CHILDHOOD EPILEPSY AND PREDICTING EDUCATIONAL SUPPORT IN SCHOOLS: A longitudinal and latent profile analysis (LPA) study

By

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ABSTRACT

Childhood epilepsy is the most common neurological condition impacting every 6/1000 school-aged children. Children with epilepsy (CWE) have higher rates of difficulties in school performance, yet school personnel are not well-equipped to identify and support these students' academic needs. Schools are often poorly informed about how childhood epilepsy affects learning and the significant challenges children with epilepsy encounter in schools. CWE have been documented in multiple domains, including cognition, adaptive behavior, academics, emotional adjustment, motor ability, and social competence, all of which can influence quality of life. Several studies have documented the differences in many of these domains for CWE compared to typically developing peers. Yet to date, comprehensive screening measures within a school setting are not typically administered for children with epilepsy. One natural time point for such screening to be done would be at the time of initial epilepsy diagnosis. If all CWE had their school performance monitored from the time of diagnosis, adequate services would be delivered early in order to achieve a quality education, improved educational experience, and positive life-course trajectory. CWE would benefit from sufficient screening that provides detailed assessment in order to identify cognitive difficulties underlying academic problems to help address the specific learning needs associated with childhood epilepsy. However, because this type of screening is not typically conducted, it is not clear which children and what type of profile might suggest the need for more specific neuropsychological assessment. This dissertation examined the impact educational support service has on academic achievement over two years by investigating factors that impact academic success and the patterns of the educational performance domains among all participants. By utilizing latent profile analysis (LPA) methodology, the

project did not identified indicators of profile membership (e.g., seizure variables & caregiver factors) that contributed to academic difficulties. The project did reveal two distinct groups of CWE. However, the degree of academic support services did not mediate CWE's educational trajectory.

Chapter 1: Introduction

1. Overview

Approximately ten to fifteen percent of children suffer from chronic illness during their school□age years (1, 2). The most common childhood neurologic condition is epilepsy, with a prevalence of 1% that amounts to 6/1000 school-aged children (2, 3, 4,). Epilepsy can impact people of all ages, but children and adults over the age of 18 are more likely to have active epilepsy (5). Many times, the cause of epilepsy can be unknown, and research has found that schools face challenges frequently associated with childhood epilepsy (5).

Children with epilepsy (CWE) struggle to achieve academic success throughout their educational trajectory (4, 6, 7, 8, 9). Schools are often inadequately informed about how childhood epilepsy affects learning and the sufficient educational supports that can lead to CWE's academic success (10, 11). Experts in the field of education who have implemented best practice policies believe that school personnel are poorly educated about epilepsy, and the impact on CWE's academic performance and educational experience (e.g., a teacher` may mistakenly assume that a child's learning, emotional, behavioral and social adjustment are unrelated to epilepsy) (5).

While there has been limited study of U.S. teachers' attitudes and knowledge of CWE, there is a robust set of international studies that have focused on teacher attitudes and knowledge of CWE that indicate reason to be concerned (10). These studies have reported that teachers report a lack of knowledge and training in epilepsy in addition to having inaccurate and potentially dangerous beliefs about how to manage seizures (10) Additionally, Hsieh and Chiou (11) note that 30% of preschool teachers in Taiwan reported thinking epileptic seizures were

associated with insanity and had significantly lower acceptance of CWE. These studies suggest that educators may view learning or difficulties with learning as unrelated to epilepsy and the impact it may have on the child's learning, emotional, behavioral and social adjustment. This lack of knowledge CWE has led to problem behaviors in children, inappropriate classroom management techniques by teachers, and inaccurate placement and inadequate support guidelines in a child's Individualized Education Plan (IEP) (5, 9, 10,11, 12, 13).

The school setting should be an enriching environment that nurtures development and fosters positive learning behaviors. However, studies have shown that epilepsy impacts quality of life and the developmental trajectory in children, which negatively affects their educational journey (6, 9, 14). Therefore, it is critical to identify the elements that empower learning and services that support academic growth among CWE. Significant challenges that CWE face not only impact education but all domains of life.

Research has concluded that CWE experience difficulties in multiple domains of life when compared to their typically developing peers (TDP) (14). It is well documented that childhood epilepsy is associated with problems in cognition, adaptive behavior, academics, emotional adjustment, motor ability, and social competence, all of which influence quality of life (6, 13, 16, 17, 18, 19). Children who have recurrent seizures in schools are at an increased risk for behavioral problems and learning difficulties (4, 20). In a study by Almane, et al. (6), parents of CWE completed a child behavior inventory (i.e., Child Behavior Checklist [CBCL] from the Achenbach System of Empirically Based Assessment [21]), and the study revealed that the CWE had significantly more behavioral problems and lower social competence skills when compared to their TDP.

Childhood epilepsy is a disorder that involves a collection of symptoms that vary in frequency and intensity from child to child (18, 19, 22). Of those CWE, approximately 25% continue to experience poor seizure control even with antiepileptic drugs (AEDs) and therapy (i.e., surgery, devices, dietary changes, and paired with counseling) (23). Even when seizures are well controlled with AEDs, behavioral problems and learning difficulties often persist because of abnormal brain formation or function or side-effects from AED medications (24). In childhood epilepsy, there are apparent deficits in critical domains of development (e.g., in executive functioning, and word fluency) that affect CWE's ability to learn. Therefore, CWE should receive quality educational support to address these learning deficits and services to offset the educational disparity among CWE. According to the 1990 Individuals with Disabilities Education Act (IDEA) (24, 25) CWE are reported under the educational classification "Other Health Impairments (OHI)" with several other disorders. This classification suggests that educational services, such as IEPs, might be limited in addressing learning problems specific to CWE. Therefore, educational services should specifically target the factors that contribute to learning that are associated with CWE.

There is a consensus that CWE have learning difficulties, and stakeholders (e.g., educators and caregivers) are struggling to support them in schools (9). Educators and caregivers have reported many adverse effects of epilepsy on the educational opportunities and achievement for CWE. According to Dunn, et al. (4), CWE have significantly lower scores overall on achievement tests in the domains of math, spelling, writing, reading, comprehension, and general knowledge with poor performance scores in verbal learning, working memory, and word fluency. These scores are further reflected in CWE's lack of classroom engagement and problem

behaviors in schools (4). Poor achievement performance scores have also shown long term impacts on CWE's educational, career, and socioeconomic stability (4).

Another study found that half of CWE did not attend school regularly, and the main contributing factors which prevented them from attending school were ongoing seizures, learning difficulties, and behavioral problems (26). Therefore, academic performance, support services, and accommodations should be closely monitored in CWE (e.g., IEP or 504 plan). Some studies have examined the relationship between childhood epilepsy and educational support in schools, while others have sought to establish the prevalence rate of educational support services provided to CWE over time and discovered persisting deficits in academic achievement (6, 13, 27).

Epilepsy is a complex disorder that affects many aspects of a child's development and functioning. As a result, these children are at an increased risk for unsuccessful school experiences, difficulties in social engagement with peers, having inadequate social skills, and having poor self-esteem (28). A partnership between educators, family members, and health care providers must be instituted so that a plan for academic success and safety, management of emotional or behavioral dysregulation, and active social integration can be developed and evaluated on an ongoing basis (28).

The current project will explore the relationship between academic achievement, educational development (e.g., cognition and academic skills), and academic support services (e.g., special education service) among CWE. In order to address the education disparity in childhood epilepsy, this chapter will provide a general introduction to childhood epilepsy. Then, chapter 2 will examine the research related to the impact of childhood epilepsy in schools.

Chapter 3 will provide the project's research methodology by characterizing the sample population and the analysis rationale. Chapter 4 will present the project's analysis results. Finally, Chapter 5 will explore the relevant findings from the results and discuss the implications of the impact of CWE and educational support provided in schools.

1.1 Childhood Epilepsy

The American Academy of Neurology (AAN) indicates that there are many different types of epileptic seizures which vary depending on the affecting area of the child's brain (29). The AAN indicates that there are two main types of seizures: focal seizures (sometimes called partial seizures) and generalized seizures. Focal seizures affect only one side of the brain, and generalized seizures affect both sides of the brain. Generally, adults and children have the same types of seizures, although some may be more common in childhood than adulthood.

Childhood epilepsy is a disorder of the brain and it is characterized by enduring seizures that have neurobiological, cognitive, psychological, and social consequences (30). CWE, particularly infants, differ from adults not only in the clinical manifestations of their seizures, but also in the presence of unique electroencephalogram (EEG) patterns, etiologies, and response to antiseizure drugs (31, 32, 33). Children are more prone to seizures, but seizures are more apt to disappear as the child ages (i.e., develops over time). Childhood epilepsy has a broad spectrum of clinical manifestations, and many other conditions may resemble epilepsy (34, 35, 36). This spectrum often makes identification and the diagnostic process challenging, with a considerable risk of misdiagnosis (31, 32, 33, 34, 35, 36).

1.2 The Issues Encountered by those with Childhood Epilepsy

There is a high prevalence of neurobehavioral problems in school-aged CWE. Reilly and colleagues (17) reported that 80% of CWE met Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for intellectual impairment, disruptive behavior, poor impulse-control (OCD), and/or conduct disorders (CD) (1, 38). Research has consistently shown that there are problems with learning and behavior among the childhood epilepsy population, which has implications for educational, pharmacological (i.e., medication regime), and behavioral interventions.

Rodenburg, et al. (39) conducted a study that compared CWE and their TDP using a multi-informant perspective (i.e., parent report, teacher report, and self-report [CWE]). The study revealed that CWE are at a higher risk for developing psychopathology (DSM-IV disorders) that impacts learning compared to their TDP. There was consensus in the study among caregivers and educators (29). Prior research shows that CWE appeared to have both internalizing and externalizing behavioral problems (29). *Externalizing problems* are a spectrum that incorporates a variety of disinhibited or externally focused behavioral symptoms, including aggression, conduct problems, delinquent behavior, oppositionality, hyperactivity, and attention problems, whereas *internalizing problems* includes a variety of over-inhibited or internally focused behaviors, such as anxiety and depression (29). Previous research has concluded that the presence of externalizing problems remains consistently higher in CWE, and that family factors often influence psychopathology in CWE (15, 29). These results suggest that hyperactivity, defiant behavior, attention problems, withdrawn behaviors, thought problems, care issues (i.e., family care), social problems, and overall cognitive problems were found to be relatively specific to CWE.

1.3 Cognitive Functional Impairment in Childhood Epilepsy

A considerable amount of research has examined the presentation of CWE's cognitive ability and how it relates to academic performance (22, 23). The literature consistently shows that CWE experience difficulties in cognition and other domains of life (i.e., socialization, communication, and adaptive behavior); these difficulties manifest as symptoms in unique and individual ways. For this reason, CWE are characterized as being part of a heterogeneous group with notable clinical variability and comorbidity (i.e., mood disorders, behavior issues, attention deficits, and psychosis) (19, 22). The ability to process information (i.e., learn) is an essential skill for development because it enables individuals to acquire new skills to succeed in school and perform activities of daily living (17). Cognitive functioning is the process of learning that includes recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills (40).

The Smith, et al. (23) study compared cognitive and academic scores between TDP and two groups of CWE (i.e., group 1 had a history of brain surgery, group 2 had no history of brain surgery). Intelligence (IQ), memory, attention, and academic skills were examined in all participant groups ages 6 to 18 years (23). The study supported previous literature, showing that TDP performed better across all cognitive domains, and revealed minimal differences in cognitive performance between the two epilepsy groups (23). This study demonstrated that CWE with and without epilepsy surgery performing similarly across cognitive domains (23) and less well than TDP.

An innovative study by Seidenberg, et al. (41) revealed CWE's academic abilities are affected by seizure frequency, which can impact cognition (i.e., IQ), reading comprehension, and arithmetic retention. The findings from this research are consistent with current reports of academic deficiencies for CWE (41), such as the study by Smith et al. (23), that demonstrated

that CWE are more cognitively delayed than their TDP. Among the epilepsy groups, it was reported that those with more frequently recurring seizures performed worse across all cognitive and academic domains (18).

Reilly, et al. (18) conducted a study that identified the frequency of impairments in global cognition and reported that 60% of CWE had at least one DSM-IV (22) behavioral or psychiatric disorder, 55% had cognitive impairment, and 40% had Intellectual Disability (ID) (18). These studies have shown that childhood epilepsy is associated with a high rate of cognitive impairment with deficits in working memory and processing speed. Given the high rates of impairment in CWE, prevention techniques (e.g., cognitive screening) and interventions (e.g., education services) should be a regular component of CWE's educational journeys. Therefore, a gated screening (i.e., identifying students at-risk for academic problems) and evaluation system that progresses from global to more comprehensive evaluation is likely necessary to detect the relative difficulties, which may be subtle with respect to everyday functioning yet have a significant impact on educational attainment and quality of life.

In summary, there is a higher rate of school performance difficulties in CWE. CWE would benefit from a gated screening system that provides global then detailed assessment in order to elucidate the cognitive difficulties underlying academic problems to help address the specific learning needs of each child (6). For this reason, all CWE should have their school performance monitored and adequate services delivered to achieve quality education for a better life-course trajectory.

The study aims to advance research and understanding in the field by examining a longitudinal data set that utilizes a general academic screener, the Wide Range Achievement

Test-Revised (WRAT-R; 42) within the first 12 months of epilepsy diagnosis for children. Children are enrolled on a rolling basis and are also seen at baseline, 2 year (data complete). Subsequent to baseline data collection with the WRAT-R, additional academic measures with more specificity were added but have been collected for only a subset of CWE and controls (first cousins of the CWE). Information on academic supports, defined broadly, was collected at baseline and 2-year follow-up. Several of these factors will be examined via cluster analysis methodology to determine possible patterns and service needs for CWE subsequent to an initial diagnosis of epilepsy. The next chapter outlines details about epilepsy and primarily focuses on the impact of an epilepsy diagnosis for children as it relates to school-based learning.

Chapter 2: Literature Review

The purpose of this chapter is to provide a review of the literature regarding skills and impairments that are present for CWE and how that compares to children without epilepsy. The chapter begins with an introduction to epilepsy and then discusses considerations and concerns related to serving CWE in school settings. Next, it addresses the importance of developing and monitoring cognitive, academic, behavioral, and social skills for CWE is reviewed, followed by a discussion of the essential components of effective interventions for CWE. The majority of this chapter is dedicated to examining research related to the impact of epilepsy for children at the school level, and the various forms of assessment and accommodations that are needed to increase their short and long-term success. Review of specific accommodations, services, and assessments are examined in greater depth. Finally, the purpose and research questions for the study are specified.

2. Epilepsy

A diagnosis of epilepsy requires the occurrence of at least one epileptic seizure (43). It has been documented that after two unprovoked seizures, the risk of a third within 60 months is 73% (59-87%, 95% confidence intervals) (44). Epilepsy is considered to be resolved when individuals, who had an age-dependent epilepsy syndrome are past the applicable age, or those who have remained seizure-free for 10 or more years with no seizure medicines for at least five years (30). In order to diagnose epilepsy, epileptic seizures must be differentiated from provoked seizures (e.g., febrile) and other paroxysmal events (45). Previous studies have found large differences in the validity and precision of epilepsy diagnosis depending on the data source and the population studied (46, 47, 48, 49, 50, 51, 52, 53, 54). Most of the previous validation studies

included subjects of all ages and did not focus specifically on children. As such, there is a more limited knowledge about childhood epilepsy. However, approximately one out of 150 children is diagnosed with epilepsy during the first 10 years of life, with the highest incidence rate observed during infancy (45).

The principles of the neurological diagnosis should include a detailed medical history, complete general clinic and neurologic examination, diagnostic hypothesis, and selective choice of evaluations. These are all critical elements for epilepsy diagnosis for a correct and complete analysis and classification of signs and symptoms. (56). A diagnosis with a childhood epilepsy syndrome indicates that the epilepsy presents with specific characteristics such as: type of seizure(s), the age of seizure onset, and results of an electroencephalogram (EEG) (29).

An EEG test records the electrical activity of the brain. Epilepsy syndromes have a unique pattern of EEG discharges, which allows the neurologist to predict how the child's condition will progress. Some epilepsy syndromes are referred to as 'benign,' meaning that they usually have a good outcome and may resolve once the child reaches a certain age. Other syndromes are much more severe and can be difficult to treat. Some may include co-occurring disabilities and may affect a child's development (29). Therefore, expert review is a critical feature of diagnosing childhood epilepsy.

2.1. Childhood Epilepsy in Schools

A primary developmental task for all children is to achieve success in school. Most American children spend about six hours per day in school, fewer in lower grades and more in higher ones. CWE are more prone to have learning problems and cognitive deficits; therefore,

they have a greater need for special education services (6, 9, 57, 58). For some children, having epilepsy will not affect their ability to learn or achieve academically, but others may need extra time or support in the classroom. For example, a child who has absence seizures may miss key points during lessons and will need time to catch up on what they missed in class if their seizures occur frequently. Often, a child may need time to recover and rest after a seizure, or a child may have seizures at night, which can disrupt sleep patterns and affect memory for some time afterward. Anti-epileptic drugs (AEDs) can also cause side effects that include tiredness and problems with memory or concentration.

As suggested, childhood epilepsy is frequently associated with school problems, with previous evidence documenting epilepsy-related cognitive and educational risks and deficits, including on overall IQ, memory, processing speed, attention, academic acquisition, peer acceptance, and access to special education (10, 59, 60, 61, 62, 63, 64). Teachers have reported concerns with being prepared to respond to a student's medical needs related to their epilepsy (e.g., classroom emergencies) and low confidence in being able to provide instruction to CWE (65, 66, 67). These findings, combined with international studies, indicate that teachers report knowing few facts about epilepsy and its treatment, which has the potential to limit teaching effectiveness (68). When taken together, these findings make clear that the key issue in managing and caring for CWE is how to increase the possibility of success. CWE are more prone to have learning problems, cognitive and attention deficits, and as a result, are often at increased need for special education services (6, 9, 57, 58, 69). In fact, a longitudinal Dutch study, conducted by Oostrom, et al (70) revealed that CWE are already at risk for learning problems prior to their diagnosis. This study found that 51% of CWE required special educational

assistance (70). CWE obtained worse scores across cognitive and behavioral tests, and parents and teachers perceived CWE as having more behavioral problems than their TDP (70).

Prior research has shown that CWE tend to have a history of academic problems throughout their lifetime, and these are associated with low performance on reading, spelling, and arithmetic (6). Almane, et al. (6) investigated the lifetime rate and distribution of academic supportive services provided to CWE. CWE were grouped based on their history of obtaining special education services at baseline (defined as formal IEP, birth to three or early education services, retention, remedial summer school, parent, school or center-based tutoring [e.g., Sylvan]). They identified two groups of CWE, those who had previously received and/or were currently receiving special services for academic problems (Group: Epi_AP+) and those who had never received any special services (Group Epi_AP−) (6). The authors revealed that CWE, across both groups, had higher rates of academic problems (52%) when compared with their TDP (18%) (6).

The Almane (6) study provides strong evidence that CWE are not performing as well in schools compared to TDP and that those CWE with (Epi_AP+) and without (Epi_AP-) support services at the time of epilepsy diagnosis continued to perform significantly worse over time (up to 5 years later). However, CWE, who were identified as having academic problems prior to their epilepsy diagnosis, made up 81% of the CWE who were identified as having academic problems (N = 26). Fifty percent of those children (N =13) had IEPs prior to their epilepsy diagnosis, demonstrating that even with academic support services, these CWE (6), continued to be identified as having academic difficulties. Therefore, an examination of children relative to identifying the type, frequency, and impact of educational services is needed as children progress from the initial diagnosis with epilepsy.

School-based support services are provided under the first 1990 Individuals with Disabilities Education Act (24). IDEA stipulates that if a student is identified by a team of professionals as having a disability that adversely affects academic performance and as such qualifies for special education and related services, the development of an Individualized Education Program (IEP) is required. The IEP is a written document for a student with an identified disability that is developed, reviewed, and revised by a team of people, including the student's family. The document outlines an educational plan for the student and is re-evaluated on an annual basis. Specific learning disabilities (SLDs, sometimes known as or learning disorders or learning disability LDs) are commonly diagnosed in children with epilepsy (25, 28). However, disentangling LD from epilepsy and the role epilepsy may play in CWE developing an LD remains unclear.

2.1.1. Specific Learning Disabilities (SLD)

According to IDEA, 34% of all students who received special education services had an SLD, and 14% had other health impairments, including epilepsy (25). An LD is a disorder in one or more of the basic psychological processes involved in understanding or using spoken or written language. The disorder may manifest itself as an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. In order to receive the diagnosis, a child must have ongoing problems in one of three areas: reading, writing, or mathematics (25, 28) that is discrepant from their identified cognitive skill. These achievement domains are foundational to a child's ability to learn.

Learning disability diagnoses account for the most common reason for educational referrals and support services and remain a significant concern in school-aged children (28).

Ismail, Mohamed, & Soltan (28) completed an investigation that revealed significant consequences for CWE diagnosed with LDs who have not received the appropriate intervention, which support, or help them access the educational curriculum. They found that CWE who go undiagnosed often have had emotional and behavioral problems, which include: 1) low self-esteem; 2) high suicidal ideation; 3) family instability; 4) substance abuse; 5) depression; 6) psychiatric problems (28). As part of their study they evaluated 212 students from elementary schools in India and categorized 30 of them as meeting criteria for an LD, two of the 30, or seven percent of the sample, were also identified as having epilepsy. They found that identification of an LD was found to be statistically significant with the increase in grade level, hypothesizing that more difficult and complex learning issues occur as grade level increases. This study suggested that early identification of academic difficulties for CWE in schools is important because it can help detect learning difficulties that can lead to developing interventions and suitable modifications in teaching techniques and support around childhood epilepsy.

It is important to note that some studies argued that cognitive ability in CWE is comparable to the typical childhood population, demonstrating that most CWE have no cognitive deficits, no learning problems, and do well at school (19). Wo, et al. (19) conducted a systematic review of the literature from 1980-2015 and found 20 studies which examined academic achievement scores in children with newly diagnosed epilepsy. Their findings indicated that even CWE of normal intelligence had lower academic achievement when compared to healthy controls. The high percentages of low achievement in CWE, especially in the older age group, and the stability of scores even as seizure frequency improved, highlights the need for early screening of learning problems, and continued surveillance. The Almane, et al. (6) study reported that 48% of CWE in their study had no history of academic problems, but still strongly

recommended efficient clinical screening to identify children at risk for school problems. The authors revealed that a brief interview with parents could help identify CWE who are at academic risk (6).

Nonetheless, the majority of the literature regarding CWE's performance in school argues that even CWE with average intelligence (i.e., IQ) are reported to have deficits in specific areas related to thinking and learning abilities (17, 63, 71). Certainly, many children do not fit the typical school definition of LDs as their reading, spelling, and math skills are developing at different rates based on the severity (frequency and intensity) and the manifestation of their epilepsy. Unfortunately, there is little data on the prevalence of LDs in the pediatric epilepsy population (72). Few studies that have researched the prevalence of LDs found that 48% of CWE have an LD in at least one academic area (63). Therefore, additional research is necessary that can identify the life-course and identified needs of CWE as they progress in school past initial epilepsy diagnosis.

A recent study by Berg, et al. (73) showed how CWE performed when special school services were provided. The authors documented that 45% of CWE are in special education, and 16% had been held back a year (73). In addition, other studies have found that CWE displayed more cognitive deficits and academic problems than their TDP (4, 2, 70, 73) and children with other health conditions (e.g., asthma) (74). These studies concluded that CWE performed poorly across all areas of academic achievement (4, 2, 70, 73). The evidence above shows that about half of CWE are in special education and/or experience academic difficulties. This evidence shows a need to evaluate the effectiveness of educational supports provided in schools, whether the academic problems identified are being properly addressed, and to what extent these concerns are being incorrectly attributed to epilepsy.

Bishop and Boag (10) conducted one of the few studies examining US teachers' awareness and attitudes towards epilepsy. 512 elementary and middle school teachers completed multiple measures regarding epilepsy knowledge, attitudes, and support needs of CWE (10). They found that although teachers' attitudes about epilepsy were generally positive, there were significant deficits in terms of general knowledge about epilepsy, its impact in an educational setting, and the appropriate management of epilepsy and seizures in the classroom (10). All of these views have the potential to impact the likelihood that teachers will identify classroom academic concerns for referral, as they misattribute the difficulties as being related to epilepsy. Even when such problems are due to epilepsy, supports and services for these academic issues should still be provided. Therefore, there is a need to put into place general screening measures of academic skills for CWE and to determine the patterns and concerns that need to be addressed to optimize learning within and outside of the classroom.

2.1.2. Educational Support

Several of the studies highlighted are in consensus about the high prevalence of cognitive deficits in CWE and a high deficiency in academic achievement (75) compared to TDP. Therefore, it is preferable that CWE be screened early for cognitive, behavioral, and academic problems so that early interventions can be developed and applied for maximum benefit. For example, CWE have been identified to often have the inattentive type of Attention-deficit/hyperactivity disorder (ADHD) (76), which is associated with poorer academic achievement in the domains of reading, math, and writing (77). One conclusion from this literature is that CWE should be screened routinely for ADHD. Screening for cognitive and academic problems CWE for ADHD, LDs, or any disorder that impacts learning is important for children as they navigate the education system and eventually the workforce (75). Screening is

necessary so that educators can identify and access interventions, programs, and/or services to help meet CWE's needs and seek accommodations throughout their developmental trajectory.

Research has established that neuropsychological testing is a critical tool for identifying major learning impairments in CWE (75). Results and recommendations from these tests are used in developing IEPs and other support protocols. Support services can range from after school tutoring to a formal IEP (24). Support recommendations could include providing: 1) occupational therapy services for fine motor skills to aid in writing; 2) a computer for written assignments; 3) alternative methods for testing (e.g., oral examinations); 4) extended time to complete work; and 5) behavioral reinforcements. Investigators have indicated that seizure severity and seizure control are among the best-documented predictors of academic success (78) and predict scores on several laboratory-based neurocognitive measures (e.g., IQ, complex verbal learning) (57). However, these studies have not collected data from school-based settings, limiting the impact of knowledge of epilepsy on CWE's academic performance (9). Therefore, there is a need for more research and evaluation of school-based impact, outcomes, and services provided for CWE.

Unfortunately, there is no quick psychometric screening tool for assessing cognitive functioning specifically for epilepsy, and more research is needed to enable the development of a tool that will help identify children at risk for academic achievement problems. There are a variety of general academic screening measures (e.g., WRAT-R) that could be used over a longer period of time to track the accuracy and usefulness of the established academic screening measures for CWE. The lack of epilepsy specific psychometric screening tools (i.e., not accurately indicating at-risk populations) indicates the importance of examining and closely looking at support services throughout a child's educational journey. Educational institutions

need to closely examine and determine the effectiveness of current support services available to CWE. One way to do this would be to examine scores using typical neuropsychological assessment batteries and examining trends for CWE that may appear differently than those for children without epilepsy and diagnosed with a LD.

There are limited studies that have explored interventions to improve the learning skills for CWE (79). However, a classroom study examined the use of direct instruction found that CWE with poor seizure control were associated with having learning difficulties (80). Humphries, et al. (80) evaluated the effect of direct instruction in CWE by identifying the children's academic needs and training all their teaching staff on the use of direct instruction. Direct instruction was provided for a range of areas, including reading, reasoning, writing, math concepts, language, and spelling. The study found significant improvement for CWE in all academic areas except word identification during reading (79, 80). This study provides an example of how interventions, such as direct instruction, can assist CWE to improve their skills and abilities in a number of academic content areas.

A single case design study by Jane Williams (58) demonstrated the effectiveness of educational support services provided for Peter, a child with epilepsy who was referred for a special education evaluation (i.e., psychoeducational evaluation). Results showed that Peter's IQ fell in the average range and he had good verbal skills. A learning disability was identified for Peter in the areas of math and written expression and his verbal and visual memory was found to be in the low average range. Peter also had attention problems related to vigilance and impulsivity and raised significant concerns for depression and oppositional behaviors (57, 58). According to IDEA (24), Peter met eligibility for special education services under the

classification of Other Health Impaired and SLD. Peter's IEP plan included modifications in his school environment. The following is an excerpt of his IEP plan:

> "His teacher was encouraged to reinforce visual information with verbal explanations such as describing elements in pictures, verbalizing each step when demonstrating new tasks, and pairing verbal cues with written instructions. Multiple-choice and matching tests were recommended as Peter demonstrated strengths in recognition skills but had problems with both word finding skills and slowness in written expression. Due to relative memory strengths, repetition and drill were encouraged with a breakdown of new information into small segments. Recommendations concerning seating preference, prepared instructions, and focusing on tasks were given due to his problems with attention." (58)

This IEP provided specific goals directly related to cognitive and behavioral areas of concern. This information, and proposed plans were based on academic needs and did not adequately account Peter's epilepsy. Though an epilepsy diagnosis may have bearing on the identified learning and behavioral needs, evidenced-based behavior and learning strategies are needed to address the concerns, regardless of their origin.

