuropsychological development of children. These three approaches were chosen as the conceptual framework to understand the neuropsychological functioning of children with epilepsy for different reasons.

Luria's (1973) model provides an understanding of the biological basis of neuropsychological functioning, particularly relevant in the case of children with epilepsy, and also supports Piaget's (1995) theory of cognitive development. Vygotsky's (1978) theory complements Luria's (1973) ideas of brain functioning and is relevant because of its focus on the role of social mediation for cognitive development. The theoretical approaches of Luria (1973), Vygotsky (1978) and Piaget (1955) will be separately discussed before a synthesis of their contribution towards the understanding of the neuropsychological development of children with epilepsy is made.

4.2 Luria's theory of the functional organization of the human brain

The main goal of the discipline of neuropsychology is to study brain-behaviour relationships, particularly the cerebral organization of mental processes. However, it is clear that there can be no complete understanding of higher mental functions

without some knowledge of the underlying substrate. As reported earlier in Chapter 1 there is sufficient knowledge of behavioural deficits following central nervous system impairment to affirm this. Thus, it is necessary to begin a discussion of the mental development of children with some consideration of the neuro-anatomical basis of brain functioning. The neurons that make up the human brain display regional variations in architecture, connectivity and transmitter neurochemistry (Kolb & Whishaw, 2003). These variations formed the basis of contemporary theories and studies in neuropsychology.

Several attempts have been made to explain the brain mechanisms underlying complex mental processes but the one most widely accepted, is the hierarchical model advanced by Luria (1973). The basic concept central to Luria's theory is his view of higher mental activity or cognitive processes as dynamic functional systems. He advocated that cognitive processes should be seen as functional systems characterized by a specific aim and carried out by a system of interconnected subprocesses, or components, in a dynamic and variable fashion.

Luria's (1973) model reflects his conviction that human behaviour is active, influenced by past experiences as well as by plans and designs which shape the future. His theory is considered important for this research because it contributes greatly to understanding cognitive development and the interconnectedness of functional components of behaviour in early childhood. However, it is noted that Luria's (1973) model has become dated, particularly by recent developments in cognitive psychology, and that the formulation of his ideas is not always clear. Nevertheless, there are key concepts of his approach which remain relevant in understanding cognitive functioning and which have concordance with the views of other theorists

such as Paiget (1955) and have formed the cornerstone of theoretical formulations of neuropsychological test batteries developed for assessment in children (Golden, 1987; Korkman et al., 1998).

Luria (1973) claimed that there are two aspects that distinguish mental processes of the human brain from those of the more elementary animal brain. One of these is that higher forms of conscious activity are based on certain external mechanisms such as mnemonic systems used to remember facts. These forms of mental activity are the result of the assimilation of socially formulated activities such as communicative acts and are therefore not direct properties of the brain. These socially formulated activities serve as external aids which are seen as essential elements in establishing functional connections between parts of the brain, enabling them to become components in a functional system. However, it is not clear how Luria conceptualized the transformation of socially formulated activities into mental events. Perhaps, it is presumed that he meant that the stimulation provided by social events brought about changes in the neuronal structure of the brain as can be extrapolated from Globus, Rozenzweig, Bennett and Diamond's (1973) findings of increased synaptic connections in the brains of rats from enriched environments in comparison with the brains of rats from non-enriched environments. Perhaps the idea of extracortical organization of complex mental functions rests on the socio-political premise within which the theory of brain functioning has been formulated. Ideologically, the theory is based on the Marxist-Leninist thesis that all fundamental cognitive activities take shape in a matrix of social history and are the products of socio-historical development (Luria, 1973). Thus, according to this doctrine, the intellectual skills or patterns of thinking that a person displays are not only determined by innate factors,

but are products of the activities practised in the social institutions of the culture in which the individual grows up. Hence, the child's socialization process and developmental history are both extremely important in influencing the ways in which the child will be able to think.

Structurally, Luria (1973) articulated that mental functions are the products of complex functional systems, that are organized in "systems of concertedly working zones", with each zone having a role to play in the functional system. Hence, it is implicit that no single area of the brain is considered responsible for any specific behaviour and neither are all areas of the brain considered to contribute equally to all behaviours. Furthermore, according to Luria (1973), a certain number of brain areas are involved in any behaviour in specific and predictable ways as parts of a functional system. Moreover, just as an area of the brain can participate in numerous functional systems, so may multiple functional systems be responsible for any given behaviour.

Luria (1973) distinguished three principle functional units, which are necessary for any mental activity. These are the arousal, sensory input and planning output units that comprise the functional systems. Man's mental processes, and his conscious activity in particular, always take place with the participation of all three units, each of which has its own role to play in mental processes and makes its contribution to their performance. A unique feature of these functional units, is that each unit itself is hierarchical in structure and each consists of at least three cortical zones. The three zones are: the primary projection area which receives impulses from or sends impulses to the peripheral system; the secondary or projection-association area where information is processed and the tertiary or gnostic area responsible for interpretation

of information and execution of behaviour, the most complex forms of mental activity.

The first functional unit (Unit I) of the brain maintains the level of cortical tone essential for organized mental activity. Subcortical structures, one of the most important being the reticular formation, are responsible for this function. There are, however, times when this tone is insufficient, and Luria (1973) claims that one source of activation is evoked by intentions and plans, in which speech plays an important role. In this way the first functional unit of the brain provides the substrate for but is also regulated by higher cortical functioning.

The second unit (Unit II) is responsible for the reception and processing of information, and the structures comprising this unit occupy the posterior regions of the cerebral cortex, including the occipital, auditory and parietal regions. This functional unit consists of modality specific zones that are hierarchically organized. The primary and secondary zones are concerned with the reception of incoming information. The tertiary zones of this unit are described by Luria (1973) as specifically human structures because of their role in meaningful perception, in converting concrete perception into abstract thinking and therefore in symbolic representation, and furthermore in memory for organized experience. It is thus clear that these zones play a major role in tasks commonly subsumed by the concept of intelligence (Golden, 1987).

While the reception, coding and storage of information form an important part of cognitive activity, another major aspect is the organization of conscious activity which is the task of the third functional unit (Unit III) of the brain. This is illustrative

of Luria's (1973) notion of the concerted working of all three functional units, as he maintained that people do not react passively to incoming information but rather form intentions, plans and programs and regulate behaviour accordingly. The third unit is structurally located in the prefrontal cortex and regulates activities in accordance with the individual's intentions and plans which are formulated with the aid of speech. Thus, the role of speech in regulating behaviour is seen as the distinguishing feature between the behaviour of humans and animals. Luria (1973) claimed that basic forms of behaviour can take place without the aid of speech but higher mental processes are formed and produced on the basis of speech. Further, speech is deliberate and carefully considered in the earlier stages of development, but become more fluent and automatic later.

The view of a hierarchical structure of the cortical zones is central to understanding Luria's (1973) three basic laws governing the work of the second and third functional units. Within this hierarchical framework, he suggests that the relationships between the primary, secondary and tertiary zones change in the course of ontogenetic development. For instance, in a child, integrity of the primary zone is essential for the formation of properly working secondary zones which in turn are necessary for the functioning of the tertiary zones. The latter are responsible for cognitive synthesis of information. The other two basic laws refer to the principles of diminishing specificity and increasing functional lateralization which, according to Luria (1973), form the basis of human cognition, with a crucial role being played by speech in the organization of mental processes.

Thus, it can be inferred from Luria's (1973) theory that higher mental processes are viewed as dynamically organized and involve the integrated activity of the three functional systems comprising various neuroanatomical substrates. For, example, a complex function such as reading, could be disrupted as a result of damage to many different parts of the cortex. Therefore, localized brain damage will not necessarily result in the loss of a single complex function, but it could create deficits across a wide variety of processes that are partially dependent on the functional integrity of the damaged or malformed area. A summary of the composition of important brain-behaviour functions such as language, memory, attention, motor performance and thinking as postulated by Luria (1973; 1980) is presented in Table 4.1.

Table 4.1: Components of Cognitive Processes according to Luria (1973; 1980)

Attention

- Regulation of vigilance, activity level
- Selective attention to biologically relevant stimuli
- Verbal regulation, goal directed attention
- Inhibition of irrelevant stimuli and impulses

Language

- Inner speech
- Motor programming of successive articules
- Articulation based on kinesthetic feedback
- Acoustic phonemic analysis of speech
- Acoustic memory
- Lexical-semantic retrieval, naming
- Logical-grammatical aspects: syntax and concepts

Movement and Action

- Intention and plan
- Dynamic organization of motor series
- Afferent (i.e., kinesthetic, tactile, visual) feedback
- Orientation of movements in space

Perceptual Functions

- Visual field
- Perception of surrounding space and own body
- Visual analysis and synthesis
- Perception of spatial coordinates
- Constructional ability

Memory and Learning

- Auditory verbal memory
- Visual and spatial memory
- Coding and long-term memory
- Preservation versus inhibition of memory traces
- Active memorizing

Example of Complex Performance – Problem Solving

- Analysis of conditions
- Strategy formation
- Execution of plan
- Evaluation

Adapted from Korkman, Kirk and Kemp (1998)

4.2.1 Principles of development corresponding to Luria's theory

Although experts in the area of child neuropsychology maintain that children may differ from adults with respect to the structure of functions as well as cognitive functions, they agree with Luria's general views of functional systems and his clinical approach. Luria's (1973) hierarchical theory of brain functioning corresponds to accepted principles of neuromaturational development. Thus, an analysis of the convergence of ideas regarding the development of a child will be presented.

A closer analysis of Luria's first functional unit shows involvement in involuntary, automatic or reflexive behaviour and this level of functioning is consistent with the largely reflexive behaviour of the newborn infant. Functional maturity of the motor and visual afferent systems is consistent with Luria's (1973) view of the functioning of the second brain unit. The early emergence of motor and somatosensory abilities seems to support the presumption that, as the relevant areas and associated neural pathways mature, changes appear in observable behaviour. Greater control over behaviour corresponds to the integration of the afferent and efferent systems as outlined by Luria (1973). Language abilities also mature slowly and seem to be related to the neuromaturational processes that continue up to the age of four to six years. Golden, (1987) argued that the relationship between neuromaturation and observable behaviour is also reflected in the relatively late ontogenetic maturational of the prefrontal cortex. There is a rapid increase in the rate of growth of the cell bodies in the area of the prefrontal regions from the first year until the child is three to four and a half years old which corresponds to the maturation of the motor cortex. Another spurt takes place at approximately ten to twelve years and only then are the prefrontal regions fully functional (Luria, 1973).

It is apparent that many of the concepts advocated in Luria's (1973) theory are shared by most contemporary neuropsychological views (Golden, 1987; Mirsky, 1996; Kemp et al., 1998). They concur with Luria's views that cognitive processes such as attention and arithmetic calculations are complex processes consisting of several subcomponents. Further, his conceptual framework on the working of the adult brain has inspired researchers in child neuropsychology to advance theories incorporating developmental issues. Moreover, Luria formulated explicit principles for analyzing disorders of complex functions and assessing subcomponents of these functions by carefully focused tests (Cristenson, 1984). Accordingly, Korkman et al., (1998) outlined the components of cognitive processes that are important for neuropsychological assessment in children, which are summarized in Table 4.2.

Table 4.2: Components of Cognitive Processes in Children

Attention Selective attention Attention span Activity level Sustained attention	Sensorimotor Functions Sensorimotor differentiation Production of motor series Tactile perception Psychomotor speed
Executive Functions Planning, strategies Fluency Shift of set Inhibition Set	Visuospatial Functions Visual perception Visuospatial judgement Visuoconstructive performance Graphomotor production
Language Motor production Verbal expression Phonemic decoding Verbal comprehension Naming	Memory and Learning Visual short-term memory Verbal short-term memory Name learning Supraspan learning Long-term memory

Adapted from Korkman, Kirk and Kemp (1998)

Thus, it seems reasonable to conclude that biological maturation is accompanied by changes in brain-behaviour relationships. This is supported by Luria's (1973) view that cerebral organization changes with ontogenetic development, that is, at different stages of development higher mental functions are carried out by different constellations of cortical zones.

4.2.2 Evaluation of Luria's theory

Luria's (1973) theory has greatly contributed to the understanding of the processes involved in higher mental functioning and of the manner in which hierarchical organization of the brain influences the behavioural deficits in brain functioning. His theory has provided considerable insight as to why damage to different parts of the brain can have the same behavioural outcomes. It is based on the postulate that damage in different parts of the functional system, affects the total functioning of system. The consequences of deficits vary according to the age of the child and the time of onset of the condition, as the structures involved in mental processes and their relationships to each other change. The implication for children with epilepsy is that the earlier the onset of seizures and more frequent attacks, the more profound the neuropsychological deficits become because of the disruptions caused to the underlying physiological processes. Thus, epileptic seizure disorders with an early age onset will lead to more profound neuropsychological deficits due to neuronal abnormalities in the arousal, sensory input and planning output functional systems than those with a later age onset.

Although Luria's model (1973) has made remarkable contributions to the understanding of the functional organization of the brain, it is apparent from this

discussion that there are many gaps in his explanation of cognitive functioning. For example, it is not clear how socially formulated activities are transformed into internal mental events. Also, it is often difficult to make a clear distinction between sensory and motor functions, since any movement that is executed produced changes in sensation, just as changes in sensation produce movement. Lastly, his theory is based on the premise that language propels cognitive development but falls short of explaining what would be the activating factor for the development of higher mental processes in children with sensory deficits such as blindness and auditory impairments. Thus, the theoretical contribution of Vygotsky (1978), will be discussed next because it complements Luria's views in many ways.

4.3 Vygotsky's socio-historical view of development

Most psychologists agree that the environment is an important influence in development. One of the earliest psychologists, Vygotsky (1896-1934) together with Luria (1902-1977), was largely responsible for pioneering the reformation of psychological thinking, epitomized in the socio-historical theory of the development of higher mental processes. This theory asserts that culture is the prime determinant of individual development. Accordingly, this theory attempts to explain how different cultural contents are transformed into cultural differences in cognitive processes, and the theory maintains that there is a close connection between social organization of behaviour and individual organization of thinking. The core premise is that culture provides a context in which a child develops and thus is a source of many important influences on cognitive development throughout childhood and adolescence. Therefore, in essence, it could be said that cognitive development is inseparable from its cultural context in that all mental functions are in actual fact internalized social

relationships. Every person is socialized in the society in which they are enveloped. Socialization is the process of cultural transmission, both unintentional and deliberate (Clabaugh & Rozycki, 2007). This key premise of Vygotskian psychology is often referred to as cultural mediation of cognitive development (Vygotsky, 1978).

According to Vygotsky (1978), there is a genetic or developmental basis to the internalization of external activity. This process of internalization is seen not as the transfer of an external activity into consciousness, but rather the process by which consciousness is formed (Kozulin, 1996). There are two unique characteristics of the process by which consciousness is formed. The first is that it is primarily social. Infant behaviour is determined by natural mechanisms that produce simple, stereotyped, non conscious behaviour. Higher mental processes which are socially constructed produce willful, controlled conscious behaviour. The second characteristic is that it depends largely on the semiotic mechanisms, particularly language that mediates social and individual functioning. It seems that from the Vygotskian social cognition model, a semiotic system is seen as first and foremost as means used for social purposes. Children's higher mental processes develop through the acquisition of semiotic mechanisms operative in their culture, through social interaction with adults and through education.

Vygotsky (1962) advocated the importance of semiotic mechanisms and his account of the internalization of external activity plays a crucial role in speech. He claimed further that the roots of speech and thought are independent but become fused at the age of three years when thought becomes expressed verbally. Consistent with Vygotsky's (1978) genetic explanation of development, egocentric speech has its

origins in earlier forms of social speech and is derived from communicative situations involving regulation by others. Thus, within the context of adult-child interaction, adults facilitate children's activities by providing behavioural regulation of which children are not yet capable. Further, egocentric speech does not disappear but gradually becomes internalized as inner speech and serves a self-regulatory function. Wertsch (1985) claimed that the progression in the attainment of self-regulatory speech is largely the result of the child's efforts to establish and maintain coherence between his or her action and the adults' speech. Hence, Vygotsky's theoretical framework provides a powerful basis for understanding how higher psychological processes emerge from social interaction.

This social nature of the process of internalization is referred to by Vygotsky as a zone of proximal development (ZPD), perhaps his most influential contribution to developmental psychology. He defined the ZPD as "...the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers" (Vygotsky, 1978, p.85). The ZPD therefore refers to a phase in development in which a child has only partially mastered a task but can participate in its execution with the assistance and supervision of more competent others. It seems that Vygotsky's (1978) theory places considerable emphasis on children's potential for intellectual growth rather than their intellectual abilities at a particular point. Further, his notion that finely tuned and coordinated adult support assists children in completing actions that they will later accomplish independently holds particular relevance for the education of children. One form of instruction inspired by Vygotskian thinking is scaffolding. This refers to temporary

assistance provided by one person to a less-skilled person when learning a new task. The defining characteristic of scaffolding is to provide support for the child to extend current skills and knowledge to a higher level of competence (Kozulin, 1996). Scaffolding is an important technique for transferring skills from others to the child, both in formal setting such as schools and in informal settings, such as the home or playground. Hence, the ZPD is a crucial concept in explaining Vygotsky's (1978) view of cognitive development in that it accounts for how cognitive functioning which first occurs on a social level, becomes internalized in individual development. It seems that interaction with surrounding culture and social agents, such as parents and more competent peers, contribute significantly to a child's intellectual development.

4.3.1 Evaluation of Vygotsky's theory

Vygotsky (1978) made a sterling contribution to explaining social cognitive development in children. However, translations of his work are of limited accessibility and the difficulties are compounded by the resultant different interpretations of the concepts made by various authors. Nevertheless, there is wide empirical support for Vygotsky's (1962) model of cognitive development (Bee & Boyd, 2002; Kozulin, 1996; Louw & Louw, 2007; Wertsch, 1985). The idea that social cognitive development is largely the result of children's effort to establish and maintain coherence between their actions and speech of adults or competent others, has important implications for intellectual growth. Thus Vygotsky's (1978) assertion on social cognitive development in children is undoubtedly his major contribution to the field.

However, Vygotsky's (1978) socio-historical theory of mental development is open to criticism. Firstly, he sees early development and lower psychological processes as having a biological basis but thereafter the contribution of biological factors is not considered. Moreover, the role of other important personality traits such as temperament in mental development is not explained (Kozulin, 1996). Bee and Boyd (2002) argue that Vygotsky's (1978) theory does little to explain the contribution of other individual factors such as affect, motivation, the phenomenon of resilience, or the ability of a child to succeed in the face of adverse social and environmental circumstances. However, the value of Vygotsky's (1978) theory lies in the realization that children's cognitive development is promoted by interaction with a sensitive and more competent adult. The importance given by Vygotsky to this aspect corresponds to findings of studies on home environments that show that maternal involvement and responsiveness relate to mental development in young children, irrespective of culture (Grieve, 1992).

Hence, the major criticisms levied against Vygotsky's (1978) theory, namely the relative exclusion of biological factors and the child's own contribution to cognitive development, is the focus of the next theoretical approach to be discussed, that of Piaget (1896-1980).

4.4 Piaget's theory of cognitive development

Piaget's (1955) theory was particularly concerned with the role of biological factors in the development of cognitive functioning in children. He proposed that cognitive development in children occurs in four major stages: the sensory-motor, pre-operational, concrete-operational and formal operational period. Progression through

each stage is paralleled by qualitative organizational stages in the child's adaptive intellectual abilities. His theory also emphasizes the interaction between maturational and experiential influences

Piaget (1955) asserted that each stage should have five qualities: (i) universality, whereby the stages are the same for all children, (ii) transformation and irreversibility, which enables children to adopt new strategies to problem-solving, (iii) invariant sequence, whereby all children must pass through the stages in the same order, (iv) gradual evolution, which states that movement to a new stage occurs gradually and (v) equilibrium, which occurs once a child has consolidated his thinking patterns in a consolidated way.

However, Piagetian theory does not require that all children pass through the stages at the same speed, nor that all children eventually reach the highest level. Piaget (1955) expected individual differences in the rate of progress, and noted that some children will fall short of the formal operational level. For, example in the case of mental retardation, the child may not even pass through the sensory-motor or pre-operational levels. Thus in Piagetian terms, cognitive change occurs when children confront problems and experiences that are familiar but different, and children give impetus to their cognitive development through the actions and interpretations of the actions of events.

4.4.1 Piaget's stages of cognitive development

Piaget's (1955) theory divides cognitive development into four major periods: sensorimotor (0-2 years), preoperational (2-7 years), concrete operational (7-11 years) and formal operational (11 years and older).

4.4.1.1 Sensorimotor phase

This phase is divided into six sub-developmental stages where the emphasis on learning occurs primarily through the senses and motor activity. During the first five stages of this phase, the infant gradually advances from purely reflexive responding to a state where the young child is not only aware of and responsive to the immediate environment but is able to take direct action upon it at the concrete, perceptual level. In this phase development is characterized by decentration whereby the infant is initially in an undifferentiated state, unable to separate the self from the environment, and gradually decenters from the self, conceiving of things existing independently. The source of intellectual operation lies in the child's actions rather than in language. For, example, object permanence is achieved through children's actions on objects well before language emerges (Inhelder & Chipman, 1977). Sensorimotor stage six marks the beginning of thought as Piaget (1955) sees it, with the child no longer limited to immediate experiences but capable of representing and imitating objects and events.

4.4.1.2 Preoperational phase

This period occurs between two and four years, whereby the child acquires the semiotic function (the ability to use signs and symbols in the place of concrete objects and events) and is able to form representations of absent things and events. Both

language and representational thought are manifestations of the symbolic function. Piaget (1955) contends that mental symbols are formed through imitation which bridges the gap between sensorimotor and abstract functioning. The meaning of mental symbols is established through the process of assimilation so that symbols are always personally related to the child's experience. While ascribing a limited role to language in the formation of thought, Piaget (1955) does not view language as shaping mental activities. However, the appearance of speech brings about considerable changes in the child's behaviour.

Piaget (1967) elucidates three consequences of the symbolic function for mental development: (i) the possibility of verbal exchange with others and the onset of socialization of action (ii) the internalization of words which Piaget equates with the appearance of thought, and (iii) the internalization of actions which were previously purely perceptual and motor, enabling representation. These events enable the child's progression from egocentrism to social existence.

4.4.1.3 Concrete operational phase

In this phase of cognitive development the child can engage in mental manipulations of internal representation of tangible objects. Children not only have thoughts and memories of objects, but they can also perform mental operations on these thoughts and memories. Piaget (1955) claims that initially children rely on their immediate perceptions of how things appear to be. Gradually they begin to formulate internal rules regarding how the world works and eventually they use these internal rules to guide their reasoning, rather than appearance alone. Some of the most dramatic evidence of the change from preoperational thought to the representational thought of

the concrete-operational phase is seen in Piaget's (1955; 1967) classic experiments on conservation (the concept that volume remains unchanged when the shape of objects changes). Thus, during this stage of development logical thinking develops, but only as it applies to real concrete objects.

4.4.1.4 Formal operational phase

The formal operational phase (from about twelve years old through adulthood) is characterized by the fact that adolescents and adults develop the ability to think about and solve abstract problems in a logical manner. This implies that the individual can engage in mental manipulations of internal representations of abstract symbols that (i) may not have specific concrete equivalents, and (ii) relate to experiences the individual may not have encountered personally (Inhelder & Chipman, 1977). It is apparent that this phase marks the development of the adolescent or adult's abstract thinking, ability to speculate on hypothetical situations and reason deductively about what may be possible.

4.5 Evaluation of Piaget's Theory

The profound influence of Piaget's theory on the field of cognitive development has been compared to the immense influence of Shakespeare on the development of English literature or of Aristotle on the development of philosophy (Flavell, 1996). Piagetian theory has certainly revolutionized thinking about children development. His theory remains a valuable "road map" for understanding how children think.

