DISCRIMINATION BETWEEN FRONTAL AND

TEMPORAL LOBE EPILEPSY IN CHILDREN

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DEDICATION

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Distinguishing between children with frontal lobe epilepsy (FLE) and children with temporal lobe epilepsy (TLE) can be difficult; however, in order to assure proper treatment and intervention it is important to accurately differentiate between these two groups. One of the intended goals of this study is to identify tabletop and behavioral rating measures that will assist in differentiating children with FLE from children with TLE. Another purpose of this study is to examine the utility of the Children's Executive Functions Scale (CEFS), a parent-report measure of executive functioning, in differentiating between children with FLE and TLE. Sixty children, ranging in age from 6 to 17, will be divided into two groups (a) children with frontal lobe epilepsy and (b) children with temporal lobe epilepsy. The participants will be evaluated using the Tower of London (TOL), The Wide Range Assessment of Memory and Learning – 2 (WRAML-2), the CEFS, and the Child Behavior Checklist (CBCL). It is hypothesized that children with FLE will display more impairment than children with TLE on both measures of executive functioning (the CEFS and the TOL).

It is further hypothesized that children with RTLE will perform significantly worse visual memory components of the WRAML-2 than individuals with FLE or LTLE . It is expected that children with LTLE will perform worse than children with RTLE or FLE on verbal memory components of the WRAML-2. Finally, it is hypothesized that scores on the CBCL will reflect that children with TLE display a greater number of internalizing symptoms than children with FLE. The findings of this study could also have important implications in the understanding of deficits associated with FLE and TLE. Furthermore, the findings could suggest direction for future research and for treatment and interventions.

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CHAPTER ONE
Introduction

The majority of epilepsies have their onset in adolescence or childhood, a time in which skills necessary for future academic functioning are acquired (Seidenberg, 1989). According to the National Center for Health Statistics with the Centers for Disease Control, over 150,000 children (ages 0 – 17 years) in the United States of America were treated for some form of epilepsy from 1985 to 1994 (National Center for Health Statistics, 1999). Guerrini (2006) estimates that over ten million children (under the age of 15) worldwide have active epilepsy. With so many children suffering from epilepsy, it is beneficial to determine the type of seizure and location of the seizure focus if correct treatment options are to be considered. In the past, epilepsy research has typically focused on temporal lobe epilepsy (TLE) in part due to difficulties diagnosing frontal lobe epilepsy (FLE) (Helmstaedter, Kemper, & Elger, 1996; Upton & Thompson, 1996a). Thus, there is much information on the neuropsychological effects of TLE. However, for years research in the area of FLE has lagged behind, and much less is known about the neuropsychological effects of FLE (Upton & Thompson, 1996a). More specifically, although research indicates that the frontal lobes are responsible for executive functioning (EF), there has not been extensive research in this area (Wishart, Barr, Bilder, & Schaul, 1997). Only recently have researchers begun to explore FLE and the relationship with EF. If individuals with FLE are to be given the best possible medical and neuropsychological treatment, it is necessary for more research to be done in this area to delineate the specific deficits associated with FLE.

Despite the advancements in medical technology, it is often difficult to diagnose individuals with FLE. Helmstaedter et al. (1996) outline several reasons for this difficulty. These reasons include the fact that, “FLE is characterized by a broad interindividual variety of seizure semiology”, suggesting that different individuals with FLE will display a myriad of different symptoms associated with seizures. In addition, they reveal, “interictually (sic) and ictually (sic) recorded EEGs frequently show widespread and/or rapidly propagating epileptic activity involving the contralateral frontal lobe and other brain regions” (p. 399). It has also been revealed that TLE can sometimes present as FLE on tabletop measures of neuropsychological functioning. For example, in a study by Hermann, Wyler, and Richey (1988), individuals with TLE presented as having FLE on the Wisconsin Card Sorting Task (WCST), a task developed to measure abstraction abilities, as well as cognitive flexibility. In addition, Mataró, Junqué, Viñas, and Escartín (1998) found that individuals with TLE performed worse than individuals with FLE on other purported tests of frontal lobe functioning, although this difference was not significant. Thus, individuals with TLE often present as having FLE, or may present as more impaired than individuals with FLE on tabletop tests of frontal lobe functioning. Hermann et al., Upton and Thompson (1996a), and Helmstaedter et al. hypothesized that individuals with TLE present as having FLE because of propagation of activity from the temporal to the frontal lobes.

Surprisingly, few studies have directly compared the neuropsychological presentation of individuals with FLE to those individuals with TLE. Upton and Thompson (1996a) examined the neuropsychological characteristics of adults with FLE as compared to those with TLE. Their findings revealed that several measures were sensitive to deficits in individuals with FLE. However, their findings further revealed that the pattern of deficits was not consistent among the various measures. It would be beneficial to find measures that will assist in differentiating between individuals with FLE and TLE. However, it should be noted that individuals with FLE and TLE may present with a variety of deficits. This variety most likely exists because various factors can influence the cognitive pattern displayed by individuals with FLE and TLE. Despite these variations there is a need for research to focus on finding measures that reveal what deficits are truly exhibited in individuals with FLE.

CHAPTER TWO
Review of the Literature

The following chapter will provide a review of the literature on executive functioning (EF) and how it is measured, and a review of the relevant aspects of temporal lobe epilepsy (TLE) and frontal lobe epilepsy (FLE). Variations in the definition of EF exist in the literature, and some authors use the term interchangeably with frontal lobe functioning. Although an exhaustive review of these viewpoints will not be provided, this chapter will begin with a description of the behaviors generally understood as components of EF and their connection to frontal lobe functioning. In this paper, frontal lobe functioning and EF also will be used interchangeably to reflect the orientation of the authors cited.

EXECUTIVE FUNCTIONING

Definitions of Executive Functioning

There is still debate over the exact meaning of Executive Functioning. EF has been described as "goal-directed behavior, including planning, organized search, and impulse control" (Welsh, Pennington, & Groisser, 1991, p. 131). Denckla describes EF as including inhibition, delay of responding, preparedness to act, and planning of sequences (Denckla, 1996). Lezak (1993) includes volition, planning, purposive action, and performance effectiveness under the EF "umbrella". Weydant and Willis (1994) further define EF as, "goal directed behavior including strategic planning, impulse control, organized search, and flexibility of thought and action" (p. 27). Thus, EF involves the ability to plan and organize behavior, as well as the ability to carry out this plan while inhibiting inappropriate behaviors. Conversely, impaired EF can be represented by poor problem solving. An individual with impaired EF may display poor impulse control and may fail to act appropriately even when he or she knows the correct behavior. Personal ineffectiveness and social difficulties are frequently manifestations of impaired EF.

Development of Executive Functioning in Children

It is commonly known that the frontal lobes play a role in EF, yet it is still uncertain to what extent the frontal lobes are responsible for EF (Cripe, 1996; Denckla, 1996). Furthermore, there is also uncertainty about the development of EF in children. The following will provide a background about the development of executive functioning in children, although age differences do not represent an area of focus of this study. Dennis (1991) contends that the belief that EF was non-functional in children resulted in little consideration of EF abilities of children. Therefore, there continue to be questions as to exactly when EF develops in children. It is generally accepted that this is one of the last cognitive areas to develop in children; thus, we would not expect younger children to have highly sophisticated executive functioning. Passler, Isaac, and Hynd (1985) suggest EF is a multi-stage process and that most children will master elements of EF by age 12. The EF abilities begin to develop between six to eight years of age. During this time a child’s ability to inhibit behaviors increasingly improves (Levin et al., 1991). Furthermore, Chelune and Baer (1986) state that performance on measures of EF improves between the ages of six and ten with adult level performance mastered by age 12. A study by Becker, Isaac, and Hynd (1987) revealed children six to eight years of age performed significantly worse on measures chosen to assess EF than children ten to twelve years of age. Furthermore, although eight-year-old children performed better than six-year-old children did, this difference was not statistically significant. Becker et al. further found the performance of ten to twelve year olds on these measures of executive functioning were essentially identical.

Similarly and more recently, the results of a study by Brocki and Bohlin (2004) parallel the findings of Levin et al., (1991) such that executive functions were beginning to develop in children between the ages of six and eight and performance tended to level off around the age of twelve. Together, the results of these studies would suggest that the development of executive functioning is a multistage process and that a transition might occur between the ages of eight and ten, where EF becomes more fully developed, with mastery evidenced by the age of twelve.

Piaget's Theory of Cognitive Development in Children

Piaget's (1952) theory is one of the most well known and easily understood theories of cognitive development. Piaget's theory provides a foundation for understanding the place of executive functions in the general scheme of child development. Piaget addresses the cognitive developmental changes in terms of the way a child perceives his or her environment and seeks to organize this information with the goal of adaptive functioning. He describes four progressive stages of children's cognitive development. The stages include the sensorimotor, preoperational, concrete operations, and formal operations stages. The sensorimotor stage typically occurs between zero and two years of age. During this stage it is believed that children develop motoric intelligence. The next stage of cognitive development proposed by Piaget is the preoperational stage. During this stage children between two and seven years of age begin to symbolize and develop language. It is generally agreed that children in this stage begin to develop executive functions. Because children can hold and manipulate concepts mentally, purposeful planning becomes possible. Furthermore, Vaughn, Kopp, and Krakow (1984) suggest that children in this age group display more self-control behaviors such as inhibition. The next stage in development is the concrete operations stage. This is a period between the ages of seven and eleven or twelve when children develop the ability to conserve, understand numbers, and develop reversibility in thought. It is during this stage that the majority of executive functions are developing. The final stage of cognitive development as described by Piaget is the formal operations stage, which typically occurs between the ages of eleven or twelve and fourteen or fifteen. Some say that this stage is not complete until adulthood. In this stage logical thought is further developed as the individual acquires the ability to think in abstract or hypothetical terms. Behaviorally, this capacity allows for flexibility of thought and action, as well as the ability to generalize information from one setting to another. Thus, mastery of the executive functions should coincide with Piaget's formal operations stage of development.

Issues and Considerations in the Measurement of Executive Functioning

Welsh and Pennington (1988) describe difficulties assessing executive functioning in children because most measures were not "designed specifically with the child's developmental level in mind, nor have extensive child norms been gathered" (p. 200). Seidenberg (1989) further suggests that there has been little research on the neuropsychological functioning of children as compared with the neuropsychological functioning of adults. In much of the research that does exist, neuropsychological tests developed for use with adults are frequently employed with children. Gnys and Willis (1991) report that tests developed for adults are not necessarily sensitive to brain dysfunction in children; thus, the validity of using such tests may be questionable. They further state that, "tests developed for adults do not necessarily measure the same abilities in children (Gnys & Willis, 1991, p. 489). Archibald and Kerns (1999) claim that there is a limited number of "developmentally appropriate" measures of executive function that are normed for the pediatric population. Anderson, Anderson, and Lajoie (1996) describe two limitations of assessing the pediatric population. The first limitation is, "lack of reliable and valid assessment tasks", the second limitation is the lack of normative data for children on the measures currently being utilized (Anderson et al., 1996, p. 54). Additionally, Anderson (1998) reported that identification of executive dysfunction in both clinical and research settings will be compromised until developmentally appropriate assessment tools are developed. In particular, these adapted measures may not be sensitive to the subtle changes that occur in children as EF develops. Thus, due to these limitations there is a need for research to delineate which measures are efficacious in measuring EF in children.