Almane. et al. (6) demonstrated that efficient clinician screening could identify CWE at risk for poor academic performance. The authors indicated that CWE would likely benefit from a more detailed neuropsychological assessment in order to explain the cognitive difficulties underlying academic problems to help address specific learning needs in CWE. The authors noted that many hesitate to refer to CWE for neuropsychological assessments due to divergent views on the presence of academic problems for CWE (6). More research is needed to both

develop new screening tools and evaluate the tools currently available for the assessment of cognitive functioning in CWE. Such knowledge would enable providers and educators to select screening tools that are best suited for identifying CWE who need further evaluation and interventions.

2.1.3. Personnel Educational Support

The attitudes of teachers and other education providers toward epilepsy can significantly influence students' school performance and development of social skills (10, 12). Teachers play an essential role in monitoring the health of CWE while they are in schools. Teachers frequently are in the best position to observe a child for possible seizures and any adverse medication effects (5, 10, 12). However, having teachers with inadequate knowledge and understanding of epilepsy can lead to an increased risk of social and academic problems for CWE (10, 12, 81, 82, 83). CWE may also encounter stigma and feel isolated from their peers who believe in common myths about epilepsy, such as people with epilepsy are mentally ill or emotionally unstable or are not as smart as other people. The lack of knowledge regarding epilepsy may also lead to the misjudgment of the abilities of people with epilepsy. The fear of potentially witnessing a seizure may be driven by the simple lack of knowledge regarding basic seizure first aid (e.g., ease the person to the floor, turn the person gently onto one side, clear the area around the person of anything hard or sharp) (3).

In several studies, the majority of which were conducted outside the U.S., teachers reported little confidence in instructing CWE and acknowledged that they have limited information about the disorder (5, 10, 12, 13). The teachers did not know how best to work with CWE, or how to respond to seizures if they occur in the classroom (5, 10,12, 13). Barnett and

Gay (83) synthesized recommendations from several scientific sources to provide specific, evidence-based strategies that teachers of students with epilepsy can employ in the classroom as part of their naturally occurring instructional routines. These recommendations showed promising results for teachers who taught CWE. The authors concluded that teachers who engaged with the evidenced-based strategy information had more school-relevant epilepsy facts than general education teachers and some special education teachers (83). As a direct result, these teachers expressed greater confidence in their ability to meet these students' instructional, safety, and psychosocial needs (83). Therefore, providing access and readily available evidence-based resources for a better understanding of epilepsy, is not only beneficial, but is also a low-resource and time-intensive effort that could be carried out in schools by the school psychologists.

Implementation of effective interventions and programs are needed for educating all parties (i.e., students, teachers, school nurses, counselors, parents, school psychologists, and other stakeholders) about the importance of having sufficient information regarding CWE's potential learning difficulties. The Epilepsy Foundation has developed programs and resources to educate teachers and to help them increase epilepsy awareness in their classrooms. For example, the website-based program, “Epilepsy Classroom”, developed by UCB, Inc., and the Epilepsy Foundation, provides lesson plans, classroom resources, and parent resources on a range of topics relevant to CWE (84). Several studies have shown that even brief, focused interventions in educational settings can produce improvements in epilepsy-related knowledge and attitudes among students (85, 86, 87). However, teacher-focused research is limited, and teacher-focused interventions need to be further developed and tested (10). Increased education

about epilepsy is needed in teacher preparation programs and continuing education for all school personnel (10).

Efforts are needed to design, evaluate, and implement interventions for school settings that build on techniques and methods that have been verified to be effective. Studies reviewed in this document have demonstrated that academic skills instruction could help CWE close the learning gap and build a strong foundation to succeed in school and improve their quality of life. However, such services can only be provided when the CWE is in need of support. Therefore, additional research that demonstrates the trajectory of academic support needs for CWE throughout a significant period of educational instruction is needed.

2.2. Quality of Life in Childhood Epilepsy

According to the World Health Organization (88), "Quality of life is defined as a person's perceptions of their life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns." Enhancing quality of life is a particular concern for those with chronic diseases such as CWE *(*89). In general, research comparing quality of life across different chronic conditions indicate that CWE are much worse off in the psychological and social quality-of-life domains *(*89). Jacoby and Baker (89) compared the quality of life of CWE and children with asthma. They found that CWE had a better quality of life in the physical domain, but significantly lower quality of life in the psychological and social domains *(*89). Addressing educational issues and concerns early and utilizing evidenced-based intervention approaches would not only improve learning and academic outcomes but would also contribute to the CWE's quality of life.

2.2.1. Social Competence

Impairments in social competence are one of the key features that contribute to the lower quality of life in CWE (14, 90). The term social competence refers to a collection of behavioral and cognitive characteristics that facilitate the development of social relationships and positive social outcomes (91). Many studies have focused on the psychosocial challenges faced in childhood (14, 90, 91). Recent comparison studies demonstrate that CWE have relatively more social problems than their TDP. These studies concluded that social problems in CWE include feelings of being different, social isolation, and being subjected to teasing and bullying (91). Younger CWE (ages 3 to 6) have been shown to exhibit fewer developmental -appropriate social skills (92), while older CWE (ages 8 to 16) were found to have significantly lower social skills (cooperation, assertion, responsibility, and self-control) compared to their TDP (92).

Not performing well in school can be frustrating for CWE, as it can result in a negative effect on social confidence, detract from learning, and lead to behavioral and emotional problems (14, 90, 91, 92). A study examining parent completed CBCL surveys found that CWE had significantly more behavior problems (e.g., total problem behavior, total internalizing behavior, total externalizing behavior, and, thought and attention problems) and lower competence (e.g., total competence including school and social) compared to their TDP (90). These results suggest that social competence and academic difficulties are a significant concern for CWE and should be monitored for early intervention (90).

2.2.2. Adaptive Behavioral Competence

Emotional and behavioral difficulties are disproportionately high in CWE. For example, psychiatric disorders were identified in 34.6% of CWE compared to 6.6% in TDP (93). Some of the more common emotional and behavioral difficulties identified for these children included

increased anxiety, depression, irritability, hyperactivity, aggression, and in some cases, irrational periods of rage (i.e., outburst) (94). In a more recent study of behavior in CWE, 24.6% were found to have elevated rates of behavioral problems (particularly attention difficulties) during the six months before their first identified seizure (94). These findings suggest that epilepsy is a more complex disorder that may manifest itself with behavioral and emotional disturbances even prior to the actual onset of seizures.

Recent studies have argued that the most frequently recorded complaint about behavioral problems from caregivers and educators has been when high doses of specific antiepileptic drugs (AEDs) are introduced to CWE; evidence points to a correlation with behavioral changes that take place in CWE. These changes include irritability and verbal, or even physical aggression (14, 93, 94, 95). Evidence shows that a combination of strategies, including assessment and follow-up therapy that can include interventions such as psychotropic medications and intensive behavioral therapy, can improve outcomes for CWE and behavior difficulties (93, 94, 95). These accommodations are needed to support students and increase self-advocacy for CWE to protect against any pervasive issues later in life.

2.2.3. Pervasive Issues in Childhood Epilepsy Later in Life.

Some people with epilepsy only experience seizures in their childhood and stop during adolescence or early adulthood (95, 96). For many other individuals, seizures continue into adulthood, and many live with long-term effects on their cognitive, social, educational, and behavioral development (95, 96, 97, 98). For example, a study on older members of the population in Finland found that compared to adults without epilepsy, adults who had epilepsy during childhood had poorer social outcomes in adulthood: they had a less formal education,

were less likely to be married or have children, and were more likely to be unemployed (99, 100). Adverse lifespan outcomes are found to be associated with histories of neurobehavioral comorbidities, including early learning or cognition, and psychiatric problems (22, 97, 98). In working to reduce the health disparities evident in those with childhood epilepsy and improve quality-of-life, it is critical to identify and address the factors that contribute to the pervasive issues among the epilepsy population. Learning abilities impact a child's access to quality education and education positively influences quality of life (101), so it is vital to address the disparity and to implement strategies that can support CWE and ensure a positive life-course.

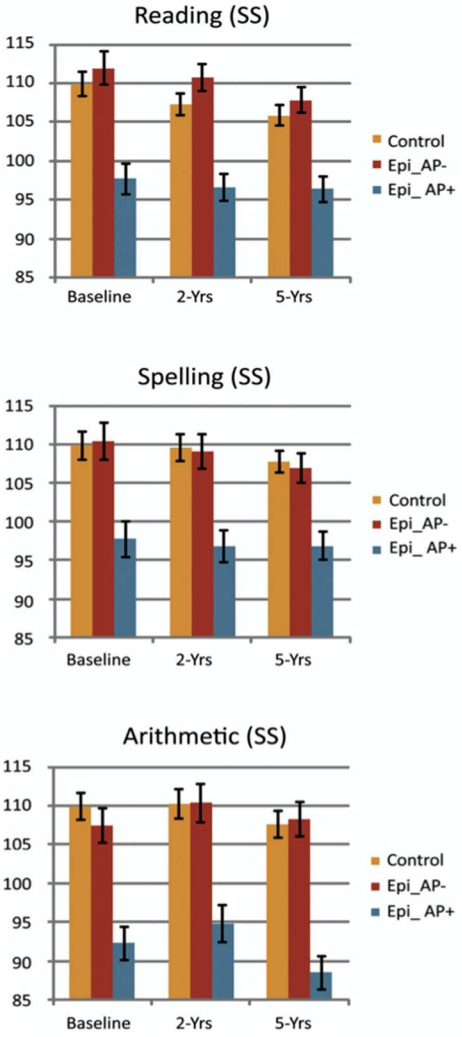


Figure 1. WRAT3 standard score means and SE service groups for reading, spelling, and arithmetic at baseline and follow-up. (Almane et al., 2015)

2.4 Precursors of Proposed Research and Analysis

Epilepsy is the most common chronic neurological disease encountered among school-age children (26). CWE face an increased risk for cognitive deficits, unsuccessful academic experiences, difficulties in social engagement with peers, poor self-esteem, and behavioral problems (25).

Figure 1 displays CWE with academic/educational supports identified at baseline (i.e., EPI_AP+ [AP = Academic Problems]) vs. those without AP (Epi_AP-). This figure illustrates the EPI_AP+ group performing below the control group as did the EPI_AP- group (EPI_AP-), which shows approximately 20% of CWE (i.e., without learning and/or unidentified learning) deficits in reading, spelling, and math. The study (represented in

Figure 1) (6) provides supporting evidence that even though 80% of CWE with learning deficits (EPI_AP+) received academic support services at a higher rate, they remained at a higher risk for academic difficulties. This indicates that CWE, who are receiving academic support services, continue to struggle to perform at a level comparable to their TDP, which provides strong evidence that CWE are not performing well in schools.

As indicated, academic support services that were accessed before an epilepsy diagnosis were found in 80.8% of CWE (6), indicating that epilepsy participants had learning deficits before their epilepsy diagnosis. Participants who received special services in schools before an epilepsy diagnosis were not excluded in this study but were excluded if after baseline enrollment they began academic support services. LD research reports that educational support services provided before any formal diagnosis, such as epilepsy diagnosis, are considered to affect skills that are unrelated to epilepsy (102,103, 104). However, regardless of the cause of LD, CWE who have a LD require proper support and services to address their learning needs.

Similar to the larger body of literature, Almane, et al. (6) study cited above utilized the frequently used statistics approach which is multiple regression analysis. Multiple regression is used to search for risk factors associated with a particular problem of interest (e.g., academic service received) in the case of the Almane, et al. (6) study, among individuals with epilepsy (9, 14, 102, 105). This statistical approach results in the identification of a group of variables that may not characterize any one individual. However, it does provide some conceptual understanding of the factors that may be responsible for the behavior of interest and each factor's relative explanatory power. Alternatives to multiple regression would be helpful to get a better sense of the characteristics that predict or identify CWE and academic skills that put them at risk of educational difficulties by trying to group, "cluster," or otherwise classify CWE by some

academic characteristics. Previous studies have used a more commonly known method called cluster analysis, which examines a data set in pursuit of the "best" cluster solution or grouping of the individuals in order to identify a "true" grouping pattern. Similarly, latent class analysis (LCA) or latent profile analysis (LPA) group's people into classes, also can be referred to as clusters, memberships, or profiles to identify indicators that best distinguish the sample (i.e.., CWE) between classes or clusters. Overall, multiple regression will help illuminate why such features have the strongest impact on academic success of CWE. However, utilizing classifications will help determine which features are shared by CWE of different academic abilities.

2.5 Cluster Analysis vs. Latent Profile Analysis (LPA)

Identifying, characterizing, and understanding the behavioral variability associated with CWE is still challenging, and a clear gap in childhood epilepsy research (5, 59, 60, 80, 81, 82) (9, 6, 14, 15, 102, 106, 107, 108). CWE would benefit from more specific assessment measures in order to identify the difficulties underlying academic problems to help address specific learning needs (6). To date, that type of study has not been investigated using either clustering or LPA methodology.

The objective of cluster analysis is to find similar groups of subjects and assign observations, such as test measures, to groups ("clusters") so that observations within each group are similar to one another with respect to variables or attributes of interest, and the groups themselves stand apart from one another (106, 109, 110). Similarly, the main objective of LPA is to group people into classes (i.e., profiles) based on multivariate response patterns to observed indicators and to identify predictors that best distinguish between classes or memberships (111).

Note: LPA's classes, groups, and profiles are used to describe memberships. LPA is a statistical method for identifying unmeasured memberships among subjects using categorical and/or continuous observed variables (111, 112, 113). For example, the project categorizes CWE based on academic achievement (observations) into different types of performance memberships (latent profiles). The project used LPA to study behavioral variability in CWE in screening for academic achievement by utilizing more specific measures of academic achievement, cognitive ability, social skills, and behavior issues that were available to identify low- or high-level performers to predict student educational experience for CWE.

LPA and clustering methodology are used to characterize "cognitive phenotypes or latent groups" and display patterns of abnormality in CWE (106, 107, 108, 109, 110, 111, 112, 113, 139). Latent groups are defined as dormant or hidden patterns in a sample that are characterized in memberships (i.e., groups) to identify a membership's unique characteristics. Poorly defined latent groups can lead to negative results and failure to replicate findings, as is frequently seen in psychiatric research (102, 106, 107, 108, 109, 110, 111, 112, 113). Therefore, LPA will be utilized to clearly define latent groups among CWE. An LPA model can be thought of as a probabilistic model and clustering as an unsupervised classification. They both identify homogenous groups within a larger population, but because the LPA model is probabilistic, it gives additional alternatives for assessing model fit via likelihood statistics, and better captures/retains uncertainty in the classification with predictors (i.e., covariates). Essentially, LPA inference can be articulated as "What is the most similar pattern using probability?", while cluster analysis would be "What is the closest thing using distance?"

In order to better understand LPA in this study, clustering techniques will be explained as a methodology that is more commonly used. The project will group cognitive phenotypes to

identify academic achievement similar to Paradiso, et al. (102) cluster study. Paradiso, et al (102) utilized cluster analysis to try to derive a meaningful taxonomy of academic competence in 117 adults with temporal lobe epilepsy using the WRAT-R (Reading, spelling and arithmetic scores). Data was subjected to hierarchical complete linkage cluster analysis, and the stability of the obtained outcome was examined by the application of two additional clustering procedures. Four of the six clusters identified were extremely stable (Moderate and Marked Reading/Spelling Underachievement, Above Average Achievement, Reading/Arithmetic Underachievement), Some evidence of external validity was found through the comparison of specific clusters to the control group on measures of neuropsychological function, neurological and demographic characteristics. These authors concluded that cluster analysis may be helpful in developing classifications of not only psychosocial impairment in epilepsy but also in understanding quality of life outcomes for adults with epilepsy. *Figure 2* displays an example of adults with epilepsy characterized into cluster memberships based on academic competence levels. It is not clear the extent to which similar clusters for CWE would compare to adults with similar measures and the extent to which these clusters may inform future academic trajectories.

Cluster analysis results

Clusters	*n*	Reading	Spelling	Arithmetic
1: Average Achievers	42	93.8 (7.2)	98.8 (5.2)	94.5 (5.5)
2: High Average Achievers	14	103.9 (10.0)	109.6 (7.9)	114.3 (5.1)
3: Moderate Reading/Spelling Underachievers	25	78.3 (5.4)	79.1 (4.8)	88.5 (10.0)
4: Marked Reading/Spelling Underachievers	9	66.5 (7.3)	63.7 (7.2)	75.6 (7.6)
5: Arithmetic Underachievers	12	107.0 (6.0)	108.8 (4.8)	85.4 (6.1)
6: Reading/Arithmetic Underachievers	15	84.8 (6.5)	95.7 (8.1)	80.3 (5.3)

Figure 2.
(Paradiso, Hermann, & Somes 1994)

Research seems unable to adequately account for the individual variability inherent in cognition and associated abilities, such as academic achievement, social, and behavior competence, within any epilepsy syndrome (110). *Figure 3* provides an example of a cluster analysis output plotted to demonstrate cognitive performance in CWE by displaying the z-score mean cluster cognitive performance across all domains. *Figure 3* Illustrates how cluster memberships can identify participants in a given sample based on similar variables.

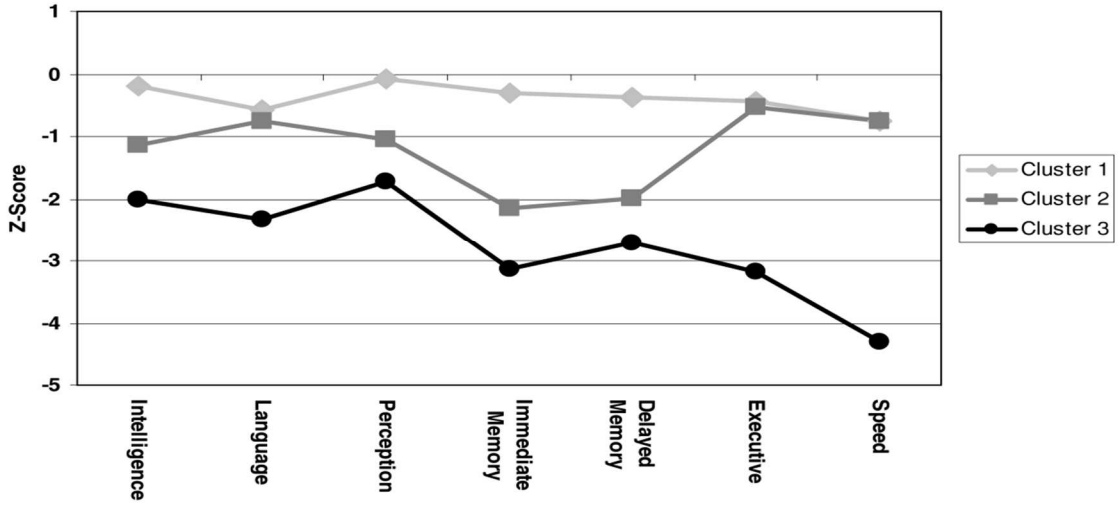


Figure 3. Mean cluster performance across cognitive domains
Hermann et al. (2012).

The current project aims ideally the number of groups (i.e., profile) based on the best-fitting model to construct a sequence of probability from sample population (i.e., CWE and TDP) performance score across multiple domains (achievement, cognition, social, behavioral), whereby similar groups become associated with one another to form meaningful profile (102, 109, 110, 111). LCA has been used by researchers in diverse disciplines such as psychology, biology, sociology, economics, engineering, and business. This technique is particularly useful when the objective of the research is classification of objects according to natural relationships

(109, 110, 111). Academic achievement or underachievement was chosen as the primary target of investigation due to three factors:

1. Achievement is known to be a significant complication for CWE, and one that can have adverse effects, ultimately, on vocational attainment.
2. It has been suggested that there may be unique predictive factors of underachievement even with access to academic services.
3. There is a lack of cluster analytic literature on academic achievement in CWE.

Utilizing LPA by using academic achievement as the primary dependent measure can serve as a reference for identifying memberships with distinct patterns of reading, spelling (i.e., word choice), and arithmetic (i.e., math) competence and evaluate factors that affect learning (102). Also, by incorporating cognitive and social componence domains the study can investigate how all 3-competence levels predict academic success and lead to a positive educational experience in schools. The study will refer to academic achievement, cognitive, social and behavioral competence as "the educational performance domains."

2.6 Summary

In childhood epilepsy, it is important to monitor the functions that contribute to learning, such as cognition, psychosocial ability, adaptive behavior, and academic ability to encourage the development of appropriate skills to succeed in school. Using appropriate educational support services to target these essential functions should enhance a child's self-esteem and contribute to a child's overall academic experience. Williams' (58) single case study demonstrated an example of an effective IEP with appropriate intervention strategies for both the home and school settings. Similar to Peter's case, IEPs should be focused on developing independent skills and decreasing

inappropriate behavioral response regardless of the epilepsy diagnosis. Humphries et al. (80) study demonstrated that the use of direct instruction was an efficient technique to help educators improve CWE's learning.

A large part of improving school services for CWE revolves around enhancing teachers' awareness about epilepsy and developing an educational plan focused on meeting students' individual needs. Although not all CWE require specialized services, these services must be available for those that do, so that all students have the opportunity to reach their full potential. A critical feature of providing specialized services is the identification and development of a plan to provide needed supports and services. Due to diverging opinions as to whether or not learning difficulties are related to an epilepsy diagnosis, recommendations for comprehensive neuropsychological assessment upon initial epilepsy diagnosis have not been fully endorsed. However, several studies highlighted within this review, including a systematic review spanning 35 years, strongly suggests that CWE should be screened at initial epilepsy diagnosis for academic, social, and behavioral difficulties in order to provide intervention as early as possible. A prospective study that follows individuals from initial diagnosis (including both those who were and were not in need of academic supports), across a significant slice of their educational history would be beneficial to documenting the services, time points, and outcomes for CWE to better inform and develop guidelines and best practice statements regarding evaluation and intervention needs for this population within the school setting.

2.7 Research Aims

The project aims to examine the impact that educational support service has on academic achievement over the course of two years. This will be achieved by investigating the factors that

impact academic success, and the patterns of the educational performance among all participants in order to identify correlates of cluster memberships (e.g., seizure variables and parent/family factors) and look at the degree of academic support services provided at baseline.

This project aims to also provide suggestions to include accommodations or identify when to initiate CWE's IEPs. This project will investigate CWE's developmental and educational trajectory over time by examining initial educational performance via an academic screening measure completed shortly after initial epilepsy diagnosis and then again two years later in order to determine the primary factors that contribute to academic success or predict academic difficulties. In addition to the academic achievement screener, cognitive, social, and behavioral (i.e., internalizing and externalizing behaviors) assessment results are available. The assessment results along with identified predictors (i.e., seizures types, frequency, duration, antiepileptic drugs, and demographic information) may contribute to CWE's academic success or difficulties. These factors are thought to be evaluative for optimizing academic potential and promoting emotional well-being and social integration in the school environment.

The proposed project will address three research questions and include 3 primary aims:

Among Children with epilepsy (CWE) memberships will be determined by those who are receiving educational support (+EP) and those who are not (-EP) receiving educational support services, in comparison to controls:

- **Aim 1:** How are CWE projected to perform across all the educational screening prolife domains at baseline with the introduction of academic support services (or not) in comparison to their typical developing peer (controls)?

- **Aim 2:** Among CWE (with or without academic problems) and controls, how does each group perform over a 2-year follow up period and the difference over time?
- **Aim 3:** Based on predictors, what latent profile do CWE and controls are predicted to be characterized into latent groups? M-plus-To identify the latent groups within latency profile classes (i.e., cluster memberships) for the educational prolife. To identify predictors of cluster memberships that impact educational prolife (e.g., academic achievement).

Chapter 3: Method

3. Overview of Neuropsychological Progression in New Onset Epilepsy Project

Participant data for this investigation is drawn from a larger project entitled "Neuropsychological Progression in New Onset Epilepsy" which represents a controlled prospective cohort investigation that was initiated in 2003. The project has a rolling recruitment of participants with epilepsy and health controls with baseline followed by two year and five year in person follow-up assessments involving neuropsychological, neuroimaging and behavioral/psychiatric procedures. This is followed by a 10-year telephone follow-up assessment. Participants were recruited from three Midwestern medical centers. The Project is supported by the National Institute of Health (R01 44351) and aims to evaluate new onset epilepsy in children. Recruitment measures and procedures changed over time including CWE with or without academic problems, and at present, the most complete set of data available is for baseline and two-year follow-up visits.

At baseline, all participants attended regular schools. CWE were recruited from three Midwestern medical centers (University of Wisconsin-Madison, Marshfield Clinic, & the Dean Clinic) and met the following inclusion criteria: (i) diagnosis of epilepsy within the past 12 months; (ii) no other developmental disabilities (e.g. intellectual impairment, autism); (iii) no other neurological disorder, and (iv) normal clinical MRI. Children entered the study with active epilepsy diagnosed by their treating pediatric neurologists and confirmed by medical record review of the research study pediatric neurologist. The project did not exclude children based on psychiatric comorbidities (including ADHD) or LDs. However, the project did exclude children with intellectual disability (IQ <70), autism, and/or other neurological disorders. Epilepsy

participants met criteria for classification of idiopathic epilepsy in that they had normal neurological examinations, no identifiable lesions on MR imaging, and no other signs or symptoms indicative of neurological abnormality (114). In general, the investigation tried to stay true to the concept of "epilepsy only" as defined broadly in the literature: normal neurological exams, average intelligence, and attendance at regular schools.

Control participants were age- and gender-matched first-degree cousins. Criteria for controls included no histories of the following:

1. Any initial precipitating event (e.g. simple or complex febrile seizures).
2. Any seizure or seizure-like episode.
3. Diagnosed neurological disease.
4. Loss of consciousness >5 min.
5. Other family history of a first-degree relative with epilepsy or febrile convulsions.

All children were attending regular schools. First-degree cousins were used as controls rather than siblings for the following reasons:

1. First-degree cousins are more genetically distant from the participants with epilepsy and, thus, less predisposed than siblings to share genetic factors that may contribute to anomalies in brain structure and cognition.
2. A greater number of first-degree cousins are available than siblings in the target age range.
3. The family link was anticipated to facilitate participant recruitment and retention over time, (which is the intent) when compared to more general control populations (e.g. unrelated schoolmates).

Each child's epilepsy syndrome was defined in a research consensus meeting conducted by the pediatric research neurologist who reviewed all available clinical data (e.g., seizure description and phenomenology, EEG, clinical imaging, neurodevelopmental history) while blinded to all research such as cognitive, behavioral data, and neuroimaging data. Two levels of epilepsy syndrome classification were undertaken and confirmed by a board-certified pediatric neurologist who was blinded to all research data. CWE were first classified into broad syndrome groups including generalized (GE) and focal (FE) epilepsy, followed by classification into specific GE (juvenile myoclonic epilepsy [JME], childhood and juvenile absence [Absence], and GE not otherwise specified [GE NOS]) and FE (childhood epilepsy with centrotemporal spikes [CECTS], temporal lobe epilepsy [TLE], childhood occipital epilepsy [COE], frontal lobe epilepsy [FLE], and FE not otherwise specified [FE NOS]).

The project was approved by the Institutional Review Boards at all institutions, and the recruitment procedures were identical. Clinic registry records were first used to identify new CWE seen in the Departments of Neurology at the respective institutions. These cases underwent preliminary review by the study coordinator to ensure that they were a new-onset case and appeared to meet criteria for study inclusion. The cases were then staffed internally within each institution with a pediatric neurologist who verified participants' eligibility. Then, monthly teleconferences were held for case review by pediatric neurologists and study personnel from both institutions where inclusion for the study was confirmed with preliminary diagnosis of epilepsy syndrome and seizure type. Eligible families and participants were then sent a letter introducing the study, and families were provided with a telephone number to immediately opt out of study participation if so desired. If families did not opt out of the study, the study

coordinator contacted the family to answer questions, schedule participation and facilitate recruitment of available first-degree cousins.