However, criticism has been directed at Piagetian theory because of the vagueness surrounding some of the concepts, such as structures. Neo-Piagetians such as Fischer

(1994) and Case (1998) have challenged the claim that clearly defined cognitive structures associated with distinct stages play a major role in determining the child's problem solving abilities. Fischer (1994) agrees that cognitive development is an action-based, self-regulatory and constructive process, but disagrees that there is "generalized competence" or cognitive structures. He contends further that cognitive development should be described for each skill (task) and in every different context. Case (1998) supports Piaget's (1955) claim that children's thinking develops in stages but argues that the stage progression is not due to cognitive structures but rather children's thinking is influenced by executive processing space (active, temporary, short-term memory).

Piaget (1955) maintained that the mastery of skills such as conservation depends on neurological maturation and adaptation to the environment and is not tied to cultural experience. Support for this view has been found in some research (Bee & Boyd, 2002; Louw & Louw, 2007). For example, children who had achieved conservation of volume showed different brain wave patterns from those who have not yet achieved it. Further, Piaget's descriptions of the changes that occur during middle childhood have generally held up well. Cross-cultural studies support a progression from the rigid, illogical thinking of younger children to the flexible, logical thinking of older children (Sternberg, 1998). However, Piaget may have not paid enough attention to the role of culture-based experience. Even though neurological maturation may make new skills possible, it takes familiarity and practice to actually develop these skills.

Another important point of contention is that Piaget's research was done mostly on Swiss children, thus raising the issue of how children from Africa will perform on

these tasks. Most of the research in this regard was conducted in the 1970's and 1980's (Bee & Boyd, 2002; Dasen & Heron, 1981; Werner, 1972). In general, the findings indicated that children from South Africa and other parts in Africa achieved the Piagetian tasks in the same sequence as Piagetian subjects. However, some of the tasks were achieved at later stages by some of the ethnic groups in Africa. Factors that seemed to play a role in the attainment of Piagetian tasks were schooling, familiarity with the materials being manipulated and the education level of the parents (Mwamwenda, 2004). Despite these criticisms Piaget's theory is still viewed as being of great historical importance and remains a major force in developmental psychology today (Gopnik & Meltzoff, 1997).

In the next section attempts will be made to compare and integrate Piaget's contribution with those of Luria and Vygotsky so as to establish a view of neuropsychological development which will form the framework for the development of an assessment procedure for the present study.

4.6 A synthesis of the three theories as a framework for the present study

The theoretical approaches of Piaget, Vygotsky and Luria are compared here in general terms as well as by referring to particular critical issues in neuropsychological development, such as the role of biological factors, language, and the social environment. There is a marked degree of convergence of ideas between Piaget's (1929) biologically based theory of cognitive development and Luria's (1973) explanation of the neuropsychological processes underlying development in children. Further, although it appears at the outset that Piaget and Vygotsky are polarized on the nature-nurture continuum with regard to cognitive development, closer inspection

of the theories reveals marked similarities, with shifts in emphasis rather than fundamental differences. The parallels between the theories has been noted by many specialists in the field, including Golden (1987) and Korkman et al. (1998). Moreover, Vygotsky was also a contemporary of Luria, thus their theories reveal considerable similarities, both being founded in the Russian school of psychology.

The role of biological factors in neuropsychological development is an important issue to consider. Luria's approach is essentially a neuroanatomical explanation of brain functioning. Both Luria and Piaget recognize that mental processes result from the functioning of the brain and that complex behaviour are not possible without complex cortical organization. Luria's (1973) idea of thought formed through practical experience is similar to Piaget's (1955) conceptualization of operational thought. Their views on hierarchical organization, sequential development and the interactive, dynamic nature of systems reveal underlying similarities, although the emphases are different. For example, Luria's (1973) hierarchical model suggests that Units I, II and III of the brain become functional in that order and that simple processes form the basis for more complex ones. Similarly, Piaget's (1955) theory describes a sequence of stages, the attainment of each being a prerequisite for the next.

Luria's (1973) Unit I comprise structures regulating cortical tone which is largely reflexive in nature. Thus unit becomes functional during the first year of life at which time cortical arousal mechanisms are developed and primary responses such as crying and grasping emerge. This corresponds with the first few stages of Piaget's (1955) sensorimotor period during which the child responds to sensory stimuli and learns to

selectively focus attention. The sensorimotor period is characterized initially by purely reflexive behaviour which later becomes differentiated and is more under the child's control.

The maturation of sensory areas in Unit II (the reception, coding and analysis of information) corresponds with Piaget's preoperational and operational periods, characterized by decentration, representation and semiotic function, as well as the ability to perform mental operations such as classification and reversal.

Maturation of the prefrontal areas (Unit III) would correspond with the period of formal operations. The discrepancy between Luria's suggestion that the frontal lobes mature during middle childhood and Piaget's view that formal operations are attained at the age of twelve, may be explained by the possibility that some behaviours controlled by the prefrontal lobes are functional before others (Korkman, et al., 1998) and that children differ in the ages at which they enter the various stages.

Similar to Piaget's stage theory, Vygotsky also viewed cognitive development as involving progressive development of structures toward the coherent organization of mental functions. This is reflected in the considerable correspondence between the stages described in their theories, for example, Piaget's periods of preoperational, concrete operational and formal operational functioning with Vygotsky's phases of syncretic images, complexes and concepts respectively.

Both Piaget and Vygotsky recognize the genetic origin of cognitive development. However, Vygotsky views only the lower mental processes as being determined by

biological mechanisms, whereas Piaget sees humans as having innate faculties for abilities such as abstract thought. While Vygotsky accepted that simple cognitive processes are biologically based, the major differences between the approaches of Vygotsky and Luria lies in the amount of emphasis placed on the role of biological factors in more complex cognitive processes. However, both Luria and Vygotsky agree on the central importance of activity, language and culture in shaping intellectual development.

4.7 Conclusion

It is apparent from Luria's explanation of the functional organization of the brain, as well as Vygotsky's socio-historical view and Piaget's genetic epistemological approach, that neuropsychological functioning is a product of (1) biological bases, in interaction with (2) the influence of the external social environment and (3) experiential factors. Thus, it can be concluded that neuropsychological development in children attests to a dynamic interaction between changing neurological structures and psychological functions. Moreover, the relationship between the changing neurological structure and psychological function is further complicated by the susceptibility to the influences of the environment and experiential factors to which the child is exposed.

In the next chapter, the influence of neurobiological and psychosocial factors on neuropsychological functioning in children with epilepsy will be discussed. These examples are firstly, neurological insults, in this instance seizure disorders, and

secondly, the psychosocial factors as well as the cultural and social environment, with particular reference to South African children with epilepsy from a non-Westernized environment.

CHAPTER FIVE

FACTORS THAT INFLUENCE NEUROPSYCHOLOGICAL TEST
PERFORMANCE IN CHILDREN WITH EPILEPSY

5.1 Introduction

The main focus of this study is to investigate the various factors that affect the neuropsychological functioning of children with epilepsy. A survey of the recent literature yielded numerous articles on epilepsy in children. Most of these, however, focus on medical issues associated with seizure disorders in children (Dodrill, 1992a; Immeldt, 2006). The selection of research findings for this review will therefore be guided by the main aim of the study and only studies reporting on the various factors that impact on the neuropsychological sequelae of epilepsy in children will be reviewed.

Epilepsy is a common chronic neurological disorder of childhood and is associated with a wide range of neuropsychological impairments (Hermann, Jones, Sheth, Koehn, Becker & Fine, 2008; Treitz, Daum, Faustmann & Haase, 2009). The neuropsychological sequelae of epilepsy in children have been investigated by numerous researchers, reporting neurological (Huang, Cilio, Silveria, & Holmes, 1999; Khalilov, Le van Quyen, Gozlen & Ben-Ari, 2005), neurodevelopmental (Ben-Ari & Holmes, 2006; Lui et al., 1999), neurosensory (Boel, 2004; Oostrom, Smeets-Schouten, Kruitwagen, Peters & Jennekens-Schinkel, 2003), cognitive (Schoenfeld et al., 1999; Schouten, Oostrom, Pestman & Peters, 2002), educational or learning (Lynch, Saying, Bownds, Janumpali & Sutula, 2000; Schouten et al., 2002), psychiatric (Plioplys, Dunn & Caplan, 2007; Rodenburg, Stams, Meijer, Aldenkamp

& Dekovic, 2005), behavioural (Dunn & Austin, 1999; Caplan, Sagum & Siddarth, 2005; Jakovljvic & Martinovic, 2006) and other impairments.

These global impairments may be explained by reciprocal multiple aetiological factors associated directly or indirectly with seizure activity. Neuropsychological impairments occur partially as a result of the sequelae of clinical symptoms associated directly with seizure activity such as type of seizure, duration of seizure, age of onset of seizures as well as the effects of anticonvulsants that compromise the central nervous system (Vingerhoets, 2006). Indirect effects are associated with psychosocial factors such as parent-child relationships, interactions with peers, as well as perceived stigma and discrimination that affect neuropsychological functioning in children with epilepsy (Rodenberg, Meijer, Dekovic & Aldenkamp, 2007).

In addition to cognitive impairments (Schoenfeld et al., 1999), an increased frequency of behaviour problems of various types has been reported in this clinical group in comparison to children without epilepsy (Austin, Dunn, Caffrey, Perkins, Harezlak & Rose, 2002; Austin, Harezlak, Dunn, Huster, Rose, & Ambrosius, 2001; Otto, Siddarth & Gurbani, 2003). Previous studies have suggested that these behavioural problems may be related to type and severity of epilepsy (Binnie, 2001), duration of the disorder (Binnie, 2003), structural changes such as ictal and interictal brain activity (Austin et al., 2001), intellectual ability (Aldenkamp & Arends, 2004), metabolic disturbances (Hommet, Sauerwein, Toffel & Lassonde, 2006), effects of antiepileptic medication (Bourgeois, 1998; Schmidt & Elger, 2004) as well as psychosocial factors (Fastenau, Jianzhoa, Dunn & Austin, 2008; Otto et al., 2003).

Thus, this chapter will firstly, outline the domains of neuropsychological functioning assessed in this study and then elucidate on the factors that are believed to affect the neuropsychological functioning in children with epilepsy living in non-westernized environments.

5.2 Domains of neuropsychological functioning

According to Bohm, Smedler and Forssberg (2004) there are five domains of basic cognitive function according to the tradition of Luria (1973; 1980): attention and executive behaviours, language function, sensori-motor functions, visual-spatial functions and memory. All these functions mentioned were investigated in the present study.

Spreen and Straus (1998) advocated that the skills in these domains may follow different developmental timetables and may become differentially impaired as a result of cerebral insults. Distinguishing among the above-mentioned domains does not imply that these capacities develop and act in isolation or that they contribute to the performance in one domain only. On the contrary, performance in one domain frequently requires contributions from other domains (Korkman et al., 1998). Moreover, increasing competence in one domain may lead to increased performance in another domain (Korkman et al., 1998).

5.2.1 Attention and Executive functions

Attention is a complex cognitive construct that includes the ability to respond to basic sensory stimulation, selectively attend to relevant stimuli, maintain focus on the environment and respond to changing demands (Reynolds & Mayfield, 1999).

Attention is subserved by a complex network involving frontal, parietal and subcortical regions. Disruption of attention abilities are among the most commonly reported deficits in cases of brain injury (Baddely & Ellis, 2002).

Despite several and distinct definitions of executive functions, there is a consensus that they encompass the ability to maintain an appropriate set to achieve a future goal (Luria, 1973). Executive functioning represents a set of mechanisms by which performance is optimized in situations requiring the simultaneous operation of a number of different cognitive processes (Baddely & Ellis, 2002). It includes an array of functions essential for effective scholastic performance, social adjustment and responsible, self-serving conduct (Lezak et al., 2004). Moreover, it requires the ability to plan and sequence complex behaviours, to simultaneously attend to multiple sources of information, to resist distraction and interference, to inhibit inappropriate responses, and to sustain behaviour for prolonged periods of time (Schouten et al., 2002). This facilitates successful adaptation to situational demands. Bohm et al. (2004) postulate that executive functioning develops sequentially from simple forms of motor inhibition and impulse control at an earlier age to more complex functions, such as selective and sustained attention, as well as fluent production of abstract content. Curtis, Lindeke, Georgieff and Nelson (2002) confirm that executive functioning may occur in a stage-like process. Distinctive levels of maturation and integration occur at age 6 years, age 10 years and in adolescence, possibly reflecting an extended period of maturation of the prefrontal cortex.

During cognitive development, the capacity to form an intention becomes increasingly important in the direction and modulation of attention (Levine, 1987;

Luria, 1973). Initially, adults direct a young child's attention to objects and events in the environment through gesture, verbal mediation and reciprocal interaction. With increasing age, a child becomes capable of internalizing culturally-mediated behaviours and intentions in order to set goals, to attend selectively, and to inhibit impulse responses in order to organize behaviour (Luria, 1973). These behaviours constitute executive functions.

5.2.1.1 Executive and attention deficits in children with epilepsy

According to recent reviews, attention difficulties appear to be more frequent in children with epilepsy than in those with other chronic illnesses such as heart disease or diabetes, or in controls (Deltour, Querne, Vernier-Hauvette & Berquin, 2008; Dunn & Kronenberger, 2006; Schubert, 2005), implicating diffuse neurological dysfunction, frontal lobe involvement, sub clinical seizure activity, and underlying neuropathology, singly or in combination (Hernandez, Sauerwein & Jambaque, 2002; Schubert, 2005). Executive dysfunction in the form of compromised inhibition (Hernandez et al., 2002), set-shifting (Gathercole, Alloway, Kirkwood, Elliot, Holmes & Hilton, 2008), problem solving efficiency and mental flexibility (Smith, Elliot & Lach, 2002) are also common deficits reported in studies of children with epilepsy. These difficulties are frequently observed at the clinical level (Bailet & Turk, 2000; Bulteau, Jambaque, Viguier, Kieffer, Dellatollas & Dulac, 2000) and may partly explain scholastic problems in this population (Williams, Phillips, Griebel, Sharp, Edgar & Simpson, 2001).

A study by Kolk, Beilmann, Tomberg, Napa and Talvik (2001) compared A Developmental Neuropsychological Assessment (NEPSY) scores obtained by

children with generalized and focal seizures and control children and reported that children with generalized epilepsy performed significantly worse on the attention span ($p = 0,0004$) tests than the children with focal seizures and the control group. Bender, Marks, Brown, Zack and Zaroff (2007) also assessed the clinical utility of the NEPSY in measuring neuropsychological functioning of children with epilepsy. Their findings reported impairments in attention and executive functions in children with generalized epilepsy, consistent with prior research reviewed by Schubert (2005).

5.2.2 Language

Language is a central domain of neuropsychological assessment, and has been studied extensively in children and adults (Savage & Frederickson, 2005). Among the multiple interactive sub-components that have been identified as critical in proficient oral and written language are phonological processing, naming, receptive language comprehension, understanding of the syntactic structure of language, and ease and facility of production (Korkman et al., 1998). From a developmental perspective, these sub-components have their roots in the infant and toddler years, but proficiency continues to develop throughout childhood and adolescence in interaction with developing conceptual abilities, experience, and education.

5.2.2.1 Language deficits in children with epilepsy

Most children develop speech and language skills without difficulty. Inadequate acquisition of language is a very common manifestation of cerebral dysfunction in the young child. Children at risk for the development of speech and language disorders include those with intellectual disabilities, hearing loss, autism, cerebral palsy or

epilepsy (Staden, Isaacs, Boyd, Brandi & Neville, 1998; Wheless, Simos & Butler, 2002).

Epilepsy may disrupt brain functions necessary for language development indirectly because of associated intellectual disabilities or directly as a consequence of the seizure disorder (Hermann et al., 2001; Bell & Seidenberg, 2001). Any process that impairs language function has long-term consequences for academic, social and occupational adjustments in children and adolescents with epilepsy (Wheless et al., 2002). Furthermore, impairments in specific language abilities, such as auditory comprehension or retrieval of lexical codes can impact memory and learning abilities (Hermann et al., 2001).

Reading is a complex cognitive function, which in addition to acquired or learnt cognitive abilities, depends on many intrinsic functions such as oral language, visuo-spatial capacities, visual attentional processing and short-term memory (Valdois, Bosse & Tainturier, 2004). Findings by Chaix, Languitton, Lauwers-Cances, Daquin, Cances and Francois-Demont, (2006) on reading abilities and cognitive functions of children with epilepsy indicated that children with complex partial seizures and tonic-clonic seizures performed significantly worse on reading speed level ($p = 0.03$) and reading understanding level ($p = 0.03$) than children with benign childhood epilepsy with centrottemporal spikes. Chaix et al. (2006) also reported significant differences in expressive speech among the aforementioned three epilepsy groups: vocabulary ($p = 0, 05$) and phonology ($p = 0.01$).

Kolk et al. (2001) indicated that children with generalized and partial seizures performed significantly worse ($p = 0.00$ and 0.0004 , respectively) on tests of receptive language than children in the control group. Primary generalized seizures and complex partial seizures disrupt the process by which children organize and formulate their thoughts (Veliskova, Claudio & Galanopoulou, 2004). The findings were confirmed by Bender et al. (2007) who reported that children with epilepsy performed significantly worse ($p = 0.05$) on the language domain tests of the NEPSY than children in the control group.

It has been found that different aspects of higher level linguistic skills are affected by age, seizure variables, cognition and gender in children with complex partial seizures and generalized seizures (Caplan et al., 2006). Furthermore, the interaction of these variables appears to vary across age in each group. According to Caplan et al. (2006), younger children with complex partial seizures have subtle verbal deficits. In addition, older children with complex partial seizures and poor seizure control, particularly boys, are at risk of having difficulty organizing and formulating their thoughts. In contrast, male gender and the increased seizure frequency experienced at the onset of primary generalized seizures increase the vulnerability of younger children to language disorders.

5.2.3 Sensory-motor functions

Traditionally, sensory-motor abilities have been viewed as markers of normal early development (Lezak et al., 2004; Thelen, 1995) and marked deviations from the expected course of the emergence of sensory-motor abilities can be indicators of atypical development and brain damage or dysfunction. Sensory-motor abilities also

have important mediating functions as goal-directed, complex systems through which knowledge is acquired (Aldenkamp & Arends, 2004; Luria, 1973), problems are solved (Harnandez et al., 2002), and intent or purpose is communicated (Oostrom et al., 2003). Most of what children learn to do requires the co-ordination of multiple systems that mediate the production of speech, smooth and efficient limb and whole body movements, and dexterous movements of the hands and fingers, as well as systems that mediate equilibrium, eye movements, and visuospatial processing (Korkmann et al., 1998). To carry out an intention as simple as reaching for a pencil requires the integration and coordination of multiple systems in order to identify what to reach for, where to reach (direction), how far to reach (distance), how quickly to reach (velocity), the size and shape of the grip to use, and the strength (force) that is needed to pick up the pencil smoothly and efficiently (Levine, 1987; Luria, 1973). Examination of sensorimotor functions is therefore an important aspect of neuropsychological assessment in children.

5.2.3.1 Sensory-motor deficits in children with epilepsy

Aldenkamp and Arends (2004) claimed that sensory-motor deficits have been found in 67% of children with epilepsy and may involve co-ordination, balance and speed of movement. Findings by Giordani et al. (2006) indicated that a generalized seizure group performed significantly worse ($p = 0.01$) on sensory-motor functions as compared to the simple partial and complex partial seizure groups. Similarly, Bender et al. (2007) reported that children with generalized epilepsy performed significantly worse ($p = 0.05$) than the control group on the sensory-motor domain. It is important to consider that most of the children included in epilepsy research are on more than

one antiepileptic medication and can exhibit global difficulties on timed tasks such as the finger tapping and visuo-motor subtests of the NEPSY.

5.2.4 Visual-spatial processing

Visual-spatial processing is complex and involves multiple distinct, but interrelated subcomponents. Cronin-Golomb and Braun (1997) distinguish the subcomponents of visual-spatial processing as follows: (a) the ability to synthesize elements into a meaningful whole (visualisation) and represent objects mentally, (b) the ability to discriminate between objects, judge the orientation of lines and angles, and distinguish between left and right (c) the ability to understand the relationships among objects in space (location and directionality), (d) the ability to copy a model or reproduce it using blocks, (e) the ability to adopt a variety of perspectives and rotate objects mentally, (f) the ability to understand and interpret symbolic representations of external space (maps and routes) and (g) the ability to solve nonverbal problems. Korkman et al. (1998) advocate that these subcomponents have their roots in the infant and toddler years, but proficiency continues to develop throughout childhood, adolescence and adulthood in interaction with the development of conceptual and visual-motor abilities, as well as the development of attention and memory, experience and education.

5.2.4.1 Visual-spatial deficits in children with epilepsy

A study by Croona, Kihlgren, Lundbeg, Eeg-Olofsson and Eeg Olofsson (1999) showed that there were differences between children with generalized epilepsy and a control group ($p = 0.05$) on the Complex Figure of Rey test, which indicates that their ability to organize complex visuospatial material and assess a figure as a whole is

impaired. This was confirmed by Bailet and Turk (2000) who found that children with epilepsy obtained significantly lower scores than their controls on visuospatial tests. In addition, Kolk et al. (2001) reported that children with generalized seizures performed worse than children with partial seizures and control groups on the Visuo-motor test of the NEPSY ($p = 0.0002$). The differential effects of seizure type were also found in a study by Pavone, Bianchini, Trifeletti, Incorpora, Pavone and Parone (2001) on the neuropsychological assessment of children with epilepsy. Their findings indicated that children with tonic-clonic seizures had lower scores on the visuospatial domain ($p = 0.05$) of the NEPSY as compared to children with simple partial seizures and absence seizures.

5.2.5 Memory and Learning

Memory and learning have been studied extensively in children (Levine, 1987; Reynolds & Mayfield, 1999; Roman, 2004). Memory improves with the development of children's ability to conceptualize, categorize, and make associations. As more sophisticated encoding strategies are used, their access to what is learnt becomes more automatic (Roman, 2004). Components of memory include characteristics of learning, such as learning capacity and learning strategies, storage or retention of information over time and the ability to retrieve stored information on recall.

Problems with learning and memory in children are common in cases of brain injury resulting in childhood epilepsy, with the formation of new memory being particularly vulnerable (Reynolds & Mayfield, 1999). Memory deficits can be devastating for children who spend much of their time in learning activities and must encode and retain large amounts of new information to meet developmental expectations.

Furthermore, one of the key factors influencing a child's ability to learn is working memory, which is the capacity to hold in mind and manipulate information for brief periods of time (Swanson, 2006). Children's working memory skills are closely associated with their academic progress in both reading (Gathercole, Pickering, Knight & Stegmann, 2004) and mathematics (Geary, Hoard, Bryd-Craven & DeSoto, 2004; Swanson, 2006), with the majority of children with specific learning difficulties in these areas experiencing poor working memory skills (Gathercole, Lamont & Alloway, 2006; Pickering & Gathercole, 2004).

5.2.5.1 Memory deficits in children with epilepsy

Findings by Kolk et al. (2001) showed that children with generalized seizures performed worse on the short-term memory and long-term memory tests ($p = 0.000$ and 0.018 , respectively) than the partial seizure group. Aylward (2002) claimed that children with epilepsy showed little memory disturbance in daily activities but memory impairments were reflected in academic achievement. The hypothesis most frequently used to explain memory deficit in children with epilepsy has been that it disrupts the consolidation of the memory trace from short-term memory to long-term memory (Dodrill, 1992b).

Thus, it appears that the learning difficulty in children with epilepsy could be due to poor initial encoding of information. Aylward (2002) also reported that children with simple partial seizures had a marked memory deficit involving visual and verbal material, whereas children with generalized epilepsy only had a slight depression of visual memory. Schouten et al. (2002) presented findings that showed children with generalized epilepsy performed similarly on registration, recall and retention tests but

recalled slightly less than controls when probed under conditions of increased demand on working memory.