Despite these cautions, various measures have shown efficacy in testing EF in children. For example, a study by Levin et al. (1991) found that the following tests are useful in revealing deficits in EF in children: Controlled Oral Word Association Test from the Multilingual Aphasia Examination [verbal fluency] (Benton & Hamsher, 1976), Design Fluency (Jones-Gotman & Milner, 1977), the California Verbal Learning Test – Children's Version (CVLT-C; Delis, Kramer, Kaplan, & Ober, 1986), the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993), the Tower of London (TOL; Shallice, 1982), Twenty Questions (Denny & Denny, 1973), and the Go – No Go task (Drewe, 1975). Levin et al. found that on the WCST, a test of cognitive flexibility, as age increased children exhibited improved concept formation, flexibility of thought, the ability to inhibit responses, and better problem solving, with major gains occurring between seven to twelve years of age. Levin et al. also found that children twelve years of age and older demonstrated increased inhibition, with the biggest shift occurring between the seven/eight and nine/twelve year age groups on the Go – No Go task, a test of problem solving and inhibition. Levin et al. further utilized the TOL, a measure designed to test complex problem solving which requires the ability to plan, anticipate, inhibit errors, as well as the use of short-term memory. Levin et al. found a trend for better efficiency in problem solving on the TOL as age increased; however, there was not a statistically significant difference between children nine to twelve years of age and seven to eight year olds. The study revealed advances in performance on the TOL in children in the thirteen to fifteen-year old age group. Children nine to twelve years of age further demonstrated increased fluency, when compared to the seven/eight age group, on the verbal and design fluency tasks, thus suggesting these tests are useful when measuring executive functioning abilities in children. Levin et al. also found that on the CVLT-C, a measure of verbal memory, there was a pattern of greater efficiency in memory and decreased number of perseverations as age increased. Finally, on the Twenty Questions procedure, which tests a child's ability to plan, problem solve, and use logical constraint, children demonstrated increased inhibition with age, with the biggest shift occurring between the seven/eight and nine/twelve year age groups.

Krikorian, Bartok, and Gay (1994) agreed that performance on the TOL increases in a linear fashion, as age increases. They found that children in the sixth to eighth grade (ages 12-14) did not perform significantly different from young adults on the TOL. This is consistent with the general findings about the development of EF in children, thus suggesting the TOL is a useful measure for examining the planning component of EF in children. In summary, despite the cautions of Gnys and Willis (1991), research has demonstrated that although they were designed for use with adults, certain measures of EF may be equally applicable to children.

In addition to the question of the suitability of the existing measures with children, there are a number of other issues in the measurement of EF. The first is the complex nature of EF. The brain is a multi-faceted organ. The brain may be subdivided into many different regions based on the functions they serve. Furthermore, many areas of the brain appear to have a specific purpose. Dodrill (1992) stated that due to the multiple functions of the brain, one must use multiple tests, in order to fully assess impairment. Specifically, Burgess, Alderman, Evans, Emslie, and Wilson (1998) reported that because EF includes a myriad of abilities that may be impaired at varying levels, it is necessary to use multiple measures to assess these behaviors.

Ecological Validity:

An additional area that merits consideration when examining EF is the ecological validity of the measures being used. Lezak (1993) reports that although individuals with frontal lobe deficits may perform well on paper tests, “their worlds – and their family members – might be falling apart” (p. 24). Cripe (1996) reports that there is often a “notable discrepancy” between an individual’s performance on tests and the actual problems they experience in day-to-day life. Similarly, Helmstaedter (2001) suggests that the structure provided by many current psychometric tests may assist patients in organized manner, such that the actual difficulties associated with frontal lobe difficulties may be overlooked. In other words, difficulties that would be present in spontaneous or unstructured interactions could be managed or controlled as a result of the structure provided with standard administration. Ecological validity refers to the degree to which there is a match between these test results and real-world consequences. Given the multifaceted nature of EF described above, a good match may be difficult. The structure and guidelines provided by the testing environment are absent in the natural environment. Furthermore, the structure and guidelines that are provided in the testing environment may actually substitute for EF. Thus, by introducing factors not found in the natural setting, individuals may appear to exhibit better EF abilities in the testing environment. Franzen and Wilhelm (1996) suggest testing in a controlled setting may result in an overestimation of the child's actual functioning in an open environment. Conversely, they report also that the testing environment may also result in an underestimation of the individual's potential due to the possible interruption of natural coping strategies the individual may have developed (Franzen & Wilhelm, 1996). For EF in particular, the structure of the testing environment may actually provide cues to the examinee to inhibit and follow a plan. Thus, the ecological validity of tests of executive functioning may be questionable. Franzen and Wilhelm (1996) propose that the best method for assessing natural behavior is self-report or report by others. However, Goldstein (1996) reports that on self-rating measures individuals with brain damage or dysfunction are not always able to report objectively about the situation. Therefore, if we are to truly understand the deficits experienced in the real world by individuals with frontal lobe injuries it may be necessary to obtain a report of the observable behavioral deficits from a person who interacts regularly with the individual being tested. Shafer and Salmanson (1997) reported that, "listening to persons with epilepsy and their family members is necessary to appreciate the inherent limitations, changes and losses that may occur" (p. 91). For children, the most obvious respondent for this type of questioning is the parent. Specifically, Giordani (1996) reports that when evaluating the psychological and behavioral characteristics in individuals with epilepsy it is necessary to consult the patient's family. By interviewing family members of individuals with epilepsy, deficits experienced in day-to-day life, which are hidden on paper and pencil tests, may be revealed. Therefore, by interviewing family members, we may get a more realistic and accurate picture of the symptoms experienced by an individual with epilepsy that is necessary if correct treatment is to be provided.

In order to elucidate the difficulties individuals with neuropsychological impairment are experiencing it is important to utilize ecologically valid measures. Goldstein (1996) proposes that measures should be designed with ecological validity in mind. Recognizing the importance of ecological validity and parents' observations of behaviors associated with EF, the members of the research consortium of the National Academy of Neuropsychology developed the Children's Executive Functions Scale (CEFS) to examine the executive functioning of children as observed by the parents in the natural environment. This measure will be described in more detail in subsequent chapters; however, using a measure such as this may prove useful in the examination of executive functioning in children. In fact, Silver, MacDonald, Lane, & Kulesza (2002) examined the difference between various data sets examining executive functioning with children using the Wisconsin Card Sorting Test (WCST) and the CEFS (parent and teacher report). The authors found a significant correlation between parent and teachers ratings on various domains, suggesting that parents and teachers agree, to a significant degree, about the difficulties in executive functioning. However, there was not a significant correlation between performance on the WCST and teachers and parents reports of difficulties with executive functioning. Silver et al., (2002) claim that this finding is representative of the difficulties in measuring executive functioning and support the use of multiple measures when measuring this construct.

THE FRONTAL LOBES AND FRONTAL LOBE EPILEPSY

Limitations in Current Research

Although a great deal of research has been done in the area of frontal lobe functioning, there are still many questions about the specific deficits caused by frontal lobe dysfunction. Walsh (1982) reported that individuals with frontal lobe lesions often present as being free of specific deficits until appropriate tests are used. Furthermore, the majority of research in this area has focused on adults; thus, even less is known about the effects of frontal lobe dysfunction in children. Boone, Miller, Rosenberg, Duraza, McIntyre, and Weil (1988) describe a scarcity in the documentation of deficits associated with FLE in children and adolescents; however, their case study on a young adolescent with FLE suggests that adolescents with FLE may display the same symptoms detected in adults. Despite the limitations and scarcity of research, the following section will review the relevant aspects of the frontal lobes and their relationship to executive functioning, specifically in reference to FLE in children and adults.

The Frontal Lobes

The frontal lobes are said to be responsible for EF (Welsh & Pennington, 1988; Welsh et al., 1991; Weydant & Willis, 1994). However, there are still questions about the extent to which the frontal lobes are solely responsible for EF. In fact, Saint-Cyr, Bronstein, and Cummings (2002) describe the presence of five complex frontal-subcortical circuits, which originate in the frontal lobes but extend to various subcortical regions of the brain. These authors suggest that damage to any area of the circuitry may result in deficits similar to those experienced by individuals with damage restricted to the frontal lobes. Knowing this, one can conclude that an injury at any point along the circuitry may also result in compromised EF. While taking into account knowledge of this circuitry, this study will consider the effects of frontal lobe dysfunction. The following section will discuss deficits associated specifically with frontal lobe dysfunction.

Shulman (2000), in reviewing the recent literature of the neuropsychological functioning of the frontal lobes, describes the generally agreed upon functions of the frontal lobes. She concludes that the frontal lobes are generally believed to play a role in working memory, the attentional system, and executive processes. Hayashi and O'Connor (1997) reported that the frontal lobes are responsible for attention, judgment, reasoning, set maintenance, set shifting, as well as the capacity for temporal order. The frontal lobes are also said to play a role in flexibility of thought and organization of information (Jones-Gotman, 1991). Studies have reported that frontal lobe dysfunction can result in a lack of initiative (Benton, 1968; Blumer & Benson, 1975; Stuss & Benson, 1984). Furthermore, individuals with frontal lesions or other frontal damage frequently display difficulties with inhibition or impulse control (Benton, 1968; Benson & Stuss, 1982; Petrides & Milner, 1982). In addition to impaired inhibition and flexibility, Walsh (1982) reported that lack of concern can be related to frontal lobe damage. According to Walsh, individuals with dysfunction of the frontal lobes often have difficulties with abstract tasks and difficulties with planning and problem solving. Benton (1968) described individuals with frontal dysfunction as presenting with "inability to plan and follow through a course of action and to take into account the probable future consequence of one's action" (p. 53). Kolb and Wishaw (1990) identify a variety of deficiencies in individuals with frontal lobe impairment within the following areas: motor functioning, temporal memory, strategy formation, spatial relations, verbal and non-verbal fluency, inhibition, flexibility, initiation, and use of feedback to modify behavior. In a study by Alivisatos and Milner (1989) a group of adolescents and adults with excisions from the frontal lobe displayed an inability to use cues to modify their behavior. Thus, it appears that frontal lobe dysfunction can result in a variety of symptoms that can alternatively be viewed as impaired EF.