The Institutional Review Board (IRB)-approved recruitment strategy for controls was to ask study participants and/or parents to identify potential first-degree cousin controls of the CWE and initially inquire into the family's interest in study participation. The parents of the CWE participants provided the research coordinator with contact information for interested control families, and a similar recruitment process to that described above ensued.

3.1 Procedures

On the day of study participation, families and children gave informed consent and assent, following which the children underwent comprehensive neuropsychological testing and MRI. Parents participated in a clinical interview and completed a set of questionnaires to characterize details regarding gestation, delivery, neurodevelopmental health history, and seizure history of their child. All medical records pertinent to the child's epilepsy and treatment were obtained after the signed release of information was garnered from the parent.

Participating children complete three study visits: baseline, 2, and 5-years following the baseline visit; however, only baseline and 2-year data will be used for this investigation. Each participant completed a comprehensive battery of neuropsychological tests, questionnaires, clinical interviews, structured psychiatric interviews (Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children [K-SADS] [115]), and MRI (*see Appendix A: The comprehensive interview and test battery that was used for Neuropsychological Progression in New Onset Epilepsy project*). At the baseline visit, each participating child was accompanied by a parent who underwent a clinical interview, and completed questionnaires characterizing the

child's gestation, delivery, neurodevelopment, academics, and seizure history. In subsequent follow-up visits, a parent accompanied participants under the age of 21 years old. All pertinent medical records were obtained after the signed release of information was completed by from the parent or the participant (if over the age 18 years).

Information regarding each child's academic course was obtained at the baseline, two, and five year follow-up visits through a structured interview with the participating parent. During the baseline interview, to date lifetime academic service history was obtained, while at two and five year follow-up visits, information was obtained only regarding "new" school-related services.

3.1.2 Neuropsychological Assessment

Both the CWE and controls were administered a comprehensive test battery that included standard clinical measures of intelligence, language, immediate and delayed verbal and visual memory, executive functions, speeded fine motor dexterity, and academic achievement. Table 2 provides an example of clinical measures that were used to target cognitive domains, the specific abilities assessed within each domain, the test measures, and the nature of the dependent measure (i.e., number correct, errors or time). However, not all measures were in place for all participants at the baseline visit. *Appendix A* indicates which measures were given to all, highlighted in yellow, and which measures were only administered to some, highlighted green, Therefore, all data measures are not available for all participants. The age range was broad (8–18 years), and particular attention was paid to the use of tests that would allow the administration of identical items across the entire age range as opposed to administering different tests of particular cognitive abilities to children in different age ranges. For example, the project assessed

intelligence using the four-subtest Wechsler Abbreviated Scale of Intelligence (WASI) (116), which involved administration of the same item content across the target age range as opposed to the administration of the Wechsler Intelligence Scale for Children—III (WISC-III) (117) to children <16 years of age and the WAIS-III to those >16 years (*see appendix A*).

For safety reasons, the research assistants were aware of each participant's group membership (epilepsy versus controls). All tests were administered in a standardized fashion, and all assistants met monthly with the investigating neuropsychology team to review scoring and protocol issues, address decision rules for scoring responses not addressed in test manuals and attend to other procedural concerns.

Subsequent to test administration, each child's IQ and academic achievement results were independently reviewed by a pediatric neuropsychologist blinded to the participants' group membership in order to obtain an independent determination of the presence of a LDs. In addition, parents were queried in detail regarding (i) the presence and number of seizures or seizure-like episodes before the formal diagnosis of epilepsy (medical records were also reviewed explicitly for this information; and (ii) the presence and type of any special education services provided to CWE before diagnosis and first recognized seizures. This information was confirmed in further detail in structured follow-up phone interviews with the families.

3.2 The Current Study

The project investigated childhood epilepsy's educational trajectory over time by examining participants' educational performance competence domains and academic support service using cluster analysis. The project used LPA techniques to identify latent members among the participants' competence domains and investigate predictor factors that impact

academic success among CWE. Academic variability and related factors within the study's participants is the core focus of the investigation. This project aims to identify distinct latent groups within well-characterized CWE participants.

3.2.1 Participants

Research participants consisted of 241 children aged 8–18, including children with epilepsy CWE (n = 173) and healthy first-degree cousin controls (HC) (n = 68) (see sample demographic able 1). The project main objective was to evaluate CWE with an established school-based support by academic service groups such as an IEP (Individualized educational program) and special services in school (i.e., Physical Therapy [PT], Occupational Therapy [OT], Academic [Small group instruction, resource room required, extended testing time, academic modifications], or Behavior/Socialization therapy) (see table 2). Note: some of the academic service categories were not provided by the school, such as parents arranged tutoring or other services outside the school system due to school's resisted provision. The project conducted all analysis in which CWE was divided into two groups (see appendix A). CWE who receives academic support services (i.e., CWE_AS+ [AS= Academic Support]), and those without a formal IEP and/or special services in or outside of school (CWE_AS-] (see table 1). CWE participants showed that CWE_AS+ (n =87) and CWE_AS- (n = 86). All participants were not randomly assigned to receive academic supports or not (AS+/-) but rather assigned based on how they presented which was due to school and family decisions. These decisions were a consequence of a combination of factors, such as symptom severity, district policies, IDEA and family resources. Therefore, on average, it was expected that participants who qualify for supports were more likely to be those who had the most severe symptoms.

Table 1
Sample Demographics

	Group		
	Control	**CWE_AS-**	**CWE_AS+**
Group N	68	86	87
Age in year	12.2 (2.7)	12.35 (3.2)	12.14 (3.03)
Gender (male/Female)	33 (47.8%)/ 35 (55.2%)	41 (52.3%)/ 45 (47.7%)	40 (45.5%)/ 48 (54.5%)
Grade	7.38 (11.47)	6.28 (3.2)	6.08 (3.03)
Child Full Scale IQ*	109 (12.9)	104.69 (13.01)	99.00 (13.67)
Parent Full scale IQ	108 (10.44)	110 (14.05)	105 (14.37)
Mother's Education	Some College	College Grad	Master+
Epilepsy Syndrome (FE/GE) **	--------	43/43	43/44
AED (0 /1/2/3)	--------	15/67/3/1	9/73/4/1
Age at Epilepsy diagnose	--------	11.6 (3.19)	11.56 (3.08)
Epilepsy Remission (No, Yes)	--------	38/43	54/33

Note: Epilepsy Syndromes: Epi_AP-: FE (7-CECTS, 4-TLE, 1-FE NOS, 1-FLE), GE (4-Absence, 7-JME); Epi_AP+: FE (6-CECTS, 1-COE, 3-TLE, 2-FE NOS, 3-FLE), GE (4-Absence, 7-JME)***Epilepsy remission status could not be determined for 2 participants

Participating CWE were selected based on their history of special education services at baseline: these variables included a history of participation in any of the following: formal Individualized Education Plan (IEP), birth-to-age-three services, early childhood programs, grade retention, remedial summer school attendance, parent arranged or school-based tutors, and learning centers (i.e., Sylvan Learning). The provision of any of these services was considered to reflect the presence of academic support/services = (AS). Epilepsy participants who received special services in schools before an epilepsy diagnosis were not excluded in this study but were excluded if after baseline enrollment, they began academic support services. CWE who had autism or other neurological disorders were excluded. CWE (N = 173) with learning problems prior to an epilepsy diagnosis (n = 6) were excluded. Healthy control participants with a history

of academic services at baseline (n = 43) were excluded and such participants will not be included from the original sample size (N = 290).

Table 2.
Education Service Summary in Children with Epilepsy (CWE_AS+)

Education Services	**N= 87**
IEP	48 (54.5%)
Birth-Age 3	12 (13.6%)
Early Childhood	18 (20.5%)
Special School Services Tutor	26 (29.5%)
Required Summer School	6 (6.8%)
Repeat Grade	0%

3.2.2 Outcome Measures

All participants were administered a comprehensive test battery. The primary outcome variables for this study are categorized into four educational performance competence domains. Tests were selected not only for their relevance to each domain of interest, but also for their broad applicable age ranges, so that the item pools were identical across the broad age range that will be investigated here (as opposed to administering different versions of a test containing varying item pools to children across age categories). This ensures the ability to directly and quantitatively characterize each educational performance domain. All tests are presented by domain (Table 3). Children were seen for two waves of assessment: baseline (Wave 1) and two years follow-up (Wave 2). (*see appendix A: Highlighted relevant test measures [yellow included green included for some not all])*

Table 3
Neuropsychological test, by educational performance competence domains, administered to epilepsy and control participants.

Competence Domains	**Ability**	**Test**	**Variables (primary/secondary)**

Academic Achievement	Reading, Arithmetic, and Spelling	WRAT3	primary
Cognition	Intelligence Executive Function	FSIQ -WASI BRIEF	secondary
Social Problems	Total Competence (activities, school, and social abilities)	ASEBA-CBCL/6–18	secondary
Behavioral Problems	Internalizing Problems, Externalizing Problems.	ASEBA-CBCL/6–18	secondary

Note: The Wide Range Achievement Test 3 (WRAT3); Wechsler Abbreviated Scale Intelligence -FSIQ (WASI), Behavior Rating Inventory of Executive Function (BRIEF); Achenbach System of Empirically Based Assessment (ASEBA) Child Behavior Checklist for children aged 6–18 (CBCL/6–18)

The three subtests related to academic achievement competence domain will be determined based on the Wide Range Achievement Test-Revised (WRAT) (42) (Reading, Spelling, Arithmetic) which served as the primary dependent variables. The achievement tests will be grouped by clinical consensus to 3 academic skills that will include reading (pronouncing out of context words), spelling (writing words to dictation), and arithmetic (math: performing written computations). The WRAT uses standard scores when interpreting the assessment results. Standard scores have an average (mean) of 100 and a standard deviation of 15.

Cognitive, social, and behavioral competence domains served as secondary dependent variables. The two tests that relate to the cognitive competence domain was determined based on Wechsler Abbreviated Scale Intelligence -FSIQ (WASI) (116) and Behavior Rating Inventory of Executive Function (BRIEF) (117). Cognitive tests will be grouped based on two functioning abilities (i.e., IQ and executive functioning). The WAIS used the same standard scores as the WRAT and the BREIF uses T-scores when interpreting the assessment results. T-scores have an average (mean) of 50 and a standard deviation of 10. Parents completed the Child Behavior

Checklist for children aged 6–18 (CBCL/6–18) from the Achenbach System of Empirically Based Assessment (ASEBA) (119). The social and behavioral competence dependent variables of interest included the following: social competence will be included CBCL/6–18 Total Competence subscales (Activities, Social Competence, and School Competence) and behavioral competence will be included overall CBCL/6–18 summary scales (Total Problems, Internalizing Problems, and Externalizing Problems). The CBCL used the same T-scores as the BRIEF. For information pertaining to the validity and reliability of the CBCL, please visit: http://www.aseba.org/ordering/reliabilityvalidity.html. Standard scores and T-scores were used only for the regression analysis. Then all test scores were converted to z-scores for the LPA.

3.3 Data Analysis Procedures for Multivariate Regression Analysis (MANOVA)

For the first and second aims each child was administered a comprehensive neuropsychology battery from the parent project data set. all behavioral measures were described and analyzed using SPSS (software package used for interactive, or batched, statistical analysis 22.0.) (120). . The initial focus of this analyses was to replicate prior research done by Almane, et al. (6) that examined the history of support services across three groups (i.e., CWE_AS+ [AS= Academic Support]), those without AS [CWE_AS-], and controls) using Multivariate analysis of variance (MANOVA) and follow-up ANOVA with post-hoc Bonferroni to adjust for multiple pairwise comparisons for Aims 1 and 2. Using this analytic approach MANOVAs were computed for the primary domains for academic achievement Competence (i.e., reading, spelling, and arithmetic performance) and the secondary competence domains (i.e., cognition, social, and behavioral educational performance domains).

3.4 Overview of Latent Profile Analysis (LPA)

Lazarfeld and Henry (111) first introduced latent Profile analysis as a way to relate a single categorical/continuous latent variable to a number of observed categorical indicators. The purpose of LPA is conceptually similar to other traditionally used classification methods (e.g., cluster analysis) however, LPA is a model-based approach that operates in a latent variable framework where the underlying profile variable is treated as an unobserved, continuous latent variable.

The LPA model with observed binary indicators, *u*, has an unordered continuous latent variable *c* with *K* classes (profiles) ($c = k$; $k = 1, 2, 3, \ldots, K$). It is important to note that indicators (i.e., variables) do not need to be binary. They can be ordinal, multinomial, and/or continuous. This project uses a combination of categorical and continuous indicators. The *K* profiles are exhaustive and mutually exclusive such that each individual in the population has membership in exactly one of the *K* latent profile memberships (121; see *Figure 4*). The marginal probability for item $uj = 1$ is

$$P(u_j = 1) = \sum_{k=1}^{K} P(c = k) P(u_j = 1 | c = k).$$

The assumption of conditional independence implies that the correlation among the indicators (i.e., *u*1, *u*2,…,*u*r) is completely explained by the latent profile variable *c* (122), thus they are uncorrelated conditioned on profile membership. Note that in the case of a continuous variable, the corresponding probability is reflected by the probability density function of the continuous variable. The joint probability for all of the observed *u*s (i.e., *u*1, *u*2,…,*u*r), assuming conditional independence is

$$P(u_1, u_2, \ldots, u_r) = \sum_{k=1}^{K} P(c = k) P(u_1 = 1 | c = k) P(u_2 = 1 | c = k) \ldots P(u_r = 1 | c = k).$$

3.4.1 Covariates in LPA with Mixture Models

In this project, we consider the most basic of fit mixture models, such as the classic LPA model that is a cross-sectional mixture model with binary indicators (111, 123, 124). This model was the most reasonable starting point for addressing the question of covariate inclusion, such as *Figure 4*.

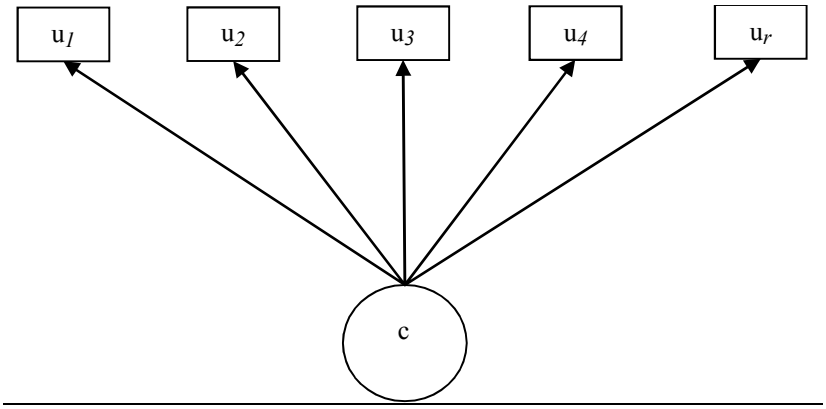


Figure 4. Standard latent profile analysis model diagram.

The latent profile memberships are characterized by the membership-specific distributions of the indicators. The measurement parameters describe the association between the latent profile variable and the latent profile membership indicators (i.e.., predicators), such as in *Figure 5*. In the case of the binary LPA model, the measurement parameters are the membership -specific item endorsement probabilities; that is, the distribution of the binary items conditional on latent profile membership. The structural parameters describe the multinomial distribution of the latent profile variable (i.e., the proportions of each membership in the population), summing to one across the total number of memberships.

Suppose there are M binary latent profile membership indicators, u1; u2; . . . ; uM observed on N individuals where umi is the observed response to item M for individual i. These M indicators are assumed to each be (imperfect) measures or indicators of an underlying

unordered continuous latent profile member variable, c , with K profiles where ci . k if individual i belongs to member k. The proportion of individuals in member k , Pr.c . k. , is denoted by πk . The K profiles are exhaustive and mutually exclusive such that each individual in the population has membership in exactly one of the K latent memberships and Σπk. 1. The relationship between the observed responses on the M items and the latent profile variable, c, is expressed as

$$\Pr(u_{1i}, u_{2i}, \ldots, u_{Mi}) = \sum_{k=1}^{K} [\pi_k \cdot \Pr(u_{1i}, u_{2i}, \ldots, u_{Mi} | c_i = k)].$$

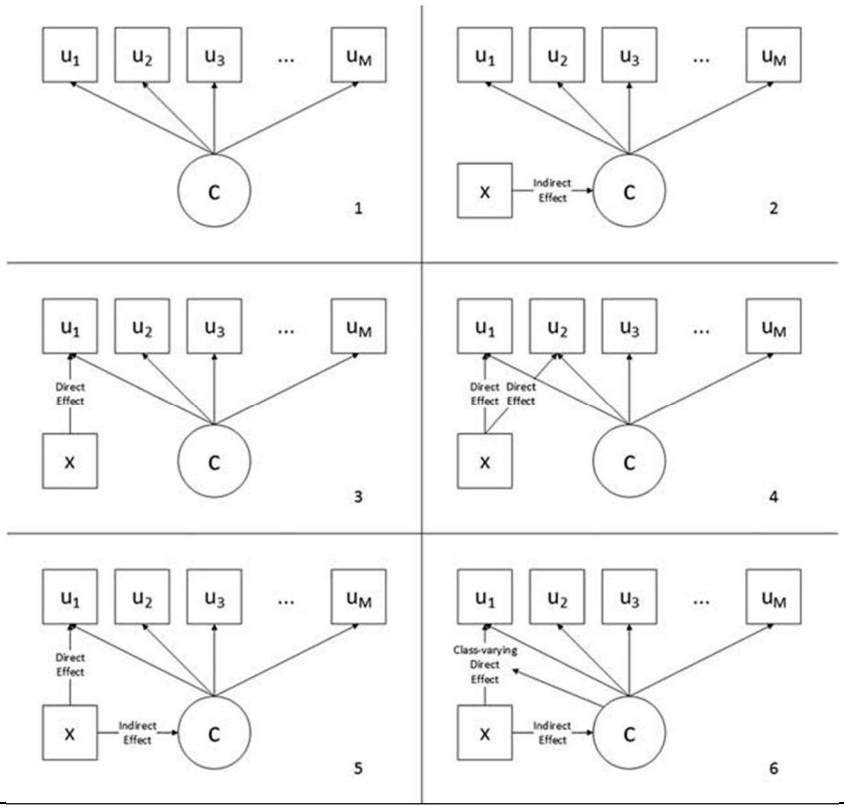


Figure 5. Latent profile analysis model diagram increasing complexity designed 1-6 with observed ordinal, count, continuous, or latent factor indicators for covariates and distal outcomes.

There are two pathways through which a covariate could influence an observed latent profile indicator: (a) an indirect pathway, via the latent profile variable (*Figure 5.2*), a direct

pathway, by passing the latent variable (*Figure 5.3).* This is analogous to the covariate effects specific cations in a mixed covariate model in the factor analytic framework. With an indirect pathway, as depicted in *Figure 5.2*, latent profile membership depends on the covariate, x, and indicator responses depend on latent profile membership. The relationship between latent profile membership and a covariate is expressed as a multinomial logistic regression model, given by becomes increasingly complex with observed ordinal, count, continuous, or latent factor indicators (e.g., with factor mixture models or growth mixture models), the parameterization of the latent profile regression model remains constant and the parameterization of covariate direct effects to the latent profile indicators is quite similar (all following a generalized linear model formulation). In addition, the statistical fi t indexes used in the prolife enumeration process (e.g., relative tests of model fi t and information criteria) are the same regardless of the nature of the latent profile indicators. Thus, we believe that our broader conclusions regarding the use of covariates in latent profile enumeration based on the binary LPA model will indeed generalize to more complicated latent profile measurement models.

3.4.2 Estimated LPA Parameters

There are two types of parameters in the LPA model – profile probability parameters and item parameters. *Profile probabilities* specify the relative size of each latent profile (i.e., how many individuals are in each profile), also known as profile prevalence. *Item parameters*, in LPA models with categorical outcomes, correspond to the conditional item probabilities for each latent profile. Specifically, these parameters are unique to a given latent profile and provide information on the probability of an individual in a latent profile endorsing a particular item. For example, a profile specific conditional item probability of .90 indicates that 90% of individuals in that given profile will endorse that particular item, while only 10% will not (121). In practice,

it is common to graph the conditional item probabilities in an *item probability plot* to get a clearer, more holistic understanding of the patterns that emerge within the data. In fact, the item probability plots often aide in the substantive interpretation of the latent profiles that emerge. Some item probability plots are ordered latent profile solutions and others are unordered latent profile solutions. Specifically, ordered latent profile solutions have latent profiles that do not cross whereas the unordered latent profile solutions do. In other words, the latent profile members in ordered solutions are differentiated by the degree to which individuals within a given profile endorse the indicators. On the other hand, the type of indicators individuals within a profile does or do not endorse differentiated latent profiles in unordered solutions.

3.4.3 Assumptions of LPA Models

The overall goal of LPA models is to group or classify similar individuals into one of *K* latent groups (or profiles). For this reason, an overarching assumption of these models is the existence of a latent exogenous variable (125, 126). Therefore, if a researcher does not hypothesize that there are underlying subgroups (or latent profile members) present in the data, this type of analysis is not justified. LPA models also assume that an individuals' profile membership is discrete and mutually exclusive (127), and that profile membership is exhaustive, meaning that the latent profiles account for 100% of the individuals in the observed data. Conditional (or local) independence is another fundamental assumption of LPA models. This assumption implies that the underlying latent variable, *c*, accounts for all relationships between the observed variables (122, 124, 127). In other words, conditional independence implies that there is no remaining relationship between the observed variables after controlling for profile membership in the data.

3.4.4. Fit Indices and Profile Enumeration

Deciding on the best-fitting model is often the most difficult part of the modeling process. In general, a researcher should consider both substantive theory and statistical fit when making this decision in practice (128). Specifically, LPA models require the examination of fit indices along with congruence of the modeling results with substantive theory. It is recommended to begin the modeling process by specifying a one-class profile model and then fitting additional models, increasing the number of profile classes by one in each model, until the models are no longer well-identified (121). Once this is completed, fit information is collected from each fitted latent profile model and aids the researcher in deciding on the statistically best fitting model. This process of deciding on the best-fitting latent profile model is also referred to as profile enumeration. The following fit indices were considered in the current simulation study: Akaike's Information Criterion (AIC), Consistent Akaike's Information Criterion (CAIC), Bayesian Information Criterion (BIC), adjusted Bayesian Information Criterion (ABIC), adjusted Lo-Mendell-Rubin likelihood ratio test (LMR-LRT), the parametric bootstrapped likelihood ratio test (BLRT), the approximate Bayes Factor (BF), and the correct model probability (cmP). The goal of examining these commonly used fit indices was to understand how well they perform in enumerating the correct latent profile model.

3.4.5 Information Criteria (ICs)

Information Criteria (ICs) are fit indices that are commonly examined across a wide range of statistical models and are used to compare a set of models. The ICs take model complexity into account and are also used to evaluate statistical fit. Importantly, they evaluate the comparative fit of models as opposed to absolute fit. These indices include the Akaike

Information Criterion (AIC; 129), the Consistent Akaike Information Criterion (CAIC; Bozdogan, 130), the Bayesian Information Criterion (BIC; 131), and the adjusted Bayesian Information Criterion (ABIC, 129), where lower values indicate a better fitting model. The AIC can be defined as:

$$AIC = -2(\text{log-likelihood}) + 2p,$$

Where p is the number of free model parameters. The CAIC is a derivative of the AIC. However it also penalizes the value of -2 times the log-likelihood of the model for the number of free model parameters and sample size (130). The CAIC is defined as:

$$CAIC = -2(\text{log-likelihood}) + p\,[\log(n) + 1],$$

Where p is the number of free parameters and n is the sample size. The BIC also includes an adjustment for the sample size and is defined as:

$$BIC = -2(\text{log-likelihood}) + p\log(n),$$

Where p is the number of free parameters and n is the sample size. Lastly, the ABIC is a derivative of the BIC that reduces the penalty associated with sample size. The ABIC is defined as:

$$ABIC = -2(\text{log-likelihood}) + p\log[(n+2)/24],$$

Where again p is the number of free parameters and n is the sample size.

Many simulation studies support the BIC as being the IC that consistently identifies the correct number of profile members for mixture models (126, 132; 133, 134, 135, 136). In fact, a previous simulation study considered all of the aforementioned ICs and found the BIC to

perform the best across various mixture models (122). A more recent simulation study considered latent class, latent profile, and factor mixture models and further confirmed these results. Specifically, findings revealed that the BIC tended to identify the correct solution with higher frequency than other indices, especially in models with more continuous than categorical indicators, or when rare profiles were not present (137). Other simulation studies have found strong evidence for the ABIC (134; 136; 138), even in instances where the sample size was relatively small (149).

Lastly, there is a consensus in regard to the AIC overestimating the number of profiles in mixture models (122, 136, 140, 141). Specifically, research has shown that the AIC overestimates the number of latent profiles with larger sample sizes (142). In fact, Nylund et al, (122) found that the AIC accuracy decreased as sample size increased and suggested this is due to the fact that the AIC includes no adjustment for sample size. The CAIC however, has been shown to perform well across multiple conditions (134), especially when the sample size is relatively large (i.e., n = 1000; 122). This is likely due to the CAIC's adjustment for the number of parameters using the sample size, but more studies are needed to fully understand the range of use of the CAIC.

3.4.6 Likelihood Ratio Tests: Adjusted LMR-LRT and BLRT

The adjusted Lo-Mendell-Rubin likelihood ratio test (adjusted LMR-LRT; 143) and parametric bootstrapped likelihood ratio test (BLRT) are commonly used to compare nested models and are implemented within Mplus. These tests compare the K-1 profile model (the null model) with the K profile model. In other words, the null hypothesis for the adjusted LMR-LRT and BLRT states that the number of profiles is equal to k-1 (H0: K = k-1), and the alternative

hypothesis states that the number of profiles is equal to k (H1: K = k) (137). Therefore, statistically significant p-values suggest that the K profile model fits the data significantly better than the K-1 profile-model (121).

A previous simulation study examined the performance of these fit indices among others for three types of mixture models: LPA models, factor mixture models (FMM), and growth mixture models (GMM; 122). Findings from this study showed the BLRT to be a very consistent indicator of profile membership across all of the models considered (122). In fact, studies show that the BLRT often outperforms the adjusted LMR-LRT (122; 136). Other simulation studies however, have found strong evidence for the adjusted LMR-LRT (138, 143, 144). Specifically, Tofighi and Enders (138) examined a series of GMM analyses and concluded that the LMR-LRT was a relatively consistent indicator of the correct number of latent profiles, however, this study did not consider the BLRT as well. Additionally, Lubke and Muthén (144) explored a series of LPA models and found that the adjusted LMR-LRT performed extremely well in conditions where the latent profiles were well separated.

3.4.7 Bayesian Fit Indices: BF and cmP

The approximate Bayes Factor (BF) and the approximate correct model probability (cmP) are two fit indices commonly used in the Bayesian framework that have more recently been suggested to be promising for mixture modeling (121). The BF is a pair-wise comparison of relative fit between two competing models, Model A and Model B (121). Specifically, Model B is the smaller model, nested in Model A. In practice, the BF is calculated by using the following equation:

$$\hat{BF}_{A,B} = \exp\left[SIC_A - SIC_B\right],$$

Where SIC is the Schwarz Information Criterion (131), which is equal to -0.5BIC (121). A BF greater than 1 and less than 3 is weak evidence for Model A, greater than 3 and less than 10 is moderate evidence for Model A, and greater than 10 is strong evidence for Model A (145).

However, correct model probability (cmP) allows a researcher to compare a set of more than two latent profile models. This statistic is calculated once all of the latent profile models are fit and generally outside of the commonly used statistical software packages. Specifically, there is a cmP value for each of the latent profile models. If the sum of the cmP values across a set of models is equal to 1, then the "true" model is assumed to be one of the models in the set being compared (121).

In practice, researchers using the set of fit indices described above to fit a LPA model will often end up with the fit indices indicating a few competing models. Thus, it has been recommended that researchers should use these indices in concert with substantive theory to decide on the final model to retain (121, 128).