5.3 Effects of neurobiological variables on neuropsychological functioning

It is apparent from the published literature on epilepsy that there is considerable variability in the neuropsychological functioning of children with epilepsy (Kolk et al., 2001; Nolan et al., 2003; Sabbagh, Soria, Escolano, Bulteau & Dellatolas, 2006). Neuropsychological impairments associated with childhood epilepsy result from the interaction of several factors such as age at seizure onset, type of seizure (partial versus generalized), frequency of seizure, duration of seizure, laterality and location of seizure focus, and the presence of brain damage (Chaix, Languitton, Lauwers-Cances, Danquin & Francois-Demonet, 2006). Nolan et al. (2003) identified the following diverse parameters as being significant risk factors affecting neuropsychological performance in a sample of 169 children with epilepsy: age of onset ($p = 0.001$), duration of active seizures ($p = 0.037$), seizure frequency ($p = 0.037$) and polytherapy ($p = 0.024$). Thus neuropsychological deficits in children with epilepsy can be explained by a number of neurobiological risk factors. Moreover, for neuropsychological studies in children with epilepsy it is a major challenge to control the different variables related to the epileptic syndrome. Therefore the influences of the type of seizure, duration of seizure, frequency of seizure and age of onset on neuropsychological functioning were examined in the present study.

5.3.1 Type of seizure

Aicardi (1999), in an earlier review of neuropsychological studies on the cognitive abilities of children with epilepsy, noted that there appeared to be no characteristic

deficit related to all seizure disorders. He recommended that studies of neuropsychological correlates should be based on a clear differentiation of seizure types and on a wide range of assessment techniques. Thus, it is apparent that the type of seizure appears to be of importance in that the neuropsychological functioning within a given seizure classification is more homogeneous than that across the spectrum of childhood epilepsy.

Most of the research examining seizure type has focussed on the relationship with specific domains of neuropsychological dysfunction (Hermann et al., 2001). Accordingly, most of the studies have investigated attention and memory abilities in children with temporal lobe seizure involvement or generalized seizures. Memory deficits have been found in children with temporal lobe seizure involvement while those with generalized epilepsy are more impaired on measures of sustained attention (Hernandez et al., 2002).

There have been very few investigations to date comparing children of different seizure types across a broad base of neuropsychological abilities. Pioneering work by O'Leary, Lovell, Sackellares, Berent and Seidenberg (1983) provided useful initial findings relevant to this issue. They investigated the neuropsychological functioning of children with generalized seizures and partial seizures on the Halstead Reitan Neuropsychological Test Battery for Children and reported that there was only a group difference on the Tactual Performance Test, with the generalized group obtaining lower scores. Similar results emerged when a subsequent study by Hermann and Seidenberg (1994) examined seizure type differences in neuropsychological functioning as assessed by the Luria Nebraska Neuropsychological Battery- children's

Revision, with the generalized seizure group performing worse on the writing, mathematics and intellectual processes scales than the partial seizure group. More recent research has shown that among generalized seizure disorders, absence seizures have generally been considered to be associated with mild neuropsychological deficits (Aldenkamp & Arens, 2004). Generalized tonic-clonic seizures are most likely to lead to greater neuropsychological deficits, with partial complex seizures resulting in intermediate levels of neuropsychological impairment (Bender et al., 2007; Chaix et al., 2006).

5.3.2 Age of onset of seizure

The age at which a neurological disorder first appears or cerebral trauma is sustained has been considered a crucial factor in predicting the nature of subsequent neuropsychological deficits (Ben-Arie et al., 2006). Several investigations have examined the potential significance of the age at which seizures begin for neuropsychological functioning (Buelow & McNelis, 2002; Seidenberg, 1998). Most studies have found that children with an early onset of seizures perform more poorly than children with a later onset of seizures (Boel, 2004; Dreifuss, 1998). This was consistent with Seidenberg's (1998) finding that an earlier age of onset was a significant predictor of greater intellectual and neuropsychological impairment in children with both generalized and tonic-clonic and partial seizures. He maintained further that children with seizures beginning before five years of age were significantly impaired, relative to children with a later onset across a wide range of test measures related to motor ability, attention, concentration, memory and complex problem solving. However, many of the earlier studies were methodologically flawed since few studies distinguished between age of onset and duration of seizures. Since

these are typically highly correlated (i.e., the earlier the onset the longer the duration), it becomes difficult to disentangle the effects of one from the other.

It remains unclear whether there is a broad based generalized impairment associated with age of onset or whether more specific domains are more vulnerable at different points in development. Further research may help to determine if there are corresponding critical periods of development and impairments associated with age of onset at different times in childhood. Furthermore, it should be noted there are inherent limitations to the assessment of age of onset that might minimize its association with cognitive functioning. First, it may be difficult to determine with any degree of accuracy when the first seizure episode occurred, particularly for some seizure types (eg., absence seizures and simple partial seizures). Also, the occurrence of a seizure is, for some children, the initial manifestation of some underlying brain dysfunction which actually occurred at an earlier point in time. Factors such as these can serve to mitigate against strong associations between age of onset and neuropsychological functioning.

5.3.3 Frequency of seizures

Although it is expected that more frequent seizures would be associated with compromised neuropsychological functioning, this has not been demonstrated clearly. There appear be two reasons for this. First, studies typically consider only recent seizure history such as the last several weeks or months rather than the lifelong history of the seizure episodes. Second, there are vast differences in the impacts of various seizure types that are rarely differentiated.

Initial studies reported in the literature indicate that as seizure frequency increased, test scores on several measures of neuropsychological functioning also significantly declined (Hermann & Seidenberg, 1994; Dodrill, 1992). Both these studies found a consistent inverse relationship between seizure control and neuropsychological functioning (more seizures correlated with poorer performance) for children with generalized tonic-clonic seizures but not for children with temporal lobe seizures on all 11 clinical scales of the LNNB-CR. Recent studies (Akman, Montenegro, Jacob, Eck, Chiribogo & Gilliam, 2009; Asano, Pawlak, Shah, Shah, Luat, & Ahn-Ewing, 2005; Sillanpaa, 2000) that considered the effect of seizure frequency on neuropsychological functioning endorsed earlier findings that greater deficits were found in the tonic-clonic group than the complex partial and simple partial groups. Thus, it appears that cognitive abilities are affected not only by the number of seizures but also the type of seizure.

5.3.4 Duration of seizures

Neuropsychological impairment in children with epilepsy appears to increase over time and this has been explained by several neuropathological processes. Seizures are associated with neuronal changes in areas of the brain directly involved in the epileptic process and even in some areas removed from the primary focus (Binnie, 2001). This process is believed to be mediated by excitotoxic effects of neurotransmitters and the secondary influx of toxic ions as cell destruction occurs (McCormick & Contreras, 2001). Thus, collective damage over time may become irreversible and may be associated with decline neuropsychological functioning depending on the site of damage.

The relationship between seizure disorder, duration and deterioration of neuropsychological functioning remains unresolved. This is due to the paucity of prospective studies and difficulty in quantifying duration as an individual variable of interest as distinct from frequency (for example, two children may each have an EEG consistent with a seizure disorder of 5 years, yet one has a total of 5 manifest seizures, while the other experienced a hundred seizures). Differences between the severity of seizures at given times also serve to further cloud this area of research. Although conclusive evidence is lacking, most studies have supported the hypothesis that longer duration of epilepsy is related to a gradual lowering of test performance, particularly in children with chronic generalized seizures or seizures of symptomatic etiology (Arzimanoglou, Guerrini & Aicardi, 2004; McCusker, Kennedy, Anderson, Hicks & Harahan, 2002).

Thus, a clearer understanding of the interaction between different seizure related variables and neuropsychological performances in children with epilepsy will most likely be answered only when large enough sample sizes are available to use powerful multivariate statistical techniques to simultaneously evaluate the contributions of multiple variables to neuropsychological performance.

5.4. Psychosocial variables and epilepsy

The impact of psychosocial factors on the functioning of children with epilepsy has been studied (Austin, 2000; Bailet & Turk, 2000; Camfield, et al., 2001; Camfield et al., 2003) and reviewed (Cowan & Baker, 2004; Ellis, Upton & Thompson, 2000; Perera & Rodrigo, 2004). Psychosocial factors play a major role in the establishment, maintenance, and severity of emotional and behavioural problems seen in children

with epilepsy (Aicardi, 1999; De Boer et al., 2008; Dilorio, Schafer, Letz, Henry, & Schomer 2004; Sillanpaa & Cross 2009). Researchers postulate that the psychosocial impact is multidimensional and related to type of epilepsy (Besag, 2004), type of medication (Guerrini & Parmeggiani, 2006), underlying neurological disorder (Austin et al., 2001; Austin et al., 2002), family environment and parenting behaviours (Austin, Dunn, Johnson & Perkins, 2004) as well as the presence of significant cognitive problems (Keene et al., 2005). Children with epilepsy have been found to have more social problems than children with other chronic disorders such as diabetes or bronchial asthma (De Boer et al., 2008).

The psychosocial consequences of epilepsy during childhood are not expected to directly contribute to neuropsychological deficits. Their influence on neuropsychological functioning appears to be more indirect through such things as impaired educational progress, dysfunctional mother-child relationships, poor self-esteem and adjustment problems (Hoare, Mann & Dunn, 2000). It is not too difficult to imagine how the presence of recurrent seizures may affect the extent to which the child develops psychologically (Hoare et al., 2000; Williams et al., 2003). For example, parental and peer relations, as well as the child's own reaction to the disorder, may have a significant impact on the child's interpersonal stability and the degree to which he or she responds to normal social influences. The present study investigated the influence of home environment (such as mean household density), self-esteem, mother-child relationships and teacher's rating of levels of adjustment in children with epilepsy, on neuropsychological functioning (Herman & Seidenberg, 2001; Rodenberg et al., 2007). In addition, other psychosocial factors such as fear of

seizures, perceived stigma and locus of control also play an intrinsic role in impacting on the above-mentioned factors and these will be elaborated on below.

5.4.1 Perceived stigma associated with seizures

The perception of epilepsy in societies may differ depending on the level of education and cultural background of the society (Jilek-Aall, Jilek, Kaaya, & Mkombachepal, 1997). Many studies in developed regions of the world have confirmed that stigma contributes to the psychological and social burden of epilepsy (De Boer, 2002; Jacoby, Snape & Baker, 2005; De Boer et al., 2008). MacLeod and Austin (2003) building on Goffman's seminal essay (Goffman, 1963) conceptualize stigma as a loss of status and power resulting from the separation of those stigmatized from the general population because of a characteristic that has been culturally defined as different and undesirable. Stigmatization includes not only discrimination, but also disapproval and rejection from others. Stigma research has generally characterized stigma as felt versus enacted stigma. Enacted stigma manifests as discrimination against the stigmatized person imposed by other, whereas felt stigma is the fear of enacted stigma experienced by the stigmatized person. Stigma associated with epilepsy has a profound impact on quality of life in developed as well as developing regions (Baker, Brooks, Buck & Jacoby, 2000; Jacoby et al., 2005).

Nowhere is epilepsy associated stigma more disabling than in sub-Saharan Africa, where epilepsy rates far exceed those in developed countries (Birbeck & Kalachi, 2003). In sub-Saharan Africa, the combination of poverty, social role expectations, limited medical care and traditional beliefs coalesce to severely impact on the lives of children with epilepsy. As has been widely described (Jilek-Aall et al., 1997; Birbeck

& Kalachi, 2003; Baskind, 2005; Baskind & Birbeck, 2005), the most obvious and feared stigmata of epilepsy in Africa is burns. This is due to the fact that most of the cooking in non-westernised environments is done over open fires as well as in cool winter months people spend long hours next to the fire for warmth. Hence, a person suffering with epilepsy may fall into the fire during an epileptic attack and sustain severe burns. These burn scars are seen as an ominous mark of intractable epilepsy. Many traditional healers interpret burns as having sealed the fate of an epileptic child. Reports from sub-Saharan Africa universally indicate that many people believe seizures to be contagious, spread by saliva, urine, faeces, or flatus expelled during a convulsion (Baskind, 2005; Baskind & Birbeck, 2005). The fear of contagion results in enacted stigma in the form of isolation and the bystanders' unwillingness to intervene in preventing injury. Profound psychological and physical disability may occur. Stigma associated with epilepsy is attributed to several other causative factors besides direct contagion. Supernatural beliefs, such as witchcraft, are frequently cited as causing seizures. A person versed in magical arts may "put a curse" on a child, thereby draining the family's precious financial resources (Baskind, 2005). Another widely held belief is that breaking taboos may cause seizures. Angered ancestors may send the ailment as a punishment for socially inappropriate behaviour. Thus, in sub-Saharan Africa epilepsy is perceived as an "African" affliction resulting from the supernatural effects of ancestral spirits or evil spirits.

Although stigma is an important factor in the lives of children with epilepsy, it has not been extensively studied and is not yet fully understood. Stigma is a complex concept to investigate in this population because it involves personal attitudes and beliefs, elements of secrecy and disclosure management, as well as the influence from the

socio-cultural environment. However, stigma associated with epilepsy is considered to be one of the most important factors associated with the negative influence on self-concept and confidence in children with epilepsy (Fernandes, Salgado, Noronha, Barbaso, & Souza, 2004) and predisposes the child to various emotional and behavioural problems (Austin, Shafer & Deering, 2002). These problems can ultimately impact on the neuropsychological functioning of children with epilepsy. Epilepsy stigma is unique to children with epilepsy and is not reported in other chronic medical conditions for example, children with diabetes and chronic renal problems.

5.4.2 Locus of control and unpredictability of seizures

The concept of “locus of control” reflects the cognitive style of attributing events and actions to either internal or external factors. Internal factors encompass the child’s own behaviour, abilities or characteristics, whereas external factors include chance or misfortune or the one hand and actions of other people on the other hand. Thus, this psychological concept deals with an individual’s tendency to perceive events as being controlled either by themselves or external force (Galleti, Rinna & Acquafondata, 1998).

The aspect of locus of control, as it occurs during seizures, may elicit fears and insecurities in the child. Certain real limitations, which have to be set in consideration of the child’s physical safety, as well as the necessity of supervision, may encourage dependence. Unpredictability of the seizures can be a distinctive feature of epilepsy and seizures can occur irrespective the social setting, time or circumstances. The threat of a sudden and unpredictable loss of control (consciousness and loss of control

because of unpredictability) has been thought to comprise an essential dimension of epilepsy. Compared to other chronic conditions epilepsy in children is associated with a greater loss of control (Sillanpaa & Cross, 2009). Birbeck and Kalachi (2003) investigated the relationship between seizure control and locus of control in a sample of 143 children with epilepsy. They contend that seizure control could predict attribution style for bad events but not for good events. The authors concludes that for children with epilepsy the occurrence of epilepsy may be so pervasive that it can negatively influence the way they perceive many events in their lives, and that a good event is any event not marred by a seizure. This finding supports previous research that highlights the impact that an unpredictable event (seizure) can have on a child's perceived control over many aspects of their lives. However, among the psychosocial factors, unpredictability of seizures has been associated with increased anxiety and negative affective responses, which in turn can exacerbate the occurrence of seizures (Baki, Erdogan, Kantarci, Kayaalp & Yalcinkaya, 2004). Thus, treatment for anxiety may reduce the frequency of seizures.

Whilst evidence demonstrates the relationship between epilepsy in children and an external locus of control, there is little understanding of its development and maintenance. It seems reasonable to hypothesize that parenting behaviour, the severity and frequency of seizures and the children's perception of themselves and their disorder all play an important role in understanding why many children with epilepsy have an external locus of control (Shore, Austin & Dunn, 2004). Furthermore, findings by Birbeck and Kalachi (2003) claim that in many African families members of more traditional societies have an external locus of control.

5.4.3 Home environment

The majority of South African children live in disadvantaged and non-Westernised communities. It is generally accepted that poverty presents a number of obstacles to optimal development in terms of inadequate housing, medical care, nutrition and education. These conditions typically describe the environmental conditions pertaining to the children in the present study.

Most psychologists agree that the home environment plays an important role in a child's development (Bronfenbrenner, 1995; Vygotsky, 1978). There is substantial empirical evidence that the home environment is able to facilitate or inhibit the young child's cognitive development (Bozalek, 1999; Grieve, 1992; Richter, 1994).

The degree of urbanization and modernization of the society in South Africa determines the characteristics of a household structure (such as the degree of overcrowding or the presence of multiple caretakers) which influence children's psychological development (Richter, 1994; Nzimande, 1996). Overcrowding is a common occurrence in South Africa because the housing shortage forces disadvantaged families to lodge with others. Richter (1994) confirms overcrowding negatively influences children's cognitive abilities by limiting and interrupting children's exploratory behaviour and decreasing the number of intimate child caretaker exchanges. These findings are consistent with research reviewed by Dawes and Donald (1994) as they concur that overcrowding has an adverse effect on the child's psychological development.

5.4.4 Parental beliefs and attitudes

Family factors account for a significant amount of variance in child adaptation to epilepsy (Stanton, 1999; Rodenberg et al., 2007). It has become apparent that, besides neurobiological factors, family factors play a substantial role in the development and maintenance of the psychological well being in children with epilepsy. Dekovic, Janssens and Van As (2003) distinguish three different clusters of family factors according to the level of proximity of the respective factor to the child's everyday life: proximal factors (the quality of the parent-child relationship and parenting), distal factors (parental characteristics), and contextual family factors (the quality of other family relationships). The present study examines the influence of mother-child relationships on neuropsychological functioning. The quality of mother-child relationship could be defined as a constellation of maternal attitudes that has built up in the history of interactions of parent and child and includes attitudes of rejection, acceptance and parental attachment to child (Rodenberg, Meijer, Dekovic & Aldenkamp, 2005).

Because child health is managed within the context of the family and mothers virtually always assume the role of co-ordinating the family's health care, a positive maternal attitude is beneficial for the mother herself, the child with epilepsy, and the family as a whole (Shore et al., 2004). Challenges specific to epilepsy include managing a chronic condition that can be unpredictable, difficult to control, and often associated with stigma. Articulation of the factors associated with a positive maternal attitude is important to promote optimal maternal, child, and family functioning in those families with a child with epilepsy as well as their siblings.

Research on proximal family factors has shown that parents of children with epilepsy seemed to be less supportive of their child and more overprotective as compared to control groups (Otero & Hodes, 2000; Rodenberg et al., 2005). A study by Govender (2005) in Limpopo, South Africa on the mother-child relationship of children with epilepsy reported that the mothers of the epilepsy group expressed a higher degree of overindulgent ($p = 0.01$) and overprotective ($p = 0.01$) attitudes towards their children than the mothers of children with chronic renal problems. Furthermore, the mothers of the epilepsy group also manifested a higher degree of rejection ($p = 0.01$) and a lower degree of acceptance ($p = 0.01$) towards their children. Thus, the nature of such a mother-child relationship may impact on the psychological development of the child with epilepsy and may also contribute to the development of deep-seated emotional and behavioural problems. Mu (2005) argued that although mothers were more emotionally over-involved with their children with epilepsy than their siblings, this might be a rather appropriate manner of parenting their child, partly due to practical parenting matters, such as medical compliance and the supervision of the child's activities. Thus, it may be that at certain periods of childhood epilepsy that emotional over- involvement or overprotection is an adaptive parenting style.

Parental beliefs and attitudes concerning epilepsy significantly impact adjustment and quality of life for both the child and family (Hoare et al., 2000; Pal, Chaudhury, Das & Sengupta, 2002). The relationship between parental anxiety and quality of life of children with epilepsy is not clearly understood. Previous findings suggest that parental anxiety may have an impact on parenting behaviours (Pal et al., 2002; Stanton, 1999). Parents often worry about their child when a seizure occurs, that seizures and anticonvulsants result in loss of intelligence and that their child has a

brain tumour (Shore, Justin, Musick, McBride & Creasy, 1998). Frequently these beliefs result in overprotection and limitations imposed on the child's activities (Williams et al., 2003). Parental anxiety, which results in restriction of activities, has been hypothesized to be associated with decreased quality of life for both the child and family (Pal et al., 2002; Williams et al., 2003). Dunn and Austin (2004) maintain that over controlling parents, ones that are intrusive and do not give their children sufficient chance to develop independence, produce children who perform more poorly on neuropsychological tests.

5.4.5 Teachers evaluation of social competence in children with epilepsy

Social competence is broadly defined as the individual ability to function equivalent to age-appropriate and cognitive abilities (Rantanen, Timonen, Hagstrom, Erikson & Nieminen, 2009). Social competence also refers to the means for achieving the major developmental tasks expected of a child of a given age and gender in the context of his or her own culture, society and time, that is, to adapt to different social contexts and demands (Masten & Coatsworth, 1998). Thus, maladaptive behaviour and behavioural problems may be regarded as undesired characteristics that may interfere with the child's development of social competence.

As mentioned earlier in this chapter, there is a large and growing body of literature has been published on behavioural issues in epilepsy in children. Research has consistently shown that children with epilepsy are at increased risk of developing behavioural and adjustment problems (Dunn & Austin, 1999; Rantanen et al., 2009). Results from several studies indicate increased levels of behavioural problems in children with epilepsy when compared with healthy children (Caplan et al., 2005;

Caplan, Guthrie & Komo, 2002; Jakovljevic & Martinovic, 2006; Oomstrom et al., 2003; Oomstrom, Schouten, Kruitwagen, Peters & Jennekens-Schinkel, 2003;), siblings (Austin et al., 2002) and children with other chronic illnesses, for example diabetes and cardiac conditions (Davies, Heyman & Goodman, 2003).

Research has consistently shown that children with epilepsy experience significantly greater difficulties in learning and evidence more problematic behaviour than the general population, regardless of their intellectual capabilities (Holmes & Ben-Ari, 1998; Aldenkamp, Overwag-Plandsoen & Arends, 1999; Lhatoo & Sander, 2001). However, it is still unclear what proportion of these difficulties originates from the actual illness itself, the antiepileptic drugs, and the social interaction that is disturbed as a result of epilepsy (Prpic, Karotaj, Vlas-Cicvaric, Paucic-Kirincic, Valerjev & Tomac, 2003). The school is the second most important social environment for the child after family (Lhatoo & Sander, 2001). The child acquires knowledge, skills and develops social skills at school. Through interaction with their peers, children satisfy their developmental task of independence, develop self-respect and social competence.

The effects of epilepsy on social competence and adjustment may be indirect rather than direct (Noeker, Haverkamp-Krois & Haverkamp, 2005). One possible explanation is that both seizures and behavioural problems are caused by the same underlying neurological disorder (Keene, Manion & Whiting, 2005; Noeker et al., 2005). Other explanations are that seizures as such disrupt behaviour or that children have negative psychological reactions to seizure activity (Austin et al., 2002). Seizure frequency in the past year, but not age at seizure onset, has been found to predict

behavioural problems (Schoenfeld et al., 1999). Recurrent seizures predict behaviour problems very early in the course of epilepsy (Austin et al., 2002). However, these seizure-related variables do not necessary predict social competence and levels of adjustment in children with epilepsy (Caplan, Siddarth, Gurbani, Otto, Sankar & Shields, 2004; Keene et al., 2005). Other variables associated with behaviour problems are family related, for example, maternal anxiety, parenting abilities and family problems (Rodenberg et al., 2005).

The perception held by teachers, both negative and positive, may affect a child's self-concept, social competence and ratings of academic abilities (Katzenstein, Fastenau, Dunn & Austin, 2007). Dunn, Austin, Caffrey and Perkins (2003) explored the association between seizures and behaviour problems in children with epilepsy using teacher's ratings of behaviour on the Child Behaviour Checklist (CBCL). Their findings indicated that children with epilepsy have significantly higher Total ($p = 0.002$) and Internalizing ($p = 0.018$) Behaviour Problem scores than children with asthma. These findings were supported by Rantanen et al., (2009) who indicated that children with early-onset seizures are at risk for developing behavioural and adjustment problems. Rantanen et al. (2009) contend that the interaction of seizure-related variables and family related factors have been found to further affect neuropsychological and behavioural deficits. Jakovljevic and Matinovic (2006) reported findings that the levels of social adjustment on the CBCL were significantly lower as a function of type of seizure and gender. With regard to type of seizure, children with generalized seizures showed more social adjustment problems than those with complex partial seizures. Gender differences showed that girls with

epilepsy showed more significantly lower social adjustment scores than the boys with epilepsy.