The frontal lobes are also said to be responsible for behavioral aspects of EF.   Kolb and Wishaw (1990) report, “one of the most obvious and striking effects of frontal lobe damage in humans is a marked change in social behavior and personality” (p. 483). In a study by Stuss and Benson (1984) individuals with frontal lobe impairment were found to have difficulties monitoring their personal behaviors. In addition, individuals with frontal lobe impairment are known to have difficulties using environmental cues that could affect the appropriateness of their behaviors (Passler et al., 1985). Walsh (1982) reported that individuals with frontal lobe dysfunction display a failure to use feedback to modify their behavior. Although less is known about the effects of frontal impairment on social functioning in children, it is known that children with frontal damage frequently have difficulties maintaining stable friendships (Riccio, Hall, Morgan, Hynd, Gonzalez, & Marshall, 1994). Thus, impairment to the frontal lobes may not only cause impairment in the problem-solving aspects of EF, but may also result in poor behavioral and interpersonal problem-solving which must be considered when working with this population.

In a review of the literature, Helmstaedter (2001) provides an anatomical summary of frontal lobe functions and possible dysfunctions. He summarizes that the posterior frontal lobe is responsible for preparation for and execution of movement, whereas the anterior frontal lobe is responsible for, “higher mental functions, such as anticipation and planning, initiative, judgment, and in the control of mood, will power, and the determination of personality (Helmstaedter, 2001, p. 385)." Furthermore, Helmstaedter (2001) delineates between the consequences of damage to the dorsolateral prefrontal cortex (impairment in executive functions and working memory) and the orbitofrontal cortex (difficulty in determining emotional valence, learning rules of social interactions, evaluating the consequences of behavior, and difficulties with attention).

Swartz, Halgren, Simpkins, and Syndulko (1994) report that the dysfunction found in individuals with FLE is expected to be similar to the dysfunction found in individual with lesions of the frontal lobe. In spite of these hypothesized similarities, Upton and Thompson (1996a) reported that individuals with FLE may also experience symptoms and characteristics different from those experienced by individuals with other types of frontal lobe dysfunction (tumor, traumatic injury, etc.). It is possible that these differences are due to the uncontrolled electrical activity associated with epilepsy which may travel to different areas of the brain causing a myriad of additional symptoms; conversely, in other types of frontal dysfunction the damaged portion is often restricted to a focal point. Due to the propagation of electrical activity, an individual with FLE may actually present with additional symptoms compared with an individual with damage restricted to a particular location within the frontal lobes. Although one could cautiously compare individuals with FLE to individuals with other types of frontal dysfunction it is necessary to examine the specific effects of FLE.

Frontal Lobe Epilepsy

Luciano (1993) and Shulman (2000) reported that research in the area of FLE has lagged behind investigation of other forms of epilepsy; thus, much less is known about the effects of FLE. In addition, Upton and Thompson (1996b) report that few studies have been conducted concerning the neuropsychological deficits of FLE. It is known, however, that individuals with FLE often present with a variety of impairments on neuropsychological testing. Despite the paucity and limitations in the research of FLE, the following section will describe what is known about the symptomatology associated with FLE.

Research has revealed a number of behavioral and neurological deficits associated with FLE. Upton and Thompson (1996a) found that adults with FLE displayed impairment in EF. Individuals with FLE were found to have difficulties with inhibition, planning, and problem solving. Helmstaedter et al. (1996) further reported adults with FLE often display deficits in attention. Behavioral difficulties, such as poor impulse control related to EF, may be exhibited in individuals with FLE. Mataró et al. (1998) found that adults with FLE were more impaired than controls on Corsi's Block Span (Milner, 1971), a measure of visual-spatial memory, and on the Category Word Generation task of the Controlled Oral Word Association (Benton & Hamsher, 1976), a measure of verbal fluency. In a review of the literature, Helmstaedter (2001) summarized that patients with FLE display difficulties in executive functions (response selection, initiation, and inhibition). Furthermore, in this same review, Helmstaedter (2001) summarizes the findings of several research studies in which he participated in the investigation, concluding that individuals with FLE also display difficulties with attention, cognitive impairments, hyperactivity, increased conscientiousness, obsessive tendencies, and addictive behaviors.

Research in the area of FLE has traditionally focused on adults. Boone et al. (1988) describe a paucity of studies in regards to children and adolescents with FLE. The following is a review of what is known about children with FLE. In a case study, Boone et al. found an adolescent with FLE to display a variety of difficulties with, "attention, response inhibition, alternation between tasks, maze solving, word generation, and motor functioning" (p. 585). Perez, Davidoff, Despland, and Deonna (1993) found four children with epilepsy from a frontal focus displayed a variety of behavioral difficulties, including the following: inattention, hyperactivity, impulsiveness, aggressiveness, disinhibition, perseverative behavior, no sense of danger, and mood changes. A study by Devinsky, Hafler, and Victor (1982) further found three patients with FLE reported experiencing aversive mental images. Waterman, Purves, Kosaka, Strauss, and Wada (1987) reported the following verbal behaviors associated with FLE: shouting, laughing, and cursing. Ott et al. (2003) report that pediatric epilepsy is associated with a higher frequency of psychopathology than that found in the general population. In fact, Ott et al. (2003) found that approximately 60% of their study population had a co-morbid psychiatric diagnosis; however, this was with a general population of children with epilepsy. Despite the findings of a higher incidence of psychopathology in children with epilepsy in general, few studies have directly examined the incidence of psychopathology in children with FLE. In an examination of behavioral difficulties in children with FLE, Hernandez et al. (2003) found only difficulties with attention problems in this population. Further research is needed to clarify the co-occurrence of psychiatric disorders in children with FLE.

More recently, Riva, Saletti, Nichelli, and Bulgheroni (2002) reported that children with FLE had variable scores on measures of frontal lobe functioning; however, the results did suggest poorer performance on measures of frontal lobe functioning than on measures of intelligence. Riva et al. (2002) concluded that the focal side of the epilepsy, age of onset, and seizure frequency influenced the nature of deficits, such that children with left-side focal FLE displayed greater deficits in categorization, verbal long-term memory, and visuospatial analysis, children with a seizure onset before the age of six displayed greater difficulty modifying behavioral strategies, and children with more frequent seizures displayed impulsivity in responding, as well as inattention. Upton and Thomson (1997) found that individuals with FLE will perform variably on measures of cognitive functions depending on the age of epilepsy onset. These authors further conclude, "Indeed, the results of this investigation, along with others, make it unlikely that a typical frontal lobe epilepsy cognitive profile will ever be described. (Upton & Thompson, 1997, p. 1110)."

THE TEMPORAL LOBES AND TEMPORAL LOBE EPILEPSY

The Temporal Lobes

Studies have revealed that the temporal lobes play a major role in the function of memory. A lateralization effect has been revealed within temporal lobe functioning, particularly in adults. The left temporal lobe is said to play a role in verbal memory, whereas the right temporal lobe is associated with visual memory (Kolb & Wishaw, 1990; Lezak, 1995). Additionally, Kolb and Wishaw reported that right temporal lobe dysfunction can result in difficulties processing music, whereas dysfunction in the left temporal lobe may cause difficulties comprehending speech sounds.

Temporal Lobe Epilepsy

A great deal of research on the effects of TLE has been conducted. Studies have revealed that adults with TLE often have difficulties with memory; furthermore, as expected, studies have revealed that lateralization of the seizure focus can influence the nature of the memory deficit. Studies have revealed that adults with left TLE (LTLE) show deficits in verbal memory, whereas adults with right TLE (RTLE) have impaired non-verbal or perceptual memory (Delaney, Rosen, Mattson, & Novelly, 1980; Hayashi & O'Connor; 1997; Perrine & Congett, 1994). A study by Helmstaedter, Pohl, and Elger (1995) suggests that adults with visual memory deficits, due to RTLE, may rely on verbalization to compensate for this deficit. Thus, deficits in visual memory may only be observed if the memory task presents a "verbal overload" (Helmstaedter et al., 1995, p. 354). Therefore, in testing for deficits in visual memory, it is necessary to use a measure that inhibits an individual's ability to compensate for visual deficits with verbal means; thus, by presenting a task with a "verbal overload", a true measure of visual memory deficits can be obtained.

Adults with TLE often display impairment in verbal fluency and psychomotor speed and attention (Helmstaedter et al., 1996). In this study, impairments also were found on the Visual-Verbal test (Feldman & Dragow, 1981), a measure of concept formation, and on the Stroop Test (Stroop, 1935), a measure of interference/response inhibition (Helmstaedter et al., 1996). Additionally, Mataró et al. (1998) found that the Verbal, Performance, and Full-Scale IQ of adults with TLE were significantly lower than the IQ scores of controls. Furthermore, significantly worse performance was displayed on a variety of measures of memory, perceptual, and frontal functions; however, when controlling for intelligence, a significant difference was present only for the Category Word Generation task.

Holzer and Bear (1997) reported that individuals with TLE often experience a variety of behavioral changes. These changes include: hyperreligiosity, viscosity or a tendency to repeatedly discuss interpersonal issues, and occasional aggressive behaviors. They further reported that there may occasionally be post-ictal aggression likely due to the confusion which accompanies this stage (Holzer & Bear, 1997). Perrine and Congett (1994) described the following personality traits as characteristic of individuals with TLE: viscosity, circumstantiality, heightened emotionality, obsessiveness, hyperreligiosity, depression, aggression, paranoia, and dependency. Bear and Fedio (1977) report that when compared to those with LTLE, adults with RTLE typically report engaging in more socially appropriate behavior. Furthermore, adults with RTLE report greater elation and demonstrate more denial than do individuals with LTLE. Patients with LTLE on the other hand, typically are more self-critical and frequently display idealistic thinking and catastrophic reactions (Bear & Fedio, 1977). In a review of the literature, Helmstaedter (2001) concludes that depression, anxiety, neuroticism, memory impairment, and social limitations are common in individuals with mesial TLE.

Research in the area of TLE has typically focused on adults. Camfield, Gates, Ronen, Camfield, Ferguson, and MacDonald, (1984) reported that most studies on the lateralization of TLE has focused on adults; they further suggest that children with TLE may present differently than adults with TLE due to damage to the brain during the crucial development that takes place in childhood. Cohen (1992) also described a shortage of research on children with TLE and reported finding only two studies involving children prior to his 1992 study.