Item probability plots are also often used to help a researcher decide on the best substantively fitting model. These plots graphically show the various latent 24 profile members that emerge and can help a researcher understand how profiles differ in terms of the patterns they exhibit. Additionally, item probability plots help researchers understand which indicators are most useful in producing meaningful latent profiles. Specifically, "good" indicators should have both high homogeneity within profile and high separation between-groups (121; discussed in more detail in Chapter 3.4). Lastly, model parsimony should also be considered while deciding on the statistically and substantively best fitting model. In general, the model with the fewest number of profiles that fits the data both statistically and substantively well is favored (128).

3.5 Data Analysis Procedures for LPA

The data analysis proceeded in three phases for aim three. All test scores were converted to Z-scores and T-score variables were reverse coded (i.e., social competence, internalizing problems, externalizing problems, and executive function) to compare the distributions of multiple variables (i.e., standard scores and T-scores), allowing for standardization of variables prior to LPA. The first phase identified and described latent profiles for each educational performance competence domain. The primary domain, that is academic achievement (i.e., reading, spelling, and math performance) and the secondary domains (i.e., cognition, social, and behavioral) to address the third aim.

The second phase examined whether prevalence rates of latent profile membership differed based on the predictors. Predictor factors will include seizure-related factors (e.g., epilepsy syndrome, seizure frequency, seizure severity, seizure onset age, AED), demographic and caregiver factor (e.g., gender, caregiver IQ, age, education) (table 4). Note: see Table 1 for seizure-related factors (i.e., syndrome and AEDs) and caregiver IQ and education.

Table 4.
Predictors used to investigate external validity

Predictive Factors	**Measures**
Seizure-Related	age of epilepsy onset, seizure frequency and severity, epileptic syndrome, AEDs
Caregiver factor	caregiver IQ, education, gender, age

Internal & External Validity

The third phase determined whether latent profile membership was related to each educational performance domain (cognitive, achievement, behavioral, social) is considered a person-centered approach, in contrast to a variable-centered approach, because it focuses on the interactions (i.e., patterns or profiles) across multiple characteristics within individuals instead of effects of single variables or interactions between variables across all individuals. This is critical because cognition, achievement, behavioral, and social problems co-occur within individuals simultaneously. LPA is a type of finite mixture model that uses manifest items with continuous responses to divide a population into a set of mutually exclusive and exhaustive latent profiles (111, 146). In a standard LPA, two sets of parameters are of most interest. The first set has to do with the latent profile membership probabilities, which describe the distribution of the profiles in the population. The second set pertains to the item-response means (and variances), which describe the profile-specific item means (and variances). Profiles are interpreted and named based on the patterns of item means. Model selection was based on the Akaike information criterion (AIC; 147), Bayesian information criterion (BIC; Schwartz, 131), sample size adjusted BIC (a-BIC; 148), entropy (149), and a bootstrapped likelihood ratio test (150, 151), as well as model stability and interpretability. Lower values for the AIC, BIC, and a-BIC indicated better model fit; higher values for entropy indicated higher classification utility; and significant bootstrapped likelihood ratio test p values indicated better model fit compared to models with 1 fewer profile. Emphasis was placed on the utility and theoretical interpretation of a solution. Model identification for all models was checked with 1000 initial stage starts and 100 final stage starts; all models were estimated using Mplus version 8.4 (152) (see *appendix B: Mplus Syntax and Outcomes)*. Item-response variances were restricted to be equal across profiles by default to improve model identification.

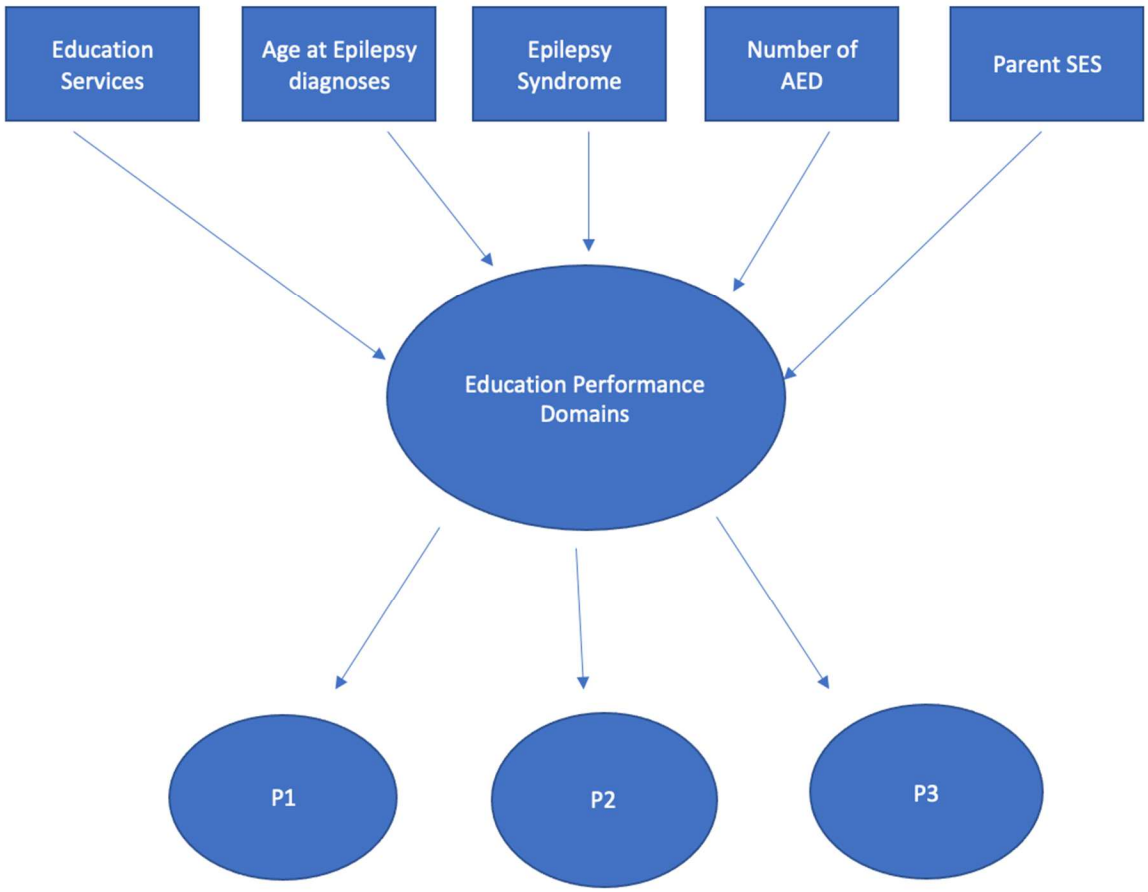


Figure 6. Path Diagram of the Educational Performance—Contribution Subscale Latent Profile Analysis Model with Covariate and Distal Outcome.
Note. See Table 4 for indicator labels

Efforts were undertaken to examine the clinical and educational relevance of the profile memberships, such as to provide preliminary evidence of external validity (27). This will be done through examination of the relationship between the obtained memberships (profiles) and selected predictors variables. The Reilly et al. (17) study provides evidence identifying contributing factors in CWE's that impact development. Factors included cognitive ability, demographic factors, epilepsy specific factors (i.e., seizure frequency, age of first seizure, epilepsy duration, current and past antiepileptic drug use, status epilepticus, predominant seizure

type), and behavior/psychiatric problems or comorbidities (17, 153). The proposed project will ascertain predictive variables that impact the educational performance domain outcome. *Figure* 6 displays a LPA model path diagram illustrating predictors that influences the relationship between the educational performance competence domains and academic support from which the current study will base the development of its own model.

Predictors were added to an LPA using baseline-category multinomial logistic regression. Effects of predictors on profile membership are expressed as odds ratios describing the increase in odds of profile membership in a particular latent profile groups (i.e., the target profile) compared to a reference latent profile, for one-unit increases in the predictor. Profile membership was selected as the reference profile to facilitate being added simultaneously to the selected model to determine if any of them were significant predictors of profile membership. Profile membership may be used to predict outcomes, although this is somewhat more difficult methodologically than adding covariates. Several new approaches have been proposed in the recent methodological literature. The project used an approach proposed by Bolck, et al. (154), colloquially termed the "BCH approach" (155, 156). This approach is currently recommended as optimal for predicting continuous distal outcomes from profile membership (157). This approach classifies individuals to profiles based on posterior probabilities, but then adjusts the outcome analysis that uses these classifications for classification error. Effects of profile membership on an outcome are expressed as pairwise differences between profiles in the means of the continuous outcome conditional on latent profile membership. Note that the standard errors available in Mplus at this time may not produce adequate coverage (157), so significance tests of the pairwise differences should be interpreted with caution. However, this is also the case for the "standard approach" that does not adjust the outcome analysis, so it does not imitate the BCH

approach itself. After identification of the profiles, profile membership was used to predict performance across the education performance competence domains.

Chapter 4: Results

For the three main research aims, the sample of controls (n = 68) and CWE (n = 173) was used. The results are presented in this chapter in the order that the research questions were asked. Additionally, similar outcome variables have been grouped together (e.g., education performance competence domains) in presenting the results.

4.1 Aim 1: How are CWE projected to perform across the educational performance measures at baseline with the introduction of academic support services (or not) in comparison to their typical developing peer (controls)? **Aim 2:** Among CWE and controls, how does each membership perform over a two-year follow up period and the difference over time?

In preparation for use in SPSS (software package used for interactive, or batched, statistical analysis 22.0.) (120) the data file was scanned for missing data, data inconsistencies, abnormalities, and outliers.

4.1.1 Time Difference by Academic Service Groups

The MANOVA for educational performance competence domains scores at baseline compared to 2-year follow-up by academic service groups yielded no significant overall main effect, F (126, 241) = 6.3, p<0.567, partial η^2 = 0.868 (Table 5). These results indicate no performance differences at baseline and the 2-year follow-up when comparing controls and CWE academic service groups across visits.

Table 5
MANOVA academic service groups main effect by visit time

Variables	Values	F	df	P	η 2
1 VS 2	.576	6.3	126	---	.868

Note: Visit: 1= (baseline), 2= (2-year follow-up), Statistically significant difference Wiks' Lamb = $p < 0.05$* $p < 0.001$**, Partial Eta Squared= η 2

The MANOVA for educational performance competence domains performance scores at baseline by academic service groups yielded a significant overall main effect at baseline, F (123, 719) = 2.26, p<0.001, partial $\eta^2 = 0.268$, and at the 2-year follow-up groups, F (126, 510) = 1.53, p<0.001, partial $\eta^2 = 0.274$ (Table 6). These results indicate performance differences within each visit at baseline and the 2-year follow-up when comparing controls and CWE academic service groups.

Table 6.
MANOVA educational performance competence domains main effect by academic service groups and study visit

Variables	**Values**	**F**	**df**	**P**	**η 2**
Baseline	.376	2.26	123	**	.268
2-year follow-up	.386	1.53	126	**	.274

Note: Statistically significant difference Wiks' Lambax = $p < 0.05$* $p < 0.001$**, Partial Eta Squared= η 2

4.1.2 Educational Performance Competence Domains Performance by Academic Service Groups & Study Visits.

Table 7
MANOVA educational performance competence domains between controls and CWE service groups differences by study visit

Competence Domains		**Visit**	**F**	**df**	**P**	**η 2**
Academic Achievement	Reading	1	7.8	3	**	.077
		2	5.6	3	**	.07
	Spelling	1	12.7	3	**	.120
		2	10.2	3	**	.127
	Math	1	15.3	3	**	.141
		2	8.0	3	**	.102

Cognition	IQ	1	12.7	3	**	.120
		2	17.9	3	**	.201
	BR	1	10.4	3	**	.10
		2	8.5	3	**	.108
	MI	1	15.9	3	**	.146
		2	14.3	3	**	.169
Social Problems	Total Competence	1	6.7	3	**	0.67
		2	9.3	3	**	.117
Behavioral Problems	Externalizing Problems	1	11.4	3	**	.109
		2	7.5	3	**	.096
	Internalizing Problems	1	16.1	3	**	.147
		2	7.7	3	**	.099

Note: Visit: 1= (baseline), 2= (2-year follow-up), Metacognition (MI), Behavioral Regulation (BR), Statistically significant difference = $p <$ 0.05* $p < 0.001$**, Partial Eta Squared= η 2

Tables 8
MANOVA educational performance competence domains within controls and CWE service groups differences.

Competence Domains		**HC vs AS-**	**HC vs AS+**	**AS- vs AS+**
Academic Achievement	Reading	---	--	**
	Spelling	---	--	**
	Math	**	**	---
Cognition	IQ	---	**	**
	BR	*	**	*
	MI	**	**	---
Social Problems	Total Competence	*	**	*
Behavioral Problems	Externalizing Problems	*	**	---
	Internalizing Problems	**	**	---

Note: Visit: 1= (baseline), 2= (2-year follow-up), Metacognition (MI), Behavioral Regulation (BR), HC= Healthy Controls, CWE_AS-, CWE_AS+ Statistically significant difference = $p < 0.05$* $p < 0.001$**, Partial Eta Squared= η 2

4.1.3 Educational Performance Primary Competence Domain for Academic Achievement

WRAT3 Reading —MANOVA for standard reading scores yielded significant group differences at baseline, F (3, 280) = 7.8, p<0.001, and 2-year follow-up visit, F (3,211) = 5.6,

$p<0.001$ (see Table 7). Group means are illustrated in Table 9 and *Figure 7*. Post-hoc analyses revealed that CWE_AS+ group had significantly lower scaled reading scores compared to CWE_AP- and controls at all study visits, $p<0.001$ (see Table 8, *Figure 7*). No significant group differences were found between CWE_AP- and the control group (see Table 8, *Figure 7*).

WRAT3 Spelling— MANOVA for standard spelling scores yielded significant group differences at baseline, F (3, 280) = 12.7, $p<0.001$, and 2-year follow-up visit, F (3,211) = 10.2, $p<0.001$ (see Table 7). Group means are illustrated in Table 9 and *Figure 7*. Post-hoc analyses revealed that CWE_AS+ group had significantly lower scaled spelling scores compared to CWE_AP- and controls at all study visits, $p<0.001$ (see Table 8, *Figure 7*). No significant group differences were found between CWE_AP- and the control group (see Table 8, *Figure 7*).

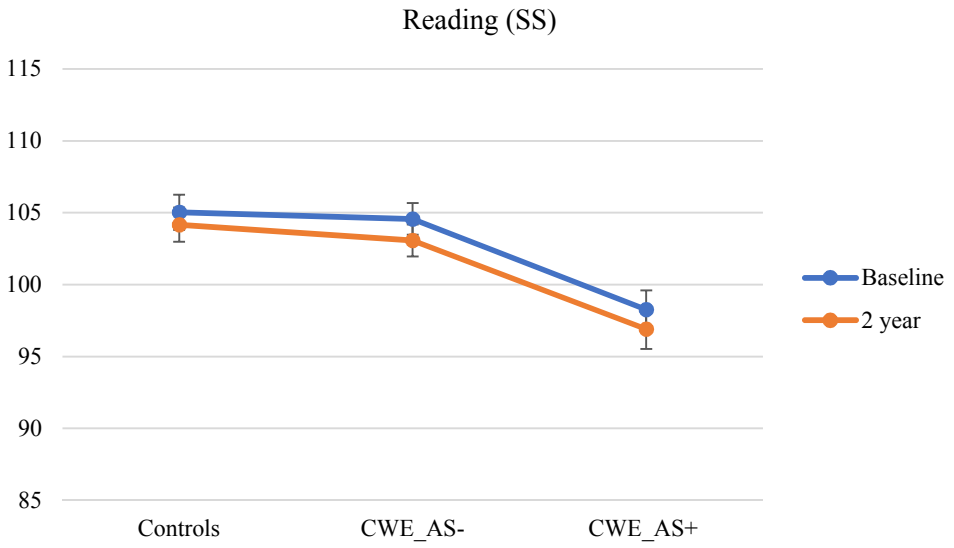
WRAT3 Math—MANOVA for standard spelling scores yielded significant group differences at baseline, F (3, 280) = 15.2, $p<0.001$, and 2-year follow-up visit, F (3,211) = 8.0, $p<0.001$ (see Table 7). Group means are illustrated in Table 9 and *Figure 7*. Post-hoc analyses revealed that CWE_AS+ group and CWE_AP- groups had significantly lower scaled spelling scores compared to controls at all study visits, $p<0.001$ (see Table 8, *Figure 7*). No significant group differences were found between CWE_AP- and CWE_AS+ groups (see Table 8, *Figure 7*).

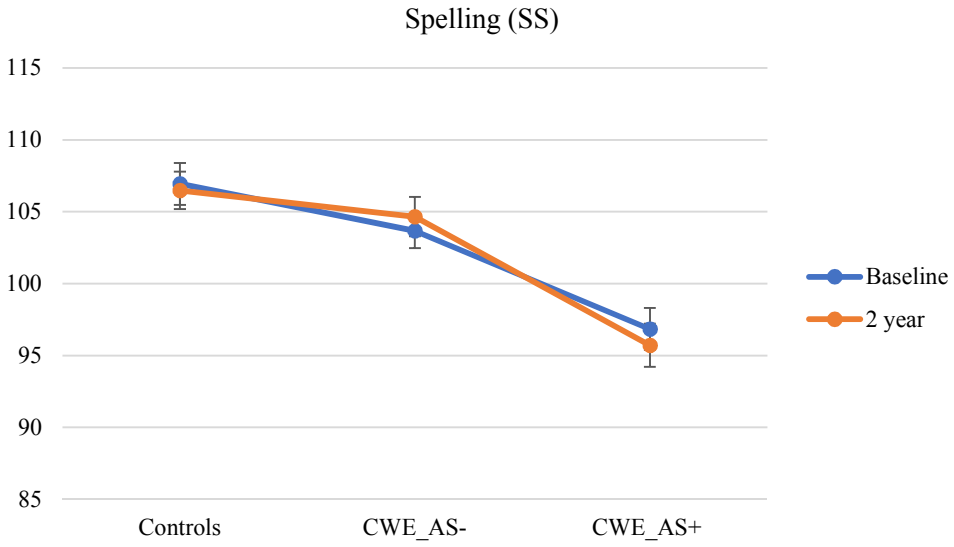
Table 9
Educational Performance competence domain for academic achievement means and SE by total sample and visit time

Test	Visit	Groups		
		Control	***CWE_AS-***	***CWE_AS+***
WRAT3				
Reading	1	105.03	104.57	98.26
		(1.225)	(1.106)	(1.338)
	2	104.17	103.07	96.91
		(1.184)	(1.106)	(1.392)

Spelling	1	106.94 (1.458)	103.67 (1.21)	96.85 (1.459)
	2	106.48 (1.304)	104.66 (1.372)	95.71 (1.498)
Arithmetic	1	108.36 (1.503)	98.4 (1.271)	95.53 (1.5)
	2	107.97 (1.53)	101.69 (1.866)	95.53 (1.674)

Note: Visit: 1= (baseline) and 2= (2-year follow-up), The Wide Range Achievement Test 3 (WRAT3) in standard scores (SS)





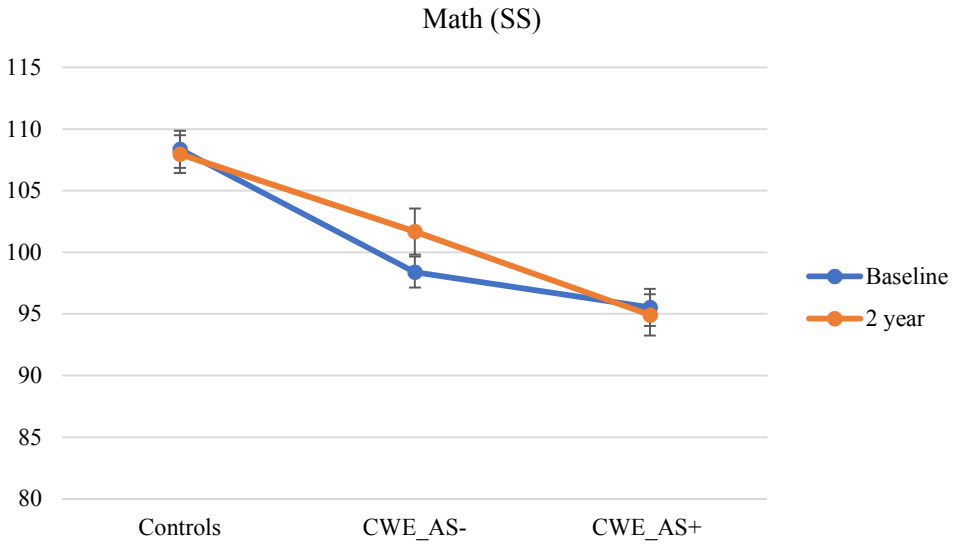


Figure 7. Means and SE by educational performance competence domains for academic achievement at baseline and 2-year follow-up.
Note: WRAT3 standard score (SS)

4.1.4 Educational Performance Secondary Competence Domain for Cognition

WASI FSIQ — MANOVA for full IQ index scores yielded significant group differences at baseline, F (3, 280) = 12.7, p<0.001, and 2-year follow-up visit, F (3,211) = 17.9, p<0.001 (see Table 7). Group means are illustrated in Table 10 and *Figure 8*. Post-hoc analyses revealed that CWE_AS+ group had significantly lower IQ scores compared to CWE_AP- and controls at all study visits, p<0.001 (see Table 8, *Figure 8*). No significant group differences were found between CWE_AP- and the control group (see Table 8, *Figure 8*).

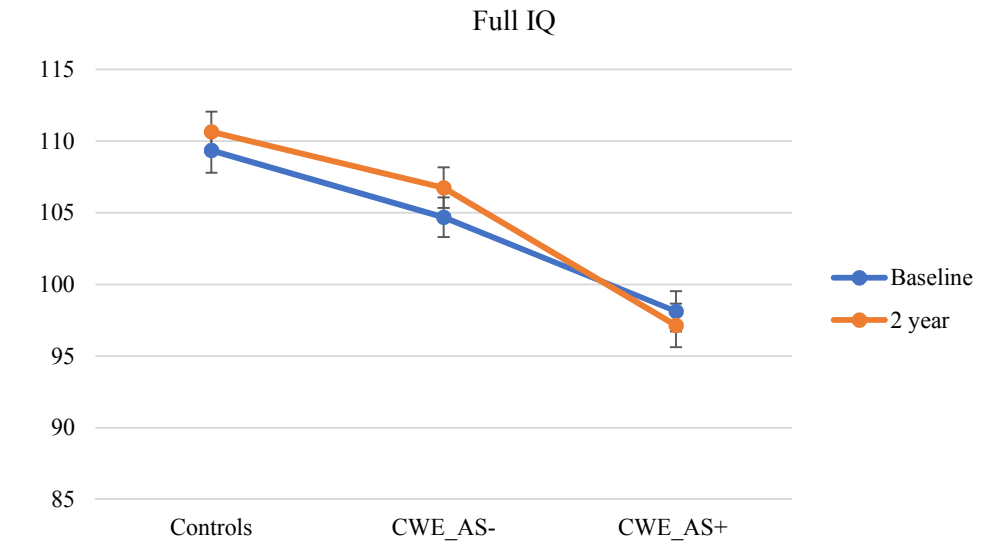
BRIEF Behavioral Regulation (BR) — MANOVA for BR T scores yielded significant group differences at baseline, F (3, 280) = 10.4, p<0.001, and 2-year follow-up visit, F (3,211) = 8.5, p<0.001 (see Table 7). Group means are illustrated in Table 10 and *Figure 8*. Post-hoc analyses revealed that CWE_AS+ group had significantly higher BR T scores compared to CWE_AP-, p<0.05 and controls p<0.001, at all study visits (see Table 8, *Figure 8*). CWE_AP- had significantly higher scores compared to the control group, p<0.005 (see Table 8, *Figure 8*).

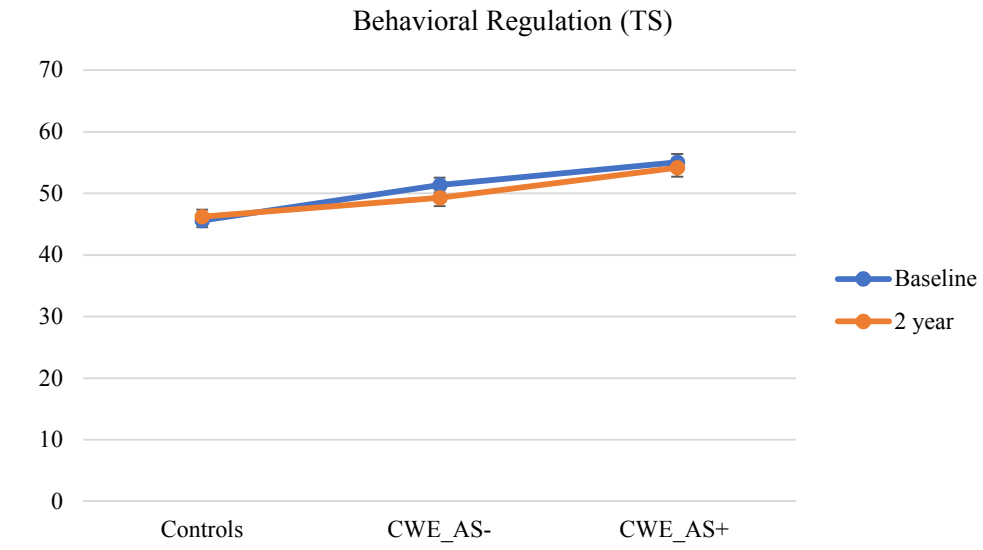
BRIEF Metacognition (MI) — MANOVA for MI T scores yielded significant group differences at baseline, F (3, 280) = 15.9, p<0.001, and 2-year follow-up visit, F (3,211) = 14.3, p<0.001 (see Table 7). Group means are illustrated in Table 10 and *Figure 8*. Post-hoc analyses revealed that CWE_AS+ and CWE_AP- groups had significantly higher MI T scores compared to the control group, p<0.001, at all study visits (see Table 8, *Figure 9*). No significant group differences were found between CWE_AP- and CWE_AP- groups (see Table 8, *Figure 8*).

Table 10
Educational performance competence domains for cognition means and SE by total sample and visit time

Test		Visit	Groups		
			Control	***CWE_AS-***	***CWE_AS+***
WAIS					
	IQ	1	109.35	104.69	98.13
			(1.557)	(1.387)	(1.407)
		2	110.66	106.75	97.15
			(1.404)	(1.421)	(1.521)
BRIEF					
	MI	1	47.16	54.41	58.16
			(1.124)	(1.275)	(1.328)
		2	46.85	54.41	58.16
			(1.284)	(1.506)	(1.485)
	BR	1	45.59	51.37	55.05
			(1.069)	(1.139)	(1.334)
		2	46.23	49.29	54.17
			(1.15)	(1.357)	(1.457)

Note: Visit: 1 = (baseline) and 2 = (2-year follow-up), Wechsler Abbreviated Scale Intelligence -FSIQ (WASI) in full scale index, Behavior Rating Inventory of Executive Function (BRIEF) in T-scores. Metacognition (MI), Behavioral Regulation (BR)


Full IQ
115
110
105
100
95
90
85
Controls
CWE_AS-
CWE_AS+
Baseline
2 year


Behavioral Regulation (TS)
70
60
50
40
30
20
10
0
Controls
CWE_AS-
CWE_AS+
Baseline
2 year

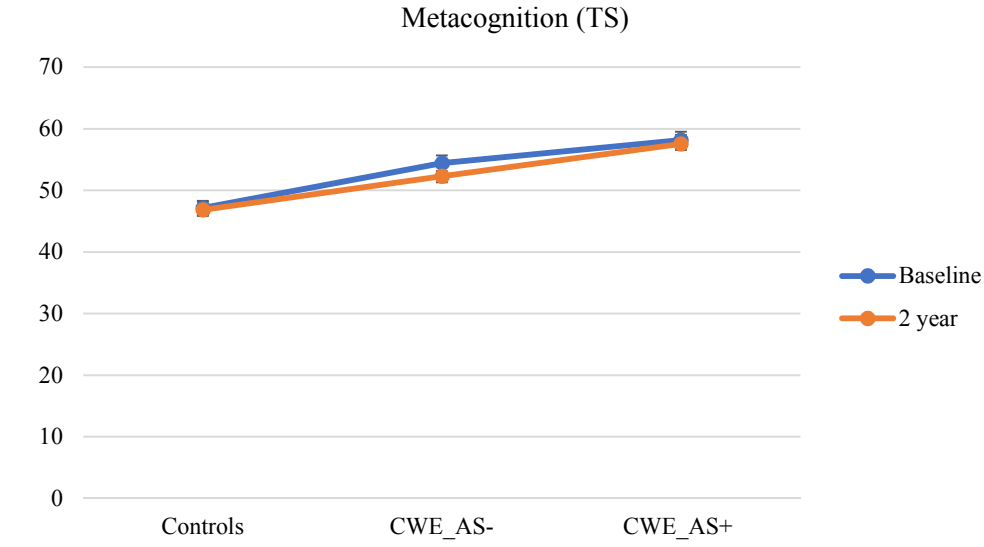

Metacognition (TS)
70
60
50
40
30
20
10
0
Controls
CWE_AS-
CWE_AS+
Baseline
2 year

Figure 8. Means and SE by educational performance competence domain for cognition at baseline and 2-year follow-up.
Note: WAIS Full IQ Index, BRIEF T score

4.1.5 Educational Performance Secondary Competence Domain for Social Problems

CBCL Total Competence — MANOVA for total competence (social problems) T scores yielded a significant group difference at baseline, F (3, 280) = 6.7, p<0.001, and 2-year follow-up visit, F (3,211) = 9.3, p<0.001 (see Table 7). Group means are illustrated in Table 11 and *Figure 9*. Post-hoc analyses revealed that CWE_AS+ group had significantly lower total competence T scores compared to CWE_AS- group, p<0.05, and controls, p<0.001, at all study visits (see Table 8, *Figure 9*). CWE_AP- had significantly lower total competence T scores compared to control group, p<0.05 (see Table 8, *Figure 9*).