5.4.6 Self-esteem and self-concept

The attainment of a stable concept about oneself as an individual is an important stage in children's development (Bee & Boyd, 2003). By the age of 6 or 7 years, most children have definite ideas about themselves and their attributes as a person. This cognitive appraisal of oneself is usually subsumed under the construct of self-concept or self-awareness.

Throughout childhood and adolescence, the self-concept changes in response to maturation and to environmental experiences. Children with epilepsy have been found to have a poorer self-concept and lower-self esteem than children with other chronic conditions (Salpekar & Dunn, 2007). Lower self-esteem has been associated with perceptions of stigma, lower quality of life, and a decreased sense of self-efficacy (Caplin, Austin & Dunn, 2002). Lower self-esteem also has been associated with depression in children with epilepsy. In a study by Buelow et al. (2003), poor self-esteem and depression were found more in girls than in boys. A negative attitude towards illness, lack of a sense of control and an external or unknown locus of control are other factors that are associated with low self-esteem in children with epilepsy (Caplin et al., 2002).

Children's drawings have been used extensively in other areas of paediatrics to assess self-concept, explore psychological issues and challenges that affect treatment of young children. Drawings have also been used to explore children's reaction to abuse,

both psychological and physical (Petersen & Zamboni, 1998) and other chronic disorders such as asthma (Gabriels, Warmboldt, McCormick, Adams & McTaggart, 2000). However, drawings have been underutilized in epilepsy, with available literature limited to only a few studies. Gomes-Correia (2000) studied human figure drawings of 32 children with epilepsy. Global analysis of body figure showed that children with epilepsy drew pictures that were below their chronological age in developmental complexity and had poor structural cohesion of body representation. Stafstrom and Havlena (2003) used human figure drawings in 105 children with epilepsy to understand the inner experiences of children with epilepsy and the impact of epilepsy on their lives. Findings revealed that across ages and epilepsy syndromes, the drawings showed evidence of impaired self-concept, low self-esteem, and a sense of helplessness and vulnerability. Overall, the drawings of human figures were less developed than expected for chronological age.

5.5 Limitations of previous studies

However, most of the studies (Bender et al., 2007; Chaix et al., 2009; Croona et al., 1999; Kolk et al., 2001; Nolan et al., 2003; Schouten et al., 2002;) reviewed herein presented with shortcomings. Firstly, many of the studies reported included children as homogeneous groups, for example, generalized seizures included children with tonic-clonic and absence seizures, yet they present with different clinical and behavioural sequelae. Second, almost all the studies abroad used cohorts of children with epilepsy from tertiary hospitals and institutions, which represents a very selective and unrepresentative sample. Third, although studies have reported on several neuropsychological domains, such as attention/ executive function, language and memory in children with epilepsy, there are few studies reporting on the motor and

visuospatial aspects. Fourth, although most studies have made an attempt to explore either the influence of neurobiological and psychosocial factors, no study has examined the combined contributing influence of both these factors on neuropsychological functioning in children with epilepsy. Fifth, there is a paucity of literature on the neuropsychological aspects of black children with epilepsy. There are few studies (Baskind & Birbeck, 2005; Birbeck & Kalachi, 2003; Jilek-Aall et al., 1997) on the psychosocial aspects of epilepsy in traditional societies in Africa. Black South African children are not strictly comparable to children from more traditional societies in undeveloped regions in Africa

Thus, the present study attempts to address these limitations and provide initial findings on the influences of neurobiological and psychosocial factors on the neuropsychological functioning of South African children with epilepsy.

5.6 Conclusion

The literature provides ample evidence that the factors that have been found to contribute to the neuropsychological deficits in children with epilepsy arise from multiple vulnerabilities. These vulnerabilities include neurobiological factors (such as type of seizures, age of onset, frequency of seizures and duration of seizures) and psychosocial factors (perceived stigma, attitude towards epilepsy and family factors. Thus, determining the precise nature, severity and predictors of co-morbid neuropsychological and behavioural problems is difficult due to the complexity and multi-factorial nature of these contributing factors. The methodological process adopted to investigate the hypotheses is presented next in Chapter 6.

CHAPTER SIX

METHOD

6.1 Introduction

The aim of the present study was to investigate the factors that affect the neuropsychological functioning of children with epilepsy. As indicated in Chapter 1, behaviour does not only become altered in the presence of variables that alter the structure and functioning of the central nervous system, but also in the presence of psychological and social variables that are mediated through the nervous system (Lezak et al., 2004).

Hence, in this chapter the method and procedures adopted in the empirical investigation of the factors that affect the neuropsychological functioning in children with epilepsy are discussed.

6.2 Research Design

This study focused on the factors that affect the neuropsychological functioning of children with epilepsy. In order to achieve the aim of the study, it was decided to adopt a quantitative approach and therefore questionnaires, rating scales and tests were used to obtain the required data. The methods used in this study, questionnaires and rating scales, are also characteristic of quantitative research (Babbie & Mouton, 2006).

The present investigation is a predictive study, since specific predictions can be made about the influence of neurobiological and psychosocial factors (predictor variables) on neuropsychological functioning (criterion variable) in children with epilepsy.

6.3 Aim of the study

Using a sample of children with tonic-clonic seizures, simple partial seizures and chronic renal problems, the present study has the following general aim:

The aim of the study is to investigate the neurobiological and psychosocial factors that influence the epilepsy groups' neuropsychological test performance. This implies looking at factors such as demographics, medical history, home environment, emotional status and behavioural adjustment. In addition, in order to control for the effects of having a chronic illness, a comparison will be made of the test performances of the epilepsy and renal groups.

6.4 Hypotheses

In accordance with the stated aim the following hypotheses were advanced:

6.4.1 Hypothesis 1

Neurobiological, psychosocial and emotional factors will affect attention/executive, language, sensorimotor, visuospatial, and memory functions in children with epilepsy.

There are five specific hypotheses that are derived from research hypothesis 1 and are stated below.

6.4.1.1 Specific Hypothesis 1.1

Neurobiological and psychosocial/emotional factors will affect attention and executive functions in the epilepsy groups.

6.4.1.2 Specific hypothesis 1.2

Neurobiological and psychosocial/emotional factors will affect language functions in the epilepsy groups.

6.4.1.3 Specific hypothesis 1.3

Neurobiological and psychosocial/emotional factors will affect sensorimotor functions in the epilepsy groups.

6.4.1.4 Specific hypothesis 1.4

Neurobiological and psychosocial/emotional factors will affect visuospatial functions in the epilepsy groups.

6.4.1.5 Specific hypothesis 1.5

Neurobiological and psychosocial/emotional factors will affect memory/learning functions in the epilepsy group

6.4.2 Hypothesis 2

In order to separate the possible effect of having a chronic medical condition, the epilepsy groups were compared with the group of children with a chronic renal condition. This gives rise to the following general hypothesis:

There are differences between the epilepsy and renal groups in medical history, maternal attitude, emotional functioning and neuropsychological functioning.

6.4.2.1 Specific hypothesis 2.1

There are differences between the epilepsy and renal groups in age and medical history, measured by birth history.

6.4.2.1 Specific hypothesis 2.2

There are differences between the epilepsy and renal groups in maternal attitude, as measured by the acceptance, overprotection, overindulgence and rejection scales of the MCRE.

6.4.2.3 Specific hypothesis 2.3

There are differences between the epilepsy and renal groups in emotional functioning, as measured by the self, social and school levels of adjustment of the CBCL, Rosenberg Self-esteem Inventory and DAP scores.

6.4.2.4 Specific hypothesis 2.4

There are differences between the epilepsy and renal groups in neuropsychological functioning as measured by the attention/executive, language, sensorimotor, visuospatial and learning and memory domains of the NEPSY

6.5 Sample

The nature of the study dictated that a highly select sample of subjects was required to investigate the aim and hypotheses described here. The sample was drawn from South African provincial hospitals within the province of Limpopo. The Limpopo province is home to 5.4 million inhabitants. Among them, 97,1 % are Africans, 0.1% are Indian/Asians, 0.1% are Coloured and 2.7% are Whites; of these 45.7% are males and 54.3% are females; many of the inhabitants live in poor socioeconomic environments, have poor healthcare and limited schooling (Health System Trust and Department of Health, 1997; Statistics South Africa, 2000).

A copy of the research proposal was sent to Limpopo Provincial Department of Health and Welfare seeking permission for the study from the relevant authorities. Once permission was granted, contact was made with the Heads of Department of the Pediatric Clinics and registrars. The researcher subsequently initiated discussions around the study proposal that informed them about the specific needs of the researcher with regard to children with epilepsy.

Over a 36-month period, the subjects selected for this study through purposive sampling were drawn from the pediatric out-patient clinics at the Polokwane, Mankweng and Ba-Phalaborwa hospitals. In keeping with the aim of the study, two epilepsy groups, a group of children with tonic-clonic seizures and a group of children with simple partial seizures were selected. These two types of seizure disorders were chosen for this study in response to the limitations of earlier studies (Aicardi, 1999) that regarded the different types of seizures as a homogeneous group yet they present with different clinical and behavioural sequelae. A third group of children with

chronic renal problems was selected to control for the effects of having a chronic medical condition. One hundred children with tonic-clonic seizures, 100 with simple partial seizures and 100 children with chronic renal problems comprised the final study sample. The age and gender distributions of the final sample are reflected in Table 6.1 while Table 6.2 depicts the language/ethnicity distribution.

Several criteria were used for the selection of the subjects. Firstly, all subjects in the epilepsy groups were diagnosed with epilepsy by a medical practitioner. The diagnosis was made in accordance with the ICES classification system (Dreifuss, 1989). Secondly, all children in these groups had the condition for at least three years, which is regarded as an indication of a chronic condition. Thirdly, all subjects chosen were between the ages 8-12. According to Korkman (1999), this is a significant period of cognitive development during which the mastery of most skills takes place. Also the age group was restricted to ensure homogeneity and because the rate of early development is very variable. Fourthly the children selected in the control group had chronic renal problems such as nephritis, glomerulonephritis and urolithiasis that were diagnosed by a medical practitioner.

Table 6.1 Classification of subjects in the tonic-clonic and simple partial epilepsy group and the renal group

Nature of child's illness	Tonic-clonic	Simple Partial	Renal	Total
Tonic-clonic	100			100
Motor simple partial		71		71
Autonomic simple partial		10		10
Sensory simple partial		19		19
Nephritis			51	51
Glomerulonephritis			17	17
Urolithiasis			32	32
Total	100	100	100	300

Thus, the sample for this study comprised 100 children with tonic-clonic seizures, 100 children with simple partial seizures (including 71 children with motor simple partial seizures, 10 with autonomic simple partial seizures and 19 with sensory simple partial seizures) and 100 children with renal problems (including 51 children with nephritis, 17 with glomerulonephritis and 32 with urolithiasis). Further details regarding the characteristics of the sample will be provided in the next chapter.

The groups were comparable in terms of family structure (see Table 6.2), most of the children being members of nuclear families.

Table 6.2 Structure of the family system

Structure of family system	Tonic-clonic	Simple Partial	Renal Group	Total
Nuclear	59	62	60	181
Extended	41	38	40	119
Total	100	100	100	300

The groups were also comparable in terms of the child's primary caretaker (see Table 6.3), most children being cared for by their mothers.

Table 6.3 Primary caretaker of the children in the study

Primary Caretaker	Tonic-Clonic	Simple Partial	Renal	Total
Mother	51	45	42	138
Grandmother	40	32	37	109
Other Family	9	23	21	53
Total	100	100	100	300

6.6 Measuring instruments

For the purposes of the present study, data were obtained using a biographical questionnaire and several psychological tests, as described below.

6.6.1 Biographical Questionnaire (Appendix A)

A biographical questionnaire was designed to elicit pertinent demographic and illness related information. The child's age, child's gender, child's primary caretaker, educational level of parents and ethnicity formed the basic demographic features of this questionnaire. The information on the birth history of the child included type of delivery, term of pregnancy, duration of labour, complications during birth, complications after birth and birth order of child. The type of medical condition experienced and concerns about child's clinical condition such as whether child's illness demanded more attention as compared to other children, whether the child's illness restricted family activities and the mother's concerns about the child's illness. The mothers understanding of epilepsy documented details such as beliefs and perceptions about epilepsy. These factors could influence neuropsychological test performance, for example, a study by Grieve (1992) has shown that home environment can influence cognitive development. Although the variables tapping information on educational level of parents, ethnicity and mothers' understanding of epilepsy did not form part of hypothesis 1 or hypothesis 2, the researcher wanted to look at all possible variables that could impact on the psychosocial aspects of epilepsy which influence the child's neuropsychological test performance. The perception of epilepsy in societies may differ depending on the level of education and cultural background of the society (Jilek-Aall et al., 1997). Furthermore, maternal beliefs and attitudes concerning epilepsy significantly impact on adjustment and quality of life for both the child and family (Hoare et al., 2000; Pal et al., 2002).

6.6.2 Psychosocial measures

In order to assess the influences of psychosocial factors on neuropsychological functioning in children with epilepsy, the mother-child relationship, teachers' evaluation of levels of adjustment and the child's level of self-esteem and emotional stability were assessed. As discussed in Chapter 5, psychosocial factors play a major role in the establishment, maintenance, and severity of emotional and behavioural problems seen in children with epilepsy (Aicardi, 1999; De Boer et al., 2008; Dilorio et al., 2004; Sillanpaa & Cross 2009).

6.6.2.1 Mother-child relationship

The nature of the children's relationship with their mothers was assessed with the Mother-Child Relationship Evaluation (MCRE) scale developed by Roth (1961) and subsequently revised in 1980. The measure provides an objective estimate of the nature of the mother-child relationship based on a five-point attitude profile. Items tap attitudes of overprotection, overindulgence, rejection and acceptance held by mothers towards their children. Each of the above scales has a total of 12 items and is scored on a five-point scale according to the procedures outlined in the Manual (Roth, 1980).

Satisfactory test-retest reliability of the MCRE has been established (Bredehoft, Mennicke, Potter & Clarke, 1998). They maintain that the MCRE is an internally valid and reliable instrument to measure parental attitudes towards the child and has the advantage of being quick to administer and easy to score. The factor structure of the MCRE has been confirmed in a local study by Mahabeer (1993). Studies conducted by Govender (1999; 2005) on mother-child relationships in children with epilepsy from populations similar to those included in the present study, indicated

good reliability for the MCRE. The MCRE is therefore considered relevant as well as a suitable and reliable instrument for the purposes of assessing mother-child relationship in the present study. Cronbach's alpha determined for the subscales of the MCRE in this study was 0.70, which indicates good reliability.

The MCRE was administered to all the mothers of children in the tonic-clonic, simple partial seizures and the renal groups, to ascertain whether the type and of chronicity of the children's illness influences aspects of the mother-child relationship.

6.6.2.2 Teacher's evaluation of levels of adjustment

It is important to assess the children's adaptation to the various environments in which they function. As noted in Spreen and Straus, (1998) it is critical to examine a child's adaptive behaviour within the family, the school, and the community. The quality of a child's relationships with parents, siblings, teachers, and peers may be symptomatic of a particular kind of learning disability or psychiatric disorder or could indicate adjustment difficulties in response to neuropsychological dysfunction (Roman, 2004). Difficulties with activities of daily living such as self-care or participation in household routines could also be diagnostic. Moreover, when the clinical interview raises questions about adaptive behaviour, more formal questionnaires or structured interviews can be administered to investigate how the child's functioning compares to that of neurologically intact peers (Korkman et al., 1998).

The Child Behaviour Rating Scale (CBRS; Cassel, 1962) was administered to teachers who assessed the psychosocial adjustment of children. The teacher rated the child's self, social and school levels of adjustment. Each item was rated on a four-point scale and was scored according to scoring procedures given in the CBRS manual (Cassel, 1962). Since all the items were directly obtained from summary case reports made by highly trained persons in different disciplines dealing with child behaviour, the CBRS is presumed to have high face validity (Cassel, 1962).

Mahabeer, (1993) also reported good construct validity for the CBRS in her study on the effects of father absence on child and family adjustment in Durban, South Africa. There were highly statistically significant correlations between the CBRS and school achievement test scores, intelligent quotients and measures of social development, indicating construct validity of the measure. The correlation (Pearson r) between mothers' and fathers' ratings was 0.65. Using the Spearman-Brown formula on odd-even CBRS items, indices of reliability were computed. Using a sample of 800 typical children, the resulting r was 0.87, in a sample of 200 maladjusted children the r was 0.59. Cronbach's alpha determined for the subscales of the CBRS in the present study was 0.88, which indicates strong reliability. Meyer and Aase (2003) in their study on the prevalence of attention and hyperactivity disorders in children in Limpopo province reported that teacher ratings yield useful information when assessing childhood disorders. In the present study, the CBRS was administered to the teachers of each child in the tonic-clonic, simple partial seizures and the chronic groups, to ascertain whether epilepsy and/or the chronicity of an illness influences the psychosocial adjustment of the child.

6.6.2.3 Self-Esteem

The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1979) was used to assess the self-esteem of children. This scale assesses self acceptance and how one feels about oneself. The scale consists of 10 items, 5 of which are phrased in a positive direction and the other five in a negative direction to control for acquiescence. These are rated on a four-point scale, ranging from strongly agree to strongly disagree. In general terms, items are given a score if positive ones are disagreed with and negative ones are agreed with, so that high scores reflect low self-esteem. The scoring was based on procedures described by Rosenberg (1979).

Schmitt and Allik (2005) claim that among the many devices for assessing global self-esteem, the self-report version of the RSES remains the most widely used measure. They claim that the popularity of the 10-item RSES is attributed to its long history of use, its simple language, its brevity and its one-dimensional factor structure. Whiteside-Mansell and Corwyn (2003) contended that this scale is worthy of high recommendation in view of its very acceptable reliability co-efficients derived on only 10 items and report a Guttman reproducibility co-efficient of 0.92. There is also considerable evidence for its construct validity derived from many theoretical relationships studied and shown to be significant in Rosenberg's (1979) study (Corwyn, 2000; Whiteside-Mansell & Corwyn, 2003).

With regard to validity, Corwyn (2000) found that the scale correlated from 0,56 to 0,83 with several similar measures and clinical assessment (N = 44). The RSES was used in a local study by Meyer, Madu and Mako (2003) on self esteem and emotional

stability of street children in some South African townships and they reported a Cronbach's alpha of 0.87 for the scale, which indicates strong reliability.

6.6.2.4 Emotional Stability

The Human Figure Drawing (HFD Test; Koppitz, 1968) was developed by Koppitz (1968) to discriminate children with emotional instability from children with emotional stability. Koppitz (1968) defined emotional indicators as a sign on a HFD that meets the following three criteria: (a) it must have clinical validity, i.e., it must be able to differentiate between HFDs of children with and without emotional problems, (b) it must be unusual and occur infrequently on the HFDs of normal children who are not psychiatric patients, and (c) it must not be related to age and maturation. Thirty signs on the HFD were believed to possess all the characteristics of Emotional Indicators. This is line with research by Koppitz (1968) and earlier researchers in this field (Machover, 1953; Hammer, 1958). According to these authors the list of the 30 signs on the HFD must consist of three different types of items: It should include:

1. Items that are related to the quality of the HFD
2. Signs that are made up of special features not usually found on HFD's
3. Omission of items which could be expected on HFD's of children at a given age.

The reliability of the scoring of the HFD's by the present author was in line with that of Koppitz (1968). A clinical psychologist and the researcher scored the HFD's independently and the 300 drawings were checked and scored for the presence and absence of emotional indicators. Both scorers differed only on 5% of the items and

concurred on 95% and it was thus concluded that the scoring of the HFD's was adequate.

With regard to validity, Koppitz (1968) studied 76 pairs of public school children matched for age and gender. After using the elimination method to exclude the clinically valid from the non-valid, 30 items remained and these qualified as "emotional indicators" (Koppitz, 1968). Meyer et al. (2003) claimed that the HFD, as a projective clinical tool, was second to the Rorschach technique in popularity as an adjunct to the work of clinicians in hospitals, clinics and counseling services. They also reported that the reliability of HFD was 0.80 (split half) in their local study on street children. The HFD is therefore considered relevant as well as suitable instrument for the purposes of measuring emotional functioning in children in the present study.

6.6.3 Neuropsychological assessment

The aim of neuropsychological assessment in children with epilepsy is to provide a detailed evaluation of cognitive abilities, strengths and deficits to better understand the child's neurological condition. Neuropsychological assessment can help in treatment decisions and can also contribute to further understanding of emotional, educational, and psychosocial problems, as well as to the planning of appropriate treatment or intervention for the child. The NEPSY (A Developmental Neuropsychological Assessment; Korkman, Kirk, & Kemp, 1998) was used to assess the neuropsychological functioning of children participating in this study. It was designed to assess basic and complex aspects of cognitive capacities that are critical to a child's ability to learn and to be productive in and outside of school settings.

Korkman et al. (1998) maintain that the NEPSY is useful in understanding the effects of brain damage in young children as a result of congenital or acquired brain damage, cerebral palsy, epilepsy, traumatic brain injury as well as in children with a medical history that is associated with neurodevelopmental risks, such as low birth-weight, prenatal exposure to alcohol and drugs, brain tumours and exposure to environmental toxins.

The NEPSY extensively assesses neuropsychological functioning in five functional domains, namely attention/executive functions, language, sensory-motor, visual spatial processing and memory/learning. Research has shown that the cognitive capacities in these domains may follow different developmental timetables and may be differentially impaired (Korkman et al., 1998). They advocated that distinguishing among these five domains does not imply that these capacities develop and act in isolation or that they contribute to performance in only one domain. On the contrary, performance in one domain frequently requires contribution from other domains (Sattler, 2001). Moreover, increasing competence in one domain may lead to increased performance in another domain.

The children in the tonic-clonic, simple partial and chronic renal group were administered the NEPSY Core Battery. The testing procedures adhered strictly to the instructions outlined in the manual (Korkman et al., 1998). Raw subtest scores converted into scaled scores, and a composite domain score was calculated for attention/executive function, language, sensorimotor, visuospatial, and learning/memory domains. A brief overview of these five domains will be presented

next as this was already discussed in Chapter 5. The validity and reliability of the NEPSY as a neuropsychological tool for this study is discussed in 6.6.3.6.

6.6.3.1 Attention/Executive functions

Attention and executive functions are central to neuropsychological assessment. Although the components of attention have been defined in different ways, many theoretical analyses include the following components: regulation of arousal and vigilance, selective attention, sustained attention, attention span or divided attention, and inhibition and control of behaviour (Barkley, 1996, Kemp, Kirk & Korkman, 2001). There are numerous studies reporting that there is evidence that individual characteristics, such as age, gender, intelligence, and experience may affect performance on attention tests and that multiple brain regions interact to mediate attentional processes (Barkley, 1996; Mirsky, 1996; Sattler, 2001; Shum, Neulinger, O'Callaghan & Mohay, 2008).

The three subtests for attention/executive functions used in this study are: (a) Tower; (b) Auditory Attention and Response Set and (c) Visual Attention.

6.6.3.2 Language

Assessment of the child's language ability is an important component of any neuropsychological evaluation. Language plays a central role in many aspects of development and is often found to be deficient in children with learning disorders and brain injuries (Kolb & Fantie, 1997). Language skill is critical for social interaction, academic achievement, and complex thought (Straus, Sherman & Spreen, 2006). Thus, children with deficient language skills may have serious problems relating to

peers and family, may experience prolonged and pervasive school failure, and may have difficulty with independent living when they enter adulthood. Identifying these problems and offering early remediation may enable the child to avoid years of difficulty.

Language evaluation may be accomplished through the use of a number of comprehensive test batteries of language development, as well as individual measures assessing more discrete language abilities. Important aspects of language evaluation should include object naming, comprehension of word meanings, the ability to understand grammatical structures of varying complexity and produce grammatical utterances, and comprehension and production of sentences and paragraphs (Straus et al., 2006)

The Phonological Processing, Speeded Naming and Comprehension of Instructions subtests of the NEPSY were used in this study.