The following is a review of what is known about children with TLE. Cohen (1992) used the Comprehensive Children's Memory Scale (Cohen, 1986) to study differences between children with FLE and TLE. The Comprehensive Children's Memory Scale was an experimental edition that consisted of five auditory/verbal memory subtests and six visual/spatial memory subtests. Cohen found that children with LTLE were more impaired on the auditory/verbal subtests than were controls. Cohen further found that children with RTLE were more impaired on measures of visual/spatial memory than were controls. He failed to identify a significant difference between children with LTLE and RTLE. A study by Camfield et al. (1984) also failed to identify differences between children with RTLE and LTLE on measures of memory. Conversely, in a study by Jambaqué, Dellatolas, Dulac, Ponsot, and Signoret (1993), children displayed memory deficits similar to the deficits found in adults on the Signoret's Memory Battery (Signoret, 1991). The Signoret's Memory Battery is composed of six verbal and six visual memory subtests. These subtests include: immediate story and geometric figure recall, word and design list learning, delayed story and geometric figure recall, delayed word and design list recall, sentence and figure recognition, as well as word and figure associated pairs. In their study, children with LTLE demonstrated deficits in verbal memory, whereas children with RTLE had difficulties with visual memory. Their study similarly found that children with bitemporal epilepsy displayed difficulties in both verbal and visual memory. A study by Fedio and Mirsky (1969) further found that children with RTLE demonstrated compromised performance on visual memory tasks, whereas children with LTLE displayed impaired performance on tasks of delayed verbal memory. There are inconsistent results surrounding the nature of memory deficits found in children with FLE and TLE. Yet, the evidence from these studies suggests that there may be similarities between the difficulties experienced by both children and adults with TLE.

Hermann, Seidenberg, Bell, Rutecki, Sheth, Ruggles, Wendt, O'Leary, and Magnotta (2002) examined the impact of childhood-onset TLE on cognitive functioning. In this studies the authors examined the neuropsychological performance of individuals with early-onset TLE (mean age of onset 7.8 years), late-onset TLE (mean age of onset 23.3 years), and healthy controls. The authors found that individuals with childhood-onset TLE performed significantly worse than healthy controls on measures of intelligence (verbal, performance, and full scale), language functioning (naming and verbal fluency), visuoperception (spatial perception and facial discrimination), memory (verbal and visual), and executive functioning (problem solving and speeded psychomotor processing). Furthermore, individuals with childhood-onset TLE performed worse than individuals with late-onset TLE on measures of performance and full scale intelligence, naming, spatial orientation, verbal and visual memory, and problem solving. Finally, individual with late-onset TLE performed worse than healthy controls on measures of nonverbal memory and speed of processing.

As previously stated, it is commonly accepted that children with epilepsy have a greater incidence of psychopathology than the general population (Ott et al., 2003). Despite this, findings related to psychopathology in children with TLE are mixed. Kaminer, Apter, Aviv, Lerman, and Tyano (1988), found that many children with TLE did display symptoms of moderate to severe depression; however, this finding also held true with children with chronic bronchial asthma. The authors also concluded that children with TLE did not have a high rate of other psychiatric disorders. Conversely, McLellan et al (2005) found that 83% of children in their study met criteria for a psychiatric illness. Clearly additional research needs to be conducted to determine the frequency of co-morbid psychiatric disorders in children with TLE.

FRONTAL LOBE EPILEPSY AND TEMPORAL LOBE EPILEPSY

Few studies have directly examined the differences between individuals with FLE and those with TLE. Individuals with FLE are believed to have primary deficits in EF, whereas individuals with TLE are believed to have primary deficits in memory. Hermann (1992) reports that if an individual with epilepsy performs poorly on tasks of frontal lobe functioning while his or her memory is intact, one would expect FLE. Hermann further reports that if the individual's performance on measures of frontal lobe functioning is adequate yet they display compromised memory one would expect TLE. In an article by Jokeit and Schacher (2004), they remind the reader that cognitive impairment in epilepsy is a function of multiple factors, including etiology, onset and duration of epilepsy, type of epilepsy, medications used, as well as seizure type, duration, frequency, and severity. These authors further conclude that, "specific associations between neuropsychological deficits and type of epilepsy and etiology are rather exceptions." (p. S19). The following section will review the general differences between individuals with TLE and FLE as well as differences related to EF and memory.

General Finding of the Differences Between FLE and TLE

Cognitively and behaviorally there are a variety of differences between adults with FLE and TLE. Various studies have found that adults with FLE were more impaired on the Stroop Test, a measure of one's ability to inhibit responses (Helmstaedter et al., 1996; Upton & Thompson, 1996a). On part B of the Trail Making Test (Reitan, 1958), a well known measure of cognitive flexibility, individuals with FLE made significantly more errors than individuals with TLE (Upton & Thompson, 1996a). Helmstaedter et al. (1996) found that individuals with FLE were more impaired on digit span tasks and measures of working memory; they further found that individuals with FLE displayed more errors on the Maze-Test, a measure of planning (Chapuis, 1992) than did adults with TLE. Furthermore, adults with FLE were more impaired than those with TLE on the Visual-Verbal test, a measure of concept formation. When the measures were clustered, adults with FLE were significantly more impaired on tasks of motor programming and coordination and on tasks requiring response maintenance and inhibition than were adults with

TLE. Exner, et al. (2002) found that adults with FLE performed significantly worse than adults with TLE on only the digit span forward task of the Wechsler Memory Scale – Revised (WMS-R; Wechsler, 1987). Mataró et al. (1998) has shown that adults with TLE performed numerically worse than controls and individuals with FLE on a battery of neuropsychological tests assessing intelligence, memory, perceptual, and frontal functions. However, in their study, a statistically significant difference between FLE and TLE was found only on the Visual Reproduction subtest of the Wechsler Memory Scale (Mataró et al., 1998). Helmstaedter (2001) summarizes that individuals with FLE are less affected by mood disorders than individuals with TLE. Furthermore, he reports that individuals with FLE frequently show better academic performance than individuals with TLE. Thus, some studies suggest that there are important differences in neuropsychological functioning between individuals with FLE and TLE.

While many studies have suggested important differences in neuropsychological functioning of individuals with FLE and TLE, other studies have not revealed significant differences in functioning. In the study by Exner et al. (2002), few differences were revealed between the neuropsychological functioning of individuals with FLE and TLE. For example, individuals with FLE and TLE did not perform significantly different on measures of intellectual functioning; however, it should be noted that individuals in both groups performed worse than controls. In the same study, individuals with FLE and TLE performed similarly poorly on the Wisconsin Card Sorting Test, with over half of participants with both TLE and FLE performing below the 16th percentile. On measures of memory functioning, as assessed by the WMS-R (Wechsler, 1987), both individuals with FLE and TLE performed more poorly than controls on the digit span backward, logical memory (immediate and delayed recall), and visual reproduction (delayed recall). The authors further found that individuals with FLE and TLE did not perform significantly different on measures of concept formation or on an emotional conceptualization task. It is important to remember that the above studies were conducted on adults with FLE and TLE. There could be significant differences between the abilities of adults and children with epilepsy.

Few studies have directly examined differences between children with FLE and TLE. Further investigation of these differences in children is merited if clinicians are to provide the best services and treatment to this population. A study by Blanchette and Smith (2002) examined language abilities in children with FLE and TLE before and after surgery to control intractable epilepsy. The results indicated no differences in language functioning (expressive and receptive vocabulary, comprehension, reading, spelling, and phonemic and categorical fluency) before or after surgery. Not surprisingly, the authors did report a laterality effect, such that children with left-sided lesions performed worse than children with right-sided lesions on the category fluency and token test (Blanchette and Smith, 2002). A study by Culhane-Shelburne, Chapieski, Hiscock, and Glaze (2002) also examined the differences between children with FLE and TLE. The authors found that both children with TLE and FLE displayed difficulties with inattention when compared to the normative sample; however, there was not a significant difference between children with FLE and TLE on measures of attention. In the same study, children with TLE performed significantly worse than children with FLE on three measures of verbal memory (immediate story memory, story memory after a delay, and a delayed recall measure); however, the overall scores for both groups were within normal limits. The results did not yield significant differences in performance for children with FLE and TLE on measures of nonverbal memory.

Differences Between FLE and TLE on Tasks of EF

Impulse control is one area in which differences have been displayed between individuals with FLE and those with TLE. As reported previously, Helmstaedter et al. (1996) revealed that adults with FLE show significant impairment in response inhibition when compared to those with TLE. Helmstaedter, Gleibner, Zentner, and Elger (1998) also found that adults with FLE were more impaired than those with TLE on response inhibition, as evidenced by their performance on maze testing and on the c.I.-Test (cerebraler Insuffizienz Test), a test which assesses visuo-perceptual speed and interference effects. Finally, Perez et al. (1993) found four children with frontally focused epilepsy displayed impulsiveness.

Executive functioning also includes the ability to interact appropriately in social interactions. Individuals with FLE often display socially inappropriate behaviors. Waterman et al. (1987) found that individuals with FLE often display the following behaviors: shouting, laughing, and cursing. Baron, Fennell, and Voeller (1995) report that children with FLE experience the following behavioral symptoms: laughter, sexual behavior, and screaming. Perez et al. (1993) reported four children with FLE displayed aggressiveness, mood changes, and reduced play. Individuals with TLE also display socially inappropriate behaviors; however, the presentation of socially inappropriate behaviors differs in individuals with FLE and TLE. Devinsky et al. (1982) reported that anxiety and aggression are often present in individuals with TLE. Holzer and Bear (1997) reported individuals with TLE may display the following traits: hyperreligiosity, viscosity, and aggressive behaviors. In addition to the aforementioned traits Perrine and Congett (1994) report individuals with TLE often display: circumstantially, heightened emotionality, obsessiveness, depression, paranoia, and dependency. Thus, both individuals with FLE and TLE may display difficulties with social inappropriateness, although the specific presentation may vary.

Problem solving ability also fits under the umbrella of EF. In the Upton and Thompson (1996a) study, adults with FLE were found to be more impaired than individuals with TLE on the Twenty Questions Task (Denny & Denny, 1973). Culhane-Shelburne, Chapieski, Hiscock, & Glaze (2002) directly examined executive functions in children with FLE and TLE. In this study, children with FLE performed significantly worse than children with TLE on eight measures of executive functioning using the Tower of London and the Twenty Questions test. This study supports the belief that the frontal lobes play an important role in executive functioning and that children with FLE are likely to be more impaired than individuals with TLE on measures of this type; however, other studies have not yielded similar findings. Anderson, Damasio, Jones, and Tranel (1991) found no differences between adults with FLE and TLE on the Wisconsin Card Sorting Task (WCST), a well known measure of problem solving. In addition, other studies have shown that individuals with TLE may present as individuals with FLE on the WCST as they demonstrated a high number of perseverative responses (Hermann et al., 1988); however, this may be due to the propagation of neural activity that takes place in individuals with epilepsy. It is possible that although individuals with TLE may display difficulties with problems solving on table-top measures, they may not evidence these difficulties in actual life experiences.

It is commonly believed that the frontal lobes play a role in initiative or volition (Kolb & Wishaw, 1990; Lezak, 1995). Although no studies have compared individuals with FLE and TLE, given that the frontal lobes are said to be responsible for initiative, it is believed that individuals with impairment of the frontal lobe, such as epilepsy, would display greater impairment in initiative than individuals with temporal lobe impairment.