Table 11
Educational performance competence domains for social problems means and SE by total sample and visit time.

Test	Visit	Groups		
		Control	***CWE_AS-***	***CWE_AS+***
CBCL				
	1	52.15	46.86	42.01
Total		(1.185)	(0.99)	(1.228)
Competence	2	50.66	49.95	42.57
		(1.249)	(42.57)	(1.228)

Note: Visit: 1 = (baseline) and 2 = (2-year follow-up), Child Behavior Checklist for children aged 6–18 (CBCL/6–18) in T-scores.

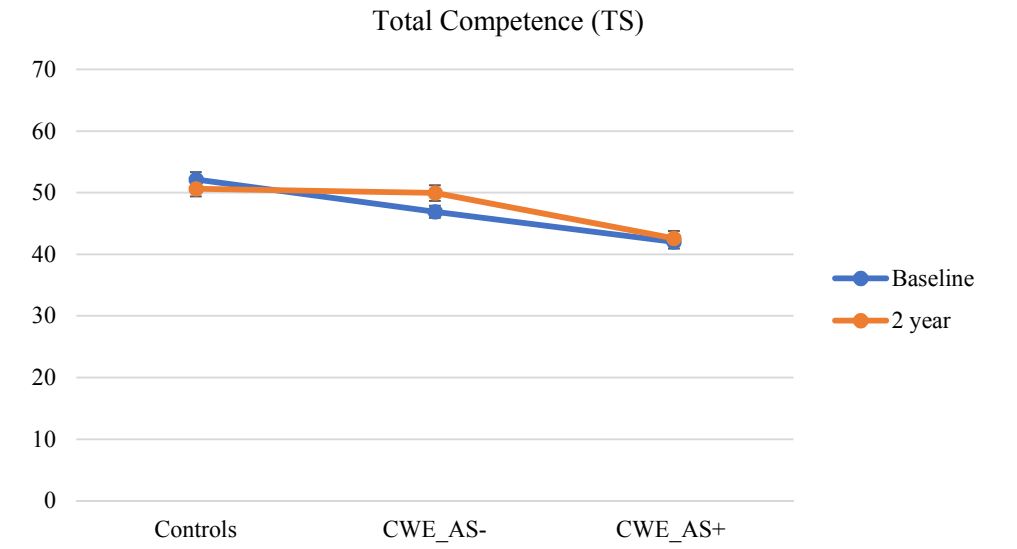


Figure 9. Means and SE by educational performance competence domain for social problems at baseline and 2-year follow-up.
Note: CBCL/6–18 in T-scores

4.1.6 Educational Performance Secondary Competence Domain for Behavioral Problems

CBCL Externalizing Problems — MANOVA for externalizing problems T scores yielded significant group differences at baseline, F (3, 280) = 11.4, p<0.001, and 2-year follow-up visit, F (3,211) = 7.5, p<0.001 (see Table 7). Group means are illustrated in Table 12 and *Figure 10*. Post-hoc analyses revealed that CWE_AS+ group had significantly T scores compared to the control group, p<0.001, at all study visits (see Table 8, *Figure 10*). CWE_AP- had significantly higher T scores compared to the control group, p<0.05 (see Table 8, *Figure 10*).

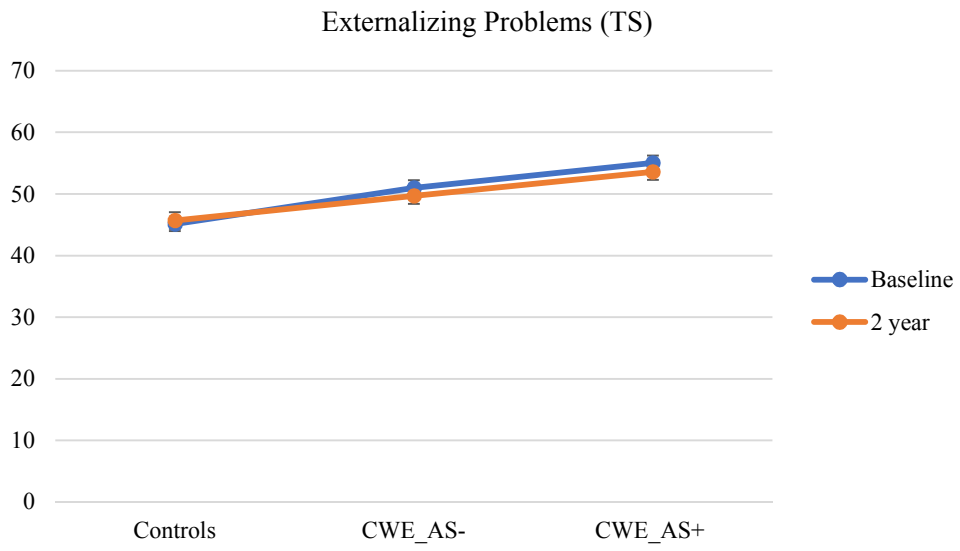
CBCL Internalizing Problems — MANOVA for internalizing problems T scores yielded significant group differences at baseline, F (3, 280) = 16.1, p<0.001, and 2-year follow-up visit, F (3,211) = 7.7, p<0.001 (see Table 7). Group means are illustrated in Table 12 and *Figure 10*. Post-hoc analyses revealed that CWE_AS+ group had significantly T scores compared to the

control group, $p<0.001$, at all study visits (see Table 8, *Figure 9*). CWE_AP- had significantly higher T scores compared to the control group, $p<0.001$ (see Table 8, *Figure 10*).

Table 12
Educational performance competence domain for behavioral problems means and SE by total sample and visit time

Test	Visit	Groups		
		Control	***CWE_AS-***	***CWE_AS+***
CBCL				
Externalizing Problems	1	45.14 (1.165)	50.99 (1.165)	55.03 (1.195)
	2	45.69 (1.362)	49.7 (1.312)	53.59 (1.293)
Internalizing Problems	1	45.59 (1.069)	51.37 (1.193)	55.05 (1.334)
	2	46.23 (1.15)	49.29 (1.357)	54.17 (1.452)

Note: Visit: 1= (baseline) and 2 = (2-year follow-up), Child Behavior Checklist for children aged 6–18 (CBCL/6–18) in T-scores.



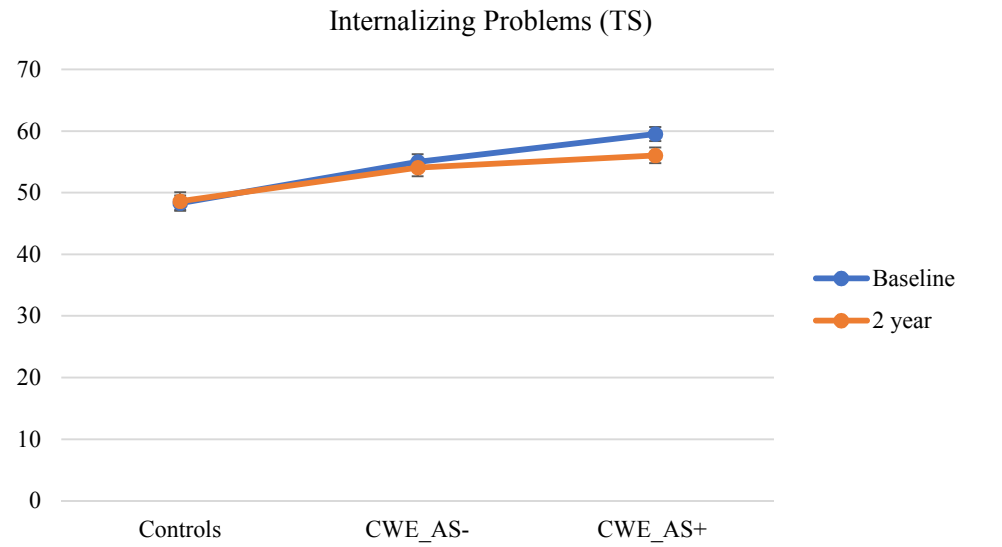


Figure 10. Means and SE by educational performance competence domain for behavioral problems at baseline and 2-year follow-up
Note: CBCL/6–18 in T-scores

4.2 Aim 3 (M-plus): To identify the latent groups within latency performance memberships at baseline for the educational performance. To identify predictors of profile memberships that impact educational performance (e.g., academic achievement).

In preparation for use in Mplus, the data file was scanned for missing data, data inconsistencies, abnormalities, and outliers.

12.2.1 LPA's Descriptive statistics

LPA's Descriptive statistics demographic characteristics, profile indicators, predictors of profile membership, and outcomes are shown in *Figure 11* and *Supplemental Table 1*.

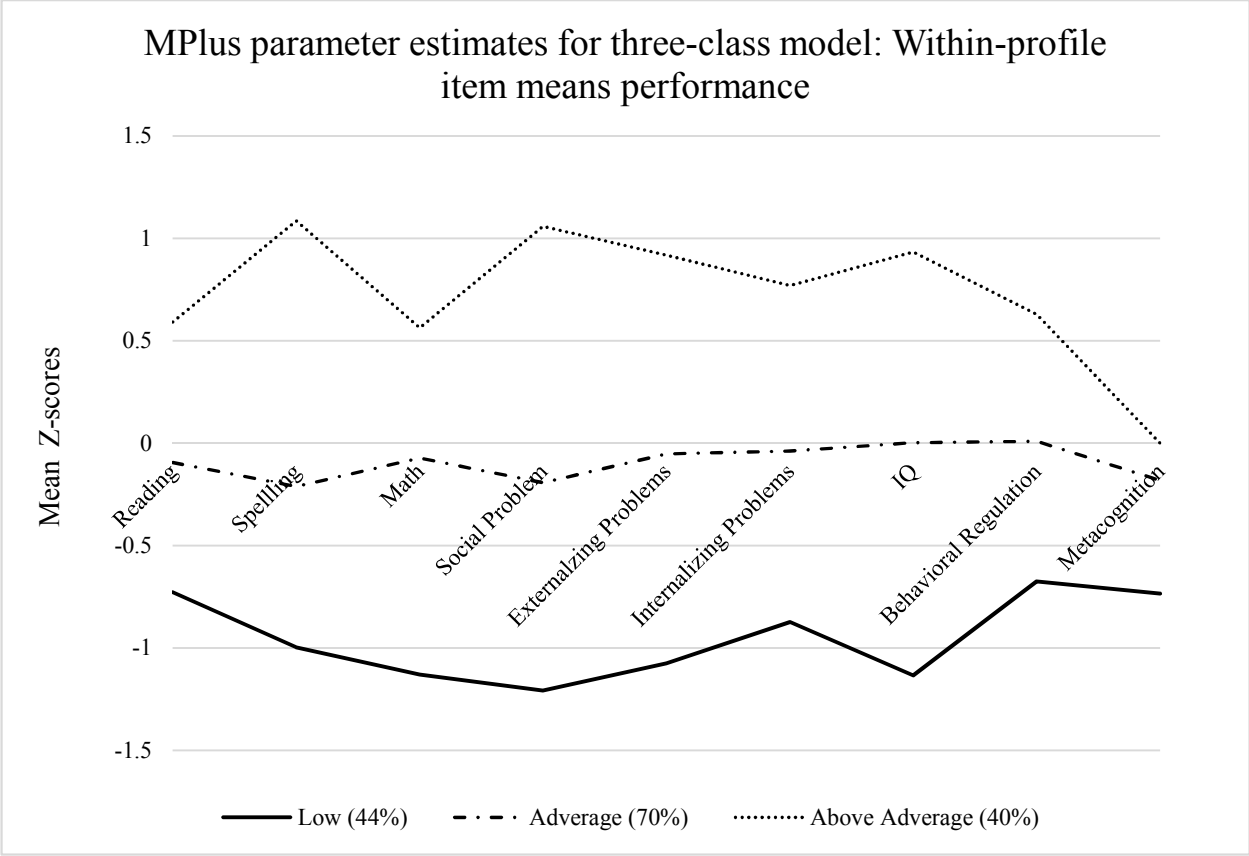


Figure 11. Parameter estimates for three-prolife model. Within-profile item mean z-score educational performance competence domains.
Note: 70% of participants potentially fit in Average profile out of the entire sample, 40% in Above Average and 44 % in Low profile.

4.2.2 LAP Model Fit and Selection Criteria

Model fit information and model selection criteria are shown in Table 13. Models with 1–5 profiles were considered; the BIC was not minimized for the 3-profile model, the AIC and a-BIC were not minimized but practical decrements stopped around the 2- to 5-profile model, and the BLRT suggested all models due to their significant p-value. However, The LMR ranged from .001 (2-profile model) to .759 (5-profile model), with values for larger models in the low to upper .70s. Therefore, the project considered models with 3 or 4 profiles. Upon examination, the 3-profile model included one profile that was split into two similar profiles in the 4-profile

model, suggesting extraction of an additional profile was redundant and uninterpretable theoretically. Thus, a 3-profile model was selected for theoretical interpretation and additional analysis due to the parameter estimate, AIC, BIC, a-BIC with the smallest fit and significant p-value.

Table 13
Model fit information for latent profile analyses.

# of Profiles	Log-likelihood	# 0f Parameters Estimated	AIC	BIC	a-BIC	*p* for LMR	*p* for BLRT
2	-1744.255	106	3700.510	4022.426	3686.921	0.000	0.000
3	**-1670.917**	**162**	**3665.833**	**4157.819**	**3645.065**	**0.037**	**0.000**
4	-1631.347	218	3698.694	4360.750	3670.747	0.759	0.000
5	-1597.861	274	3743.722	4575.847	3708.596	0.676	0.000

Note: Bold indicates selected model. AIC = Akaike information criterion; BIC = Bayesian information criterion; a-BIC = sample size adjusted BIC; BLRT = bootstrapped likelihood ratio test.

4.2.3 LPA 3-Profile Model

Parameter estimates for the 3-profile model are shown in Table 14 and *Figure 11*. Profile 1 (44% prevalence) was characterized by low educational competence domain performers and was labeled 'Very Low' performers. Profile 2 (70%) was characterized by moderate (i.e., low to average) educational competence domain performers and was labeled "Moderate" performers. Profile 3 (40%) was characterized by above average educational competence domain performers, and we labeled "Above Average" performer.

Table 14
LPA parameter estimates for 3-Profile Model by educational performance competence domains.

	Latent Profile Membership		
Domain Outcomes	**P1 (Low [44%])**	**P2 (Average [70%])**	**P3 (Above Average [(40%])**

	Mean Z-scores (SEs)		
Reading	-0.996 (0.125) a	-0.211 (0.105)	1.086 (0.196) b
Spelling	-1.129 (0.141) a	-0.071 (0.123)	0.564 (0.123) b
Math	-1.208 (0.1114) a	-0.193 (0.110)	1.059 (0.174) b
Social Problems	-1.076 (0.174) a	-0.052 (0.107)	0.919 (0.168) b
External Problems	-1.135 (0.128) a	0.004 (0.159)	0.934 (0.219) b
Internal Problems	-0.874 (0.165) a	-0.037 (0.113)	0.77 (0.167) b
IQ	-0.729 (0.219) a	-0.094 (0.162)	0.592 (0.156) b
Behavioral Regulation	-0.675 (0.092) a	0.010 (0.213)	0.629 (0.326)
Metacognition	-0.735 (0.170) a	0.181 (0.141)	0. 416 (0.236)

Domain Outcomes	**P1 (Low [44%])**	**P2 (Average [70%])**	**P3 (Above Average [(40%])**
	Mean Stander Score (%)		
Reading	85 (15.8%) a	97 (41.68%)	116 (86%) b
Spelling	83 (12.92%) a	99 (47.2%)	108 (71.2%) b
Math	82 (11.3%) a	97 (42.47%)	116 (85.5%) b
Social Problems	84 (14%) a	99 (48%)	114 (82.1%) b
External Problems	83 (12.9%) a	100 (50%)	114 (82.4%) b
Internal Problems	87 (19.2%) a	99 (48%)	112 (77.9%) b
IQ	89 (23.3%) a	99 (46.4%)	109 (72.2%) b
Behavioral Regulation	90 (25.1%) a	100 (49.6%)	109 (73.6%)
Metacognition	89 (23.3%) a	103 (57.1%)	106 (66.3%)

Note: WART (reading, spelling, math), Social indicates CBCL: Total Competence.
a=Statistically significantly lower than the overall item mean at $p < .05$.
b=Statistically significantly higher than the overall item mean at $p < .05$.
Within-item variances were constrained to be equal across profiles.

4.2.4 LPA Indicator on Latent Profile Membership

Academic Service, Age at Epilepsy Diagnosis, Epilepsy Syndrome, Number of Anti-epileptic drugs (AEDs), and Caregiver SES (parent IQ) yielded no significant predictors of profile membership. Effects of predictors on profile membership are shown in Table 15. Despite large non global effects of the predictors, Academic Service is suggested to be the most noteworthy predictor (*see supplement Table 1*. Indicator correlation with the educational performance competence domains).

Table 15
Effects of Indicator on Latent Profile Membership

Indicator	**Latent Profile Membership**		
	P1 (Low [44%])	**P2 (Average [70%])**	**P3 (Above Average [(40%])**
	chi-square p values		
Academic Service	0.189	0.560	0.179
Age Ep_Diagnosis	0.539	0.751	0.416
Epilepsy Syndrome	0.413	0.824	0.355
Number of AED	0.248	0.540	0.464
Caregiver SES	0.845	0.046	0.830

Note: Age Ep_Diagnosis= Age at Epilepsy Diagnosis, Anti-epileptic drugs (AEDs),
*Indicator statistically significantly effects Latent Profile Performer mean at $p < .05$.

Mean levels of the educational performance competence domains differed significantly across profile membership. Effects of profile membership on outcomes are shown in Table 14. Due to current limitations with obtaining high-quality standard errors in LPA with distal outcomes, the patterns of statistically significant pairwise differences should be interpreted with caution. Generally, the results showed the following patterns.

4.2.5 LPA's Membership Description by Educational Performance Competence Domains

Educational Performance Primary Competence Domain for Academic Achievement: Profiles characterized by 'Very' had significantly lower levels of performance across the entire competence domain compared to Average and Above Average profiles, shown in Table 14 and *Figure 11*: reading (M=-0.996, SE=0.125), spelling (M=-1.129, SE=0.141), and math (M=-1.208, SE=0.1114). Profiles characterized by 'Average' showed approximately average levels of performance across the entire competence domain compared to Low and Above Average profiles, shown in Table 14 and *Figure 11*: reading (M=-0.211, SE= 0.105), spelling (M=-0.071, SE= 0.123), and math (M=-0.193, SE=0.110). Profiles characterized by

'Above Average' had higher levels of performance across the entire competence domain compared to Low and Average profiles, shown in Table 14 and *Figure 11*: reading (M=1.086, SE= 0.196), spelling (M=0.564, SE=0.123), and math (M=1.059, SE=0.174).

Educational Performance Secondary Competence Domain for Cognition: Profiles characterized by 'Low' had lower levels of performance for IQ, behavioral regulations (BR), and metacognition (MI) across the competence domain compared to 'Average' and 'Above Average' profiles, shown in Table 14 and *Figure 11*: IQ (M=-0.729, SE=0.219), BR (M=-0.675, SE=0.092), and MI (M=-0.735, SE=0.170). Profiles characterized by 'Average' had average levels performance for IQ, BR and MI across the competence domain compared to 'Low' and 'Above Average' profiles, shown in Table 14 and *Figure 11*: IQ (M=-0.094, SE=0.162), BR (M=0.010, SE=0.213) and MI (M=0.181 (0.141). Profiles characterized by 'Above Average' had higher levels of performance for IQ, BR, and approximately equal to average levels for MI of performance across the entire competence domain compared to Low and Average' profiles, shown in Table 14 and *Figure 11*: IQ (M=0.592, SE=0.156), BR (M=0.629, SE=0.326), and MI (M=0. 416, SE=0.236).

Educational Performance Secondary Competence Domain for Social Problems: Profiles characterized by 'Low' had significantly lower levels of performance (M=-1.076, SE=0.174) across the entire competence domain compared to Average and Above Average profiles, shown in Table 14 and *Figure 11*. Profiles characterized by 'Average' showed approximately average levels of performance (M=-0.052, SE=0.107) across the entire competence domain compared to Low and Above Average profiles, shown in Table 14 and *Figure 11*. Profiles characterized by 'Above Average' had higher levels of performance

(M=0.919, SE=0.168) across the entire competence domain compared to Low and Average profiles, shown in Table 14 and *Figure 11*.

Educational Profile Secondary Competence Domain for Behavioral Problems:

Profiles characterized by 'Low' had lower levels of performance for externalizing problems (EP) and significantly lower to equal levels of performance for internalizing problems (IP) across the competence domain compared to 'Average' and 'Above Average' profiles, shown in Table 14 and *Figure 11*: EP (M=-1.135, SE=0.128) and IP (M=-0.874, SE=0.165). Profiles characterized by 'Average' showed approximately average levels of performance for EP and IP across entire competence domain compared to 'Low' and 'Above Average' profiles, shown in Table 14 and *Figure 11*: EP (M=0.004, SE=0.159) and IP (M=-0.037, SE=0.113). Profiles characterized by 'Above Average' had higher levels of performance for EX and IP across the entire competence domains compared to 'Low' and 'Average' profiles, shown in Table 14 and *Figure 11*: EP (M=0.934, SE=0.219) and IP (M=0.77, SE= 0.167).

4.3 Conclusions of Results

This chapter included a detailed application of the analysis steps of Chapter 2 - Literature Review to study academic support in a sample of CWE to identify latent variables that contribute to success in school. Several important contributions are made in this chapter. The illustration of the analysis steps in the context of an applied example is a contribution itself. The systematic application of these steps is intended to be general enough to be used in a range of applications. The choice to present results from each of the analysis steps allowed for the demonstration of a complete modeling process compared to regression analysis, which is not commonly seen in publications using LPA.

Chapter 5: Discussion and Conclusions

This chapter provides a review of the materials presented in this dissertation, beginning with the primary purpose of this project. Following that is a discussion that focuses on the extension of the previous work done by Almae, et al. (6) by summarizing results to highlight how the findings of the MANOVA and LPA contributes to our understanding of how educational support services impact CWE achievement in school from a multi-domain approach (i.e., academic achievement, cognitive, social, and behavioral abilities). This is followed by an innovative comparison of MANOVA, and LPA modeling contributions made in this dissertation, which is not commonly seen in LPA studies. The interpretations of the results will be presented in the order of educational performance competence domains starting with academic achievement, social problems, behavioral problems, and ending with cognition. This chapter concludes by discussing predictor correlation implications regarding LPA modeling. After that, a discussion of an advanced application of LPA modeling using multimodal neuroimaging to investigate biological predictors influencing CWE educational competence domains over time as an opportunity to extend the current findings for future work is described. A dissection of the project's limitations follows and leads into concluding statements regarding the project's contributions and overall findings.

5.1 The Primary Purpose of this Dissertation

The primary purpose of this project was to identify predictors that impacted CWE's academic success in school. Additionally, the project hoped to provide insight that can aid in

developing clinically useful approaches to screen for the risk of academic problems in CWE. The project examined predictors that influenced the educational performance competence domains that characterize latent profile groups among the project's sample. Three latent profiles were identified: Above Average, Moderate, and Very Low performers.

5.1 Extension of Previous Work

This dissertation delineated how epilepsy is the most common chronic neurological disease among school-age children impacting many domains of a child's developmental trajectory (26). Academic problems are known complications of childhood epilepsy and likely have a long-term impact on education, career path, socioeconomic outcomes, an increased risk for cognitive deficits, difficulties in social engagement with peers, and behavioral problems (13, 25). The study by Almae, et al. (6) demonstrated that CWE are associated with significant deficits in the academic achievement domains for reading, spelling, and math, even with formal educational services, that is, an IEP. *Figure 1* displays CWE with academic supports compared to those without supports and their typically developing peers (TDP) (i.e., controls), CWE with academic supports performed significantly worse. Thus, it is evident that the academic support group performed below the control group and the group without support. Almae, et al. (6) also provided evidence that CWE with learning deficits who received academic support services were at a higher risk for academic difficulties, supporting the literature on LD in CWE (19, 25, 28). Almae, et al. (6), demonstrated that CWE who are not receiving academic support services do not differ compared to their TDP, suggesting that among CWE there are predictors that influence performance in school.

In contrast to the study by Almae, et al. (6), this project revealed three distinct performance groups that emerged from the study sample. CWE with academic support differed significantly compared to CWE without support and their TDP across academic achievement measures (i.e., reading, spelling, and math) similar to the Almae, et al. (6) study. Yet, when examining performance across the educational performance competence domains, CWE out performed their TDP on specific domains, suggesting that each group experiences difficulties in their educational trajectory from baseline to a two year follow-up. The project discovered that CWE without academic support performed below their TDP, but higher than CWE with support. When observing performance levels beyond academic skills to examine contributing domains for CWE overall achievements, CWE in specific abilities for the domains of behavioral problems and cognitive abilities (see Table 3), CWE outperformed their TDP, or there were no differences. This suggests that there are underlying factors (predictors) that each group potentially shares that classifies them into performance groups (latent profiles) that can better explain these findings and overlap in performance abilities.

Therefore, in order to identify CWE as at-risk for long term academic underachievement, the project extended the research done by Almae, et al. (6) by investigating CWE educational performance competence domains by comparing a multiple regression analysis (MANOVA) with a latent profile analysis (LPA). Several core findings emerged from this examination of academic histories and performance of CWE and controls. In fact, previous studies have shown that a history of academic problems in CWE is associated with significantly more impaired neuropsychological test performance (6, 15), signifying that there is an essential need for formal assessment for children presenting with academic problems. Thus, this project implemented a

comprehensive approach that examined the domains of academic achievement, cognition, social problems, and behavioral problems to demonstrate the challenges CWE face in a school setting.

A primary goal of this project was to apply a person-centered analytic approach to the sample population using LPA. Three latent profiles of CWE and controls were identified, and in turn, profile memberships were a meaningful predictor of the educational performance competence domains. Across these profiles, it was possible to compare the three latent profiles (Above Average, Average, and Low performers) to each other. Various implications emerged for each latent profile comparison of the educational performance primary competence domain. The three profiles were consistent with the project's hypotheses. However, specific implications for each domain presented unique interpretations. Therefore, this dissertation will present the project's results' interpretations for each domain as suggested above to streamline the project's aims and hypothesis. Reflecting on the educational performance competence domains outcome patterns, although at first glance it may appear that receiving academic services did not help CWE, it is more likely that those who were AS+ were more in need of those academic services. This study is not intended as a causal determinant. The definition of academic services was broad, therefore data were not collected relative to how services differed in quality and quantity as well as where and how they were provided (in school or outside of school). Therefore, it is also possible that those children needed more or different types, quality or time with support and/or parents advocated for or obtained services (i.e., self-selected services). Furthermore, there may be a difference relative to the level of impairment to begin with for the child who is or is not receiving services that needs further examination.