6.6.3.3 Sensory-motor functions

Intact sensory functioning is essential for the learning process because incoming information must be perceived accurately to be learnt accurately. Most of the child's skills require the coordination of multiple systems that mediate the production of speech, smooth and efficient limb and whole body movements, and dexterous movements of the hands and fingers, as well as systems that mediate equilibrium, eye movements and visual spatial processing. Sensory-motor ability is, therefore, important in neuropsychological assessment in children.

The Finger Tapping; Imitating Hand Positions and the Visuomotor Precision subtests of the NEPSY were used in this study to measure sensorimotor skills.

6.6.3.4 Visual-spatial functions

Visual spatial skill allows one to appreciate the spatial configuration of a visually perceived form or the relationship among its parts. Tasks assessing this skill might require the child to arrange blocks, to copy a pictorial model or to identify objects from other parts. Patterns of spatial, analytic, and visuomotor deficit tend to differ as a function of the site of neurological insult in the brain. Lezak et al. (2004) reported that injury to the left hemisphere in adults tends to interfere with the ability to appreciate and render visual details, whereas right hemisphere injury produces deficits relating to the global form or overall configuration of visual images. This same distinction is found for a period of time even in children whose lateralized brain insults occurred in infancy (Straus et al., 2006). Thus, analysis of detail versus configural aspects of children's drawings as well as their errors or task strategies on other spatial tasks can provide clues as to localization of their impairment within the brain.

The two subtests used in this study to measure visuospatial processing are the Design Copying and Arrows tests of the NEPSY.

6.6.3.5 Memory and learning functions

Components of memory include characteristics of learning, such as learning capacity and learning strategies used, storage or retention of information over time, and the ability to retrieve stored information on recall. Verbal and visual learning modalities can be differentially affected by brain injury and should be investigated separately in

a neuropsychological assessment (Roman, 2004). Remote memory, or memory for information learnt well in the past, is typically resistant to brain injury but may be assessed through formal tests or informal questioning.

The NEPSY Memory and Learning Domain subtests which comprised Memory for Faces, Memory for Names and the Narrative Memory subtests were used in this study.

6.6.3.6 Validity and reliability of the NEPSY

Several studies advocate that the NEPSY is a reliable and valid instrument that taps important neuropsychological functions so that clinicians can better understand children with neurological disorders (Bender et al., 2007; Schmiddt & Wodrich, 2004; Till, Koren & Rovet, 2001). Korkman et al. (1998) reported strong reliability scores for the above core domains as follows: attention/executive 0.85, language 0.90, sensory-motor 0.88, visual-spatial 0.84, and memory/learning 0.89.

There are few studies on cultural influences and performance on the NEPSY. A study by Mulenga, Ahonen, and Aro (2001) found that literate Zambian children performed better than children in the United States (the standardisation sample) on visual spatial tasks but worse on some measures of attention/executive function and language. Overall, however, they concluded that the NEPSY was relatively unaffected by language and cultural factors that often limit the use of such psychometric tests in other cultures. In addition Bender et al. (2007) purport that the NEPSY is a useful instrument to assess children with epilepsy given the varied sequelae and neurologic soft signs within this population.

Cronbach's alpha coefficients were calculated for all five domains for the present study and found to be as follows: attention/executive functions $\alpha = .94$; language $\alpha = .94$; sensory-motor functions $\alpha = .90$; visual-spatial functions $\alpha = .91$; learning and memory $\alpha = .88$ which indicates good reliability. Hence, the NEPSY is considered the appropriate test instrument for neuropsychological assessment of children with epilepsy and chronic renal problems in the present study.

6.7 Procedure

Written permission was obtained from the Department of Health and Welfare, Limpopo Province. The researcher subsequently made contact with registrars and other healthcare workers in charge of the various Pediatric Departments in the Provincial Hospitals to discuss aspects about the research and highlight awareness of the type of patients that were sought for the investigation.

On receiving permission, regular visits were made to the Pediatric Clinics at local hospitals in Limpopo Province over a thirty six month period. The researcher collaborated regularly with health care workers in the clinic to establish whether further participants meeting the selection criteria had been identified. The medical records of patients at these clinics were inspected and a pre-selection list of patients in the three groups was compiled. The parents of these children were informally interviewed to gather more information with respect to the selection criteria for each group. Once the final sample for the three groups was selected, prior arrangements were made with the mothers or child's caretaker regarding issues related to the nature and purpose of the study, obtaining written consent, clarification of doubts and the dates and time of testing. The child was requested to participate in the study with the

proviso that he/she would be free to terminate his/her involvement in the study at any stage without any prejudice to the child's continued health care. In addition, it was emphasized to the mother or child's caretaker that no immediate benefit would derive from the study and that once completed, the results of the investigation would be made known to them. Complete anonymity was guaranteed to all parents or child's caretakers, regarding information about the patients that was recorded.

On subsequent visits to the clinics, the mothers/caretakers of each child from the tonic-clonic seizure, simple partial seizure and the chronic renal groups, were requested to fill in the biographical questionnaire (Appendix A) and a scale measuring mother-child relationship. They were also requested to approach the child's schoolteacher to complete a child behaviour rating scale. Once completed, it was returned to the investigator on a subsequent clinic visit.

Each child was requested to draw a person. The researcher administered a measure of self-esteem and recorded the responses also during the same visit. On a subsequent visit the neuropsychological test was administered to each child. The child was informed that there were numerous tasks to be performed and they were encouraged to work quickly, but accurately. The testing was staggered over two days with an average testing duration of 1.5 hours to optimize performance. The scoring and interpretation of the tests were in accordance to the instructions in the manuals (Roth, 1980, Koppitz, 1968; Rosenberg, 1965 & Korkman et al., 1998). All the measuring instruments outlined above were administered by the researcher in English. The researcher was always accompanied by an African research assistant who verified whether the child was able to take the tests in English. This was possible as the

research assistant was a Psychology postgraduate student who was bilingual in terms of English and the Sotho (Northern and Southern) African languages of the Limpopo Province. All the children in the sample were attending mainstream schools with English as the main medium of teaching. Thus, the children included in the sample were able to comprehend and complete the test in English as the test instructions used simple language, which made it easy for second language English speakers to comprehend.

6.8 Data Analyses

All psychological tests yielded quantitative data and these were entered in the form recommended in the respective manuals or by the authors from whom the test was derived. Data were analyzed by using the computer programme STATISTICA 7.1 (StatSoft, 2007) and SPSS 15 (SPSS, 15.0). Discriminant function analyses were used to investigate group differences. Forward stepwise regression analyzed the influence of neurobiological and psychosocial factors and emotional functioning on neuropsychological test performance.

6.9 Conclusion

The methodology adopted and the measuring instruments used to assess the factors that influence neuropsychological performance in children with epilepsy were discussed in this chapter.

The results are discussed in the next chapter.

CHAPTER SEVEN

RESULTS

7.1 Introduction

In this chapter the results are presented regarding the influences of neurobiological and psychosocial/emotional factors on the neuropsychological performance of children with epilepsy.

Several studies have specified the diversity of potential risk factors that impact on neuropsychological functioning of children with epilepsy, and, overall a very heterogeneous group of variables has been identified (Herman et al., 1998; Rodenberg et al., 2007). Critical variables influencing neuropsychological test scores in children with epilepsy can be grouped in two domains. The first is seizure related variables such as: type of seizure, duration of seizure, age of onset of seizures and effects of anticonvulsants. The second is psychosocial factors such as the child's self-esteem and social adjustment, reactions of the child's parents, peers and teachers as well as the perceived stigma and discrimination associated with epilepsy.

In the present study these factors were grouped into two conceptual categories: neurobiological and psychosocial/emotional (Table 7.7). The neurobiological and neurophysiological variables define the characteristics of the child's epilepsy, such as the number of years the child has had epilepsy, how often the child has epileptic seizures and the child's age at onset of the epilepsy.

Psychosocial/emotional factors also constitute a salient dimension of epilepsy. For the purposes of this study, these include social factors relating to the home environment (such as the number of adults and children living in the household as well as the number of earners versus dependents in the household), the nature of the mother-child relationship (attitudes of acceptance, overprotection, overindulgence and rejection as measured with the MCRE), the teacher's ratings of the child's self, social and school adjustment (as measured with the CBRS), the child's self esteem (as measured with the Rosenberg Self-Esteem Scale) and the emotional indicators (as reflected in the drawing of a person).

Thus, the results obtained are then discussed in terms of the specific hypotheses stated in Chapter 6. In part one the results of the biographical analyses are reported descriptively. In part two, the three groups are classified according to the values of the different variables, as obtained by discriminant function analysis. Part three reports on the relative influence of neurobiological and psychosocial/emotional factors on neuropsychological functioning in the epilepsy groups as computed by stepwise regression analyses.

7.2 Part one: Description of demographic information, pertinent birth details and mothers' understanding of epilepsy

The aim of this part of the study was to compare demographic information, birth details and mothers' understanding of epilepsy in the epileptic and renal groups.

7.2.1 Demographic information

Table 7.1 Age and gender details of the tonic-clonic, simple partial and renal groups.

Group	Gender	N	Mean age in months (S.D.)
Tonic-Clonic	Male	50	123.08 (13.00)
Tonic-Clonic	Female	50	124.16 (14.28)
Simple Partial	Male	50	123.48 (13.42)
Simple Partial	Female	50	123.92 (13.21)
Renal Problems	Male	50	123.92 (13.02)
Renal Problems	Female	50	123.50 (13.25)
All Groups		300	123.43 (13.27)

The groups do not differ significantly in terms of age and gender ($F = 0.10$, $p \leq 0.99$).

Table 7.2 Language distribution of the sample

Language	Ethnicity	Frequency	Percentage
Sepedi	Northern Sotho	173	57
Setswana	Western Sotho	11	04
Tshivenda	Venda	59	20
IsiZulu	Zulu	07	02
Xitsonga	Tsonga	50	17
Total (N)		300	100

The main effect analysis as a function of language and ethnicity for the three groups showed that there were no significant differences ($F = 1.99$, $p \leq 0.95$).

Table 7.3 Education level of parents

	Tonic-clonic		Simple Partial		Renal		N
Ed. Level	Mother	Father	Mother	Father	Mother	Father	Total
Primary	26	26	31	29	32	31	175 (29%)
Secondary	34	42	28	40	37	46	227 (38%)
Tertiary	40	32	41	31	31	23	198 (33%)
Total	100	100	100	100	100	100	600(100%)

More parents (38%) indicated that they had secondary levels of education, than tertiary levels (33%) or primary levels (29%). The groups do not differ significantly in terms of the educational level of the mother ($X^2 = 1.87$, $p \geq 0.39$) and father ($X^2 = 2.35$, $p \geq 0.31$).

7.2.2 Birth Details of the tonic-clonic, simple partial and renal groups.

Table 7.4: Summary table of the birth details of the tonic-clonic, simple partial and renal groups

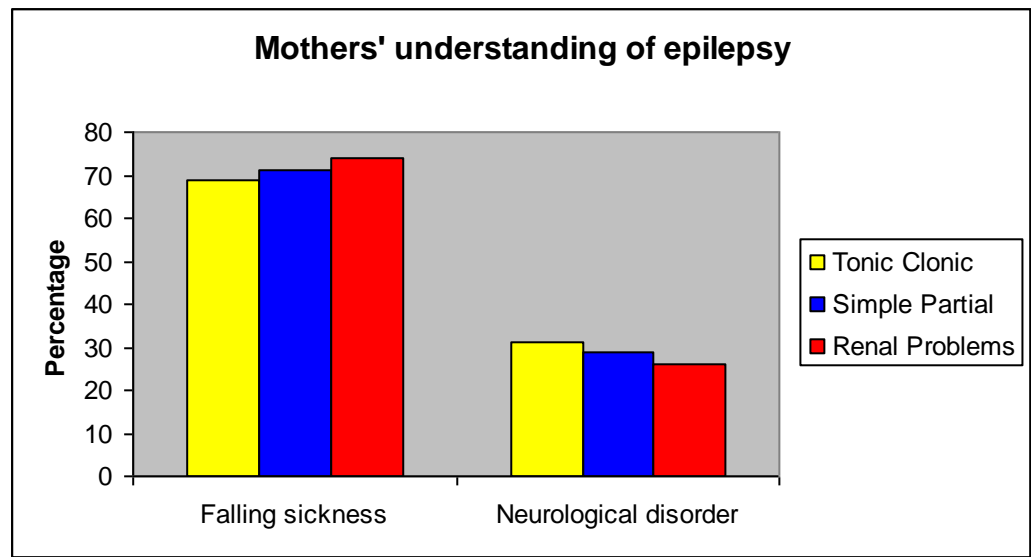
Variable	Stats	Df	P	S/NS
Type of birth delivery	$X^2 = 7.295$	4	0.121	NS
Term of pregnancy	$X^2 = 4.201$	2	0.122	NS
Duration of labour	$F = 3.502$	298	0.05	S
Complications during birth	$X^2 = 15.397$	2	0.05	S
Complications after birth	$X^2 = 14.338$	2	0.001	S
Birth order of child	$X^2 = 3.509$	4	0.476	NS

The Chi-Square analyses suggest that there were significant associations among the tonic-clonic, simple partial and renal groups relating to complications during and after birth. The mothers in the tonic-clonic group experienced a longer duration of labour and reported more complications during and after birth than the mothers of the simple

partial and renal groups. These factors were also considered in hypothesis 1 to determine their impact on neuropsychological functioning.

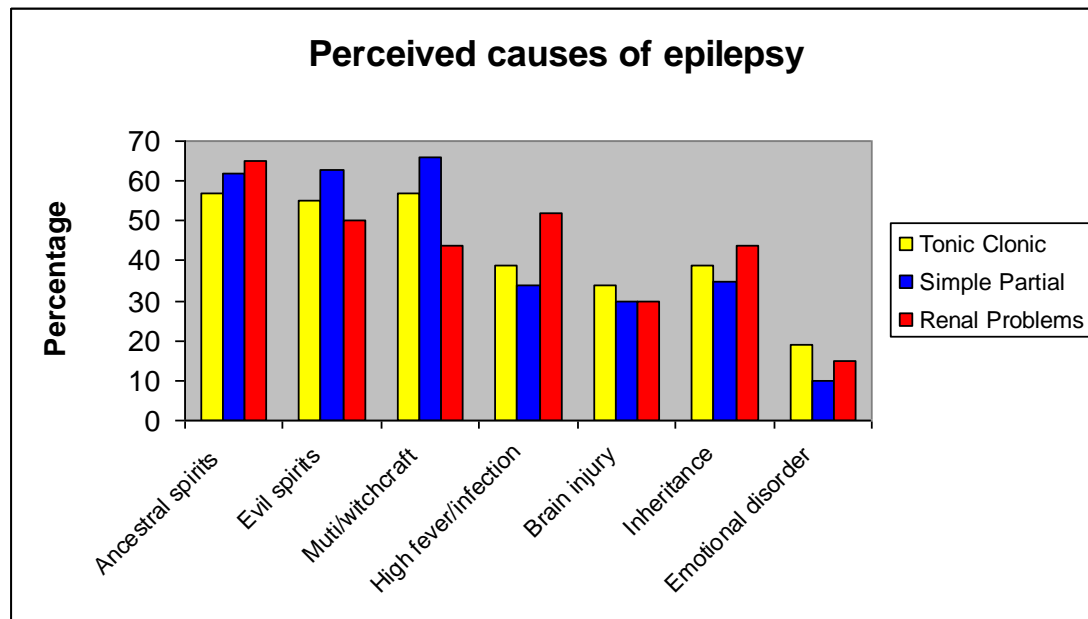
7.2.3 Mothers’ understanding of epilepsy

Figure 7.1 Mothers understanding of epilepsy



The majority of mothers (71%) understood epilepsy to be a falling sickness associated with an external locus of control (ancestral spirits; evil spirits and muti/witchcraft) while 29% of the mothers regarded the disorder as a neurological or medical condition.

Figure 7.2 Perceived causes of epilepsy



Perceived causes of epilepsy were mainly seen as ancestral spirits visitation, evil spirits and muti/witchcraft as compared to the medical causes such as high fever/infection, brain injury, inheritance and an emotional disorder.

Table 7.5 Mothers' perceptions of and beliefs about epilepsy

Perceived beliefs	TCS	SPS	Renal	Total
Epileptics should be isolated	28	48	30	106
Epilepsy cannot spread by contact	44	37	28	109
Epilepsy is treated only with medication	32	66	25	123
Epileptics are normal	69	46	24	139
Epileptics are abnormal	1	0	54	55
Epileptics are disabled	8	0	20	28
Epileptics are not disabled	16	3	0	20

Mothers of children with epilepsy generally hold positive beliefs about and attitudes towards epilepsy. They reported that those afflicted with this condition should not be

isolated/avoided, that epilepsy does not spread through contact and that people with epilepsy can lead a normal life. They also tend to believe that epilepsy is treatable only with medication. However, the mothers of children with renal disease hold more negative views, regarding children with epilepsy as abnormal and disabled.

Table 7.6 Summary table of the mother's concerns about child's clinical condition

Mother's concerns about child's condition	Tonic-clonic		Simple Partial		Renal	
	No	Yes	No	Yes	No	Yes
Lesser attention to other children	50	50	82	18	100	0
Restrict family activities	64	36	85	15	100	0
Effect on development	76	24	52	48	100	0
Medication side effects	64	36	63	37	11	89
Stigma	46	54	95	5	100	0
Surgery	100	0	100	0	68	32
Discomfort from infections	100	0	100	0	51	49

With respect to concerns about the child's condition, more mothers in the tonic-clonic group than the other groups reported that their child's condition resulted in their paying less attention to the needs of other children at home as well as restricting family activities. Mothers in both the tonic-clonic and simple partial epilepsy groups were concerned about the effects of epilepsy on areas of cognitive development and the long-term usage of medication, while mothers in the tonic-clonic group expressed their concern about the stigma of epilepsy. The mothers in the renal group were concerned about the possibility of surgery to remove kidney stones and the discomfort caused by infections. Thus, it is apparent that there were different areas of concern for the mothers of the epilepsy and renal groups.

7.2.4 Conclusions for Part one

The groups did not differ significantly in terms of demographic variables such as age, gender and language. With regard to birth details there were significant differences reported by the mothers, with the tonic-clonic group having longer duration of labour, and a higher incidence of complications during and after birth.

Most mothers understand epilepsy to be a falling sickness caused mainly by ancestral spirit visitation, evil spirits or muti and witchcraft. Mothers of children with epilepsy reported positive beliefs about epilepsy, stating that those afflicted with the condition should not be isolated or avoided, epilepsy does not spread through contact and epilepsy sufferers can lead a normal life, whereas the mothers of children with renal illness had a more negative perception of epilepsy. Finally, mothers in the tonic-clonic group felt that their child's condition resulted in their paying less attention to their other children as well as restricting the family's activities. The mothers in the tonic-clinic and simple partial groups expressed concerns about cognitive development, stigma and long-term usage of medication while the mothers of the renal group were concerned about threats of surgery and discomfort caused by infections.

7.3 Part two: Influences of neurobiological, psychosocial/emotional factors on neuropsychological functioning in children with epilepsy

7.3.1 Hypothesis 1

Neurobiological, psychosocial and emotional factors will affect attention/executive, language, sensory-motor, visual-spatial, and memory functions in children with epilepsy. In order to investigate this hypothesis, forward stepwise regression was performed.

Earlier studies reported have specified the diversity of potential risk factors that impact on neuropsychological functioning of children with epilepsy, and, overall a very heterogeneous group of variables such as neurobiological, psychosocial and treatment have been identified (Herman et al., 1998; Rodenberg et al., 2007). In the present study these factors were grouped into two conceptual categories: neurobiological and psychosocial/ emotional (Table 7.7). The neurobiological and neurophysiological variables define the characteristics of the child's epilepsy. For instance, the number of years the child has been suffering with epilepsy, how often the child has an epileptic attack and the age of onset of the epilepsy. Psychosocial/emotional factors constitute a salient dimension of epilepsy. For the purposes of this study the social factors of the home environment such as the number of adults and children living in the household as well as the number of earners versus dependents in the household, the mother's attitudes regarding acceptance, overprotection, overindulgence and rejection as measured on the MCRE, teacher's ratings of self, social and school adjustment as measured on the CBRS, the child's

self- esteem as scored on the Rosenberg Self-esteem inventory and the emotional indicators as reflected on the Draw-A-person.

Table 7.7: Neurobiological and psychosocial/emotional predictor variables

Neurobiological	Psychosocial/Emotional
Age in months	Adults (household)
Gender*	Children (household)
Birth order	Employees (household)
Duration of labour	Dependents (household)
Duration of epilepsy	Acceptance
Frequency of seizures	Overprotection
Age at onset of seizures	Overindulgence
	Rejection
	Self-adjustment
	Social Adjustment
	School Adjustment
	Self-esteem
	Emotional indicators

* The effect of gender was analysed with t-tests, and females obtained significantly lower scores than males on the attention/executive functions ($t = -3.83, p \leq 0.001$), language ($t = -4.36, p \leq 0.001$), sensory-motor ($t = -2.13, p \leq 0.001$), visual-spatial ($t = -3.98, p \leq 0.001$) and memory/learning ($t = -2.07, p \leq 0.001$).

Table 7.8: Correlations between all variables

	Atten/Exec	Language	Sensory- motor	Visual- spatial	Memory
Age	-.176**	-.207***	-.224***	-.093	-.016
Gender	.263***	.296***	.150*	.272***	.146*
Birth order	.093	.016	.027	-.043	-.055
Duration (labour)	-.180**	-.207	-.134*	-.181**	-.103
Duration (seizures)	.205***	.171***	.224***	.236***	.255***
Frequency (seizures)	.168**	.154**	.042	.123*	.105
Onset (seizures)	-.243***	-.278***	-.319***	-.201***	-.081
Adults (hh)	-.147	-.130	-.204	-.178	-.200***
Children (hh)	.163	.105	.005	.019	-.064
Employers (hh)	-.162	-.133	-.136	-.136	-.142
Dependents (hh)	-.007	-.027	-.147	-.121	-.176**
Acceptance	-.007	.011	-.061	-.025	-.013
Overprotection	.419***	.416***	.293***	.417***	.329***
Overindulgence	.387***	.405***	.312***	.384***	.327***
Rejection	.464***	.475***	.266***	.410***	.307***
Self-adjustment	.359***	.344***	.315***	.398***	.426***
Social adjustment	.176***	.166***	.187***	.232***	.317***
School adjustment	.244***	.272***	.282***	.366***	.372***
Self-esteem	.198***	.220***	.168**	.151*	.146*
Emotional Indicators	.006	.006	-.047	.006	-.063

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

It is apparent from Table 7.8 that the following variables: gender, duration of seizures, overprotection, overindulgence, rejection, self adjustment, social adjustment and self-esteem correlated significantly with all five neuropsychological domains (attention/executive, language, sensory-motor, visual-spatial and memory functions). Duration of labour and duration of seizures correlated significantly on the

attention/executive, language, sensory-motor and visual-spatial domains but duration of labour did not correlate with the memory functions. Age correlated significantly with the attention/executive, language and sensory-motor functions while onset of seizures showed significant correlations with the attention/executive, language and visual-spatial functions. The variables of number of adults and dependents in a household correlated significantly only with memory functions. However, the variables birth order, number of children in the household, number people employed in the household, acceptance and emotional indicators showed no correlations with any of the five neuropsychological functions.

7.3.1.1 Specific hypothesis 1.1:

Neurobiological and psychosocial/emotional factors will affect attention and executive functions in the epilepsy groups.

In order to test hypotheses 1.1 to 1.5, forward stepwise multiple regression was used as the method of analyses using the SPSS programme. When the forward stepwise method is employed, the initial model includes only a constant and single predictors are added to the model based on a specific criterion (Field, 2005). The criterion is the value of the statistic: the variable with the most significant score is added to the model. The analysis proceeds until none of the remaining predictors have a significant score statistic (the cut-off point for significance being 0.05). At each step the variables in the model are examined to see if any should be removed. This is done in one of three ways: (1) use of the likelihood ratio statistic whereby the current model is compared to the model when that predictor is removed. If the removal of that predictor makes a significant difference to how well the model fits the observed data,

then the predictor is retained, (2) conditional statistic which is an arithmetically less intense version of the likelihood ratio statistic and a less popular choice, (3) Wald statistic, in which case any predictors in the model that have significant values of the Wald statistic (above the default criterion statistic of .1) will be removed. Of all these methods the likelihood ratio method is the best removal criteria because the Wald can, at times be unreliable (Field, 2005).