Helmstaedter et al (1996) found that individuals with FLE were more impaired on measures of psychomotor speed and attention, motor coordination, and motor control than were individuals with TLE. Additionally, Upton and Thompson (1996a) found that adults with FLE were more impaired on tests of motor sequencing than were individuals with TLE. Helmstaedter et al. (1998) found greater impairment in adults with FLE than TLE in motor coordination, specifically a task in which they were required to do unimanual and bimanual alternating sequences. The literature suggests that behavioral differences, as well as differences on standardized tests will need to be examined if the specific effects of FLE in children are to be determined.

AIMS OF STUDY

Despite advances in medical technology there is still considerable difficulty differentiating between behavioral components in children with frontal and temporal lobe epilepsy. Furthermore, often times when children's performance on traditional tabletop tests suggests an absence of neuropsychological dysfunction, parents may report a different story. Many sources have discussed the necessity of parent-report measures when assessing for deficits in EF (Franzen & Wilhelm, 1996; Goldstein, 1996; Shafer & Salmanson, 1997). Giordani (1996) further discussed specifically the need to consult family members in order to delineate symptoms experienced by individuals with epilepsy.

Given the deficits associated with executive functioning and the need for an ecologically valid measure, The Children's Executive Functions Scale (CEFS) may be useful to supplement tabletop measures. The CEFS was designed as a parent-report behavior rating scale to assess the following five behavioral domains: social appropriateness, impulse control, problem solving, initiative, and motor control. The CEFS was designed specifically with ecological validity in mind. This measure may be useful in differentiating between children with frontal and temporal lobe epilepsy. The CEFS may additionally be useful in delineating specific deficits in executive functioning that may be missed on traditional tests of executive functioning.

Current literature suggests that adults with FLE display impairment in the following areas: inhibition, cognitive flexibility, working memory, and planning. The Tower of London (TOL) is a well-known measure of EF. Anderson et al. (1996) suggests the TOL may be a useful tool in assessing impairment in EF in young children. The TOL is known as a measure of planning and problem solving; however, a score may also be calculated on the number of failed attempts, which is expected to correlate with impulsivity. Given that the TOL has shown utility with the pediatric population and that the TOL assesses many of the constructs of EF it was chosen as a representative measure for EF.

It is commonly believed that adults with RTLE display difficulties with visual memory, whereas adults with LTLE display deficits in verbal memory. It is likely that this pattern is also displayed in children with epilepsy. However, as Williams and Haut (1995) stated, there is a paucity of standardized memory measures; thus, assessment in children and adolescents has been limited. A measure of memory, which includes both verbal and visual memory components, may assist in delineating deficits in memory evidenced by children with FLE and TLE. The Wide Range Assessment of Memory and Learning – Second Edition (WRAML – 2; Sheslow & Adams, 2003), which yields a visual and verbal memory index, as well as a attention/concentration index and a general memory standard score, is expected to be sensitive to TLE. Williams and Haut (1995) report that children with epilepsy displayed greater impairment in memory than did children with substance abuse or psychiatric disorders in their exploratory study, which utilized the WRAML. They further stated that the WRAML appears to be a useful measure in the assessment of memory; however, they stated there is a need for additional studies. Given that studies have suggested the utility of the WRAML in assessing memory deficits in children and given the need for a measure which examines both verbal and visual memory, the WRAML-2 seems an appropriate choice.

Despite the knowledge that parents or other caregivers can provide valuable information regarding symptomatology, most studies have continued to use traditional tabletop measures when studying children with epilepsy. Several authors have suggested that to measure deficits accurately in individuals with neurological impairment, it is necessary to have an ecologically valid measure, which would include the observations of others. The CEFS, a parent report measure of EF, was specifically designed with ecological validity in mind. It is believed that the CEFS will be useful in delineating deficits in EF in children with FLE and TLE.

An additional measure that may prove useful in assessing the various behavioral domains of EF in children with FLE and TLE is the Child Behavior Checklist (CBCL). Similar to the CEFS, the CBCL is a behavior rating scale completed by parents, but it differs from the CEFS in that it comprises a broader range of behavioral domains. The CBCL also is a more well-known and accepted measure that yields scores on both problem behaviors and social competence. The CBCL also appears to be ecologically valid. It is also believed that the CBCL will be useful in differentiating between children with FLE and TLE.

This study will attempt to delineate specific deficits experienced by children with FLE and TLE to assist in outlining differences between the two groups. The study will further attempt to evaluate the utility of the TOL, WRAML-2, CEFS, and CBCL in discriminating between FLE and TLE in children.

HYPOTHESES

1. Individuals with FLE will have significantly higher Total scores (i.e., more impaired) on the CEFS than individuals with TLE.

Research has indicated that individuals with FLE have deficits in the various constructs of EF (Helmstaedter et al., 1996; Upton & Thompson, 1996a); therefore, it is hypothesized that individuals with FLE will display more impairment on the total score of the CEFS than will individuals with TLE.

2a. Individuals with FLE and TLE will not differ on the Social Appropriateness scale of the CEFS.

Research has revealed that individuals with FLE and TLE both display difficulties with social appropriateness at times. Individuals with FLE have been reported to display the following behaviors: aggression, anxiety, shouting, laughing, cursing, mood changes, and sexual behaviors (Baron et al., 1995; Devinsky et al., 1982; Perez et al., 1993; Waterman et al., 1987). Individuals with TLE also display a variety of behaviors which could be described as socially inappropriate. Studies have revealed that individuals with TLE display the following behavioral traits: obsessiveness, circumstantiality, hyperreligiosity, heightened emotionality, dependency, depression, paranoia, viscosity, and aggressive behaviors (Holzer & Bear, 1997; Perrine & Congett, 1994). Furthermore, findings are mixed related to the presence of co-morbid psychiatric illnesses in children with TLE (Kaminer, Apter, Aviv, Lerman, & Tyano, 1988); however, some research suggests a greater incidence of psychiatric difficulties in children with TLE (McLellan et al., 2005). Furthermore, limited research has examined the frequency of psychiatric disorders in children with FLE; however, one study suggested a greater incidence of attention difficulties in children with FLE. Given that in general pediatric epilepsy is associated with a higher frequency of psychiatric illness than that found in the general population (Ott et al., 2003) and that both children with FLE and TLE have been found to have psychiatric difficulties, both individuals with FLE and TLE may display difficulties with social inappropriateness.

2b. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Impulse Control scale of the CEFS than individuals with TLE.

Various studies have demonstrated that individuals with FLE are more impaired on measures of impulse control than are individuals with TLE (Helmstaedter et al., 1996; Helmstaedter et al., 1998). Furthermore, Perez et al. (1993) found impulsiveness in four children with epilepsy that had a frontal focus.

2c. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Problem Solving scale of the CEFS than individuals with TLE.

Studies have yielded inconsistent results related to problem solving abilities in individuals with FLE and TLE. Although some studies have indicated that individuals with FLE display greater impairment in problem solving than individuals with TLE (Upton & Thompson, 1996a) other studies have found no differences between individuals with FLE and TLE on measures of problem solving (Anderson et al., 1991). Additional studies have found individuals with TLE may present as having FLE on measures of problem solving (Hermann et al., 1988). The studies previously mentioned measured problem solving on table-top tests. Given that the present study will utilize parent report measures in addition to table-top measures, it is expected that individuals with FLE will be found to have greater impairment in problem solving.

2d. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Initiative scale of the CEFS than individuals with TLE.

Although no studies could be found that discussed initiative in individuals with FLE and TLE, the frontal lobes are believed to play a role in initiative or volition (Kolb &Wishaw, 1990; Lezak, 1995); thus, it is hypothesized that individuals with FLE will display greater impairment in initiative than individuals with TLE.

2e. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Motor scale of the CEFS than individuals with TLE.

Studies have revealed that individuals with FLE are more impaired on measures of psychomotor speed and attention, motor coordination, motor sequencing, and motor control than are individuals with TLE (Helmstaedter et al., 1996; Helmstaedter et al., 1998; Upton & Thompson, 1996a).

3a. Individuals with FLE will earn significantly lower overall standard scores (i.e., more impaired) on the TOL than individuals with TLE.

Individuals with FLE are expected to be more impaired on the overall score of the TOL, given their reported deficits in planning, problem solving, and impulsivity (Upton & Thompson, 1996a; Helmstaedter et al., 1996; Helmstaedter et al., 1998).

3b. Individuals with FLE will make significantly more errors related to broken rules on the TOL than individuals with TLE.

The TOL is a measure of planning, problem solving, and impulsivity (Upton & Thompson, 1996a; Helmstaedter et al., 1996; Helmstaedter et al., 1998). Given that these are constructs of EF and that individuals with FLE are believed to be more impaired on measures of planning, problem solving, and impulsivity, it is hypothesized that individuals with FLE will display greater impairment on this variable than will individuals with TLE.

3c. Individuals with FLE will have significantly more failed attempts on the TOL than will individuals with TLE.

The failed attempts scale of the TOL is a measure of impulsivity. Given that individuals with FLE are commonly believed to be more impulsive than individuals with TLE (Helmstaedter et al., 1996; Helmstaedter et al., 1998), it is hypothesized that individuals with FLE will display greater impairment than individuals with TLE on this variable of the TOL.

3d. Individuals with FLE will have a significantly faster reaction time on the first move of trial one of the TOL than individuals with TLE.

It is believed that a faster reaction time on the first move of the TOL is indicative of impulsivity. Individuals with FLE are known to be more impulsive than individuals with TLE (Helmstaedter et al., 1996; Helmstaedter et al., 1998); thus, it is expected that they will display faster reaction times on the first move of the TOL.

3e. Individuals with RTLE will perform significantly worse on the Visual Memory Index of the WRAML-2 than individuals with FLE or LTLE.

Individuals with RTLE display deficits in visual memory (Jambaqué et al., 1993). Thus, it is hypothesized that individuals with RTLE will score significantly worse on the visual memory index of the WRAML-2 than will individuals with LTLE or FLE.

3f. Individuals with LTLE will perform significantly worse on the Verbal Memory Index of the WRAML-2 than individuals with FLE or RTLE.

Individuals with LTLE are believed to have deficits in verbal memory (Jambaqué et al., 1993); thus, it is hypothesized that individuals with LTLE will score significantly worse on the verbal memory index of the WRAML-2 than will individuals with RTLE or FLE.

4a. Individuals with FLE and TLE will not differ significantly from the externalizing scale of the CBCL.

The externalizing scale of the CBCL is made up of Delinquent and Aggressive behavior syndrome scales (Achenbach, 1991). Research suggests that both individuals with frontal lobe impairments and FLE, as well as individuals with TLE may display aggressive behaviors (Holzer & Bear, 1997; Perez et al., 1993). It is likely that children with FLE will have clinical elevations on the externalizing scale, although it may not be a useful scale in differentiating between children with FLE and TLE; however, the information will provide valuable information about the functioning of both individuals with FLE and TLE.

4b. Individuals with TLE will have a significantly higher score (i.e., more impaired) on the Internalizing scale of the CBCL than individuals with FLE.