5.3 Interpretations

The first and second aims examined the overall group performance at baseline and at the two-year follow-up, which confirmed no differences over time when comparing CWE and TDP across each domain. These results are reinforced by previous studies that indicated academic performance neither improved or worsened in CWE with academic problems over time up to two and five years (6). There is consensus among the literature that cognitive abilities do not change significantly over time unless due to environmental factors (158, 159). Therefore, a comprehensive initial screening can identify children at risk for persisting academic problems without a follow-up screen. Significance was seen within each domain using MANOVA and LPA modeling to evaluate the third aims. It appears that the use of LPA can result in the identification of distinct groups, similar to cluster analysis, of patients who are homogeneous with regard to the educational dimensions of interest.

Educational Performance Primary Competence Domain for Academic Achievement: The identified three profiles were consistent with the regression analysis groups supporting the hypothesis that TDP would outperform CWE on academic measures. The novelty finding was that CWE who received support services, performed worse than CWE without support in school; however, both groups performed lower than their TDP. This directly contrasts the literature, proposing that CWE perform similarly to their TDP without formal educational support (6). The findings from this project would argue that regardless of the demonstrated need for school-based support, CWE would benefit from a support plan or additional services to address their learning needs. Furthermore, it is likely that a more comprehensive screening method is required to identify CWE's needs, in order to identify a more comprehensive and specific support plan/service needs in order to decrease the achievement gap between CWE and their TDP. This finding mirrors the single case of Peter, by Williams (58), who's IEP provided

specific goals that went beyond accounting for his epilepsy, supporting this project's findings that individualized support is needed for all CWE and a confirmation of the validity of comprehensive screening for CWE. It is important to note that academic achievement performance was not correlated with academic support, but rather CWE are in need of a more comprehensive approach to better identify specific support needed due to how epilepsy might impact a child's performance.

As expected, there were two extreme groups in the latent profiles. The 'Above Average' and 'Low' achievers' profiles were the most prevalent and included 84% of the sample. *Figure 7* and *11* illustrated the symmetry between the sample population and the latent profiles. While the primary goal of this investigation was to determine whether patterns of academic achievement could be detected among CWE, an equally important aim was to document the internal validity of the profile solution. Examining LPA's model fit output information (see Table 14 and appendix B), each profile was found and determined to be able to prove excellent replication, confirming their stability.

Educational Performance Secondary Competence Domain for Social Problems: Impairments in social ability have shown to be key features that contribute to the quality of life in CWE (14, 90). In the domain of social problems, results yielded similar findings to the academic achievement domains (*see Figures 7, 9 and 11*). *It is important to note that low T scores are not clinically significant compared to high T scores.* Social problems are characterized by the CBCL total competence composite, which captures the sample's activities, school, and social abilities (see Table 3). These findings are congruent with previous research indicating a positive correlation with academic performance and social skills (14, 90, 91, 92). Thus, CWE's confidence in performing well in school can negatively affect their overall

confidence, which has been shown to detract them from learning, leading to behavioral and emotional problems (14, 90, 91, 92). Therefore, part of a individualized support plan for CWE should also focus on ways to address and improve social functioning as well as academic achievement.

Educational Performance Secondary Competence Domain for Behavioral Problems: Research suggests that emotional and behavioral difficulties are disproportionately high in CWE including anxiety, depression, irritability, hyperactivity, aggression, and behavior outbursts (94). The competence domain for behavioral problems' results yielded significant group differences for both externalizing and internalizing problems, in comparison to TDP, regardless of educational support level. This finding supports the literature that CWE experience more behavioral problems in school (*see Figure 10*).

Interestingly the regression analysis and LPA were close in symmetry, but there were conceptual differences between externalizing and internalizing problems (*see Figures 10* and *11*). In *Figure 10*, the significance for behavioral problems were marginal, suggesting that all children in an educational setting having behavioral problems. When interpreting *Figure 11*, externalizing and internalizing problems for the three profiles illustrated a modest balance between the profiles prevalence rates. The results indicated that the majority of the sample experienced behavioral problems less often compared to 40% of the sample population who were experiencing significant problems. These findings suggest that the study's sample population, including CWE, are open about the emotional struggles they are experiencing or are supported with coping with internalizing strategies either from peers, school personnel, or caregivers.

Educational Performance Secondary Competence Domain for Cognition: Childhood epilepsy is characterized by seizures that have neurobiological, cognitive, psychological, and social consequences (30). The results indicate that the controls outperformed CWE across the cognitive domain. CWE without support's IQ scores were significantly higher than CWE who were receiving support, which contradicts the body of available research (*see Figure 8*), suggesting all children with CWE have low IQ. However, there are prior findings that reinforce the project's results that cognitive abnormalities are common in CWE, alluding to academic problems being more prevalent prior to the onset of epilepsy diagnosis and treatment (6, 160). As these cognitive and academic difficulties co-occur, it would seem that CWE receiving support are characterized as those at extreme risk for underachievement, whereas CWE without support are simply not identified as children not in need of support. Therefore, effects of CWE and treatment may manifest themselves, further supporting the need for a more robust screening method to identify CWE at risk for academic problems.

The evident cognitive consequences for CWE are shown in the executive function abilities of the cognitive domain. There are apparent cognitive abnormalities between CWE and TDP. Incongruously, the results for metacognition between CWE groups show no difference in contrast to IQ (see *Figure 8* and Table 8). There is literature that discusses the implications of intelligence tests, arguing that IQ tests are not interchangeable and language demands may produce different results that could impact clinician interpretation (158). Grondhuis et al. (158) conducted a study that advocated for the use of a non-verbal IQ test to support the interpretation of traditional IQ tests for children with CWE, supporting the need for better screening methods for CWE (158) to pinpoint and focus specific skills and support needs.

The LPA three profiles were symmetric with the results in the regression analysis (*see Figure 11*). As a whole, the current findings challenge a conceptualization of the cognitive domain. The sample prevalence for IQ and behavior regulation EF displays marginal difference between the profiles but still emerged as a three distinct profile. Yet, metacognition displayed subgroups (i.e., a fusion of profiles). Metacognition's subgroups for 'Average' and 'Above Average' profiles were not significantly different. However, the majority of the sample was prevalent with the 'Average' profile at the border of significance when using the executive function ability metacognition (i.e., awareness of one's thoughts). Developing classification of the project's sample on the basis of educational performance competence domains characteristics through the use of a multiple regression analysis and LPA may be a fruitful approach to investigate the behavioral heterogeneity inherent in CWE and to conceptualize children at risk for academic problems in particular.

5.4 Predictor Implications

In this investigation, the LPA identified three distinct profiles (e.g., clusters). As indicated, the examination of the relationship between the obtained profile memberships and selected predictors variables was to understand the clinical and educational relevance of the project (see Table 1 and 4). The Reilly et al. (17) study provided evidence that identified contributing factors in CWE that impact development, such as cognitive ability, demographic factors, epilepsy specific factors, such as seizure frequency, age of first seizure, epilepsy duration, current and past antiepileptic drug use, status epilepticus, predominant seizure type, and behavior/psychiatric problems or comorbidities (17, 153).

The project utilized predictive variables that would impact the educational performance outcomes, according to previous research findings (6, 17, 160). In *Figure 6,* an LPA diagram displays predictors that were used in this project. The study by Reilly et al. (17) references predictors that impact individuals with epilepsy. This was supported by the Almae, et al. (6) study, which argued that parental history of lifetime academic problems was significantly associated with CWE's performance on tests of reading, spelling and math. However, there was no relationship between academic problems and epilepsy syndromes (see Table 4 for the list of epilepsy syndromes in this dissertation). Almae, et al. (6) and Jackson et al. (160) both argued that academic problems are phenotypes that are independent of epilepsy syndromes. Furthermore, it is unlikely that medication (i.e., AED) or social consequences of seizures would solely be responsible for academic problems (6, 160). Notably, this project appears to have mixed findings regarding the impact of specific predictors in comparison to the literature.

Despite the evidence provided by Reilly et al. (17) identifying specific predictors for CWE, and Almae, et al. (6) indicating that parental history influences academic performance among CWE, the LPA findings yielded no correlation with caregiver SES (i.e., parent IQ and education). However, the project results did support the literature (6, 160) by showing no direct correlation with academic problems impacting epilepsy related predictors including epilepsy syndromes, age at epilepsy diagnosis, and number of AEDs for the profile membership (see Table 15 for effects of predictors on profile membership). However, academic services seems to be the only valid predictor when examining the impact of educational support in this project. Traditionally, the LPA comes with a limitation regarding incorporating predictors into the LPA model.

This project used predictors to explore the impact of covariates on the educational performance competence domains with LPA. LPA incorporates covariates into a mixed model, which can impact the estimates and standard errors in regression or the results of a mean comparison test, such as the covariates (i.e., predictors) influence on the profile memberships (143). One issue for LPA is related to the incorporation of covariates into a mixed model, which is whether the latent profiles variable can be treated as an observed or exact variable (121, 128). Sometimes, treating profile membership as an observed variable can result in incorrect estimates and standard errors when including many covariates as predictor variables for interpretation (121, 128, 143). That was not the case for this dissertation. Based on the data results, there was no correlation with the predictors and the membership fitting model.

The literature suggests that if the problem of incorporating covariates into the mixed model creates errors then the recommendation is to limit the amount of covariates (112, 143). Another recommendation, when it is a viable option, is to incorporate the covariates while forming the latent profile (121, 128, 143). However, this is often not feasible because as the number of profiles increases, the computation time of the model also increases. Additionally, covariates can impact the formation and interpretation of the latent profiles. If incorporating the covariates while forming the latent profiles is not an option, then one alternative is to use most likely class membership (i.e., manually selecting the number of profiles), but only when the entropy is high (122). Additional recommendations were made about how to select which covariates to include in an analysis when there are a large number from which to choose. The issue of how to incorporate covariates into mixture models is important when evaluating the effectiveness of a BLRT (i.e., bootstrapped likelihood ratio test) (121,122, 128). By including covariates into an analysis, rival hypotheses, which might also explain why a BLRT is effective,

can be ruled out. The method chosen to incorporate the covariate into a mixture model can affect the estimation of the covariate effect, which in turn, can impact the ability to correctly rule out alternative explanations for the results in an BLRT (121, 122, 128, 143). Research suggests increasing the START, so that the LPA model can replicate the best fit probability for each profile membership (*see Appendix B: Mplus LPA Syntax and Outcomes*).

For this project, it appears that the use of LPA can result in the identification of distinct groups or profiles of the participants who are homogeneous with regard to the behavioral dimensions of interest. The obtained profiles, at least in this instance, appear quite replicable. Furthermore, there seems to be some symmetry with the regression analysis and LPA, supporting previous research suggesting that many of the behavioral trends and academic service provided are not specific to epilepsy and are independent phenotypes (6, 139, 160).

5.5 LPA Model Extension Using Multimodal Neuroimaging (Machine Learning)

It is possible to use a brief and efficient clinic screen to identify CWE at risk to continue to have significantly poor performance across educational domains. These children would likely benefit from more detailed neuropsychological assessment. This findings from this study suggest a more advantageous approach because it is possible that a number of other factors may contribute to the development of academic problems such as language and language dependent abilities (161). Language impairments include both expressive and receptive components of oral and written language (162, 163, 164, 165). However, how can these factors affect CWE or brain networks and other related predictors?

The current study is interested in expanding the LPA molding as a future direction that focuses on the characterization of abnormalities associated with CWE and comorbidity related

complications and determining longitudinal abnormalities in onset childhood epilepsy relationships to disorder, comorbidity, and protective (or detrimental) factors that influences their educational course trajectory. The aim would be to identify the network disruptions associated with the project educational performance competence domains, focusing on patterns of cognitive abnormality, and regional and network-based analyses of cortical-subcortical covariance in structural MRI. *Figure 12* displays an example of using multimodal neuroimaging data to plot a sample population of adults with TLE epilepsy into clusters (i.e., profiles) base on quantitative volumetric measurements (i.e., cerebral tissues, gray matter, whiter matter, cerebrospinal fluid [CSF], and hippocampus). *Figure 12* illustrates significant abnormality in the hippocampus region. Thus, indicating an increased cognitive impairment in clusters 2 to 3 and a widespread volumetric abnormality for cluster 3 overall. These findings demonstrate the application of neuroimaging techniques using latent group methodology.

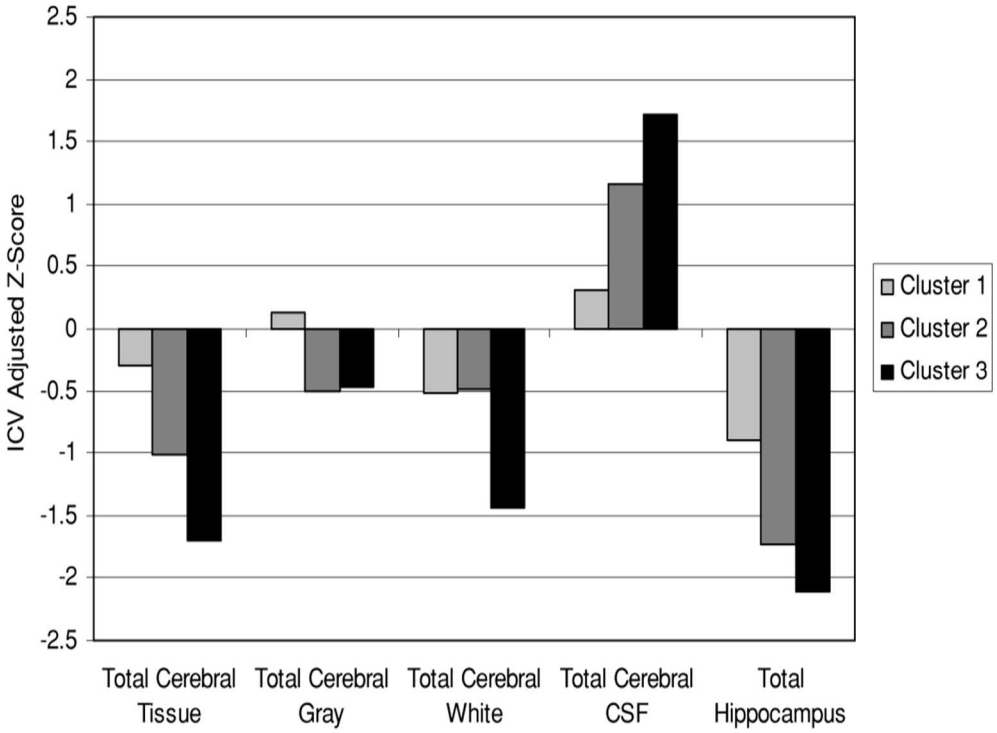


*Figure 12***.** Mean z-scores of quantitative volumetric measurements across cluster groups.
Note: Cluster 1 (*Minimally Impaired*), Cluster 2 (*Predominantly Memory Impaired*), and Cluster 3 (*Generalized Impairment*).
Hermann et al. 2006

There is a growing application of multivariate pattern recognition techniques such as machine learning to enable the discovery of multivariate relationships beyond those identifiable by traditional univariate analysis (166, 167). Several studies have underscored the utility of machine learning to not only differentiate between-group effects but also make predictions regarding behavioral outcomes using regression models, all of which have advanced our understanding of altered brain functionalities of the epilepsy population (168). While underlying mechanisms regarding the specific brain regions and networks that are most amenable to CWE with academic problems remains to be revealed. A classification approach using Support Vector Machine (SVM) and a prediction approach using Support Vector Regression (SVR) can be used

to classify CWE with “good performers” versus “poor performers,” and examine change over time outcomes, as well as predict the brain features (i.e., resting fMRI based functional, structural, connectivity, laterality, and microstructure, metabolism, vascular integrity, morphology) that contribute to accurate classification (169). Furthermore, the SVR approach can assist in identifying specific brain features that correlate with changes that are adaptive versus maladaptive in hopes of identifying additional predictors.

5.6 Limitations and Future Directions

More generally, these results suggest that it is possible to derive meaningful educational performances of CWE. LPA has served to identify academics problems well for CWE, and cognitive and neurobehavioral taxonomies and phenotypes might prove to be a valuable addition for both clinical and research purposes. Although LPA is a powerful technique for simplifying a complex data set, the sample size examined here may limit the representativeness of CWE. Additional latent profiles of CWE should be obtained with larger and more representative samples to confirm the findings described here. Furthermore, the reproducibility of latent profile across the educational competence domains varying in the sample population characteristics, administered test batteries, data reduction procedures, and other methodological details will speak to the robustness of specific profiles across the sample group of CWE.

The study did not account for remission seizure status among CWE when evaluating seizure-related factors within the study's predictors. Among CWE, 25% experience poor seizure control with AEDs; however, even when seizures are well controlled with AEDs, learning difficulties still persist (24). Research found that half of CWE did not attend school regularly, and the main contributing factors which prevented them from attending school were ongoing

seizures, learning difficulties, and behavioral problems (26). Therefore, future studies should examine CWE in remission from seizures compared to those not in remission to better identify CWE who may/may not be more impacted by epilepsy factors.

In addition, a more comprehensive and standardized set of evaluation measures that allow for proactive assessment, screening, monitoring, and identification of services and supports that are a part of epilepsy clinical visits rather than school-based evaluation is recommended for future direction. Overall, the study does not attribute CWE's low performance to academic services received. Still, academic services should be examined in the future to identify the role services may play in tracking and monitoring support provided for CWE and the types of professional development needed for school personnel. The reality is that all children enrolled in this study were having seizures but those seizures may not be equal in terms of the number or severity. It would be worthwhile for future research to determine if number and severity of seizures predict group membership of academic services at intake and could potentially predict those who may experience less remission and more medication use 2 years later. Future research that separates participants by severity would better allow for examination of the impact of epilepsy across a variety of domains in and outside of school performance and supports.

5.7 Conclusion

The dissertation evidence concludes that all CWE experience significant academic problems that are behavioral independent of epilepsy factors. Therefore, when CWE with academic problems are not achieving at expected rates in school there are several ways in which CWE can be best supported.

Federal and state laws are designed to make sure that a child who meets the definition of having a disability has the necessary extra support to meet their educational goals. The federal government, through the Individuals with Disabilities Education Act (IDEA), regulates special education services provided through public school systems. IDEA states that children that qualify for special education services will have an Individualized Education Program (IEP) drafted that describes the educational goals and the specific services being provided to address and meet the identified areas of need. The IEP goals must enable the child to be involved in and progress through the general curriculum to the greatest extent possible. The IEP must outline the accommodations, modifications, and supports to be provided by the school. The present study demonstrated and supported the literature that there is a need for more comprehensive testing and screening to accurately identify CWE who are at risk for academic problems and in need of supporting services.

"Accommodations" in the context of the law means making changes in a school's routine, environment, or instruction that will help a child overcome the particular barrier to learning that has been identified (24, 25). Therefore, it can be interpreted that the inability to identify CWE adequately is arguably the result of low achievement among CWE. One significant finding from this study, is that some CWE who continue to have difficulties in the classroom might not qualify for special education but still require support and accommodations to address their educational needs. This support can be provided through the Americans with Disabilities Act or Section 504 of the Rehabilitation Act. This law requires the school to take the necessary actions (i.e., sufficient screening and testing) to guarantee an appropriate education. The increased use and services that can be provided with a 504 accommodation plan would enable CWE to better perform up to his or her potential in the general classroom rather than placing

them into special education. Examples of 504 accommodations might include extra time for tests, sitting close to the teacher for more frequent understanding checks, and spoken rather than written responses on tests to address the specific educational competence domains.

According to the Epilepsy Foundation (84), sometimes all that is needed for a child to understand and remember what is being taught is a slower pace of instruction and extra time to practice. Tutoring after school or during the summer can help reinforce basic academic skills and build the child's confidence. Therefore, the need for screening is essential to identify what areas CWE are experiencing difficulties in and to better identify children at risk for persisting academic problems. The findings of this study make clear, that CWE need additional focus and monitoring during the school years in order to proactively identify and support individual needs. Teachers and other school personnel do not know enough about epilepsy and therefore are not able to notice or initiate support requests unless skills and impact are significant and clear. The findings from this study indicate that the needs and skill deficits may be subtle and less obvious but there is still a need for screening, follow-up, and support that will enable CWE the opportunity to learn, engage, socialize, and benefit from an educational experience that will allow them to pursue a high quality of life.

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Supplement Materials

Supplement Table 1
LPA's Educational Profile Competence Domains Description with Indicator Correlation

Educational Profile Competence Domains sample size, M (SE)								
Academic Achievement			**Social Problems**	**Behavioral Problems**		**Cognition**		
Reading	*Spelling*	*Math*	*Social*	*External*	*Internal*	*IQ*	*BR*	*MI*
N=154	N=154	N=154	N=154	N=154	N=153	N=146	N=154	N=154
1.03	-0.20		-0.09	-0.07	-0.07	-0.06	-0.02	-0.02

	(1.03)	(0.91)	-0.15 (1.04)	(1.16)	(1.12)	(1.06)	(1.14)	(1.14)	(1.05)
Indicator Correlations									
Academic Service	-0.07	-0.15	-0.06	-0.01	-0.08	-0.01	0.05	0.05	0.04
Age Ep_Diagnosis	-0.03	0.01	0.12	0.03	0.02	0.07	-0.04	0.10	0.02
Epilepsy Syndrome	-0.02	-0.06	-0.01	-0.01	0.01	-0.08	0.14	0.07	0.11
Number of AED	-0.05	0.05	0.02	0.07	0.04	0.06	-0.05	0.06	0.01
Caregiver SES	-0.04	0.01	0.0	0.07	0.03	0.04	-0.04	0.01	0.04

Note: WART (Reading, spelling, math), Social indicates CBCL: Total Competence, External indicates CBCL: Externalizing Problems, Internal indicates CBCL: Internalizing Problems, BR indicates BRIEF-Behavioral Regulation, MI indicates BRIEF-Metacognition. Age Ep_Diagnosis (Age at Epilepsy Diagnosis)
*Indicator is correlated with Latent Educational Profile Domains membership mean.

Appendix A

Code book for Peds Project

Peds TIME 1

Date of Visit **VISIT** _____

_____
(ex. 10/10/2010)

Primary participating parent/guardian:
(0=None or n/a, 1=Bio-mother, 2=Bio- father, 3=Adoptive mother, 4=Adoptive father, 5=Other) **PARPARNT** _____
ONLY administer WASI to *biological parent!*

Participant's Age *(Total months)* **AGE** _____

Years: ☐ **Months:** ☐

Height *(inches)* **HEIGHT** _____

Weight *(lbs)* **WEIGHT** _____

Head Circumference *(cm)* **HEADCM** _____

Interviewer *(1=BH, 2=DA, 3=JJ, 4=Other)* **INTERV** _____

Test Administrator (*4=MS, 7=Other,* ***8=KAY, 9=DNA****, 10=KD,* ***11=BJH****,* ***12=DS,*** ***13=MH****)* **TESTER** _____

FAMILY DEMOGRAPHICS

PRIMARY CARE PROVIDER(S)

0=None	*7=Foster mother*
1=Biological mother	*8=Foster father*
2=Biological father	*9=Legal Guardian, NOS*
3=Stepmother	*10=Grandmother*
4=Stepfather	*11=Grandfather*
5=Adoptive mother	***12=Other, specify***
6=Adoptive father	*13=Live independently*

CAREP1 _____
CAREPoth1 _____

CAREP2 _____
CAREPoth2 _____

HOUSEHOLD COHABITANTS *(DO NOT complete if living independently)*

# of biological siblings *(including half sibs*) **SIBS** _____
# of non-biological siblings (*including step-sibs*) **NSIBS** _____
# of cousins **CSNS** _____
TOTAL # of people presently in home **TOTPEOP** _____

TOTAL SIBLINGS *(both cohabitating & non-cohabitating)*
# of FULL biological siblings between the ages of **8-18yrs** **FLSIB8to18** _____
Total # of FULL biological siblings **FLSIBSNO** _____
# of HALF biological siblings **HLFSIBSNO** _____
# of STEP siblings *(non-biological)* **STPSIBSNO** _____

MARITAL STATUS

Parents/Guardians *(Current status for PARTICIPATING parent/guardian(s))* **MARITAL** _____
(1=Single, 2=Divorced, 3=Married, 4=Widowed, 5=Cohab, 6=Separated)

PARENT EDUCATION

Biological **Mother's Education** **MOMED** _____

1= < HS	*4=AA degree/trade school*	*7=Master's degree*
2=GED/HSED	*5=Some college*	*8 = Masters +*
3=HS	*6=College graduate*	*99=unknown*

Mother's handedness *(1=right, 2=left, 3=mixed, 99=unknown)* **MOMHAND** _____

Mother's paid employment status *(0=No, 1=Part-time, 2=Full-time, 99=unknown)* **EMPMOM** _____

Mother's Current Position: _____ **MOMJOB**

Biological **Father's Education** **DADED** _____

1= < HS	*4=AA degree/trade school*	*7= Master's degree*
2=GED/HSED	*5=Some college*	*8= Master's +*
3=HS	*6=College graduate*	*99=unknown*

Father's handedness *(1=right, 2=left, 3=mixed, 99=unknown)* **DADHAND** _____

Father's paid employment status *(0=No, 1=Part-time, 2=Full-time, 99=unknown)* **EMPDAD** _____

Father's Current Position: _____ **DADJOB**

ACADEMICS

Is your child currently home schooled? *(0=no, 1= yes, 99=n/a)* **HMESCHL** _____

Current Grade *(only if currently still attending grade ≤ 12)* **GRADE** _____

Level of Education *(if still attending high school mark **"1 < HS"**)* **HDEGR** _____

1= < HS	*6=College graduate*
2=GED/HSED	*7=Master's degree*
3=HS	*8 = Masters +*
4=AA degree/trade school	***99=n/a***
5=Some college	

Any neuropsychological assessment? *(0=no, 1=yes, 99=unknown)* **PREVNP** _____

If yes, details of assessments *(when/where/date):* **PREVDET**

_____

_____

EDUCATION SERVICES

Please indicate NOT Applicable if: 1) child is homeschooled; 2) child does not attend school currently.