Table 7.9: Forward multiple regression results of neurobiological and psychosocial/emotional factors on attention and executive functions

Predictors	<i>B</i>	<i>R</i> ²
Neurobiological		.20**
Gender	.24***	
Onset of seizures	-.20***	
Duration of labour	-.19***	
Duration of seizures	.19***	
Frequency of seizures	.18**	
Psychosocial/emotional		.41**
Rejection	.35***	
Overprotection	.33***	
Self-adjustment	.27***	
School adjustment	.19***	
Self-esteem	.14**	

** $p \leq 0.01$ *** $p \leq 0.001$

Table 7.9 shows ten predictor variables (five neurobiological and five psychosocial/emotional) that influenced the child's performance on the

attention/executive function scores, as well as their beta coefficients and significance levels. Age in months (neurobiological) and two psychosocial/emotional factors (overindulgence and social adjustment) were excluded as predictor variables from the model. With regard to the neurobiological factors, 20% of the variance was explained by five predictor variables (gender, onset of seizures, duration of labour, duration of seizures and frequency of seizures). Female gender, a younger age of onset of seizures, longer duration of labour, longer duration of epilepsy, and a higher frequency of seizures contributed to lower scores on the attention/executive domain. Gender was the strongest predictor, explaining 24% of the variance on the neurobiological factors.

For the psychosocial/emotional predictor variables, 41% of the variance was explained by increased maternal rejection and overprotection, lower teacher ratings of self and school levels of adjustment as well as the child's lower scores of self-esteem. Rejection was the strongest predictor, explaining 35% of the variance in the psychosocial/emotional predictor variables.

Table 7.10: Significant independent predictors of attention/executive functions as determined by final forward stepwise regression

	<i>B</i>	<i>R</i>²
Predictors		.45**
Rejection	.35***	
Overprotection	.29***	
Self-adjustment	.29***	
Onset of seizures	-.16**	
School adjustment	.18***	
Frequency of seizures	.13*	
Self-esteem	.13*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

From Table 7.10 it is apparent that when the five neurobiological and five psychosocial/emotional predictor variables were entered in a final stepwise regression, only seven of the ten variables remained statistically significant and were included in the model. An increase in attitudes of rejection ($p = .000$) and overprotection ($p = .000$), lower levels of self adjustment ($p = 0.000$) and school adjustment ($p = .000$), an earlier age onset of seizures ($p = 0.000$), increased frequency of seizures ($p = .05$) and lower levels of self-esteem ($p = .05$) were predictors that contributed to lower performance on the attention/executive functions. The multiple correlation of determination ($R^2 = .45$) indicated that these seven variables accounted for about 45% of the variance in the attention/executive domain scores. However, rejection was still the strongest predictor explaining about 35% of the variance in performance on the attention/executive domain. Thus, it can be concluded that psychosocial/emotional factors appear to play a bigger role than the

neurobiological factors in influencing attention/executive functions and accordingly, explain a higher proportion of the variance in performance on the attention/executive functions.

7.3.1.2. Specific hypothesis 1.2:

Neurobiological and psychosocial/emotional factors will affect language functions in the epilepsy groups.

Table 7.11: Forward multiple regression results of neurobiological and psychosocial and emotion factors on language functions

Predictors	<i>B</i>	<i>R</i> ²
Neurobiological		.18*
Gender	.25***	
Onset of seizures	-.25***	
Duration of seizures	.17**	
Frequency of seizures	.15*	
Psychosocial/Emotional		.42***
Rejection	.37***	
Overprotection	.32***	
Self-adjustment	.25***	
School adjustment	.21***	
Self-esteem	.17***	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 7.11 shows nine predictor variables (four neurobiological and five psychosocial/emotional) that contributed as influences on the language scores, as well

as their beta coefficients and significance levels. Age in months (neurobiological) and two psychosocial/emotional factors (overindulgence and social adjustment) were also excluded from the model as predictor variables for influences on language scores. Four neurobiological factors (female gender, a younger onset of seizures, longer duration of seizures, and higher frequency of seizures) contributed to 18% of the variance in explaining performance on language functions.

For the psychosocial/emotional factors, 42% of the variance was explained by five variables: an increase in attitudes of rejection and overprotection, lower of ratings on self and school levels of adjustment by their teachers and well as lower scores of self-esteem. Rejection was the strongest predictor, explaining 37% of the variance in the psychosocial/emotional factors.

Table 7.12: Significant independent predictors of language functions as determined by final forward stepwise regression

	<i>B</i>	<i>R</i> ²
Predictors		.47*
Rejection	.37***	
Overprotection	.28***	
Self- adjustment	.27***	
Onset of seizures	-.19***	
School adjustment	.20***	
Self-esteem	.15**	
Frequency of seizures	.11*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

In Table 7.12 it is apparent that seven of the nine variables remained statistically significant when entered into a final forward stepwise multiple regression analysis. An increase in attitudes of rejection ($p = .000$) and overprotection ($p = .000$), lower levels of self adjustment ($p = 0.000$), an earlier age onset of seizures ($p = 0.000$), school adjustment ($p = .000$), lower levels of self-esteem ($p = .05$) and increased frequency of seizures ($p = .05$) were predictors that contributed to lower performance on the language functions. The multiple correlation of determination ($R^2 = .47$) indicated that these seven variables accounted for about 47% of the variance in the language domain scores. However, rejection was still the strongest predictor explaining about 37% of the variance in performance on language functions. Thus, it can be concluded that psychosocial/emotional factors appear to play a bigger role than the neurobiological factors in influencing language scores and accordingly, explain a higher proportion of the variance in explaining performance on the language functions.

7.3.1.3 Specific hypothesis 1.3:

Neurobiological and psychosocial/emotional factors will affect sensory-motor functions in the epilepsy groups.

Table 7.13: Forward multiple regression results of neurobiological and psychosocial and emotion factors on sensory-motor functions

Predictors	<i>B</i>	<i>R</i> ²
Neurobiological		.15***
Onset of seizures	-.33***	
Duration of seizures	.24***	
Psychosocial/Emotional		.18*
Self-adjustment	.28***	
Overprotection	.18*	
Overindulgence	.17*	

* $p < 0.05$ *** $p < 0.001$

Table 7.13 shows five predictor variables (two neurobiological and three psychosocial/emotional) that contributed as influences on the sensory-motor scores, as well as their beta coefficients and significance levels. Two neurobiological variables (age in months and duration of labour) and four psychosocial/emotional variables (rejection, social adjustment, school adjustment and self-esteem) were excluded from the model as predictor variables for influences on sensory-motor functions. Onset and duration of seizures (neurobiological) contributed to 15% of the variance in explaining performance on the sensory-motor functions. Comparatively, the psychosocial/emotional variables (lower levels of self-adjustment, an increase in attitudes of overprotection and overindulgence) only contributed to 18% of the variance in explaining performance on the sensory-motor functions. An earlier onset of seizures was the strongest predictor, explaining 33% of the variance in the neurobiological variables.

Table 7.14: Significant independent predictors of sensory-motor functions as determined by forward final stepwise regression

	<i>B</i>	<i>R</i> ²
Predictors		.28*
Onset of seizures	-.32***	
Self- adjustment	.28**	
Overindulgence	.21**	
Duration of seizures	.15*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

In Table 7.14 it is apparent that four of the five variables remained statistically significant when entered into a stepwise multiple regression analysis. An earlier age of onset of seizures ($p = 0.000$), a lower rating on levels of self-adjustment ($p = 0.01$), increased attitudes of overindulgence ($p = 0.01$) and a longer duration of seizures ($p = .05$) were predictors that contributed to lower performance on the sensory-motor functions. The multiple correlation of determination ($R^2 = .28$) indicated that these four variables accounted for about 28% of the variance in the sensory-motor domain scores. However, an earlier onset of seizures was still the strongest predictor explaining about 32% of the variance sensory-motor functions. Thus, it can be concluded that neurobiological factors appear to play a bigger role than the psychosocial/emotional factors in influencing sensory-motor scores and accordingly, explain a slightly higher proportion of the variance in performance on the sensory-motor functions.

7.3.1.4 Specific hypothesis 1.4:

Neurobiological and psychosocial/emotional factors will affect visual-spatial functions in the epilepsy groups.

Table 7.15: Forward stepwise regression results of neurobiological and psychosocial and emotion factors on visual-spatial functions

Predictors	<i>B</i>	<i>R</i> ²
Neurobiological		.18*
Gender	.25***	
Duration of labour	-.19**	
Duration of seizure	.22***	
Onset of seizures	-.16*	
Frequency of seizures	.15*	
Psychosocial/Emotional		.40*
Overprotection	.36***	
Self-adjustment	.17*	
Rejection	.28***	
Overindulgence	.15**	
School adjustment	.21**	
Self-esteem	.11*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 7.15 shows all eleven predictor variables (five neurobiological and six psychosocial/emotional) that influenced the child's performance on the visual-spatial function scores, as well as their beta coefficients and significance levels. With regard to the neurobiological factors, 18% of the variance was explained by five predictor

variables (gender, onset of seizures, duration of labour, duration of seizures and frequency of seizures. Female gender, longer duration of labour, longer duration of epilepsy, a younger age of onset of seizures and a higher frequency of seizures contributed to lower scores on the visual-spatial domain. Gender was the strongest predictor, explaining 25% of the variance on the neurobiological factors.

For the psychosocial/emotional predictor variables, 40% of the variance was explained by increased attitudes of overprotection, lower levels of self adjustment, an increase in attitudes of rejection and overindulgence as well as lower levels of school adjustment and self-esteem. Overprotection was the strongest predictor, explaining 36% of the variance in the psychosocial/emotional predictor factors.

Table 7.16: Significant independent predictors of visual-spatial functions as determined by final stepwise regression

	<i>B</i>	<i>R</i> ²
Predictors		.40*
Overprotection	.33***	
Self-adjustment	.21**	
Rejection	.28***	
Onset of seizures	-.12*	
Overindulgence	.13*	
School adjustment	.17*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

In Table 7.16 it is apparent that only six of the eleven variables (one neurobiological and five psychosocial/emotional) remained statistically significant when entered into

a stepwise multiple regression analysis. An increase in attitudes of overprotection ($p = .000$) lower levels of self adjustment ($p = 0.01$), increased attitudes of maternal rejection ($p = 0.000$), an earlier age onset of seizures ($p = 0.05$), increased maternal attitudes of overindulgence ($p = .05$) and lower levels of school adjustment ($p = .05$) were predictors that contributed to lower performance on the visual-spatial functions. The multiple correlation of determination ($R^2 = .40$) indicated that these six factors accounted for about 40% of the variance in the visual-spatial domain scores. However, an increase in maternal overprotection was still the strongest predictor explaining about 33% of the variance on performance on the visual-spatial domain. Thus, it can be concluded that psychosocial/emotional factors appear to play a bigger role than the neurobiological factors in influencing visual-spatial functions and accordingly, explain a higher proportion of the variance in performance on the visual-spatial functions.

7.3.1.5 Specific hypothesis 1.5:

Neurobiological and psychosocial/emotional factors will affect memory/learning functions in the epilepsy groups.

Table 7.17: Forward stepwise regression results of neurobiological and psychosocial and emotion factors on memory/learning functions

Predictors	<i>B</i>	<i>R</i>²
Neurobiological		.08*
Duration of seizures	.27***	
Gender	.15*	
Psychosocial/Emotional		.30*
Self-adjustment	.35***	
Overprotection	.26***	
Rejection	.19**	
Dependents (hh)	-.13*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 7.17 shows six predictor variables (two neurobiological and four psychosocial/emotional) that contributed as influences on the memory/learning scores, as well as their beta coefficients and significance levels. Five psychosocial/emotional factors (number of adults in the household, overindulgence, social adjustment, school adjustment and self-esteem) were excluded from the model as predictor variables for influences on learning/memory functions. A longer duration of seizures and gender (neurobiological) contributed to 8% of the variance in explaining performance on the memory/learning functions. Comparatively, the psychosocial/emotional variables (lower levels of self-adjustment, an increase in attitudes of overprotection and rejection as well as the number of dependents in the household) contributed to 30% of the variance in explaining performance on the

learning/memory functions. A lower rating on levels of adjustment was the strongest predictor, explaining 35% of the variance in the psychosocial/emotional variables.

Table 7.18: Significant independent predictors of learning/memory functions as determined by final forward stepwise regression

	<i>B</i>	<i>R</i> ²
Predictors		.30*
Self-adjustment	.39***	
Overprotection	.27**	
Duration of seizures	.18**	
Gender	.13*	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

In Table 7.18 it is apparent that four of the six variables (two neurobiological and two psychosocial/emotional) remained statistically significant when entered into a stepwise multiple regression analysis. A lower rating on levels of self-adjustment ($p = 0.000$), an increased attitudes of overindulgence ($p = 0.01$), a longer duration of seizures ($p = .01$) and female gender ($p = .05$) were predictors that contributed to lower performance on the memory/learning functions. The multiple correlation of determination ($R^2 = .30$) indicated that these four variables accounted for about 30% of the variance in the memory/learning domain scores. However, a lower rating on levels of self adjustment was still the strongest predictor explaining about 39% of the variance on memory/learning functions. Thus, it can be concluded that psychosocial/emotional factors appear to play a bigger role than the neurobiological factors in influencing memory/learning scores and accordingly, explain a slightly higher proportion of the variance in performance on the memory/learning functions.

7.3.1.6 Conclusion: Part two

Research hypothesis 1 can be fully accepted. Neurobiological and psychosocial/emotional factors influenced attention/executive ($p = .01$), language ($p = .05$), sensory-motor ($p = .05$), visual-spatial ($p = .05$) and learning/memory ($p = .05$) functions in children with epilepsy.

It is apparent from the results of specific hypotheses 1.1 to 1.5 that psychosocial variables (particularly mother's attitude) appear to play a bigger role than neurobiological factors in influencing attention/executive, language and learning/memory functions and accordingly, explain a higher proportion of the variance in performance than neurobiological factors on these neuropsychological domains. However, neurobiological factors such as the age of onset of seizures play a greater role in influencing sensory-motor function.

7.4 Part three: Investigation of group differences

To investigate possible group differences, an attempt was made to classify groups according to the following variables of interest since they are regarded as critical variables (see Chapter 5) that may influence neuropsychological development in children with epilepsy: age, duration of labour, nature of the mother-child relationship as reflected in the mothers' attitudes toward their children (acceptance, overprotection; overindulgence and rejection), emotional functioning (self, social and school adjustment), self-esteem and emotional distress as well as neuropsychological functioning (attention/executive, language, sensory-motor, visual-spatial and learning/memory).

7.4.1 Hypothesis 2:

In order to separate the possible effect of having a chronic medical condition, the epilepsy groups were compared with the group of children with a chronic renal condition. This gives rise to the following general hypothesis:

There are differences between the epilepsy and renal groups in medical history, maternal attitude, emotional functioning and neuropsychological functioning.

There are four specific hypotheses that are derived from research hypothesis 2, as stated in Chapter 6.

In order to test specific hypotheses 2.1 to 2.4 for hypothesis 2, discriminant function analyses were performed to identify variables that best discriminate members of three groups from one another and predict group membership.

Table 7.19: Description of the variables included in discriminant function analyses for the three groups

Variables	Tonic-clonic Means (SD)	Simple Partial Means (SD)	Renal Means (SD)
Demograph: Age in mths	123.62 (13.59)	123.70 (13.25)	122.97 (13.08)
Birth Info: Dur-labour	7.22 (4.22)	5.99 (3.46)	6.24 (2.87)
Psychosocial: Acceptance	33.97 (1.01)	33.47 (2.93)	34.61 (2.30)
Overprotect	43.49 (1.56)	46.19 (3.71)	36.13 (2.54)
Overindulge	41.17 (2.05)	44.68 (4.34)	34.33 (2.40)
Rejection	36.45 (1.86)	39.35 (4.00)	32.58 (1.79)
Emotional: Self adjust	64.57 (8.62)	71.55 (4.99)	81.59 (5.28)
Social adjust	54.84 (5.81)	57.27 (4.25)	67.16 (3.76)
School adjust	31.38 (8.04)	33.82 (6.08)	37.44 (5.89)
Self-esteem	23.02 (0.76)	23.64 (0.67)	16.84 (1.90)
DAP	4.27 (0.94)	4.21 (1.13)	3.48 (1.03)
Neuro: Attent/Executive	72.58 (5.88)	84.93 (6.53)	105.41 (8.06)
Language	75.45 (3.92)	85.17 (6.76)	100.61 (7.70)
Sensory-motor	71.23 (4.83)	77.17 (6.04)	88.14 (10.23)
Visual spatial	78.80 (3.82)	85.46 (4.77)	99.07 (9.99)
Learning/Memory	70.10 (4.69)	76.79 (4.80)	90.94 (7.45)

The above table summarizes the means and standard deviations of the variables used in the discriminant function analyses.

Table 7.20: Comparison of the three groups with regard to the included variables

Variables	Wilks	F	Df	P
Demograph: Age in mths	.990	1.413	(2,283)	0.244
Birth Info: Dur-labour	.989	1.492	(2,283)	0.226
Psychosocial: Acceptance	.982	2.473	(2,283)	0.860
Overprotect	.912	13.553	(2,283)	0.000 ***
Overindulge	.853	24.365	(2,283)	0.000 ***
Rejection	.962	5.500	(2,283)	0.000 ***
Emotional: Self adjust	.886	18.083	(2,283)	0.000 ***
Social adjust	.970	4.309	(2,283)	0.01 **
School adjust	.864	22.237	(2,283)	0.000***
Self-esteem	.575	104.514	(2,283)	0.000 ***
Neuro: Attent/Executive	.847	25.366	(2,283)	0.000 ***
Language	.967	4.698	(2,283)	0.01 **
Sensory-motor	.981	2.689	(2,283)	0.070
Visual spatial	.958	6.053	(2,283)	0.000***
Learning/Memory	.980	2.848	(2,283)	0.060

** $p < 0.01$ *** $p < 0.001$

Table 7.20 shows that the three groups differed on three of the maternal attitude scales (psychosocial factor), all of the emotional scales and three of the neuropsychological domains. With regard to the psychosocial factor, there was a greater incidence of overprotection ($p < 0.001$), overindulgence ($p < 0.001$) and rejection ($p < 0.001$) on the MCRE amongst the mothers of the simple partial group than the mothers of the tonic-clonic and renal groups.

On the emotional factors, the teachers rated the children with tonic-clonic seizures lower on self ($p < 0.001$), social ($p < 0.01$) and school ($p < 0.001$) levels of adjustment as compared to the tonic-clonic and renal children. However, the simple partial group

manifested lower levels of self-esteem ($p < 0.001$) than the tonic-clonic and the renal children.

Neuropsychological assessment revealed that the tonic-clonic group obtained lower scores on the attention/executive ($p < 0.001$), language ($p < 0.01$) and the visual-spatial ($p < 0.001$) domains of the NEPSY than the simple partial and renal groups.

Thus, groups differ on these variables: the mother's attitudes on the overprotection, overindulgence and rejection scales, teacher's ratings on the self, social and school levels of adjustment and the child's self-esteem as well as performance on the attention/executive, language and visual-spatial domains.

Subsequently, the discriminant function analyses yielded two functions, based on the combination of the variables (so called canonical discriminant functions). These functions are used to separate the cases and classify them into three groups. The structures of the functions and the correlation coefficients for each of the variables are shown in Table 7.21

Table 7.21: Factor Structure Matrix of functions

	Function	
	Root 1	Root 2
Self esteem	-.607*	-.183
Attention/Executive	.453	-.590*
Overindulgence	-.324	-.390*
Self adjustment	.243	-.353*
School adjustment	.084	-.119*
Overprotection	-.367*	-.340
Learning and Memory	.354	-.378*
Rejection	-.225	-.360*
Visual spatial	.293	-.323*
Language	.375	-.505*
Social adjustment	.277*	-.166
Acceptance	.046	.076*
Sensory-motor	.220	-.263*
Duration of labour	-.012	.118*
Age in months	-.006*	-.002

* Largest absolute correlation between each variable and any discriminant function.

Of the included variables, self-esteem contributes the most to the first root, which is expected from the previous comparison of group means (-.607). Lower self esteem leads to a higher correlation with function. Overprotection and social adjustment also had more influence on the group classification than attention/ executive, overindulgence, self adjustment, school adjustment, learning and memory, rejection, visual-spatial and language function.

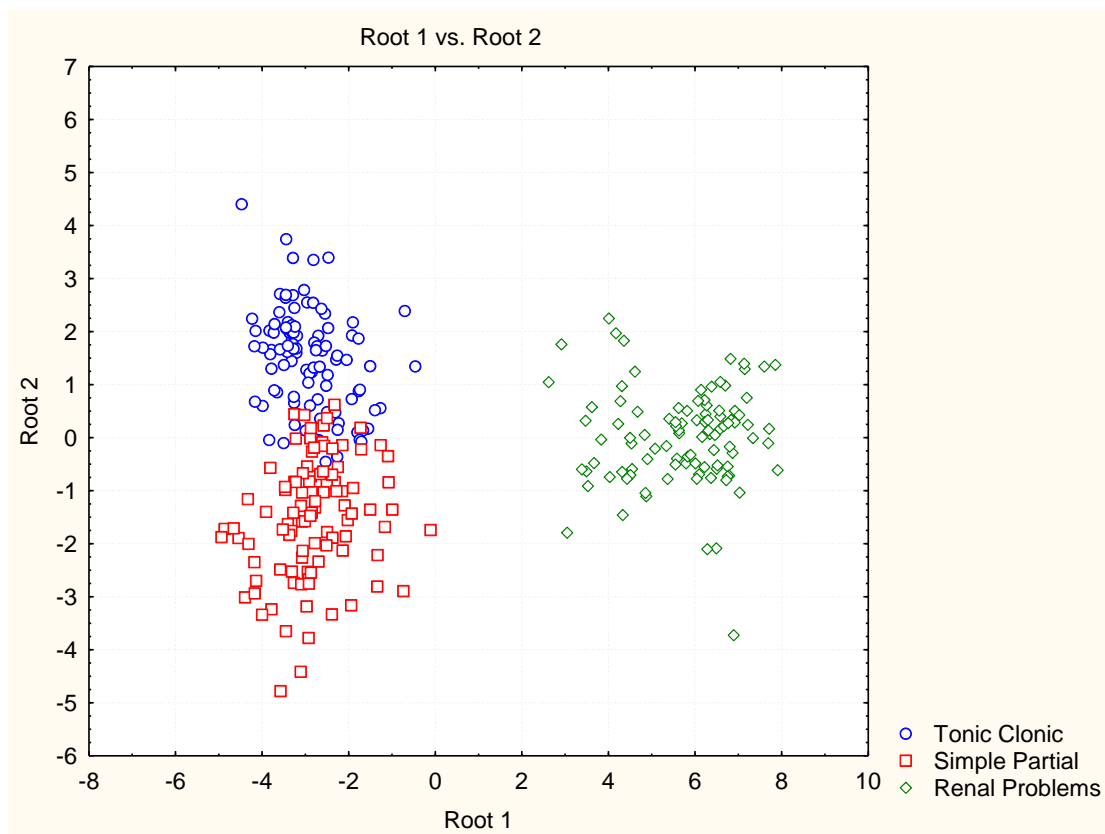
Table 7.22: Canonical discriminant functions

Test of functions	Wilks Lamda	Chi-square	Df	Sig.
1 through 2	.023	1094.223	30	0.000***
2	.401	264.833	14	0.000***

*** $p < 0.001$

Table 7.22 shows that the first function will maximally separate the three groups. Thus, this function will discriminate the three groups according to their performance on the above variables. The second function will classify the rest of the children after function 1 has been applied.