The following behaviors are associated with the Internalizing scale of the CBCL: withdrawal, somatic complaints, anxiety and depression (Achenbach, 1991). Research suggests that both individuals with FLE and TLE often display anxiety (Baron et al., 1995; Devinsky et al., 1982;

Waterman et al., 1987). This is not surprising given the unexpected nature of epilepsy. Furthermore, it is likely, given their medical condition that both individuals with FLE and TLE would display somatic complaints. Perrine and Congett (1994) reported that individuals with TLE often display depressive symptomatology. Both individuals with FLE and TLE display symptoms that are consistent with the Internalizing scale of the CBCL. However, it appears that individuals with TLE may display a higher number of internalizing symptoms; thus, it is hypothesized that individuals with TLE will have a higher score on the Internalizing scale of the CBCL.

4c. Individuals with FLE and TLE will not differ on the Social Competence scale of the CBCL.

Individuals with FLE and TLE both display difficulties with social appropriateness or social competence, as reported for Hypothesis 1a. Thus, both individuals with FLE and TLE may display impairment on the Social Competence scale of the CBCL.

CHAPTER THREE
Methodology

OVERVIEW OF STUDY

One purpose of this study is to compare the neuropsychological presentation of children with FLE to children with TLE with the intent of finding both tabletop and behavioral rating measures that will assist in differentiating between the two groups. Another purpose of this study is to examine the usefulness of the Children's Executive Functions Scale (CEFS) in differentiating children with FLE and TLE. The CEFS, a measure designed to be ecologically valid, may assist in delineating specific deficits in executive functioning that may be missed on traditional tests of executive functioning. Finally, this study aims to distinguish the types of memory deficits which may be unique to children with RTLE versus LTLE. A total of 60 children, 30 with FLE and 30 with TLE, and their parents will be included in this study. All participants will be administered a battery of neuropsychological measures, which research has indicated are relevant to use with these children. Additionally, a parent or guardian of each child will complete two rating scales about his/her children's behavior.

Participants

The participants will consist of 60 children with epilepsy, who are patients at Children's Medical Center (CMC) of Dallas in Dallas, Texas and their parents. The participants will be divided into two groups: (a) children with FLE and (b) children with TLE. Children with TLE will further be divided into two groups (a) children with RTLE and (b) children with LTLE. The participants with epilepsy will range in age from 6 to 17. Basic demographic data such as age at diagnosis, gender, ethnicity, age, and socioeconomic status will be collected. The participants will be chosen from current files from the CMC epilepsy clinic. Participation will be on a voluntary basis. Furthermore, participants will receive no compensation for their part in the study. An introductory letter will be sent to the parents explaining the nature of the study. The following criteria will be used to determine if participants are appropriate for the study:

1. Diagnosis of purely frontal lobe or purely temporal lobe epilepsy, as defined by EEG findings.
2. Chronological age between six and seventeen.
3. Estimated Full Scale IQ above 70.
4. No primary sensory impairments.
5. No other neurological conditions (e.g., traumatic brain injury, brain tumors, etc.) or additional medical conditions involving the central nervous system.

Materials

Parent Questionnaire

A parent questionnaire designed to collect basic demographic information and information regarding the health status of the participants will be utilized.

Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003a)

The Vocabulary and Block Design subtests of the WISC-IV, will be utilized as a screening of intellectual functioning. This short-form of the WISC-IV demonstrates good reliability, (r=.916) and validity, (r=.874) (Sattler & Dumont, 2004). Scores from the short-form will be converted into a deviation quotient using the Tellegen and Briggs (1967) method as detailed in Sattler and Dumont (2004). This WISC-IV is the “gold standard” for assessing intellectual functioning in children. The WISC-IV was chosen to be used in this study given the solid research supporting the use of this measure with children and because of the option to use the short-form to assess intellectual functioning. As with previous versions of the Wechsler Intelligence Scale for Children, the WISC-IV demonstrates good reliability and validity (WISC-IV; Wechsler, 2003a).

Children’s Executive Functions Scale (CEFS; Silver, Kolitz-Russell, Bordini, & Fairbanks, 1993)

The CEFS is a 99-item parent-report measure designed by members of the research consortium of the National Academy of Neuropsychology. At the present time normative data for the CEFS are still being collected. However, given the development of EF it appears appropriate to give the measure to children between the ages of six and twelve and older children with impaired EF. It is expected that children under the age of six have just begun to develop EF abilities; thus, “deficits” in EF are to be expected. Furthermore, children over the age of twelve should have fully developed EF abilities; thus, a “ceiling effect” would likely be demonstrated in unimpaired children. However, the measure may be useful in elucidating EF deficits in neurologically impaired children over the age twelve. The CEFS was designed to examine the EF of children in the natural environment. Five domains of EF assessed by the CEFS are: social appropriateness, impulse control, problem solving, initiative, and motor control. Items are rated by the parent on a three point Likert-type scale based on how often the child exhibits the various behaviors (0 = Never or Almost Never, 1 = Sometimes, 2 = Very Much). Thus, the CEFS may be useful in delineating specific deficits in individuals with FLE and possibly TLE. Furthermore, the CEFS addresses the issue of ecological validity by obtaining ratings about EF from individuals in the children's immediate environment. Preliminary data from Goulden (1998) suggest that the CEFS correlates highly with the Externalizing scale of the Child Behavior Checklist (CBCL; r=.73), as well as the Hyperactivity, Impulsivity, and the Conduct scales of the Conner's Parent Rating Scale (Conners, 1989), (r=.72, r=.62, and r=.62), respectively. A study by Molho (1996) found that the CEFS successfully discriminated children with ADHD from nonclinical controls, (p<.0001). The utility of the CEFS with children with FLE and TLE has not yet been examined. Given that initial research suggests the utility of the CEFS in assessing executive functioning abilities in the pediatric population and the need to determine additional measures that are useful in distinguishing children with FLE from children with TLE, this measure was chosen over other pediatric measures of executive functioning.

The Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1986)

The CBCL is a widely tested and accepted parent report measure; thus, this measure will be used as a tool to assist in comparing the behavioral difficulties related to EF experienced by children with FLE and TLE. The CBCL is a 118-item parent report measure designed to assess behavioral and emotional problems in children two to 18 years of age. On the Problem Behavior scales, parents rate their children's behavior of the past six months on a 3 point Likert-type scale using the following ratings: 0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true. In this study the CBCL/4-18, a version designed for individuals between four and eighteen years of age, will be utilized. This test yields internalizing and externalizing scores and scores on eight problem behavior domains. Furthermore, this measure yields scores based on both Syndrome and Competence scales. The Syndrome scales include Withdrawn, Somatic Complaints, Anxious/Depressed, Social Problems, Thought Problems, Attention Problems, Aggressive Behavior, Delinquent Behavior, as well as the Internalizing, Externalizing, and Total Problems scales. The Competence scales include Activities, Social, School, and Total Competence. Achenbach (1991) reported test-retest reliabilities of .87 and .89, respectively, for the Competence and Problems scales at a significance level of $p<.01$ (Achenbach, 1991). Furthermore, a study by Dorenbaum, Cappelli, Keene, and McGrath (1985) found that children with epilepsy were most impaired on the Social Functioning scale. The study revealed children with epilepsy display impairment on the overall Social scale and on the Social Competence scale. They suggest that the CBCL is useful in the assessment of children with epilepsy. Given the strong validity and reliability of the CBCL (CBCL; Achenbach & Edelbrock, 1986) and the fact that this measure has been extensively used to assess behavioral difficulties in the pediatric epilepsy population (Dorenbaum, Cappelli, Keene, and McGrath, 1985; Huberty, Austin, Harezlak, Dunn, & Ambrosius, 2000), this measure was chosen over other measures of behavioral functioning.

Wide Range Assessment of Memory and Learning – Second Edition (WRAML-2; Sheslow & Adams, 2003)

The WRAML-2 is a test battery developed by Sheslow and Adams to assess immediate and delayed memory, as well as verbal and visual aspects of memory. The WRAML-2 was developed for use with individuals from the ages of five to 90. The battery contains six core subtests, from which a Verbal Memory index, a Visual Memory index, and an Attention/Concentration index, as well as a General Memory standard score can be derived. Four optional subtests, three delayed recall subtests, and four recognition memory subtests are also available and can yield additional index scores. Results from a study by Williams and Haut (1995) suggest that the WRAML is helpful in delineating deficits in memory and attention in children with compromised neurological functioning. It is believed that the WRAML-2 will also prove efficacious for this same population; however, research investigating this new version of the WRAML is limited. The WRAML is a widely used and accepted measure of memory. This measure was chosen over other tests of pediatric memory functioning for several reasons. First, the age range for which the WRAML-2 is normed for late adolescents to be assessed; whereas some other measures of memory have a cut-off age of 16 (i.e., the Children's Memory Scale, Cohen, 1998). Furthermore, the WRAML- 2 demonstrates sound reliability and validity data.

Tower of London (TOL; Shallice, 1982)

The TOL, originally developed by Shallice for use with adults, was an adaptation of the Tower of Hanoi. Although this test was originally designed for use with adults, developmental norms have been established for children as young as seven years of age (Anderson et al., 1996; Krikorian et al., 1994). In this test, individuals are given an apparatus with three pegs and three colored beads (red, yellow, and blue). They are instructed to move the beads from their initial position to make certain patterns using a limited number of moves. The test consists of 12 combinations of increasing difficulty. Individuals are given three trials in which they are to form the correct configuration within the required number of moves. A total score is calculated from the sum of points from all 36 trials. The total score ranges from 0-36. This raw score can then be converted into a standard score. A score for failed attempts during each trial can be obtained as a measure of impulsivity. Additionally, the number of rules broken during each of the trials may be obtained. The purpose of the test is to measure problem solving or executive planning abilities. A study by Krikorian et al. revealed that as age increases, performance on the TOL improves in a linear fashion, with adult level performance being mastered by 12 to 14 years of age. Additionally, Anderson et al. found a significant correlation between the TOL and the following measures of executive functioning: the Controlled Oral Word Association Test (Gaddes & Crockett, 1975), Trail Making Test (Reitan, 1958), Rey Auditory-Verbal Learning Test (Rey, 1964), and the Rey-Osterreith Complex Figure (Osterreith, 1944,). Shallice (1982) looked at the performance of individuals with left, right, anterior, and posterior lesions on the TOL. The results suggest that the TOL is sensitive to dysfunction involving the left frontal lobe. The standardized procedures for the TOL, developed by Anderson et al. (1996), will be used in this study. Given that the TOL is a brief measure of executive function that is easy to administer and score and that research supports the utility of this measure in assessing frontal lobe difficulties this measure was chosen over other table-top measures of executive functioning.

Procedure

The participants will be tested at Children’s Medical Center of Dallas. A Masters-level psychology student will administer the tests. There will be two clinical groups. They will be as follows: (a) Children with FLE. (b) Children with TLE. There will be two types of participants (a) children with epilepsy and (b) their parents.