Educational Services *(0=no, 1=yes, 99=n/a)* **EDSP** _____

Birth to Age 3? *(0=no, 1=yes, 99=n/a)* **AGE3PRO** _____

If yes, Birth to Age 3 Services received: **AGE3SRV** _____

0=None	*4=Life Skills*
1=Physical Therapy	*5=More than 1 service*
2=Occupational Therapy	***6=Other, specify***
3=Speech Therapy	*99=n/a*

AGE3SRVoth _____

Early Childhood Programs? *(0=no, 1=yes, 99=n/a)* **ERLYPRO** _____

If yes, Early Childhood Services received: **EARLYSRV** _____

0=None	*4=Life Skills*
1=Physical Therapy	*5=More than 1 service*
2=Occupational Therapy	***6=Other, specify***
3=Speech Therapy	*99=n/a*

EARLYSRVoth _____

Does your child have an IEP (EEN, 504)**?** *(0=no, 1=yes, 99=n/a)* **IEP** _____

Does your child receive special services in school? *(0=no, 1=yes, 99=n/a)* **SPECPRO** _____

If yes, Special Services received: **SPECSRV** _____

0=None	*3=Behavior/Socialization*
1= Therapies (PT or OT)	*4= More than 1 service*
2=Academic (Small group instruction, resource room required, extended testing time, academic modifications)	***5=Other, specify***
	99=n/a

If other, specify: ***SPECSRVoth*** _____

Sylvan, Tutor, Homework club, Title I, Reading/Math groups, assistance before/after school? *(0=no 1=yes, 99=n/a)* **TUTOR** _____

Previously repeated a grade? *(0=no 1=yes, 99=n/a)* **REPEAT** _____

Attended summer school *(Walbridge, Wilson Camp, etc.)* **for academic reasons?** *(0=no, 1=yes, 99=n/a)* **SUMSCH** _____

Learning problems identified before seizure onset? *(0=no 1=yes, 99=n/a)* **LPBFORE** _____

Did your child receive services prior to 1st seizure? *(0=no 1=yes, 99=n/a)* **SRVSEIZ** _____

Did your child receive services before Epi diagnosis? *(0=no 1=yes, 99=n/a)* **SRVDIAG** _____

INITIAL PRECIPITATING INJURIES

Any IPI present *(0=no, 1=yes, 99=unknown)* **IPI** _____

IPI Timing *(0=n/a, 1=prenatal, 2=perinatal, 3=postnatal, 4=mixed, 99=unk)* **IPITIME** _____

Prenatal IPIs *(listing)*

0=none	*4=serious injury*
1=preterm labor	*5=premature rupture of membranes*
2=high blood pressure	*6=significant illness during pregnancy*
3=toxemia	*99=unknown*

PRENAT1 _____

PRENAT2 _____

PRENAT3 _____

Prenatal details: **PRENAT_Details**

Perinatal IPIs *(listing)*

0=none	*3=infant required oxygen*
1=premature delivery	*4= placed in incubator*
2= late delivery	*99=unknown*

PERIPI1 _____
PERIPI2 _____
PERIPI3 _____

Perinatal details: **PERIPI_Details**

Postnatal IPIs

0=none	*4=infectious*
1=simple FC	*5=non-cerebral*
2=complex FC	*6=other*
3=CHI	*99=unknown*

Postnatal IPI #1: **POSTIPI1** _____
Child's age (months): ***AGEIPI1*** _____
Did they have a seizure? (0=n/a, 1=yes, 2=no) **Seizure1** _____

Postnatal IPI #2: **POSTIPI2** _____
Child's age (months): ***AGEIPI2*** _____
Did they have a seizure? (0=n/a, 1=yes, 2=no) **Seizure2** _____

Postnatal IPI #3: **POSTIPI3** _____
Child's age (months): ***AGEIPI3*** _____
Did they have a seizure? (0=n/a, 1=yes, 2=no) **Seizure3** _____

Postnatal details: **POSTIPI_Details**

TOTAL number of IPIs **IPINUM** _____

IPI Combination **COMNUM** _____
(0=none, 1=pre+peri, 2=pre+post, 3=peri+post, 4=pre+peri+post)

GENERAL MEDICAL HISTORY

Co-morbid medical condition(s): *(0=no, 1=yes)* **MCOMOR** _____

0= None	*4= Migraines*
1= Thyroid disease	*5= Other, specify*
2= Asthma	***6=Head Injury:*** **Details →**
3=Diabetes (IDD/NIDD	

HeadInj_Details

Co-Morbid condition 1: *(if other, specify below)* **MCOMORA** _____

Age at diagnosis A (months) **AGEDXA** _____

OTHER Condition A: *MCOMORAOth* _____

Co-Morbid condition 2: *(if other, specify below)* **MCOMORB** _____

Age at diagnosis B (months) **AGEDXB** _____

OTHER Condition B: *MCOMORBOth* _____

Co-Morbid condition 3: *(if other, specify below)* **MCOMORC** _____

Age at diagnosis C (months) **AGEDXC** _____

OTHER Condition B: *MCOMORCOth* _____

Co-Morbid condition 4: *(if other, specify below)* **MCOMORD** _____

Age at diagnosis D (months) **AGEDXD** _____

OTHER Condition D: *MCOMORDOth* _____

OTHER MEDICATIONS

Medications *(including psych meds)* **other than AED's**: *(0=no, 1=yes)* **MEDS** _____

Summary of other meds: **OTHERMEDS**

FAMILY HISTORY *(Parents & Siblings of the participant ONLY)*

Family history of neurological disorders *(0=no, 1=yes)* **FAMNEU** _____

0=None	*5=Dementia NOS*	*9=ADHD*
1=Epilepsy	*6=Multiple sclerosis*	***10= Other, specify***
2=Stroke	*7=ALS*	*11=Autism*
3=Parkinson disease	*8=LD*	*12=Mental Retardation*
4=Alzheimer's disease		

Family Disorder #1: *(if other, specify below)* **FAMDIS1** _____

Family member affected *(0=none, 1=mother, 2=father, 3=siblings)* **FAMMEM1** _____

OTHER Family Disorder #1: *FAMDIS1oth* _____

Family Disorder #2: *(if other, specify below)* **FAMDIS2** _____

Family member affected *(0=none, 1=mother, 2=father, 3=siblings)* **FAMMEM2** _____

OTHER Family Disorder #2: *FAMDIS2oth* _____

Family Disorder #3: *(if other, specify below)* **FAMDIS3** _____

Family member affected *(0=none, 1=mother, 2=father, 3=siblings)* **FAMMEM3** _____

OTHER Family Disorder #3: *FAMDIS3oth* _____

EPILEPSY VARIABLES

Patient's current neurologist: **NEURO** _____

0=None	*3=Edelman*	*6=Swink*	*9=Ikonomidou*	*12=TBD*
1=Sheth	*4=Koehn*	*7=Doescher*	*10=Zawadzki*	***99=n/a***

2=Stafstrom	*5=Hsu*	***8=OTHER***	*11=Morris*

Site: **SITE** _____

1=UW-Hospital	*4=Marshfield*	*7=Gunderson*
2=Physicians +	*5=Dean*	*8=MCW*
3=UW-Satellite	*6=OTHER*	*99=n/a*

Has the patient received any financial aid? **FINAID** _____
Government aid *SSI, SSDI, WW: (0=no,1=yes, 99=n/a)*

SEIZURES

Patient's age at diagnosis *(months)*: DIAGNOS

Duration of epilepsy from diagnosis *(months):* DURAT

When was the patient's most recent seizure? ***RECSEIZ_Month*** _____
(month & year of most recent seizure, or 99=unknown) ***RECSEIZ_Year*** _____

Total ***months*** since most recent seizure occurred: RECSEIZ

Did patient have a seizure in the last 24 hours? *(0=no, 1=yes, 99=unknown)* **24HRSZ** _____
If yes, specify *(0=none or n/a, SP=1, CP=2, SG=3, 4=G)* **SZTYPE** _____

When did patient's 1st witnessed afebrile seizure occur? ***ONSETA_Month*** _____
(month & year of their 1st witnessed seizure, or 99=unknown) ***ONSETA_Year*** _____

Patient's age *(in months)* at 1st witnessed afebrile seizure: ONSETA

Probably seizures prior to diagnosis? *(0=no, 1=yes)* **EARLYSZ** _____

If yes, when did earlier seizure(s) occur: ***EARLYSZ_Month*** _____
(month & year of earlier seizure, or 99=unknown) ***EARLYSZ_Year*** _____

Patient's age *(in months)* when onset of seizures is believed to have occurred: EARLYAG

Epilepsy NOTES: _____

STATUS EPILEPTICUS

Episodes of (SE) *(seizure lasting > 30 min)***?** **STATUS** _____
(0=no, 1=yes, 99=unknown)

If yes, when did SE occur: *(month & year of SE, 99=unknown)* — ***STUSAGE-month*** _____ ***STUSAGE-year*** _____

Participant's age *(in months)* at the time of SE: **STUSAGE**

Lifetime episodes of SE: **STUSLIF** _____

SEIZURE RELATED INJURIES

Any seizure related injuries requiring medical attention? **INJUR** _____

(0=no, 1=yes, 99=unknown)

If yes, what type of injuries:

0=None	*3=Dental*
1=Burn/Scald	*4=Fracture*
2=Head	*5=Other*

Seizure related injury 1: **INTYPEA** _____

Seizure related injury 2: **INTYPEB** _____

Seizure related injury 3: **INTYPEC** _____

Details of injuries: **INJSPEC**

ANTIEPILEPTIC MEDICATION

0*= None*	***7****=Gabatril (Tiagabine)*	***14****=Lorazepam (Ativan)*
1*=Dilantin (Phenytoin)*	***8****=Felbamate (Felbatol)*	***15****=Trileptal (Oxcarbazepine)*
2*=Tegretol (Carbatrol; Carbamazepine)*	***9****=Phenobarbital*	***16****=Zonegram (Zonisamide)*
3*=Depakote (Valproate)*	***10****=Mysoline (Primidone)*	***17****=Lyrica (Pregabalin)*
4*=Gabapentin (Neurontin)*	***11****=Ethosuximide (Zarontin)*	***18****=Keppra (Levetiracetam)*
5*=Lamictal (Lamotrigine)*	***12****=Klonopin (Clonazepam)*	***19****=Other*
6*=Topamax (Topiramate)*	***13****=Diazepam (Valium)*	

First AED used: **FRSTMED** _____

When *(month & year)* **did the participant start the AED regiment:** ***AGEMED_Month*** _____ ***AGEMED_Year*** _____

Participant's age *(in months)* at the time AED treatment was initiated: AGEMED

Any changes in AED regimen *(0=no, 1=yes, 99=unknown)* **MEDCHG** _____

If yes, details of AED changes *(e.g., date, reason, what AED's):* **MEDDTL**

Current AED Regimen *(See Antiepileptic Medication list above)*

Anti-Epileptic Drug 1: **AEDA** _____

Anti-Epileptic Drug 2: **AEDB** _____

Anti-Epileptic Drug 3: **AEDC** _____

Total Number of AED's *(raw):* **AEDNUM** _____

COGNITIVE DATA

Parent-WASI (2 Sub-tests)

Estimated FSIQ	**RAW SCORE**	**IQFULRM**	__ __ __
	Index Score	*IQFULSM*	__ __ __
Vocabulary	**RAW SCORE**	**IQVOCRM**	__ __
	Scaled Score	*IQVOCSM*	__ __
Matrix Reasoning	**RAW SCORE**	**IQMRRM**	__ __
	Scaled Score	*IQMRSM*	__ __

Lateral Dominance

Total Right Hand	**HANDRT**	__ __
Total Left Hand	HANDLT	__ __
Eye Right	**EYERT**	__ __
Eye Left	EYELT	__ __
Foot Right	**FOOTRT**	__ __
Foot Left	FOOTLT	__ __

WASI

Estimated VIQ	**Raw Score**	**IQVERBR**	__ __ __
	Index	*IQVERS*	__ __ __
Estimated PIQ	**Raw Score**	**IQPERFR**	__ __ __
	Index	*IQPERFS*	__ __ __
Estimated FSIQ	**Raw Score**	**IQFULLR**	__ __ __
	Index	*IQFULLS*	__ __ __
Vocabulary	**Raw Score**	**IQVOCR**	__ __
	Scaled	*IQVOCS*	__ __
Block Design	**Raw Score**	**IQBDR**	__ __
	Scaled	*IQBDS*	__ __
Similarities	**Raw Score**	**IQSIMR**	__ __
	Scaled	*IQSIMS*	__ __
Matrix Reasoning	**Raw Score**	**IQMRR**	__ __
	Scaled	*IQMRS*	__ __

PPVT-III

	Raw Score	**PPVTRAW**	__ __ __
	Standard Score	*PPVTSTN*	__ __ __

EVT

	Raw Score	**EVTRAW**	__ __ __
	Standard Score	*EVTSTN*	__ __ __
EVT & PPVT-III Score comparison	**Difference Score**	**EVPPDIF**	__ __

WRAML Not administered to full sample

Zoo	**Raw Score**	**WRAMLZooR**	__ __
	Commission Errors	*WRAMLZooError*	__ __
Classroom	**Raw Score**	**WRAMLClasR**	__ __
	Commission Errors	*WRAMLClasError*	__ __
Garage	**Raw Score**	**WRAMLGarR**	__ __
	Commission Errors	*WRAMLGarError*	__ __
Living Room	**Raw Score**	**WRAMLLivR**	__ __
	Commission Errors	*WRAMLLivError*	__ __
TOTAL SCORE	**Raw Score**	**WRAMLTotalR**	__ __
(Zoo + Classroom + Garage + Living Room)	*Scaled Score*	*WRAMLTotalS*	__ __

WRAT3

Reading	**Raw Score**	**READRAW**	__ __
	Standard Score	*READSTN*	__ __ __
	Grade Score*	READGS	__ __.__
Spelling	**Raw Score**	**SPELRAW**	__ __
	Standard Score	*SPELSTN*	__ __ __
	Grade Score*	SPELGS	__ __.__
Arithmetic	**Raw Score**	**ARITRAW**	__ __
	Standard Score	*ARITSTN*	__ __ __
	Grade Score*	ARITGS	__ __.__
	** If participant >HS=13*		

WISC-IV

Digit Symbol Coding	**Raw Score**	**IQDSYMR**	__ __ __
	Scaled Score	*IQDSYMS*	__ __

GROOVED PEGBOARD

Dominant Hand	**Time in seconds**	**PGDOM**	__ __ __
	# of drops	*PGDOMDR*	__ __
Non-dominant Hand	**Time in seconds**	**PGNDOM**	__ __ __
	# of drops	*PGNDOMDR*	__ __

CMS-III (Word Lists)

Learning	**Raw Score**	**WLLRS**	__ __
	Scaled Score	*WLLSS*	__ __
Delayed Recall	**Raw Score**	**WLDRS**	__ __
	Scaled Score	*WLDSS*	__ __
Recognition	**Raw Score**	**WLDRRS**	__ __
	Scaled Score	*WLDRSS*	__ __

CPT-II

# Omissions	**Raw Score**	**CPOMR**	__ __
	T-Score	*CPOMT*	__ __.__ __
# Commissions	**Raw Score**	**CPCOMMR**	__ __
	T-Score	*CPCOMMT*	__ __.__ __
Hit Rate	**Raw Score**	**CPRTR**	__ __ __.__ __
	T-Score	*CPRTT*	__ __ __.__ __
Hit Rate Standard Error	**Raw Score**	**CPRTSER**	__ __.__ __
	T-Score	*CPRTSET*	__ __.__ __
Variability of Standard Errors	**Raw Score**	**CPVARSER**	__ __.__ __
	T-Score	*CPVARSET*	__ __.__ __
Detectability	**Raw Score**	**CPDETECR**	__ __.__ __
	T-Score	*CPDETECT*	__ __.__ __
Response Style	**Raw Score**	**CPRESSTR**	__ __.__ __
	T-Score	*CPRESSTT*	__ __.__ __
Perseverations	**Raw Score**	**CPPERSVR**	__ __
	T-Score	*CPPERSVT*	__ __.__ __
Hit Rate Block Change	Raw Score	**CPRTBLKR**	__.__ __
	T-Score	*CPRTBLKT*	__ __.__ __
Hit SE Block Change	**Raw Score**	**CPBLKSER**	__.__ __
	T-Score	*CPBLKSET*	__ __.__ __
Hit Rate ISI Change	**Raw Score**	**CPRTISIR**	__.__ __
	T-Score	*CPRTISIT*	__ __.__ __
Hit SE ISI Change	**Raw Score**	**CPISISER**	__.__ __
	T-Score	*CPISISET*	__ __.__ __
Overall Index Score*	**Raw Score**	**CPINDEX**	__ __.__ __

Score found on page 7 or 8 of CPT output report

D-KEFS

VERBAL FLUENCY

Letter Fluency	**Raw Score**	**LETFLUR**	__ __
	Scaled Score	*LETFLUS*	__ __
Category Fluency	**Raw Score**	**CATFLUR**	__ __
	Scaled Score	*CATFLUS*	__ __

Category Switching	**Raw Score**	**CATSWR**	__ __
	Scaled Score	*CATSWS*	__ __
Category Switching Accuracy	**Raw Score**	**CATSWAR**	__ __
	Scaled Score	*CATSWAS*	__ __
Letter vs. Category Fluency	**SS Difference**	**LETCATD**	__ __
	Contrast SS	*LETCATC*	__ __
Category Switching vs. Fluency	**SS Difference**	**SWFLUD**	__ __
	Contrast SS	*SWFLUC*	__ __
COLOR-WORD			
Color Naming	**Raw Score**	**COLRAW**	__ __
	Scaled Score	*COLSS*	__ __
Word Reading	**Raw Score**	**WORDRAW**	__ __
	Scaled Score	*WORDSS*	__ __
Inhibition	**Raw Score**	**INHRAW**	__ __ __
	Scaled Score	*INHSS*	__ __
Naming + Reading	**Sum of SS**	**NRSSS**	__ __
	Composite SS	*NRCSS*	__ __
Inhibition vs. Color Naming	**SS Difference**	**INHCOLD**	__ __
	Contrast SS	*INHCOLC*	__ __
CARD SORTING TEST			
Confirmed Correct Sorts	**Raw Score**	**CORSORR**	__ __
	Scaled Score	*CORSORS*	__ __
Free Sorting Description Score	**Raw Score**	**FREESORR**	__ __ __
	Scaled Score	*FREESORS*	__ __
Word Reading Errors	***Raw Score***	**WREADR**	__ __
Word Comprehension Errors	***Raw Score***	**WCOMPR**	__ __
Confirmed Correct Sorts: Card Set 1	**Raw Score**	**CARD1R**	__ __
	Scaled Score	*CARD1SS*	__ __
Confirmed Correct Sorts: Card Set 2	**Raw Score**	**CARD2R**	__ __
	Scaled Score	*CARD2SS*	__ __
Confirmed Correct Verbal Sorts	**Raw Score**	**VERBR**	__ __
	Scaled Score	*VERBSS*	__ __
Confirmed Correct Perceptual Sorts	**Raw Score**	**PERCEPR**	__ __
	Scaled Score	*PERCEPS*	__ __
Confirmed/Unconfirmed Target Sorts	**Raw Score**	**TARGETR**	__ __
	Scaled Score	*TARGETS*	__ __
Repeated Sorts	**Raw Score**	**REPEATR**	__ __
	Scaled Score	*REPEATS*	__ __
Set-Loss Sorts	**Raw Score**	**SETLOSR**	__ __
	Percentile Rank	*SETLOSP*	__ __ __
Non-Target Even Sorts	**Raw Score**	**NONTARR**	__ __

	Percentile Rank	*NONTARP*	__ __ __
Attempted Sorts	**Raw Score**	**ATTMPTR**	__ __
	Scaled Score	*ATTMPTS*	__ __
Percent Sorting Accuracy	**Raw Score**	**PERACCR**	__ __ __
	Scaled Score	*PERACCS*	__ __
Time-Per-Sort Ratio	**Raw Score**	**TIMER**	__ __
	Scaled Score	*TIMES*	__ __

BOSTON NAMING TEST

TOTAL Spontaneous Correct Responses	**BNTSPON**	__ __
# Stimulus Cues	**BNTCUE**	__ __
Correct Responses following Stimulus Cue	*BNTSTIM*	__ __
# of Phonemic Cues	**BNTPHCU**	__ __
Correct Responses following Phonemic Cues	*BNTPHON*	__ __
# of Multiple Choice Cues	**BNTMC**	__ __
Correct Responses following Multiple Choice	*BNTMCCR*	__ __
TOTAL # of Correct RESPONSES (1+3)	**BNTTOT**	__ __

WOODCOCK-JOHNSON III – Not administered to full sample

Reading Fluency	**Raw Score**	**REAFLUR**	__ __ __
	Scaled Score	*REAFLUS*	__ __ __
	GE score	REAFLUG	__ __ . __
Math Fluency	**Raw Score**	**MATFLUR**	__ __ __
	Scaled Score	*MATFLUS*	__ __ __
	GE score	MATFLUG	__ __ . __
Word Attack	**Raw Score**	**WORATTR**	__ __ __
	Scaled Score	*WORATTS*	__ __ __
	GE score	WORATTG	__ __ . __

PARENT Surveys & Questionnaires

Pediatric Survey of Race & Ethnicity

Ethnic Category ETHNICCAT _____

(0=Not Hispanic/Latino, 1=Hispanic/Latino, 2=Unknown)

Racial Category RACECAT _____

1=American Indian/Alaska Native	*4=Black/African American*	*6=More than one race*
2=Asian	*5=White*	*7=Unknown*
3=Native American/Pacific Islander		

Family Resources Questionnaire

Total Score **Raw Score** **FRQRAW** __ __

YALE Neuropsychoeducational Assessment Scales

Mother's age at child's birth: *(years)*	MOMAGE	___ ___
Number of prior pregnancies:	PRIPREG	___ ___
Miscarriages prior to this child's birth: *(0=0, 1=1, 2=2 or more)*	MISCARR	___ ___
Weight (lbs) gained during this pregnancy: *(1=<20, 2=21-30, 3=>30)*	WTGND	___ ___
Length of labor: *(1=2hrs or less, 2=3-12hrs, 3=12-24hrs, 4=24hrs or longer)*	LABDUR	___ ___
Birth Weight: _____ *lbs* _____ *Oz*		
TOTAL Birth weight: *(in total OUNCES)*	BRTHWT	___ ___ ___
Morning sickness: *(0=no, 1=yes)*	AMILL	___ ___
Bleeding from the vagina: *(0=no, 1=yes)*	BLDVGN	___ ___
Premature contractions: *(0=no, 1=yes)*	CONTR	___ ___
Edema of face, hands, ankles: *(0=no, 1=yes)*	EDEM	___ ___
High blood pressure: *(0=no, 1=yes)*	HIBP	___ ___
Incompatible RH factor: *(0=no, 1=yes)*	INCRH	___ ___
Toxemia: *(0=no, 1=yes)*	TOX	___ ___
Rubella: *(0=no, 1=yes)*	RUB	___ ___
Diabetes: *(0=no, 1=yes)*	DIAB	___ ___
Anemia: *(0=no, 1=yes)*	ANEM	___ ___
Serious Injury: *(0=no, 1=yes)*	INJ	___ ___
Emotional problems: *(0=no, 1=yes)*	EMOT	___ ___
Scale 1: TOTAL Medical Complications	**TotalMEDCOMP**	
More than 10 cigarettes per day: *(0=no, 1=yes)*	SMOKE	___ ___
2 or more alcoholic drinks per day: *(0=no, 1=yes)*	ETOH	___ ___
3 or more cups of coffee per day: *(0=no, 1=yes)*	CAFF	___ ___
Scale 2: TOTAL Adverse Behavior	**TotalADVBEH**	

Blood pressure pills: *(0=no, 1=yes)*	BPRX	___ ___
Tranquilizers or sedatives: *(0=no, 1=yes)*	SEDAT	___ ___
Pills for nausea: *(0=no, 1=yes)*	NAUSRX	___ ___
Antibiotics: *(0=no, 1=yes)*	ANTIB	___ ___
Water pills: *(0=no, 1=yes)*	WATER	___ ___
Medication for pain: *(0=no, 1=yes)*	PAINRX	___ ___
Medication to prevent miscarriage: *(0=no, 1=yes)*	MISCARRX	___ ___
Medication to prevent weight gain: *(0=no, 1=yes)*	WTGNRX	___ ___
Valium: *(0=no, 1=yes)*	VALIM	___ ___

Prednisone: *(0=no, 1=yes)*	PRED	___ ___
Amphetamine:*(0=no, 1=yes)*	AMPH	___ ___
Thyroid medication: *(0=no, 1=yes)*	THYR	___ ___
Other Prescription Drugs	PROTRDRUG	___ ___
If yes, Name of Prescription Drug	PRDRUGNAME	_____
Scale 3: TOTAL Prescription Use	**TotalPRDRUG**	
Methadone: *(0=no, 1=yes)*	METH	___ ___
Marijuana: *(0=no, 1=yes)*	POT	___ ___
LSD: *(0=no, 1=yes)*	LSD	___ ___
Cocaine: *(0=no, 1=yes)*	COKE	___ ___
Heroin: *(0=no, 1=yes)*	HERO	___ ___
Other Drugs: *(0=no, 1=yes)*	OTRDRG	___ ___
Name of other drug used:	OTRDRUG	_____
Scale 4: TOTAL Illicit Drug Use:	**TotalILDRUG**	
Premature delivery: *(0=no, 1=yes)*	PREM	___ ___
Late delivery: *(0=no, 1=yes)*	LATEDEL	___ ___
Labor induced by drugs: *(0=no, 1=yes)*	INDUCE	___ ___
Cesarean section before labor: *(0=no, 1=yes)*	CSECBF	___ ___
Cesarean section after labor: *(0=no, 1=yes)*	CSECAF	___ ___
General anesthesia: *(0=no, 1=yes)*	GANES	___ ___
Local anesthesia: *(0=no, 1=yes)*	LANES	___ ___
Prolonged labor: *(0=no, 1=yes)*	PROLAB	___ ___
Breech delivery: *(0=no, 1=yes)*	BREECH	___ ___
Use of forceps: *(0=no, 1=yes)*	FORCEP	___ ___
Cord around neck: *(0=no, 1=yes)*	CORDNK	___ ___
Blue at birth: *(0=no, 1=yes)*	BLUE	___ ___
Slow heartbeat: *(0=no, 1=yes)*	SLOHR	___ ___
Didn't breathe at first: *(0=no, 1=yes)*	NOBRTH	___ ___
Infant jittery: *(0=no, 1=yes)*	JITTER	___ ___
Infant unusual cry: *(0=no, 1=yes)*	UNUSCRY	___ ___
Infant required oxygen: *(0=no, 1=yes)*	REQO2	___ ___
Infant required blood transfusion: *(0=no, 1=yes)*	TRANFU	___ ___
Infant in incubator: *(0=no, 1=yes)*	INCUB	___ ___
Twin or multiple birth: *(0=no, 1=yes)*	TWNMLT	___ ___
Other problem: *(0=no, 1=yes)*	OTRLABR	___ ___
If other labor problems, specify:	LABRSPEC	_____
Scale 5: TOTAL Complications During Delivery:	**TotalCOMPDEL**	

Child Behavior Checklist Scores

Activities	**Total Score**	**ACTIV**	__ __.__
	T-Score	*ACTIVT*	__ __
Social	**Total Score**	**SOC**	__ __.__
	T-Score	*SOCT*	__ __
School	**Total Score**	**SCHL**	__ __.__
	T-Score	*SCHLT*	__ __

Total Competence	**Total Score**	**TOTCOM**	__ __.__
	T-Score	*TOTCOMT*	__ __
Anxious/Depressed	**Total Score**	**AXDEPTS**	__ __.__
	T-Score	*AXDEPT*	__ __
Withdrawn/Depressed	**Total Score**	**WDDEPTS**	__ __.__
	T-Score	*WDDEPT*	__ __
Somatic Complaints	**Total Score**	**SMCMTS**	__ __.__
	T-Score	*SMCMT*	__ __
Social Problems	**Total Score**	**SOCPTS**	__ __.__
	T-Score	*SOCPT*	__ __
Thought Problems	**Total Score**	**THTPTS**	__ __.__
	T-Score	*THTPT*	__ __
Attention Problems	**Total Score**	**ATTNTS**	__ __.__
	T-Score	*ATTNT*	__ __
Rule-breaking	**Total Score**	**RULETS**	__ __.__
	T-Score	*RULET*	__ __
Aggressive Behavior	**Total Score**	**AGGRSTS**	__ __.__
	T-Score	AGGRST	__ __
Internalizing Problems	**Total Score**	**INTLTS**	__ __.__
	T-Score	*INTLT*	__ __
Externalizing Problems	**Total Score**	**EXTNLTS**	__ __.__
	T-Score	*EXTNLT*	__ __
Total Problems	**Total Score**	**PRBLMTS**	__ __.__
	T-Score	*PRBLMT*	__ __
Affective Problems	**Total Score**	**AFFCTTS**	__ __.__
	T-Score	*AFFCTT*	__ __
Anxiety Problems	**Total Score**	**ANXTS**	__ __.__
	T-Score	*ANXT*	__ __
Somatic Problems	**Total Score**	**SOMATTS**	__ __.__
	T-Score	*SOMATT*	__ __
AD/H Problems	**Total Score**	**ADHDTS**	__ __.__
	T-Score	*ADHST*	__ __
Opp. Def. Problems	**Total Score**	**OPDEFTS**	__ __.__
	T-Score	*OPDEFT*	__ __
Conduct Problems	**Total Score**	**CONDCTTS**	__ __.__
	T-Score	*CONDCTT*	__ __

Behavior Rating Inventory of Executive Function (BRIEF)

Inhibit	**Raw Score**	**INHIBR**	__ __
	T-Score	*INHIBT*	__ __
Shift	**Raw Score**	**SHIFTR**	__ __
	T-Score	*SHIFTT*	__ __
Emotional Control	**Raw Score**	**EMTCTLR**	__ __
	T-Score	*EMTCTLT*	__ __
BRI	**Raw Score**	**BRIR**	__ __

	T-Score	*BRIT*	__ __
Initiate	**Raw Score**	**INITR**	__ __
	T-Score	*INITT*	__ __
Working Memory	**Raw Score**	**WKMEMR**	__ __
	T-Score	*WKMEMT*	__ __
Plan/Organize	**Raw Score**	**PLANORGR**	__ __
	T-Score	*PLANORGT*	__ __
Organization of Materials	**Raw Score**	**ORGMATR**	__ __
	T-Score	*ORGMATT*	__ __
Monitor	**Raw Score**	**MONTRR**	__ __
	T-Score	*MONTRT*	__ __
MI	**Raw Score**	**MIR**	__ __ __
	T-Score	*MIT*	__ __
GEC (BRI+MI)	**Raw Score**	**GECR**	__ __ __
	T-Score	*GECT*	__ __
Negativity	**Raw Score**	**NEGSC**	__ __
Inconsistency	**Raw Score**	**INCONS**	__ __