Figure 7.3: Visualization of functions at group centroids



As visualized in Fig 7.3, the first root mainly distinguishes the renal group from the tonic-clonic and simple partial seizure groups. The figure shows that the renal group centroid is higher on root 1 than the tonic-clonic and simple partial groups. This is explained by better scores on the psychosocial, emotional and neuropsychological variables. It is also apparent that the simple partial centroid scores is lowest on both roots. The renal group obtained the highest scores on psychosocial, emotional and neuropsychological variables. Thus, these variables cluster into three groups which correspond to the tonic-clonic, simple partial and renal groups. To investigate this further, the classification matrix below has been drawn.

Table 7.23: Classification Matrix: observed classifications vs predicted classifications

	Percentage	Tonic-Clonic	Simple Partial	Renal
Tonic-Clonic	92	92	8	0
Simple Partial	92	8	92	0
Renal	100	0	0	100
Total	95	100	100	100

The above table shows that 95% of the cases are correctly classified according to their performances on the functions measured into the tonic-clonic (92%), simple partial (92%) and the renal (100%) groups, respectively. Only 8% of the children in the tonic-clonic group showed classifications similar to the simple partial and 8% of the simple partial group showed classifications similar to the tonic-clonic group. Hence, this classification matrix confirms that most of the tonic-clonic children fell in one group, most of the simple-partial children in another group and all of the renal children in a third group.

7.4.1.5 Conclusion: Part three

Hypothesis 2 is partially accepted as there were no differences between the epilepsy and renal groups on demographic (age), birth information (duration of labour), psychosocial (acceptance) and some of the neuropsychological domains (sensorimotor and learning/ memory). However, there were differences between the epilepsy and renal groups in terms of psychosocial factors, that is some of the maternal attitudes (overprotection, overindulgence and rejection), emotional functioning (self, social and school adjustment) and self-esteem, as well as the remaining neuropsychological: domains (attention/executive, language and visuospatial).

Interpretations of the results are provided in the next chapter.

CHAPTER EIGHT

DISCUSSION AND CONCLUSIONS

8.1. Introduction

The aim of the present study was to investigate the influences of neurobiological and psychosocial factors on the neuropsychological functioning of children with epilepsy. As elucidated in previous chapters, the influence of various neurobiological and psychosocial factors influence the neuropsychological functioning of children with epilepsy was confirmed by the results of the statistical analyses in the present study (as presented in Chapter 7).

This chapter provides a discussion of the results regarding the relative contribution of neurobiological and psychosocial factors in influencing neuropsychological test performance of children with epilepsy. The results correspond to those obtained in international studies (Hermann et al., 2008; Rodenberg et al., 2005), that neurobiological and psychosocial factors enhance the risk of physiological, emotional, behavioural, cognitive, and psychiatric problems in children with epilepsy. Some of these difficulties persist throughout childhood and adolescence and into adulthood (Akman et al., 2009).

8.2 Characteristics of the sample

Because the selection of children for participation in the present study was based on circumstance rather than design, it cannot be claimed that the sample is representative of disadvantaged rural African language families in South Africa. Although the sample was drawn from disadvantaged semi-rural areas, the characteristics of the families in the present study are comparable to those of families living in peri-urban

townships, as established in other local research projects in the Limpopo Province (for example, Meyer, Eilersten, Sundet, Tshifularo & Sagvolden, 2004; Peltzer, 2001).

The families of the tonic-clonic, simple partial and renal groups did not differ in terms of language and ethnicity as well as parental education. However, it is apparent from Table 7.3 that parents tended to have only a secondary level of education level. Perhaps this is due to the fact that most of the children in the three clinical groups were drawn from disadvantaged areas (recruitment being based on hospital attendance) where education and occupation levels are typically lower than in urban areas (Dawes & Donald, 1994).

8.2.1 Birth details

Straus et al. (2006) claimed that maternal disease, cardiovascular difficulties and the contractions of the uterus during delivery may interfere with the normal oxygen supply to the foetus resulting in periods of anoxia. They maintained further that anoxic episodes experienced during the perinatal period account for the largest percentage of neurological difficulties. Convulsive disorders which result from anoxic episodes are the most common neurological problem that occurs in the postnatal period.

Compared to the other groups in the present study, mothers of children with tonic-clonic epilepsy experienced a higher proportion of birth difficulties relating to hypertension and postnatal complications particularly the onset of jaundice in the neonate. They also experienced a significantly longer duration of labour during parturition than the mothers of children in the simple partial and chronic renal groups.

The current findings of a high incidence of perinatal and postnatal complications reported by the mothers of children with tonic-clonic seizures confirm earlier findings in South Africa (Leary, Riordan, Schlegel & Morris 1999; Eastman, 2005). The duration of labour, perinatal and postnatal factors were also considered as risk factors in the present study. Although there was an association between these variables and neuropsychological test scores, these variables did not contribute significantly to variance in neuropsychological test performance of children with epilepsy.

8.2.2 Concerns about child's clinical condition

The mothers of the children with epilepsy expressed common concerns about the possible negative effects of epilepsy on cognitive development and long-term usage of anticonvulsant medication. In addition, the mothers of the tonic-clonic group also raised concerns about paying less attention to other siblings, restricted family activities and the stigma of epilepsy. In contrast, the mothers of the children with chronic renal problems were concerned about impending surgery to remove kidney stones and the discomfort caused by infections.

These findings are consistent with prior research (Modi, 2009; Quittner & DiGirolamo, 1998) reporting that parents of children with epilepsy have significant worries and stress about the epilepsy diagnosis (stigma), co-morbid conditions, treatment (e.g., the effect of seizures and medication on the brain, behaviour problems), and lifestyle changes that persist over time. Plausible explanations for the concerns raised by the mothers of the tonic-clonic group are that this type of seizure is more dramatic and prone to stigma than the simple partial seizures, thus restricting family activities to the home environment. This finding concurs with Spangenberg

and Lalken (2000) who also reported that most parents are extremely upset when their child is diagnosed with epilepsy, mainly because of the stigma associated with the condition. Typical parental responses are shock, devastation, anger, frustration, sorrow and depression (Ziegler, Erba, Holden & Dennis, 2000). Witnessing a seizure in one's young child, especially a tonic-clonic seizure, can be one of the most anxiety-provoking experiences for a parent. It usually leads to feelings of helplessness and fear and often results in overprotection or rejection of the child (Ellis et al., 2000).

It is not surprising that mothers of children with epilepsy pay less attention to other siblings, given the routine of administering anticonvulsant medication, attending hospital with their children with epilepsy as well the extra caregiving tasks related to the child's emotional, physical and academic demands. Thus, these tasks require intense and ongoing maternal involvement, which may limit the time and emotional availability the mother has for the "well" sibling. This is in line with findings of studies of children with epilepsy from westernized samples that mothers spend more time with children with chronic illnesses than with their siblings (Buelow et al., 2006; Wirrell, Wood, Hamiwka & Sherman, 2008; Wood, Sherman, Hamiwka, Blackman & Wirrell, 2008). This may produce patterns of parenting such as overprotection and rejection which may restrict the opportunities for children to learn according to Vygotsky's (1978) notion of social mediation.

8.2.3 Mothers' understanding of epilepsy

The majority of mothers understood epilepsy to be a falling sickness. Perceived causes of epilepsy were mainly seen as ancestral spirit visitation, evil spirits and witchcraft as compared to the medical causes such as high fever, brain injury,

inheritance and emotional disorder. Mothers of children with epilepsy generally held positive beliefs about attitudes towards epilepsy as compared to mothers with children with chronic renal problems. These findings are consistent with explanations provided by mothers in other studies in sub-Saharan Africa who attributed their child's epileptic condition to supernatural forces including witchcraft and divine intervention (Allotey & Reidpath, 2007; Baskind & Birbeck, 2005; Keikelame & Swartz, 2007).

Throughout the world epilepsy was once considered sacred but more often viewed through the lenses of fear and superstition and it remains poorly understood by the general public (Bagic, Bagic & Zivkovic, 2009). It is not surprising that the onset of a convulsive seizure and the peculiar behaviours that often constitute seizures have fuelled millennia of epilepsy stigmatization. Thus, religious or spiritual notions of its causes and treatment are common especially, in developing countries (Njamnushi, Angwafor, Tabah, Jallon & Muna, 2009). The family reaction to caring for a child with epilepsy is also important. As indicated earlier the mother is the primary caretaker of the child in the current study. According to Mokhosi and Grieve (2004) denial is a common reaction to brain injury and if it is maladaptive it can impede progress towards functional independence. Thus, it is important for the mother to accept the child's condition of epilepsy or else it can lead to inappropriate parenting styles which negatively impacts on the child's cognitive development.

8.3 Influences of neurobiological and psychosocial/emotional factors on neuropsychological functioning in children with epilepsy

Meijer et al. (2007) claimed that neurobiological and psychosocial factors are potential risk factors that impact on neuropsychological functioning in children with epilepsy. Thus based on earlier studies (Herman et al., 1998; Rodenberg et al., 2007) on the diversity of risk factors that impact on neuropsychological functioning in children with epilepsy, the present study has identified such neurobiological and psychosocial/emotional variables, outlined in Table 7.7. A discussion of the role played by neurobiological and psychosocial/emotional factors on the neuropsychological test performance in children with epilepsy will be presented next.

8.3.1 Role of neurobiological factors in influencing neuropsychological functioning in children with epilepsy

The results of the present study regarding the impact of neurobiological factors on the neuropsychological functioning of children with epilepsy are comparable to overseas studies such as Chaix et al. (2006). These findings show that an earlier age of onset of seizures, an increased frequency of seizures and a longer duration of seizures are significant predictors of neuropsychological impairment in children with epilepsy (Bender et al., 2007; Kolk et al., 2001). Similar findings were reported by Bender et al. (2007) and Kolk et al. (2001). It is possible that seizures may adversely influence the maturation and maintenance of normal brain function. There is evidence that an earlier age of seizure onset is associated with neuronal damage due to a number of factors such as hyperactivity of glutamate and oxidative stress (Vendrame et al., 2009). In the present study age of onset, frequency and duration of seizures all

contributed significantly to variance in neuropsychological test performance (see Table 7. 8).

Although there is a relation between neurobiological factors and neuropsychological test performance in children with epilepsy the results of the present study indicate that an earlier onset of seizures is a significant predictor of impaired sensory-motor functions in particular. According to the theoretical underpinnings of Luria's (1973) model an early onset of seizures may interfere with the development of sensory-motor skills that are maturing at that particular time. Structures and functions that are in the process of maturation and change are the most vulnerable to insult. Impaired sensory-motor abilities can in turn affect higher cortical functions (Luria, 1973).

Another possible reason for impaired sensory-motor ability is that anticonvulsant medications may result in sedation and cognitive dulling which invariably influences test performance on sensory-motor functions. While it has long been suspected that anticonvulsant medications influence cognitive and behavioural deficits in children with epilepsy, many of the earlier studies (Baddely & Ellis, 2002) yield contradictory findings regarding the relative impact of anticonvulsants on neuropsychological functioning in children with epilepsy. However, Loring and Meador (2004) concluded from reviewing the available literature that most of the major anticonvulsant medications interfere in subtle ways with all neuropsychological functions, including attention, concentration, motor speed, memory and mental processing and visual spatial skills. Hypothesized mechanisms include direct neural damage (Schmidt & Elger, 2004), secondary injurious effects accompanying folate deficiency (Bourgeois,

1998), disturbances in monoamine metabolism and endocrine disturbances (Reynolds & Mayfield, 1999).

These findings are noteworthy considering that all the children with epilepsy in the present study were receiving poly-therapy (two types of anticonvulsants) as part of their psychopharmacological treatment. Since many of the anticonvulsants are metabolised by similar systems and act through the same neurotransmitters that possibly cause deficits in sensory-motor functioning, disruption of the biochemical ecology with poly-therapy could be playing a role in the emergence of neuropsychological deficits. Thus, more systematic research concerning the various drug parameters (such as dosage, history of toxicity and selective side effects) need to be completed prior to developing definitive statements regarding the interrelationships between different anticonvulsants medications and neuropsychological deficits in children with epilepsy.

However, despite the effects of seizure related variables, psychosocial/emotional factors appear to play a bigger role than neurological factors in influencing test performance in the four remaining neuropsychological functions measured with the NEPSY.

A discussion on the relative contribution of psychosocial/emotional factors in influencing neuropsychological performance in children with epilepsy will be presented next.

8.3.2 Role of psychosocial/emotional factors in influencing neuropsychological functioning in children with epilepsy

Psychosocial/emotional factors appear to play an important role in influencing test performance on the attention/executive, language, visual-spatial and memory/learning functions in children with epilepsy (Rodenburg et al., 2005; Straus et al., 2005). The findings of the present study indicate that increased attitudes of rejection and overprotection by mothers as well as levels of the children's self-adjustment are significant predictors of neuropsychological impairment of children with epilepsy.

More specifically, an increased attitude of rejection was associated with poorer performance on the attention/executive and language scales while increased attitude of overprotection was associated with poorer performance on the visual-spatial scales in children with epilepsy.

Parents are the most significant agents of primary socialization in the child's immediate environment. Rodenberg et al. (2005) advocated that an important aspect of the process of socialization is the interaction between parents and children and this involves parental perceptions and attitudes. The perceptions and attitudes a parent develops towards a child influences parental behaviour which in turn conveys complex and powerful messages to children. Thus, the child's psychological development and the environment are inter-dependent. This is in line with Vygotsky's (1978) theory about the importance of the social context for cognitive development.

Mothers generally play an important role in the primary socialization of children. This is also characteristic of the present study as the mothers were the primary caretakers

of their children. Dunn and Austin (2004) claim that mothers of children with chronic epilepsy manifest a higher degree of chronic anxiety than mothers of children with other chronic medical illnesses, which may produce patterns of parenting which will negatively affect the psychological development of the child and influence performance on neuropsychological tests. The findings of the present study correspond to Rodenberg et al. (2005)'s findings that negative maternal attitudes and overprotection are intrinsic influences on neuropsychological test performance. A possible explanation is that mothers of children with epilepsy perceive their child as being different from other children and accordingly communicate with their child in a way that encourages dependency and incompetence. Another plausible explanation is that since the mother assumes the burden of care for the child with epilepsy, this can lead to feelings of resentment which manifests in negative attitudes towards their children.

Attention/executive and language skills are critical for effective social interaction, academic achievement, and complex thought (Straus et al., 2006). Thus, children who experience some difficulties in these core skills may also experience problems relating to peers, family and school performance. A negative maternal attitude in turn leads to lower self esteem and adjustment difficulties and can become an obstacle in promoting optimal psychological development in children with epilepsy.

In the present study, an increase in maternal overprotection was the strongest predictor in influencing test performance on the visual-spatial functions. Visual-spatial abilities are a vital skill for daily life and especially for academic achievement. The mother's social mediation is crucial for providing the necessary scaffolding for

the child's cognitive development (Vygotsky, 1978). Mothers of children with epilepsy have been consistently reported to show a greater need to protect their children than mothers of children with other chronic illnesses (Shore et al., 2004). Overprotection restricts the opportunities for children to learn and interact with the environment, which would limit children's development of visual spatial skills.

The findings of the importance of psychosocial factors in the present study are congruent with those of Dunn and Austin (2004) and Govender (2005) that overprotective parents who do not give their children sufficient opportunities to develop independence produce children who perform more poorly on neuropsychological tests. Potential reasons for the mothers' need for overprotection may be related to the mothers' anxiety, personal characteristics and resources as well as the mothers' beliefs about epilepsy and the consequences for her child with epilepsy. Perhaps specific features of epilepsy such as the challenges of managing a chronic disorder that is unpredictable and the stigmatization attached to the disorder especially in non-Westernized African societies fosters negative attitudes such as rejection but also leads to a greater need to protect their children than mothers of children with other chronic illnesses. Thus, it may be that in response to the child's condition of epilepsy, overprotection becomes an adaptive parenting style. However, more research is needed to articulate these relationships.

Several authors (Jakovljevic & Martinovic, 2006; Prpic et al., 2003; Rantanen et al., 2008) have argued that the psychological development of children can be best understood in relation to the various environments in which they live, and to the complex and continuous interactions which occur between them and their

environments. The schoolteacher plays a pivotal role as a secondary socialization agent outside the home, particularly in a more formal setting than the home environment. Thus, the teacher's attitudes towards the child and assessment of levels of adjustment will also have a significant impact on the child's interpersonal development.

The results of the present study showed that a lower rating on level of adjustment by the teachers was associated with poorer performance on the memory/learning scales. These findings support evidence from previous studies (Dunn & Austin, 1999; Rantanen et al., 2009) regarding learning difficulties, behavioural and adjustment problems in children with epilepsy. A possible explanation is that a teacher's reaction to a child with epilepsy, either covert or overt, can influence the child's belief that he or she is a social victim of epilepsy and can lead to lowered self-efficacy. The label of epilepsy can carry many negative perceptions, which can affect the way teachers rate levels of adjustment and academic performance of children with epilepsy. This may result in negative feelings of self worth contributing to a pattern of underachievement in school. Thus, the teacher's attitudes and expectations may be implicated as negatively influencing learning and memory test performance in children with epilepsy.

8.4 Neuropsychological functioning of children with epilepsy from non-Western cultures

The predominant Western approach to understanding neurological disorders is based on a biomedical perspective that regards primary syndromes as universal and similar across diverse cultures. Thus for neuropsychological studies from non-Western

backgrounds it is important to ascertain whether cultural differences do affect performance on neuropsychological measures. Nsameng (2003) advocated that culture influences development by ensuring children acquire appropriate cognitive, communicative, motivational, socio-emotional and spiritual attributes as well as practical skills that will make them competent adults. Thus, it is apparent that in every society children are exposed more directly to cultural influences than universal expectations.

Contrary to expectations, the findings of the present study do not support Nsameng's (2003) claim that culture may affect the brain's organization of cognition. The current findings is consistent with that of Meyer et al. (2004) who reported that motor control in children with attention deficit and hyperactivity disorders were not associated with culture and ethnicity and were comparable to findings implicated in Western studies.

The present study supports the notion of universal applicability of Piaget's theory to children from non-Western backgrounds (Mwamwenda, 2004). These results are not unexpected as a study by Mulenga et al. (2001) on literate Zambian children revealed remarkable similarities in their performance on neuropsychological measures as compared to that of American children. These findings further confirms the view that the basic process of cognitive development in children may be universal (Gielen, 2003).

Thus, the findings in the present study show that even within relatively impoverished environments, non-Western children with epilepsy experience similar effects of neurobiological and psychosocial factors on neuropsychological test performance as

compared to children with epilepsy from Western backgrounds. This finding is interesting considering the children in the present study were drawn from a fairly traditional cultural environment. Although the perceptions of epilepsy were related to culture, namely ancestral spirit visitation, evil spirits and witchcraft, the effects of epilepsy appear to be similar.

8.5 Investigation of group differences

Research has consistently shown that children with epilepsy experience significantly greater difficulties in cognitive, emotional and behavioural problems than the general population as well as children with other chronic illnesses, regardless of their intellectual capabilities (Davies et al., 2003; Hermann et al., 2008; Lhatoo & Sander, 2001; McNelis et al., 2007; Rantanen et al., 2009). Some of the significant consequences of chronic medical conditions are regular visits to health care clinics, frequent school absenteeism, activity limitation and the bother associated with the management of pain, diet and medication. In addition, there is evidence that chronic illness can have a negative impact on the nature of mother-child and/or family interaction, which in turn affects development (Austin et al., 2004). Accordingly children with chronic conditions have been found to be at higher risk for mental health problems compared to healthy children (Immeldt, 2006). An increased risk of psychosocial adjustment problems in children with chronic medical conditions included the following: severity of illness, duration of illness, diagnosis, functional impairment, perceived stress, low self-esteem and maternal distress (Mitchell, Murdock & McQuaid, 2004). Thus, in order to control for the effects of having a chronic illness, a comparison was made of the test performances of groups of children with epilepsy and children with a chronic renal condition. The findings of the current

study showed that despite all three groups having a chronic condition, the groups differed in psychosocial, emotional and neuropsychological functioning. Therefore illness chronicity should be excluded as a possible confounding variable.

8.5.1 Group differences in psychosocial functioning

It is apparent that children with epilepsy face multiple psychosocial difficulties that can impact on their psychological development. The findings in the present study (Hypothesis 2) indicate that psychosocial factors, especially maternal attitudes are the strongest predictor of variance in the neuropsychological test performance of children with epilepsy. Further confirmation for this hypothesis was provided by discriminant function analyses, which also indicated that mothers of the simple partial epilepsy group manifested a higher degree of overprotective, overindulgence and rejection than the mothers of the tonic-clonic and renal groups.

Societal ideologies and gender role assignments delegate child and family care to women. Thus, maintaining the health of the family, especially the health of the children, is almost always assumed to be a maternal role. Research has shown that mothers are responsible for family health care in the case of general family health concerns and when a child has a chronic illness (Rodenberg et al., 2005). This is evident in the present study as mothers are the primary caregivers of their children. Mothers of children with epilepsy have reported more family stress and a greater need to protect their children than the mothers of children with other chronic illnesses (Dunn & Austin, 2004). Perhaps this is due to the challenges specific to epilepsy such as managing a chronic condition that can be unpredictable, difficult to control and often associated with stigma.

The current findings augment evidence from previous studies (Govender, 2005; Rodenberg et al., 2005) which reported that the mothers of the epilepsy group exhibited more overprotective attitudes than mothers of children with renal and other medical conditions. However, an interesting finding emerged showing that these differences in maternal attitude were more significant among mothers of children with simple partial seizures as compared to those in the tonic-clonic group. Tonic-clonic seizures are more visible and therefore it would be expected that the stigma should be greater. Although simple partial seizures are a less visible type of seizures as compared to tonic-clonic seizures, it is possible that they are more disruptive, anxiety provoking and less well understood. Birbeck and Kalachi (2003) have indicated that epilepsy stigma is more disabling in sub-Saharan Africa than other parts of the world. This is largely attributed to the interplay between poor socio-economic environment, limited medical care and traditional beliefs that can impact on the lives of children with epilepsy.

Thus, the findings on non-optimal maternal attitudes suggest that the nature of such mother-child interaction may impact negatively on the psychological development of the child with epilepsy and may contribute to the development of deep-seated emotional and behavioural problems. Furthermore, simple partial seizures with a temporal lobe involvement may lead to the child developing a difficult personality style. Nolan et al. (2003) claim that children with such a type of seizure activity may exhibit violent outbursts, symptoms consistent with ADHD and a higher rate of psychiatric disorders such as anxiety and depression. They argue further that the development of such a personality style may be a consequence of the site of epileptogenic foci in the temporal lobe, unpredictability of seizures, restricted social

activities, low self esteem, stigma and rejection from society. However, research on personality aspects related to seizure activity in the temporal lobe still remains contentious and needs to be further explored.

8.5.2 Group differences in emotional functioning and self-adjustment

According to Lhatoo and Sander (2001) the school is the second most important social environment for the child after family. The child acquires knowledge, skills and develops social skills at school. Through interaction with their peers, children satisfy their developmental task of independence, develop self-respect and social competence. Thus, the teacher's attitude towards the child, as well as peer relations can also have a significant impact on the child's emotional and interpersonal development.

Findings of the present study showed that the children in the tonic-clonic seizure group were rated significantly lower on self, social and school levels of adjustment by their teachers as compared to the children in the simple partial epilepsy and renal groups. These findings are in line with prior studies reporting that children with epilepsy especially tonic-clonic seizures show more adjustment and behaviour problems than children with other chronic medical conditions (Dunn et al., 2003; Rantanen et al., 2009). The results of the present study also confirm earlier findings by Schoenfeld et al. (1999) who asserted that chronic seizures affect the extent to which a child achieves satisfactory levels of psychological functioning, particularly relating to self, social and school adjustment.

Teacher's opinions and approaches towards children with a chronic illness significantly influence the success or failure of the children's social and academic development (Rantanen et al., 2009). Findings by Prpic et al. (2003) have shown that teachers have a limited understanding of common chronic childhood illnesses, especially epilepsy. These findings were also confirmed by a recent local study by Rakubu (2011) on teachers' attitudes towards and knowledge of epilepsy in Mankweng, Limpopo Province. This is characteristic of schools in non-Westernized communities such as those attended by the sample in the present study. Katzenstein et al. (2007) articulated that the perception held by teachers, both positive and negative, may affect a child's self-concept, social competence and rating of academic abilities.