Statistical Analyses

An analysis comparing children with FLE and TLE on the total score of the CEFS (Hypothesis 1) will likely be analyzed using a t-test for independent groups, given that the distribution is normal. Analyses to determine if children with FLE differ from children with TLE on impulse control, social appropriateness, problem solving, initiative and motor coordination scales of the CEFS (Hypotheses 2a-2e) will be analyzed using the Kruskal-Wallis procedure for independent groups. Given a normal distribution, multivariate analysis of variance (MANOVA) will be used for the following analyses: broken rules, failed attempts, and overall score of the TOL, and the verbal and visual memory indices of the WRAML-2 (Hypotheses 3a-3f). If analyses reveal that there is not a normal distribution of scores on the scales of the TOL, Kruskal-Wallis will be used. Furthermore, if the results reveal that there is a need to control for IQ, or age of onset, for the neuropsychological variables, analyses will be completed using a multivariate analysis of covariance (MANCOVA). Additionally, a MANOVA will be used to analyze the Externalizing, Internalizing, and Social Competence scales of the CBCL (Hypotheses 4a-4c). Given the number of analyses being performed, the level of significance will be set at $p < .01$. Upon completion of analyses, if significant variables are found, a discriminant function analysis (DFA) will be used to determine how effectively one could predict if an individual has FLE or TLE utilizing these measures.

CHAPTER FOUR
Implications

The purpose of the following section is to consider the implications of the study if 1) the hypotheses are supported and 2) if the hypotheses are not supported. Support (or lack of support) for these hypotheses could have numerous implications related to the utility of the measures, the nature of deficits in FLE and TLE, and the role of the frontal and temporal lobes in neuropsychological functioning. The findings of this study could also have important implications in the understanding of deficits associated with FLE and TLE, would suggest the importance of educating significant others (i.e., family members, friends, and teachers) about the deficits, and could lead to treatment interventions to ameliorate deficits associated with FLE and TLE. The implications will be considered on a hypothesis by hypothesis basis; however, overall implications will be considered as well. This section will also discuss the limitations of this study.

1. Individuals with FLE will have significantly higher Total scores (i.e., more impaired) on the CEFS than individuals with TLE.

There are many possible implications if this hypothesis is supported. First, if this finding was supported, it could suggest that the CEFS is sensitive to delineating deficits in EF in children with epilepsy. This could provide further support for the utility of using various measures, including ecologically valid measures when examining the EF in children. Second, validation of this hypothesis would provide additional support that the frontal lobes are responsible for EF. Similarly, if individuals with FLE are more impaired on the Total score of the CEFS than individuals with TLE, it provides support that FLE is associated with deficits in EF. A finding such as this, would highlight the importance of educating those involved in day-to-day interactions with children with FLE to assist in understanding limitations associated with this condition. Finally, this finding would help treatment providers working with children with FLE to guide their interventions to assist in ameliorating the negative consequences of diminished executive functioning.

If this hypothesis is not supported (i.e., if there is not a significant difference between the Total score for individuals with FLE compared with individuals with TLE, or if individuals with TLE have a significantly higher Total score than individuals with FLE), it could suggest that the CEFS is not an efficacious measure for examining executive functioning abilities in children with FLE and TLE. Second, these findings could suggest that due to propagation of electrical activity from the temporal lobes to the frontal lobes, individuals with TLE have similar symptom presentation as those with FLE. This conclusion would provide support for researchers such as Jokeit and Schacher (2004) that believe that, "specific associations between neuropsychological deficits and types of epilepsy and etiology are rather exceptions." (P. S19). Lack of support for this hypothesis could also suggest that the frontal lobes are not solely responsible for executive functioning. Again, regardless of the direction of the findings, results could provide important implications for treatment and education.

2a. Individuals with FLE and TLE will not differ on the Social Appropriateness scale of the CEFS.

Support for this hypothesis could have implications related to the assessment of and intervention with children with FLE and TLE. Again, finding such as this could suggest that the CEFS is efficacious in assessing this population. Furthermore, if it is revealed that both children with FLE and TLE have limitations in the area of social appropriateness, it could guide clinicians in developing programs to assist in the enhancement of social skills in children with FLE and TLE. Interventions designed to address deficits in social appropriateness could assist children with FLE and TLE in having better peer interactions and relationships and possibly better academic functioning.

While it is expected that the scores on the Social Appropriateness scale of the CEFS will not differ for individuals with FLE and TLE, it is possible that individuals with TLE may present as more impaired or vice versa. Again, this finding could suggest the benefit of developing interventions to assist in developing social skills with either group. If the results revealed that individuals with FLE are more impaired than those with TLE, it could provide support that the frontal lobes solely are responsible for various aspects of executive functioning (i.e., behavioral inhibition).

2b. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Impulse Control scale of the CEFS than individuals with TLE.

This hypothesis is based on the fact that several studies have indicated that individuals with FLE are impulsive (Helmstaedter et al., 1996; Helmstaedter et al., 1998; Perez et al., 1993). If this hypothesis is supported, there could be numerous implications. First, it provides further evidence of the utility of the CEFS in assessing executive functioning in this population. Second, further evidence that the frontal lobes are solely responsible for executive functioning would be provided. Again, this would suggest that educational and intervention efforts should be geared at addressing impulse control in children with FLE.

Negative findings could provide further evidence that the frontal lobes are not independently responsible for EF. Failure to provide evidence in favor of this hypothesis could also imply that the CEFS is not good at measuring this dimension of EF.

2c. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Problem Solving scale of the CEFS than individuals with TLE.

As previously stated, studies have yielded inconsistent results related to problem solving abilities in individuals with FLE and TLE; however, most studies have measured problem solving on table-top tests. Support for this hypothesis would indicate that an ecologically valid measure, such as the CEFS, is necessary for determining deficits in problem solving in children with FLE and TLE. Again, this provides support for the theory that the frontal lobes are responsible for the EF, particularly problem solving. Such a finding would again highlight the importance of addressing problem solving abilities when caring for individuals with FLE and TLE. A lack of support for this hypothesis could indicate that both the frontal and temporal lobes play a role in problem solving or that the CEFS is not a useful measure in assessing problem solving.

2d. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Initiative scale of the CEFS than individuals with TLE.

While the frontal lobes are believed to play a role in initiative or volition (Kolb & Wishaw, 1990; Lezak, 1995), no studies could be found that discussed initiative in individuals with FLE and TLE. Such a finding, would provide further evidence that the findings from the frontal lobe literature can be generalized to the FLE literature, provide further validation for the CEFS, and would add support for the role of the frontal lobes in EF, particularly initiative. If this hypothesis was proven incorrect, it may bring into question the usefulness of the CEFS in examining initiative and could indicate that the temporal lobes play a role in EF (or in initiative).

2e. Individuals with FLE will have significantly higher scores (i.e., more impaired) on the Motor scale of the CEFS than individuals with TLE.

If this hypothesis is supported, it would suggest that interventions designed to enhance the motor abilities of individuals with FLE are warranted. Again, support for this hypothesis provides support for the CEFS. Where if the hypothesis is not supported, this could suggest limitations in the CEFS and could suggest that both the frontal and temporal lobes play a role in motor functioning. Realistic expectations and feasible interventions could be specified as a result of the findings from this hypothesis. .

3a – 3d. Individuals with FLE will earn significantly lower overall standard scores (i.e., more impaired), will make significantly more errors related to broken rules, will have significantly more failed attempts, and will have a significantly faster reaction time on the first move of trial one on the TOL than individuals with TLE.

The TOL requires the ability to plan, problem-solve, and inhibit responses. A lower overall standard score or a greater number of failed attempts suggest impairment in these abilities. Also, a high number of broken rules can suggest poor planning and impulsivity. Faster reactions times on the TOL are also indicative of impulsivity. Support for these hypotheses could further substantiate the use of the TOL in assessing EF and as a valid measure with children with FLE and TLE. Furthermore, this finding would provide evidence that the frontal lobes are solely responsible for these aspects of EF and would suggest that impairment in the frontal lobes, such as with FLE, leads to poorer planning and problem solving and greater impulsivity. Based on these findings, it would suggest that those interacting on a daily basis with individuals with FLE would want to be aware of these deficits and take steps to compensate or overcome such limitations.

If support was not provided for these hypotheses, it could indicate that the TOL is not useful in assessing EF in children with FLE or TLE. Lack of validation for this hypothesis could indicate that the deficits associate with epilepsy may not be due solely to the seizure localization, but rather the extent of the propagation of the electrical activity is a better indicator of functional limitations or deficits.

3e. Individuals with RTLE will perform significantly worse on the Visual Memory Index of the WRAML-2 than individuals with FLE or LTLE.

If the results of this study provide support for this hypothesis, this would provide further validation that the right temporal lobe is responsible for visual memory. Furthermore, such a finding would replicate the findings of Jambaqué et al. (1993). Additionally, if this hypothesis was supported, it could suggest that the WRAML-2 is an efficacious measure for examining memory functioning in children with epilepsy. With consistent findings that the right temporal lobes are responsible for visual memory, it could lead to the development of interventions and/or remediation programs designed to overcome or compensate for this deficit in children with RTLE.

If the results of the study did not confirm this hypothesis, it could suggest that the WRAML-2 is not efficacious in assessing visual memory deficits in children with RTLE.

This finding could also suggest that visual memory abilities are not differentially affected by TLE. Given that prior research has indicated that the right temporal lobes play a predominate role in visual memory, such a finding would indicate the need for further research.

3f. Individuals with LTLE will perform significantly worse on the Verbal Memory Index of the WRAML-2 than individuals with FLE or RTLE.

Similar to the last hypothesis, if the results of this study provide support for this hypothesis, this would provide further validation that the left temporal lobe is responsible for verbal memory. Support for this hypothesis could provide further evidence that the WRAML-2 is an efficacious measure for examining memory functioning in children with epilepsy. Again, consistent findings suggesting the verbal memory abilities are localized in the left temporal lobe would suggest the importance of developing interventions and treatments designed to address this deficit in children with LTLE.

If this hypothesis was not supported by the research study, it could suggest methodological difficulties, that the WRAML-2 is not sensitive to deficits in verbal memory experienced by individuals with LTLE, or that the left temporal lobes are not solely responsible for verbal memory. Given that previous research has indicated that the left temporal lobes are responsible for verbal memory, such a finding would suggest the importance of further research in this area.

4a. Individuals with FLE and TLE will not differ significantly from the externalizing scale of the CBCL.

Validation of this hypothesis would mirror the findings of Holzer and Bear (1997) and Perez et al. (1993) that individuals with FLE and TLE may display aggressive behaviors.

If this hypothesis was not confirmed (i.e., either individuals with FLE or individuals with TLE scored higher on the externalizing scale of the CBCL, this could indicate the utility of the CBCL in differentiating behavioral differences between children with FLE and TLE.

4b. Individuals with TLE will have a significantly higher score (i.e., more impaired) on the Internalizing scale of the CBCL than individuals with FLE.

Support for this hypothesis could indicate that children with TLE have higher levels of depression, anxiety, or withdraw than children with FLE. If this was revealed, it could be advantageous for researchers to further examine the nature of symptoms that led to elevation on this scale. An ability to determine if specific symptoms led to an elevation on the internalizing scale could assist treatment providers in making decisions about interventions with this population. Furthermore, support for this hypothesis could indicate that the CBCL is efficacious in distinguishing between children with FLE and TLE. Failure to find support for this hypothesis could simply be due to the fact children with FLE and TLE have similar levels of depression, anxiety, withdraw, and somatic complaints. If this hypothesis was not supported, it may indicate that the CBCL is not a useful measure to determine deficits in children with FLE and TLE.

4c. Individuals with FLE and TLE will not differ on the Social Competence scale of the CBCL.

If both individuals with FLE and TLE were impaired on the Social Competence scale of the CBCL, this finding would highlight the importance of addressing this deficit through treatment (i.e., this finding could suggest the importance of social skills training for children with FLE and TLE). On the other hand, if both children with FLE and TLE were rated within normal limits on this measure, it could suggest that the measure is insensitive to deficits associated with FLE or TLE or it could indicate that children with FLE and TLE are as socially competent as their peers. If one group was more impaired than the other, this information would be useful to assist treatment providers in intervening to address this deficit.

Overall, if the expected hypotheses are supported, this could suggest direction for future research and for treatment and interventions. However, if the hypotheses are not supported, it could be indicative of the nature of epilepsy. A growing number of researchers are questioning the utility of examining deficits associated with localized epilepsy (Jokeit & Schacher, 2004). Jokeit and Schacher (2004) summarize numerous studies that suggest that due to the anatomical connections and propagation of electrical activity, temporal lobe epileptic activity can also affect the frontal lobes. Similarly, Shulman (2000) concludes that deficits associated with FLE may "elude simple characterization" (p. 392). Riva et al. (2002) makes similar conclusions that clear classification of deficits by localization of epilepsy may not be realistic given the spread of electrical activities into anatomically close regions. Nevertheless, physicians do express the need for more knowledge about behavioral and performance differences that may differentiate between the two clinical groups.

LIMITATIONS OF STUDY

There are a number of limitations of this study that could influence the findings. The following section will review possible limitations. Specifically, limitations related to medication, measures utilized, sample size, and the statistical analyses performed will be considered.

Side Effects of Antiepileptic Drugs

One limitation of this study is the inability to accurately control for medication effects. Perrine and Congett (1994) report conflicting results of studies examining the cognitive side effects of antiepileptic drugs (AEDs). Loring and Meador (2001) state that the risk of cognitive side effects of AEDs is increased when the patient is involved in polytherapy, is taking higher doses of the medication, and has higher blood levels. Furthermore, Loring and Meador (2001) suggest that children may have increased susceptibility to cognitive or behavioral effects of AEDs due to the use of medication over the course of neurodevelopment. Durwen, Elger, Helmstaedter, and Penin (1989) found that the cognitive side effects of AEDs may vary as a function of seizure focus. Specifically, they found that individuals with left TLE had improved verbal memory following the reduction or depletion of AEDs. The following section will provide a review of medications currently used to treat children with FLE and TLE, as well as the side effects often related to these medications. Given the variety of medications and the numerous side effects experienced by individuals on AEDs, this review will not be exhaustive but rather a description of the common cognitive and behavioral side effects.

Carbamazepine

Perrine and Congett (1994) describe inconsistencies regarding the side effect profile of carbamazepine. In a review of the literature, Perrine and Kiolbasa (1999) suggest that current literature indicates there are no significant differences in the cognitive side effects of carbamazepine when compared with phenytoin and valproate. A study by Meador et al. (2001) examined the cognitive and behavioral effects of carbamazepine and lamotrigine in healthy adults. The results revealed that individuals using lamotrigine performed significantly better than individuals taking carbamazepine on 19 variables, including both objective cognitive measures (cognitive speed, reading speed, memory and coding) and subjective behavioral measures (mood factors, perception of cognitive performance, and perception of quality of life). Furthermore, individuals taking carbamazepine performed worse on measures of vigilance, cognitive speed, motor speed, coding, mood measures, perception of cognitive performance, and self-evaluated quality of life than individuals not taking medication. Although there is some indication that this drug can cause cognitive impairments, this finding is not consistent. Thus, there is a need for more studies to truly delineate the nature of cognitive impairment with carbamazepine.

Ethosuximide

Among the side effects associated with the use of ethosuximide are restlessness/agitation and inattention (Baron et al., 1995).

Phenobarbital

Side effects associated with phenobarbital include: depressive symptomatology, sedation, inattention, hyperactivity, and disinhibition (Baron et al., 1995). Calandre, Dominguez-Granados, Gomez-Rubio, and Molina-Font (1990) suggest that long-term phenobarbital use can have a negative effect on learning ability. Perrine and Congett (1994) further report that the AED that is expected to cause the greatest extent of cognitive impairment is phenobarbital.

Phenytoin

Baron et al. (1995) reported both cognitive and motor deficits are possible side effects of phenytoin (PHT). Perrine and Congett (1994) describe inconsistent reports of cognitive side effects in both comparison and control studies involving PHT. Although previous studies have suggested that PHT usage may result in more cognitive side effects than carbamazepine, a review of the current literature by Perrine and Kiolbasa (1999) suggests this is inaccurate.

Valproate

Perrine and Kiolbasa (1999) report that studies regarding the cognitive effects of valproate are inconsistent; yet they further report that a review of the literature indicates no significant increase of cognitive deficits resulting from the use of valproate when compared with other AEDs such as carbamazepine and phenytoin.

Vigabatrin or Gama-Vinyl GABA

Studies have yielded inconsistent results related to the side effects caused by vigabatrin. Baron et al. (1995) state that agitation is a common side effect experienced by children using vigabatrin. However, a study by Dijkstra, McGuire, and Trimble (1992) found no adverse side effects related to the use of vigabatrin. In a review of the literature, Ortinski and Meador (2003) claim that vigabatrin is associated with no substantial deterioration in cognitive functioning and no negative effects on quality of life.

Gabapentin

In a review article on the side effects of antiepileptic drugs, Ortinski and Meador (2003) report that the most common cognitive side effect associated with use of gabapentin is drowsiness. In a review of the literature by Meador, Gilliam, Kanner, and Pellock (2001) it is suggested that there were no significant differences in psychomotor and memory functioning in individuals taking gabapentin versus placebo.

Lamotrigine

Lamotrigine is a relatively new antiepileptic drug. As previously stated, in a review of the literature, Meador, Loring, Ray, Murro, King, Perrine, Vazquez, & Kiolbasa (2001) summarized that when compared with carbamazepine, lamotrigine was associated with better performance on 19 of 40 variables, including both objective cognitive measures (cognitive speed, reading speed, memory and coding) and subjective behavioral measures (mood factors, perception of cognitive performance, and perception of quality of life). Furthermore, in the same study, healthy adults taking lamotrigine performed better than individuals not taking medication on a measure of reading speed. Ortinski and Meador (2003) state that while numerous studies have revealed that lamotrigine use is not associated with negative cognitive side effects, use of lamotrigine is associated with better performance on measures of attention and memory functioning, fewer affective symptoms, and enhanced quality of life.

Measures

Another limitation of this study is that the Children's Executive Functions Scale (CEFS) is a measure which is still in development; therefore, comprehensive validity studies and factor analysis have not been performed. However, an item analysis revealed adequacy for all but one item on the CEFS. This item has been retained because it may provide information on a unique problem. Despite the fact that a factor analysis has not been completed on the CEFS, it is expected to be a beneficial measure in differentiating between children with FLE and TLE because of the face validity and positive results from a study of its discriminative validity (Molho, 1996).

Sample size and statistical analyses

An additional limitation of this study is the small sample size; however, the low incidence of discrete FLE and TLE makes acquiring a larger sample infeasible in this clinical setting. Furthermore, the study involves a large number of statistical analyses. Due to the small sample size and the various statistical analyses to be performed, the researcher set the level of significance at $p < .01$ to account for the high number of statistical analyses.

APPENDIX A
PARENT-CARETAKER QUESTIONAIRE

This information will remain strictly confidential and will be used

only to provide information necessary to complete this study.

Name of child:___________________________________ Gender: M F

Date of birth:_______________ Age:_____ Grade:_____

Age when diagnosed with epilepsy:_____ Handedness: R L

Name of parent/s completing this form:___________________________________

Parent's mailing address:____

Parent's phone number:(H)____________________ (W)____________________

Is your child currently taking any prescription medications? Y N

If yes, please list:____

Is your child enrolled in any content mastery, resource programming, or special ed. classes? Y N

If yes, please describe:____

Is your child currently being treated for a medical disorder, other than epilepsy? Y N

If yes, please describe the nature of the illness:_____________________________

____

The following questions are necessary in order to determine demographic information:

Years of school mother has completed:___________________________________

Mother's occupation:____

Years of school father has completed:____________________________________

Father's occupation:____

APPENDIX B
Letter

Dear Parent or Guardian:

We would like to ask your permission for your son or daughter to participate in a research project. This research project, called "Discrimination between Frontal and Temporal Lobe Epilepsy in Children," will help us better understand epilepsy.

What is involved? Participation in this study will take approximately three hours. One of the measures your child completes will be a measure of memory. The second measure is a measure of planning and problem solving. We will also ask you to complete two short surveys about the behavior of your child and one questionnaire providing demographic information.

Potential Benefits and Concerns. A possible benefit of this study is that through participation in this study, we will get a better understanding of epilepsy; thus, better treatment may be provided. Additionally, we will provide you with a report of the results and suggestions of how to incorporate these results into your child's everyday life. These suggestions will include tips to assist with your child's school performance. Third, this information may aid you in better understanding the experiences of your child. A potential concern is that although we will schedule this meeting with you, it may be necessary for your child to schedule the meeting during school hours. We will attempt to schedule all meetings during breaks from school or after school hours.

Participation is voluntary. Your participation and the participation of your child in this study is completely voluntary. At any time during the study, you may choose to withdraw or may refuse to answer any question.

Information is confidential. All information will be held as confidential. Only the researchers will have access to the questionnaires and test results.

Scheduling. I will be calling you with in the next couple of weeks to assess your willingness to participate in the study. If you choose to participate in this study, you may schedule a meeting at that time.

Questions? If you have any questions, please feel free to call Ms. Jennifer Clark (214) 648-1049. I will be happy to answer questions you may have about this study.

Sincerely,

Jennifer Clark, B.A.
Graduate Student
Rehabilitation Counseling Psychology

Cheryl Silver, Ph.D.
Professor
Rehabilitation Counseling Psychology

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VITAE

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