Clearly the prevalence of poor self-esteem in children with epilepsy has important implication for psychosocial functioning. According to Salpekar and Dunn (2007) children with epilepsy have a poorer self-concept and lower self-esteem than children with other chronic conditions. They also reported adolescents with epilepsy felt that they would have a high self-esteem if they did not have epilepsy. In the present study, the test performance of the simple partial group showed lower levels of self-esteem than the tonic-clonic and renal groups. A possible explanation for the low self-esteem score in this group could be the uncertainty associated with the unpredictability of seizures and the fact that it could occur in public making their seizure status known. Also the stigma associated with epilepsy had a role to play as parents worry about disclosing the fact that their children had seizures for fear that responses of others would be negative (Austin et al., 2004). Earlier findings by Caplan et al. (2002) advocated that a negative attitude towards illness, lack of a sense of control and an external or unknown locus of control are other factors that are associated with low

self-esteem in children with epilepsy. Thus, the perceived stigma associated with seizures, unpredictability of when seizures can happen and the fact that in sub-Saharan Africa epilepsy is viewed as an “African” affliction whereby the supernatural effects on ancestral spirits and evil spirits are explained as a source of external locus of control can negatively influence a child’s self-esteem, sense of mastery and self efficacy. This can further impact on the neuropsychological functioning of children with epilepsy.

Contrary to expectations, no differences were found between the three groups on emotional instability as measured by the HFD. Thus, the results of the present study may indicate a lack of sensitivity of the HFD in differentiating children with emotional instability from children with emotional stability. Furthermore, these findings do not support Stafstrom and Havlena’s (2003) study which reported that drawings done by children with epilepsy showed evidence of impaired self-concept, low self-esteem, and a sense of helplessness and vulnerability. However, drawings of children with epilepsy are a powerful method to understand the psychological impact and challenges encountered by this population and could be a useful therapeutic tool. Drawings are easy to obtain and allow a child to express himself or herself in a way that is not forthcoming verbally.

The findings of the present study provide insight into the seizure group that is more vulnerable to adjustment and emotional difficulties. Most of the studies reported consider children with seizures to be a homogeneous group (Chaix et al., 2006) although it is well documented that there are different types of seizures with differing

pathologies, clinical presentations and varying psychological and behavioural sequelae.

8.5.3 Group differences in neuropsychological functioning

Many studies have reported on the deleterious impact of epilepsy on a child's academic, neuropsychological, emotional and behavioural functioning as compared to children with other chronic conditions (Chaix et al., 2006; Hermann et al., 2001; Kolk et al., 2001). Thus, given the elevated risk of cognitive and academic deficits within this population, neuropsychological assessment can identify subtle cognitive impairment and learning disability (Buelow & McNelis, 2002).

Findings of the present study suggest that the children in the tonic-clonic group showed greater deficits on attention/executive functions, language skills and visual-spatial abilities than the simple partial and renal groups. These findings are in line with those of Kolk et al. (2001) who also reported that children with generalized seizures performed significantly worse on attention/executive, language and visual-spatial subtests of the NEPSY. The test scores obtained by children with renal chronic problems on the NEPSY are comparable to the norm scores obtained by normal healthy children as outlined in Korkman et al. (1998).

8.5.3.1 Attention and executive functions

Attention problems are frequently reported in children with epilepsy (Dunn & Kronenberger, 2005; Schubert, 2005). However, children with generalized epilepsies are more frequently reported to have problems with attention than children with partial seizures and other non-neurological disorders (Deltour et al., 2008; Parisi,

Maovero, Verrotti & Curatolo, 2010). In the present study, children with generalized seizures manifested significantly more impairments on the tasks tapping executive functions relative to children with simple partial seizures and chronic renal problems. A plausible explanation could be that generalized seizures have a more widespread epileptic activity and may accordingly compromise the functioning of several areas of the brain. This claim is supported by Korkman et al. (1998) and Lezak et al. (2004) who noted that any diffuse dysfunction interfering with normal brain activity can disrupt executive functions. Furthermore, it is well known that seizure activity in the frontal lobe can rapidly spread to other regions owing to the rich connections of this lobe with neighbouring cortical and sub-cortical areas (Parisi et al., 2010, Trimble 1998). Hernandez et al. (2003) suggested that attention and executive problems in children with tonic-clonic seizures appear to be attributable to fluctuation in arousal due to sub-cortical involvement. These problems are most obvious on tasks requiring sustained attention (Mirsky, Duncan & Levav, 2001).

8.5.3.2 Language functions

Characteristic neuropsychological findings, such as linguistic problems in naming and phonological analysis have been reported previously in children with tonic-clonic seizures and seem to predispose them to learning disabilities, especially verbal learning problems at school (Chaix et al., 2006; Kolk et al., 2001). Cohen and Le Normand (1998) asserted that in children with tonic-clonic seizures, early epileptic damage to the anterior area of the left hemisphere, a brain area noted for its importance in speech and language, is associated with severe and lasting deficits in language function.

Hermann et al. (2001) advocated that epilepsy may disrupt brain functions necessary for language development indirectly because of associated disabilities or directly as a consequence of the seizure disorder. Any process that impairs language function has long-term consequences for academic, social and behavioural adjustments in children with epilepsy (Wheless et al., 2002). Furthermore, impairments in specific language abilities, such as auditory comprehension or retrieval of lexical codes can impact memory and learning abilities. Language skills are important for successful academic performance. At school, information is frequently presented to children in a verbal format (lecturing, discussing, reading and writing). Therefore, the current findings of lower performance of children with tonic-clonic epilepsy on language skills have important clinical implications. They strengthen conclusions from other studies (Kolk et al., 2001) stressing the correlation between epilepsy, academic achievement and performance in other neuropsychological domains.

8.5.3.3 Visual-spatial functions

The tonic-clonic group obtained significantly lower scores on the visual spatial subtest of the NEPSY than the simple partial and chronic renal groups. This finding is in keeping with other studies (Bailet & Turk, 2000; Croona et al., 1999; Kolk et al., 2001; Pavone et al., 2001) that also indicate significant visual-spatial and visual-motor problems among children with generalized seizures.

Visual-spatial skills are a vital skill for daily life and especially for academic achievement. According to the literature, the achievement of visual-spatial skills is primarily associated with the right hemisphere, mainly non-speech dominant hemisphere and is assigned to parieto-temporo-occipital brain areas (Lezak et al.,

2004; Luria, 1973; Spreen et al., 2006). The application of visual-spatial skills requires the integrated functioning of various parts of the brain. Thus, children with tonic-clonic seizures may be at risk of visual-spatial deficits due to the widespread epileptic activity involving these areas.

Deficient visual-spatial functions are bound to have a crucial effect on the functioning of an individual, particularly in terms of performance at school. It is therefore of the utmost importance to examine the exact nature and impact of this problem in children with epilepsy in future research as there is a paucity of literature in this area.

8.6 Integration of results

The findings of the present study indicate that seizure variables such as the age of onset, frequency of seizures and duration of seizures have an impact on NEPSY scores. Furthermore, the investigation of group differences show that children with tonic-clonic seizures obtained significantly lower scores on the attention/executive, language and visual-spatial neuropsychological domains and adjustment scores than children in the other groups. These findings confirm Luria's (1973) and Piaget's (1955) view that complex cognitive functions can be impaired in ways that are comparable to what occurs in a breakdown of a complicated system. If one subcomponent of a function is impaired as in the case with brain damage, then complex functions to which it contributes may also be impaired. Thus, it seems that the neuronal activities that occur during tonic-clonic seizures may impair cognitive processes by disrupting the system of zones of the brain working in concert (Luria, 1973). It is likely that effects are more severe in children with tonic-clonic than simple partial epilepsy because of the more widespread epileptic activity and

subsequent brain involvement. The implication for children with tonic-clonic seizures is that an early age of onset of seizures, more frequent attacks and a longer duration of seizures results in more profound neuropsychological deficits due to the disruptions caused by the underlying physiological process.

The results of the present study also suggest that having a child with epilepsy affects maternal attitudes and parenting styles. Specific features of epilepsy such as stigmatization and unpredictability of seizures foster negative maternal attitudes such as rejection but also lead to a greater maternal overprotection. This has an indirect impact on NEPSY scores because children with epilepsy are exposed to decreased maternal support and opportunities to learn. According to the Vygotskian notion of social mediation (ZPD and scaffolding), such a type of mother-child relationship generally does little to nurture and facilitate cognitive development.

It is also apparent that seizure variables such as age of onset, frequency of seizures and the duration of seizures affect the child's self-esteem and levels of self and school adjustment as well as the teacher's perception of adjustment. Negative maternal and parental styles can also affect the child's adjustment. Children with epilepsy tend to have low self-esteem and adjustment problems. Contributing factors are that seizures often occur without warning, may occur in public and can involve embarrassing signs such as drooling, shaking and abnormal vocalizations (Srafstrom & Havlena, 2003). All of these features add to the unique stigma of epilepsy. A low self-esteem and poor adjustment levels can affect NEPSY scores because a child requires confidence to perform optimally on tests.

Thus, epilepsy presents with unique problems (relative to other chronic illnesses) because of the underlying neurobiological substrates, stigma, unpredictability and feeling out of control. The current study showed that the groups can be separated according to differences in psychosocial factors (maternal attitudes of overprotection, overindulgence and rejection), emotional functioning (self, social, school adjustment and self esteem) as well as neuropsychological functioning (attention/executive, language and visual-spatial skills). The renal groups is characterised by the highest levels of psychosocial, emotional and neuropsychological functioning, while the simple partial seizure group showed lower levels of psychosocial and emotional functioning and the tonic-clonic seizure group the lowest level of neuropsychological functioning and adjustment. Thus, these findings suggest that the possible effect of chronicity has been excluded. The three groups differ on test scores with the NEPSY scores of children in the renal group being comparable to normal healthy children as indicated in the manual by Korkman et al. (1998).

However, it is apparent that the psychosocial and emotional factors appear to have a greater impact than the neurobiological variables on the neuropsychological functioning of children with epilepsy. But this finding was not consistent as it is evident that neurobiological variables played a bigger role in influencing test scores on the sensory-motor domain. As indicated earlier this finding is consistent with Luria's model whereby an early age of onset of seizures may interfere with the development of sensory-motor skills by disrupting the system of zones of the brain working in concert (Luria, 1973). Moreover, the children in the simple partial seizure group seem to have worse psychosocial scores with regard to maternal attitude and self-esteem. A plausible explanation is perhaps simple partial seizures are not so

visible therefore the child's condition is not recognised. The mother-child interaction may be inappropriate and not supportive of the child's needs. This can hinder the process of social mediation and impact on the cognitive development as outlined in Vygotsky's (1978) theory. These findings on psychosocial aspects in children with simple partial seizures highlight the heterogeneous nature of seizure disorders and the need for future studies to confirm these findings.

Thus, the perspective of the neuropsychological functioning of children with epilepsy is consistent with the theoretical stance taken in Chapter 4, that is, that neuropsychological functioning is the product of biological bases as well as the mediating influences of psychosocial factors.

8.7 Limitations and possibilities for future research

The present study is one of only a few conducted with children with epilepsy in a developing world. Continuous research on the influence of neurobiological and psychosocial factors on children with epilepsy, such as neuropsychological impairments, emotional and behavioural problems, will ensure awareness, early detection of impairments and the optimization of the treatment and outcomes of these children, given the context that epilepsy is one of the most common neurological disorders in developing countries, with a corresponding increase in public health cost. The literature indicates (Bennet, 1994; Rodenberg et al., 2007) that there are a variety of neurobiological and psychosocial factors that influence neuropsychological test performance in children with epilepsy. However, most of the studies reviewed regarded children with epilepsy as a homogeneous group, for example, generalized seizures groups included children with tonic-clonic and absence seizures (Bender et

al., 2007; Schouten et al., 2002), yet they present with different clinical and behavioural sequelae. Moreover, although most studies (Kolk et al., 2001; Rodenberg et al., 2005) have made an attempt to explore either the influence of neurobiological and psychosocial factors, no study has examined the combined contributing influence of both these factors on neuropsychological functioning in children with epilepsy. Thus, while the present study avoided these limitations, it warrants future research to establish how comparable these findings are, especially in other samples of children with epilepsy that live in non-Western environments.

Furthermore, as indicated in Chapter 5, the prevailing paradigm existing in the literature suggests a trend in pursuing neurobiological predictors of neuropsychological functioning in children with epilepsy, almost to the total exclusion of psychosocial variables (Hermann et al., 1998). Thus, the current study should be seen as a response to this paradigm and as an initial step in searching for a more comprehensive way of understanding the neuropsychological functioning of children with epilepsy.

The findings of the present study indicate that psychosocial/emotional factors were the main predictors of variation in NEPSY scores, accounting for 28 to 47 % of the variance. According to Rodenburg et al. (2007) a variation of 39% in psychosocial factors (maternal attitudes and child temperament) is a good percentage of variance in explaining predictors of parental stress and parenting. Thus, the percentage of variance reported in the present study on psychosocial factors as the main predictors of NEPSY scores can also be interpreted as very acceptable. However, these findings illustrate that there are other predictor variables aside from those measured in the

present study that may play a role. Perhaps intrapersonal risk factors such as the child's level of knowledge of epilepsy, personality style and self-efficacy (belief in one's ability to control or influence health-related outcomes), and locus of control (the degree to which the child perceives health outcomes are due to one's own efforts versus due to outside forces over which one has little control) needs to be considered. Another important consideration is the role of anticonvulsants (monotherapy versus poly-therapy and medication induced alterations in cerebral metabolism) needs to be also considered.

The role of gender differences as an influence on neuropsychological functioning of children with epilepsy has infrequently been assessed in the literature. The findings of the present study showed that females with tonic-clonic seizures performed significantly worse than males on the NEPSY domains. This finding may support the statement by Bender et al. (2007) claiming that more neuropsychological insults are seen in girls with tonic-clonic seizures, however this need to be confirmed by other studies as the sample size was not optimal. Thus, these findings on gender differences have important clinical implications. It suggests that the impact of tonic-clonic seizures is more severe than in boys and special attention should be given to girls who are struggling academically at school.

The finding of the present study support the need for building a comprehensive model that explains the neuropsychological functioning of children with epilepsy. However, the findings of the present study are insufficient to advance such a model as the other variables specified above related to anticonvulsants and intrapersonal variables were not captured as predictor variables.

In addition, the study was conducted in a developing country with no national incidence and prevalence statistics or regional data base of epilepsy in children. One major difficulty associated with the methodological process of subject selection for the present study was the lengthy process involved in selecting samples of children with tonic-clonic seizures and simple partial seizures. An appropriate alternative to this approach would be epidemiologically based studies that include a database of all children diagnosed with the different types of seizures. This will ensure that the diversity of a disease that is inherently heterogeneous in its neuropathology will be included in subsequent analyses. By embarking on such epidemiologically-based studies, the urgent need to develop an appropriate database for the rigorous standardization of several neuropsychological tests will be catalyzed (Nell, 2000). This will facilitate establishing normative data for different groups, for example children with different type of epilepsies, children with no neurological disorders as well as healthy normal children. In this way the judicious use of statistics to determine the relative contribution of factors that influence neuropsychological test scores may assist to circumvent the arguments of race and politics that are pervasive in discussion on appropriate norms.

The finding that the neuropsychological performance of children with epilepsy in the present study was similar to children with epilepsy elsewhere in the world confirms the validity of the measures for local use. These results indicate that the NEPSY is suitable for children from different cultural groups and can be used for future studies.

Another limitation of the study concerns the possible confounding effects of anticonvulsants on neuropsychological test performance. There will always be particular concern about the effects of medication on the developing child. This is especially pertinent at times of rapid brain development with regard to drugs primarily targeted at epileptic seizures in childhood. Thus, the relation between poly-therapy and neuropsychological functioning in children with epilepsy is highly complex. Children with epilepsy on poly-therapy treatment generally have more-difficult-to-control seizures, which are frequently related to some underlying brain pathology. They are at greater risk for developing drug toxicity resulting from higher blood serum levels of antiepileptic drugs. Considering all of these factors, it is difficult to determine the etiology of neuropsychological changes. To more precisely delineate the relation between poly-therapy and level of control, future studies need to compare the neuropsychological performance of children on poly-therapy with and without adequate seizure control.

The relationship between children with epilepsy and co-morbid disorders such as attention deficit/ hyperactivity disorder (ADHD) was not explored. ADHD is a frequent co-morbid condition experienced by children with epilepsy. It has a negative impact on their quality of life and represents a significant risk factor for academic underachievement (Parisi et al., 2010). Several factors may contribute to this co-morbidity, including the underlying brain pathology, the chronic effects of seizures and of the epileptiform EEG discharges as well as the effects of antiepileptic drugs. Thus, future studies should screen for ADHD symptoms as early identification of this co-morbidity is crucial in understanding the neuropsychological functioning of children with epilepsy.

Finally, the use of only a quantitative approach may be seen as a limitation of the present study. Although multivariate data analyses were utilised, it has been argued by Babbie and Mouten (2006) that it is a fallacy to assume that complex phenomena require complex forms of analysis. They claim that simple forms of data analyses together with the use of qualitative methods are more beneficial to social scientists. Thus, it is envisaged that perhaps by also including a qualitative explorative approach, valuable information regarding information would be obtained from interviews regarding the cultural aspects and stigma of epilepsy, children's understanding of epilepsy and the quality of mother-child interaction

8.8 Recommendations

The findings of the importance of psychosocial factors for children's neuropsychological functioning have salient implications for intervention programmes with parents. Parents need to be educated about epilepsy, helped to guard against overprotecting their children and encouraged to facilitate their children's emotional, social and psychological development. Thus, mothers should be advised that the child with epilepsy should be given age-appropriate opportunities and responsibilities. These workshops will empower parents to better understand epilepsy and to demystify myths regarding aspects of epilepsy. Also support groups with other parents would provide opportunities to talk about their fears about their children's future.

Teachers also have an important role to play in the successful adjustment of children with epilepsy. They may have a negative perception of the academic abilities of

children with epilepsy that could negatively influence their interaction with the children as well as influence how they evaluate a child on levels of adjustment and academic performance. These findings could have significant effects on the child psychosocially and academically. Future research in this area is needed to understand perceptions and knowledge about epilepsy. Based on these findings workshops for teachers could enhance their understanding of epilepsy.

8.9 Conclusions

There are several major conclusions that can be drawn from the present study.

- In the epilepsy groups psychosocial and emotional factors appear to have a greater impact than neurobiological variables on neuropsychological test performance.
- Neurobiological variables, specifically seizure related variables such as the age of onset, frequency of the seizures and a longer duration of seizures have an impact on neuropsychological test scores, the child's self esteem, levels of self and school adjustment as well as the teacher's perception of adjustment.
- Having a child with epilepsy affects maternal attitudes and parenting styles. This has an indirect impact on neuropsychological test scores.
- Negative maternal attitudes such as overprotection and rejection, may restrict the opportunities for children to learn according to the Vygotskian notion of social mediation.
- Findings regarding the influence of neurobiological and psychosocial functioning on neuropsychological test performance in children with epilepsy from non-Western backgrounds in South Africa are comparable to those of children with epilepsy elsewhere in the Western world.

- The current findings on neuropsychological functioning in children with epilepsy are consistent with the theoretical perspectives set out in Chapter 4, combining the view of Piaget (1955) that cognitive development proceeds as a result of the child's own activities, with Luria's (1973) model of brain functioning and the stance of Vygotsky (1978) that development is a socially mediated process.
- The group differences found in the present study showed that epilepsy presents with unique problems relative to other chronic illnesses. The renal group was characterised by higher levels of psychosocial, emotional and neuropsychological functioning, while the simple partial group showed lower levels of psychosocial and emotional functioning and the tonic-clonic seizure group the lowest levels of neuropsychological functioning and adjustment.

Thus, the risk factors for compromised neuropsychological performance are multivariate and critical for understanding and establishing a complete neuropsychological profile in children with epilepsy. It is apparent that psychosocial and neurobiological factors play a varying role in impacting on neuropsychological test performance. This is a useful contribution to understanding and treating children with epilepsy with regard to educational problems, vocational planning, psychosocial adjustment, intervention programmes for parents and workshops for teachers on perceptions and knowledge of epilepsy.

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Appendix A: Biographical Questionnaire

Biographical questionnaire to be completed by mothers

Instructions: Please complete the following questionnaire as **fully** and **honestly** as possible. There are no right or wrong answers. All information provided to the researcher will be treated in **strict confidence**.

DETAILS OF CHILD

1. **Name:** _____
2. **Age:** **Date of birth** _____ **Years** _____ **Months** _____
3. **Sex:** _____

4. Birth details of child

- 4.1 What was the type of birth delivery _____
- 4.2 Describe the term of pregnancy _____
- 4.3 What was the duration of the labour (hours)
- 4.5 Where there any complications during the birth process?

Yes	1
No	0

- 4.5.1 If yes, specify the nature of the complications. For example was the baby placed in an incubator or given a drip etc.

- 4.6 Where there any complications immediately after birth?

Yes	1
No	0

- 4.6.1. If yes, specify the nature of the complications

5. What is the **birth order** of the child in the family?

6. **Language spoken at home**

What language is spoken at home _____

7. **Family details**

7.1. Describe the structure of your family system?

7.2 Indicate the total number of people living in your household

Adults
Children

7.2.1 Indicate how many are employed/earners and how many are dependents.

Employed _____

Dependents _____

7.3 Who is the primary caretaker of the child? _____

7.4 Indicate the level of education in years

Mother _____

Father _____

7.5. State the occupation of the parents as well as any other earner in the household.

Mother
Father
Other

7.6. Does the parent/s suffer from any illness?

Yes	1
No	0

Mother
Father

7.7.1 If yes, please provide details on the nature of the illness

8. Health history of the child

8.1 Is there anything about your child's health that is worrying you ?

Yes	1
No	0

8.1.1 If, yes explain what are your concerns

8.2 Does the child have a physical defect?

Yes	1
No	0

8.2.1 If yes, what is the nature of the defect?

8.3 Mention any form of injury/illness suffered by the child that required a doctor's attention or hospitalization.

8.4 Has the child undergone any surgery?

Yes	1
No	0

8.4.1 If yes, please provide details of the surgery performed, including when this took place.

8.5 Details of present illness

8.5.1 Provide details of the child's present illness

8.5.2 Who diagnosed the child with the above condition?

Questions 8.5.3 to 8.5.8 should only answered if your child suffers with epilepsy.

8.5.3 Do you know how this diagnosis was made for e.g., was an EEG recording done? When?

8.5.3.1 Did the doctor explain the findings and the meanings of the EEG to you?

8.5.4 When do you think that the child had his/her first seizure?

8.5.5 How long has the child had epilepsy?

8.5.6 How often does the child get an epileptic seizure /fit ?

8.5.7 Does any particular event/cause trigger the child's condition?

Yes	1
No	0

8.5.7.1 If, yes, please provide details:

8.5.8. Is there any change in the presentation of the epilepsy since the diagnosis? Explain.

Treatment

9.1 How is the child's chronic medical condition currently treated ?

9.2. If the child is on medication, provide details on the types of drugs taken, dosages and frequencies?

9.3. Have there been any changes in drugs? Why?

9.4. Have you sought alternative method/s of treatment besides medical treatment. If yes provide details of the other method/s.

9.5 Indicate what do you think could be a better treatment for epilepsy.

10. Mother's reaction to child's illness

10.1. How did you feel when your child was first diagnosed with epilepsy/chronic condition

10.2. Was the condition explained in detail to you by your doctor? Elaborate

10.3. Has your child's illness made it more difficult for you to give as much attention to your other children?

10.4. Has your child's illness restricted the activities that you do as a family?

10.5 What worries you the most about your child's illness?

11. Cultural understanding of epilepsy

11.1 Explain your understanding of what epilepsy is

11.2 What do you think causes epilepsy?

11.3 What are your beliefs about epilepsy?

END

Thank you for your co-operation