Seizure Severity Scale for Children

Total Score	**Raw Score**	**SSSCRAW**	__ __

PedsQL (*Parent*) Not administered to full sample

Physical Functioning	Transformed Score	**PEDQLPHYp**	__ __ __
Emotional Functioning	Transformed Score	**PEDQLEMTp**	__ __ __
Social Functioning	Transformed Score	**PEDQLSOCp**	__ __ __
Academic (School) School Functioning	Transformed Score	**PEDQLACDp**	__ __ __
PHYSICAL	*Summary Score*	**PEDQLPHYSUMp**	__ __ __ __
PSYCHOSOCIAL	*Summary Score*	**PEDQLPSYSUMp**	__ __ __ __
TOTAL	*Summary Score*	**PEDQLTOTALp**	__ __ __ __

SCARED (*Parent*) Not administered to full sample

Somatic Symptoms	Subscale Total	**SCAREDsomatP**	__ __
Generalized Anxiety	Subscale Total	**SCAREDgenerP**	__ __
Separation Anxiety	Subscale Total	**SCAREDseparP**	__ __

Social Anxiety	Subscale Total	**SCAREDsociaP**	__ __
School Avoidance	Subscale Total	**SCAREDschooP**	__ __
TOTAL SCORE	*TOTAL*	**SCAREDtotalP**	__ __

PARTICIPANT Surveys & Questionnaires

PedsQL (*Child*) Not administered to full sample

Physical Functioning	Transformed Score	**PEDQLPHY**	__ __ __
Emotional Functioning	Transformed Score	**PEDQLEMT**	__ __ __
Social Functioning	Transformed Score	**PEDQLSOC**	__ __ __
Academic (School) School Functioning	Transformed Score	**PEDQLACD**	__ __ __
PHYSICAL	*Summary Score*	**PEDQLPHYSUM**	__ __ __ __
PSYCHOSOCIAL	*Summary Score*	**PEDQLPSYSUM**	__ __ __ __
TOTAL	*Summary Score*	**PEDQLTOTAL**	__ __ __ __

SCARED (*Child*) Not administered to full sample

Somatic Symptoms	Subscale Total	**SCAREDsomatC**	__ __
Generalized Anxiety	Subscale Total	**SCAREDgenerC**	__ __
Separation Anxiety	Subscale Total	**SCAREDseparC**	__ __
Social Anxiety	Subscale Total	**SCAREDsociaC**	__ __
School Avoidance	Subscale Total	**SCAREDschooC**	__ __
TOTAL SCORE	*TOTAL*	**SCAREDtotalC**	__ __

Children's Depression Inventory (CDI)

Total Score	**Raw Score**	**CDITOTR**	__ __
	T-Score	*CDITOTT*	__ __
Negative Mood	**Raw Score**	**CDINMR**	__ __
(Scale A)	*T-Score*	*CDINMT*	__ __
Interpersonal Problems	**Raw Score**	**CDIIPR**	__ __
(Scale B)	*T-Score*	*CDIIPT*	__ __
Ineffectiveness	**Raw Score**	**CDIIR**	__ __
(Scale C)	*T-Score*	*CDIIT*	__ __
Anhedonia	**Raw Score**	**CDIAR**	__ __
(Scale D)	*T-Score*	*CDIAT*	__ __
Negative Self-Esteem	**Raw Score**	**CDINSER**	__ __

(Scale E) *T-Score* *CDINSET* __ __

Cleveland Adolescent Sleepiness Questionnaire

Total Score **Raw Score** **CLSLEEP** __ __

TIME 1 PSYCHIATRIC INFORMATION

Psychiatric interview type: *(0=n/a, 1=K-SADS, 2=SCID)* **PSYCHintrw** 1

Interview videotaped? *(0=no, 1=yes)* **KSADSVideo** _____

PARTICIPANT Interviewer *(0=n/a, 1=JJ, 2=JB, 3=JJ/JB, 4=DJ, 5=AKJ, 6=KB, 99=Other)* **KINTERV** _____

PARENT Interviewer *(0= n/a, 1=JJ, 2=JB, 3=JJ/JB, 4=DJ, 5=AKJ, 6=KB, 99=Other)* **KINTERVp** _____

Previously seen a psychiatrist, psychologist, counselor, or therapist? **PSYCHTX** _____
(0=no, 1=yes, 9=unknown)

If yes, what was the nature of treatment: **PSYNOUT** _____
(0=none, 1=inpatient, 2=outpatient, 3=both)

Notes: _____

Child's age *(years)* **at 1st Outpatient treatment:** **AGETX** _____

Child's age *(years)* **at 1st Psychiatric Hospitalization:** **AGEINPT** _____

Currently taking Psychiatric medication? *(0=no, 1=yes)* **PSYMED** _____

Notes: _____

Taken Psychiatric medications in the past? *(0=no, 1=yes)* **PREMED** _____

Notes: _____

Was onset of the psychiatric episode prior to the 1st seizure? **PSZONST** _____
(0=no, 1=yes, 9=n/a)

Child ever been placed in a special class for emotional problems? **CLSSEM** _____
(0=no, 1=yes, 9=unknown)

In the immediate family is there a history of Depression or Anxiety? **FAMHXa** _____
(0=none, 1=mother, 2=father, 3=sibling, 9=unknown) **FAMHXb** _____
FAMHXc _____

Is there history of depression/anxiety in Mom's family? **MFAMHXa** _____
(0=none, 1=mother, 2=father, 3=sibling, 9=unknown) **MFAMHXb** _____
MFAMHXc _____

Is there history of depression/anxiety in Dad's family? **DFAMHXa** _____
(0=none, 1=mother, 2=father, 3=sibling, 9=unknown) **DFAMHXb** _____
DFAMHXc _____

Any <u>current</u> diagnosis? *(0=no, 1=yes)* **SCIDDX** _____

Any <u>lifetime</u> diagnosis? *(0=no, 1=yes)* **SCIDLT** _____

DSM-IV Diagnoses:

0=none	*15=Schizophreniform*	*30=Encopresis**	*45=Delusional Dis.*
1=Major Depressive Dis.	*16=Brief Reactive Psychosis*	*31=Anorexia*	*46=ADHD, NOS*
2=MDD w/psychotic feat.	*17=Panic w/ Agoraphobia*	*32=Bulimia*	*47= Tobacco Use*
3=Dysthymia	*18=Separation Anxiety*	*33=ADHD/inattent.*	*48= Alcohol Abuse*
4=Depressive Dis., NOS	*19=Avoidant Disorder*	*34=ADHD/hyper.*	*49= Substance Abuse*
5=Adjustment Dis. w/Dep. mood	*20=Specific Phobia*	*35=ADHD/comb.*	*50=Anxiety NOS*
6=Mania	*21=Social Phobia*	*36=Conduct Dis.*	*51=Alcohol Use*
7=Hypomania	*22=Agoraphobia*	*37=Oppositional Def. Dis.*	*52=Substance Use*
8=Cyclothymia	*23=N/A*	*38=Adjust. Dis. w/conduct*	*53=Panic w/o Agoraphobia*
9=Bipolar, NOS	*24=Generalized Anx.*	*39=Adjust Dis. w/mixed*	*54=Somatization Disorder*
10=Bipolar I	*25=OCD*	*40=Tourettes*	*55=Pain Disorder*
11=Bipolar II	*26=PTSD*	*41=Chronic motor/vocal tics*	*56=Undifferentiated Somatoform*
12=Schizoaffective-Manic	*27=Acute Stress Dis.*	*42=Transient tic dis.*	*57=Somatoform Disorder*
13=Schizoaffective-Depressed	*28=Adjustment Dis.-Anx*	*43=Other Psychiatric Dis.*	*58=Hypochondriasis*
14=Schizophrenia	*29=Enuresis**	*44=Psychotic Dis., NOS*	*59=Body Dysmorphic Disorder*

CURRENT Diagnosis

Current diagnosis A: **CURDXA** _____

Age (years) at onset of diagnosis A: *AgeDxCURA* _____

Current diagnosis B: **CURDXB** _____

Age (years) at onset of diagnosis B: *AgeDxCURB* _____

Current diagnosis C: **CURDXC** _____

Age (years) at onset of diagnosis C: *AgeDxCURC* _____

Current diagnosis D: **CURDXD** _____

Age (years) at onset of diagnosis D: *AgeDxCURD* _____

Current diagnosis E: **CURDXE** _____

Age (years) at onset of diagnosis E: *AgeDxCURE* _____

LIFETIME Diagnosis

Lifetime diagnosis A: **LIFEDXA** _____

Age (years) at onset of lifetime diagnosis A: *AgeDxLA* _____

Lifetime diagnosis B: **LIFEDXB** _____

Age (years) at onset of lifetime diagnosis B: *AgeDxLB* _____

Lifetime diagnosis C: **LIFEDXC** _____

Age (years) at onset of lifetime diagnosis C: *AgeDxLC* _____

Lifetime diagnosis D: **LIFEDXD** _____

Age (years) at onset of lifetime diagnosis D:	*AgeDxLD*	
Lifetime diagnosis E:	**LIFEDXE**	
Age (years) at onset of lifetime diagnosis E:	*AgeDxLE*	
Total Number of Lifetime Diagnoses:	**TOTDX**	

ELIMINATION DISORDER(S)*

Elimination Disorder Diagnosis: *(0=None, 29=Enuresis, 30=Encopresis)*	**ELIMNDX**	

SUICIDE

Suicidal Behavior: *(0=no, 1=yes)*	**SUICIDE**	
Suicidal Thoughts: *(0=no, 1=yes)*	**THDEATH**	
Suicidal Ideation: *(0=no, 1=yes)*	**IDEATE**	
Suicidal Gestures: *(0=no, 1=yes)*	**GESTURE**	
Suicide Attempts: *(0=no, 1=yes)*	**ATTEMPT**	

ADHD

Current ADHD medications: *(0=no, 1=yes)*	**ADHDMED**	
Previous ADHD medications: *(0=no, 1=yes)*	**PREADHDMED**	
Evidence of ADHD: *(0=no, 1=yes)*	**ADHD**	
Inattentive Type: *(0=no, 1=yes)*	**ADHDI**	
Predominantly Hyperactive Impulsive Type: *(0=no, 1=yes)*	**ADHDH**	
Combined Type: *(0=no, 1=yes)*	**ADHDC**	
ADHD NOS: *(0=no, 1=yes)*	**ADHDNOS**	

Current DSM-IV Diagnosis Domains:

Anxiety *(0=no, 1=yes, 99=n/a)* — **CURanxiety**
DSM-IV Diagnoses: **17-22, 24, 50, 53**

ADHD *(0=no, 1=yes, 99=n/a)* — **CURadhd**
DSM-IV Diagnoses: **33-35, 46**

Depressive Disorders *(0=no, 1=yes, 99=n/a)* — **CURdepression**
DSM-IV Diagnoses: **1-4**

Bipolar *(0=no, 1=yes, 99=n/a)* — **CURbipolar**
DSM-IV Diagnoses: **6-11**

Psychosis *(0=no, 1=yes, 99=n/a)* — **CURpsych**
DSM-IV Diagnoses: **12-16, 43-45**

ODD/Conduct *(0=no, 1=yes, 99=n/a)* — **CURoddcondct**
DSM-IV Diagnoses: **36-37**

Post-Traumatic Stress Disorder *(0=no, 1=yes, 99=n/a)* — **CURptsd**
DSM-IV Diagnoses: **26 & 27**

Tics *(0=no, 1=yes, 99=n/a)* — **CURtics**
DSM-IV Diagnoses: **40-42**

Eating Disorders *(0=no, 1=yes, 99=n/a)* — **CUReating**
DSM-IV Diagnoses: **31 & 32**

Substance Abuse *(0=no, 1=yes, 99=n/a)* — **CURsubabuse**
DSM-IV Diagnoses: **47-49, 51-52**

Somatic Disorders** *(0=no, 1=yes, 99=n/a)* — **CURsomat**
DSM-IV Diagnoses: **54-59**

Adjustment Disorders *(0=no, 1=yes, 99=n/a)* — **CURadjust**
DSM-IV Diagnoses: **5, 28, 38-39**

OCD *(0=no, 1=yes, 99=n/a)* — **CURocd**
DSM-IV Diagnoses: **25**

*****K-SADS Interview value 99=n/a***

Lifetime DSM-IV Diagnosis Domains:

Anxiety *(0=no, 1=yes, 99=n/a)* — **LIFEanxiety**
DSM-IV Diagnoses: **17-22, 24, 50, 53**

ADHD *(0=no, 1=yes, 99=n/a)* — **LIFEadhd**
DSM-IV Diagnoses: **33-35, 46**

Depressive Disorders *(0=no, 1=yes, 99=n/a)* — **LIFEdepression**
DSM-IV Diagnoses: **1-4**

Bipolar *(0=no, 1=yes, 99=n/a)* — **LIFEbipolar**
DSM-IV Diagnoses: **6-11**

Psychosis *(0=no, 1=yes, 99=n/a)* **LIFEpsych**
DSM-IV Diagnoses: **12-16, 43-45**

ODD/Conduct *(0=no, 1=yes, 99=n/a)* **LIFEoddcondct**
DSM-IV Diagnoses: **36-37**

Post-Traumatic Stress Disorder *(0=no, 1=yes, 99=n/a)* **LIFEptsd**
DSM-IV Diagnoses: **26 & 27**

Tics *(0=no, 1=yes, 99=n/a)* **LIFEtics**
DSM-IV Diagnoses: **40-42**

Eating Disorders *(0=no, 1=yes, 99=n/a)* **LIFEeating**
DSM-IV Diagnoses: **31 & 32**

Substance Abuse *(0=no, 1=yes, 99=n/a)* **LIFEsubabuse**
DSM-IV Diagnoses: **47-49, 51-52**

Somatic Disorders** *(0=no, 1=yes, 99=n/a)* **LIFEsomat**
DSM-IV Diagnoses: **54-59**

Adjustment Disorders *(0=no, 1=yes, 99=n/a)* **LIFEadjust**
DSM-IV Diagnoses: **5, 28, 38-39**

OCD *(0=no, 1=yes, 99=n/a)* **LIFEocd**
DSM-IV Diagnoses: **25**

*****K-SADS Interview value 99=n/a***

Appendix B

Mplus LPA Syntax and Outcomes

To help the reader better understand the syntax provided, and because Mplus only allows variable names up to 8 characters long, a definition for each of the variables used in the syntax is provided.

```
Mplus VERSION 8.4
MUTHEN & MUTHEN

INPUT INSTRUCTIONS

    Title:        CHILDHOOD EPILEPSY Latent Class Analysis.
    Data:         FILE IS
\\sscwin\dfsroot\Users\Lwilliams25\Documents\Mplus\m+sz.dat;
    Variable:     NAMES ARE
           EDSP_IEP FREALL2 DIAGNOS AEDNUM ZIQFULSM
           ZIQVERS ZIQPERFS ZIQFULLS
           ZREADSTN ZSPELSTN ZARITSTN
           ZTOTCOM ZINTLT ZEXTNLT
           ZBRIT ZMIT ZGECT;
           usevariables = EDSP_IEP FREALL2 DIAGNOS AEDNUM ZIQFULSM
           ZIQFULLS ZREADSTN ZSPELSTN ZARITSTN
           ZTOTCOM ZINTLT ZEXTNLT ZBRIT ZMIT;
           MISSING ARE all(-999);
         classes = c(3);
    Analysis:
      Type=mixture;
        LRTSTARTS = 0 0 5000 1000;
      MODEL:
      %OVERALL%
      c ON EDSP_IEP DIAGNOS FREALL2 AEDNUM ZIQFULSM;
    Plot:
      type is plot3;
      series is ZIQFULLS(1) ZREADSTN(2) ZSPELSTN(3) ZARITSTN(4)
      ZTOTCOM(5) ZINTLT(6) ZEXTNLT(7) ZBRIT(9) ZMIT(10);
    Savedata:
      file is
"\\sscwin\dfsroot\Users\Lwilliams25\Documents\Mplus\lcaprobe2.sav";
      save is cprob;
      format is free;
    output:
    tech11 tech14;


CHILDHOOD EPILEPSY Latent Class Analysis.
```

```
SUMMARY OF ANALYSIS

Number of groups                                                 1
Number of observations                                         154

Number of dependent variables                                    9
Number of independent variables                                  5
Number of continuous latent variables                            0
Number of categorical latent variables                           1

Observed dependent variables

  Continuous
   ZIQFULLS    ZREADSTN    ZSPELSTN    ZARITSTN    ZTOTCOM     ZINTLT
   ZEXTNLT     ZBRIT       ZMIT

Observed independent variables
   EDSP_IEP    FREALL2     DIAGNOS     AEDNUM      ZIQFULSM

Categorical latent variables
   C


Estimator                                                      MLR
Information matrix                                        OBSERVED
Optimization Specifications for the Quasi-Newton Algorithm for
Continuous Outcomes
  Maximum number of iterations                                 100
  Convergence criterion                                0.100D-05
Optimization Specifications for the EM Algorithm
  Maximum number of iterations                                 500
  Convergence criteria
    Loglikelihood change                               0.100D-06
    Relative loglikelihood change                      0.100D-06
    Derivative                                         0.100D-05
Optimization Specifications for the M step of the EM Algorithm for
Categorical Latent variables
  Number of M step iterations                                    1
  M step convergence criterion                         0.100D-05
  Basis for M step termination                         ITERATION
Optimization Specifications for the M step of the EM Algorithm for
Censored, Binary or Ordered Categorical (Ordinal), Unordered
Categorical (Nominal) and Count Outcomes
  Number of M step iterations                                    1
  M step convergence criterion                         0.100D-05
  Basis for M step termination                         ITERATION
  Maximum value for logit thresholds                          15
  Minimum value for logit thresholds                         -15
  Minimum expected cell size for chi-square            0.100D-01
Maximum number of iterations for H1                         2000
Convergence criterion for H1                           0.100D-03
Optimization algorithm                                       EMA
Random Starts Specifications
  Number of initial stage random starts                       20
```

```
  Number of final stage optimizations                           4
  Number of initial stage iterations                           10
  Initial stage convergence criterion                  0.100D+01
  Random starts scale                                  0.500D+01
  Random seed for generating random starts                     0

Input data file(s)
  \\sscwin\dfsroot\Users\Lwilliams25\Documents\Mplus\m+sz.dat
Input data format  FREE


SUMMARY OF DATA

     Number of missing data patterns             4
     Number of y missing data patterns           4
     Number of u missing data patterns           0


COVARIANCE COVERAGE OF DATA

Minimum covariance coverage value   0.100


     PROPORTION OF DATA PRESENT FOR Y


           Covariance Coverage
              ZIQFULLS      ZREADSTN      ZSPELSTN      ZARITSTN
ZTOTCOM
              ________      ________      ________      ________
________
 ZIQFULLS       0.948
 ZREADSTN       0.948         1.000
 ZSPELSTN       0.948         1.000         1.000
 ZARITSTN       0.948         1.000         1.000         1.000
 ZTOTCOM        0.948         1.000         1.000         1.000
1.000
 ZINTLT         0.942         0.994         0.994         0.994
0.994
 ZEXTNLT        0.948         1.000         1.000         1.000
1.000
 ZBRIT          0.948         1.000         1.000         1.000
1.000
 ZMIT           0.935         0.987         0.987         0.987
0.987
 EDSP_IEP       0.948         1.000         1.000         1.000
1.000
 FREALL2        0.948         1.000         1.000         1.000
1.000
 DIAGNOS        0.948         1.000         1.000         1.000
1.000
 AEDNUM         0.948         1.000         1.000         1.000
1.000
```

ZIQFULSM	0.948	1.000	1.000	1.000
1.000				

Covariance Coverage

	ZINTLT	ZEXTNLT	ZBRIT	ZMIT
EDSP_IEP				
ZINTLT	0.994			
ZEXTNLT	0.994	1.000		
ZBRIT	0.994	1.000	1.000	
ZMIT	0.987	0.987	0.987	0.987
EDSP_IEP	0.994	1.000	1.000	0.987
1.000				
FREALL2	0.994	1.000	1.000	0.987
1.000				
DIAGNOS	0.994	1.000	1.000	0.987
1.000				
AEDNUM	0.994	1.000	1.000	0.987
1.000				
ZIQFULSM	0.994	1.000	1.000	0.987
1.000				

Covariance Coverage

	FREALL2	DIAGNOS	AEDNUM	ZIQFULSM
FREALL2	1.000			
DIAGNOS	1.000	1.000		
AEDNUM	1.000	1.000	1.000	
ZIQFULSM	1.000	1.000	1.000	1.000

UNIVARIATE SAMPLE STATISTICS

UNIVARIATE HIGHER-ORDER MOMENT DESCRIPTIVE STATISTICS

Variable/	Mean/	Skewness/	Minimum/	% with	Percentiles		
Sample Size	Variance	Kurtosis	Maximum	Min/Max	20%/60%	40%/80%	Median
ZIQFULLS	-0.062	-0.451	-3.000	2.05%	-		
1.000	0.000	0.000					
146.000	1.140	-0.031	2.000	4.11%			
0.000	1.000						
ZREADSTN	-0.091	0.257	-2.000	7.14%	-		
1.000	0.000	0.000					
154.000	1.031	-0.071	3.000	0.65%			
0.000	1.000						

```
     ZSPELSTN             -0.201      -0.124      -3.000    0.65%      -
1.000      0.000      0.000
             154.000       0.914       0.008       2.000    3.25%
0.000      1.000
     ZARITSTN             -0.149       0.265      -2.000    8.44%      -
1.000      0.000      0.000
             154.000       1.036       0.117       3.000    1.30%
0.000      1.000
     ZTOTCOM              -0.084       0.074      -3.000    1.30%      -
1.000      0.000      0.000
             154.000       1.155       0.601       3.000    1.95%
0.000      1.000
     ZINTLT               -0.065       0.095      -3.000    1.31%      -
1.000      0.000      0.000
             153.000       1.055       0.561       3.000    1.31%
0.000      1.000
     ZEXTNLT              -0.071       0.175      -3.000    0.65%      -
1.000      0.000      0.000
             154.000       1.118      -0.025       3.000    0.65%
0.000      1.000
     ZBRIT                -0.019       0.682      -2.000    0.65%      -
1.000     -1.000      0.000
             154.000       1.136      -0.743       2.000   13.64%
0.000      1.000
     ZMIT                 -0.020       0.003      -2.000    7.24%      -
1.000      0.000      0.000
             152.000       1.046      -0.385       3.000    0.66%
0.000      1.000
     EDSP_IEP              2.253      11.302       0.000   54.55%
0.000      0.000      0.000
             154.000      64.657     133.086      99.000    0.65%
2.000      4.000
     FREALL2             137.565       0.419      84.000    1.30%
101.000    119.000    131.500
             154.000    1380.596      -1.029     216.000    1.30%
146.000    177.000
     DIAGNOS               1.487       0.052       1.000   51.30%
1.000      1.000      1.000
             154.000       0.250      -1.997       2.000   48.70%
2.000      2.000
     AEDNUM                0.929       0.486       0.000   14.94%
1.000      1.000      1.000
             154.000       0.248       3.798       3.000    1.30%
1.000      1.000
     ZIQFULSM              1.519      -0.078       1.000   48.05%
1.000      1.000      2.000
             154.000       0.250      -1.994       2.000   51.95%
2.000      2.000

RANDOM STARTS RESULTS RANKED FROM THE BEST TO THE WORST LOGLIKELIHOOD
VALUES

Final stage loglikelihood values at local maxima, seeds, and initial stage
start numbers:
```

```
           -1747.312  unperturbed      0
           -1992.004  637345           19
           -1992.004  939021           8
           -1995.739  76974            16


THE MODEL ESTIMATION TERMINATED NORMALLY



MODEL FIT INFORMATION

Number of Free Parameters                       48

Loglikelihood

          H0 Value                       -1747.312
          H0 Scaling Correction Factor      1.1164
            for MLR

Information Criteria

          Akaike (AIC)                    3590.624
          Bayesian (BIC)                  3736.398
          Sample-Size Adjusted BIC        3584.471
            (n* = (n + 2) / 24)



FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON THE ESTIMATED MODEL

    Latent
   Classes

       1         43.14729          0.28018
       2         70.50714          0.45784
       3         40.34557          0.26198


FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON ESTIMATED POSTERIOR PROBABILITIES

    Latent
   Classes

       1         43.14729          0.28018
       2         70.50714          0.45784
       3         40.34557          0.26198


FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT CLASSES
BASED ON THEIR MOST LIKELY LATENT CLASS MEMBERSHIP
```

Class Counts and Proportions

Latent Classes		
1	44	0.28571
2	70	0.45455
3	40	0.25974

CLASSIFICATION QUALITY

Entropy	0.863

Classification Probabilities for the Most Likely Latent Class Membership (Column)
by Latent Class (Row)

	1	2	3
1	0.954	0.046	0.000
2	0.040	0.935	0.026
3	0.000	0.053	0.947

Logits for the Classification Probabilities for the Most Likely Latent Class Membership (Column)
by Latent Class (Row)

	1	2	3
1	13.769	10.727	0.000
2	0.448	3.600	0.000
3	-13.761	-2.879	0.000

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Latent Class 1				
Means				
ZIQFULLS	-0.729	0.219	-3.325	0.001
ZREADSTN	-0.996	0.125	-7.994	0.000
ZSPELSTN	-1.129	0.141	-8.029	0.000
ZARITSTN	-1.208	0.114	-10.619	0.000
ZTOTCOM	-1.076	0.174	-6.197	0.000
ZINTLT	-0.874	0.165	-5.304	0.000
ZEXTNLT	-1.135	0.128	-8.868	0.000
ZBRIT	-0.675	0.092	-7.347	0.000

ZMIT	−0.735	0.170	−4.331	0.000
Variances				
ZIQFULLS	0.911	0.105	8.683	0.000
ZREADSTN	0.431	0.080	5.413	0.000
ZSPELSTN	0.512	0.079	6.513	0.000
ZARITSTN	0.338	0.091	3.711	0.000
ZTOTCOM	0.616	0.080	7.705	0.000
ZINTLT	0.690	0.087	7.930	0.000
ZEXTNLT	0.534	0.087	6.129	0.000
ZBRIT	0.905	0.112	8.108	0.000
ZMIT	0.834	0.099	8.462	0.000
Latent Class 2				
Means				
ZIQFULLS	−0.094	0.162	−0.579	0.563
ZREADSTN	−0.211	0.105	−2.001	0.045
ZSPELSTN	−0.071	0.123	−0.577	0.564
ZARITSTN	−0.193	0.110	−1.758	0.079
ZTOTCOM	−0.052	0.107	−0.485	0.628
ZINTLT	−0.037	0.113	−0.331	0.740
ZEXTNLT	0.004	0.159	0.024	0.981
ZBRIT	0.010	0.213	0.047	0.962
ZMIT	0.181	0.141	1.285	0.199
Variances				
ZIQFULLS	0.911	0.105	8.683	0.000
ZREADSTN	0.431	0.080	5.413	0.000
ZSPELSTN	0.512	0.079	6.513	0.000
ZARITSTN	0.338	0.091	3.711	0.000
ZTOTCOM	0.616	0.080	7.705	0.000
ZINTLT	0.690	0.087	7.930	0.000
ZEXTNLT	0.534	0.087	6.129	0.000
ZBRIT	0.905	0.112	8.108	0.000
ZMIT	0.834	0.099	8.462	0.000
Latent Class 3				
Means				
ZIQFULLS	0.592	0.156	3.793	0.000
ZREADSTN	1.086	0.196	5.540	0.000
ZSPELSTN	0.564	0.123	4.596	0.000
ZARITSTN	1.059	0.174	6.080	0.000
ZTOTCOM	0.919	0.168	5.486	0.000
ZINTLT	0.770	0.167	4.613	0.000
ZEXTNLT	0.934	0.219	4.262	0.000
ZBRIT	0.629	0.326	1.931	0.054
ZMIT	0.416	0.236	1.760	0.078
Variances				
ZIQFULLS	0.911	0.105	8.683	0.000
ZREADSTN	0.431	0.080	5.413	0.000
ZSPELSTN	0.512	0.079	6.513	0.000

ZARITSTN	0.338	0.091	3.711	0.000
ZTOTCOM	0.616	0.080	7.705	0.000
ZINTLT	0.690	0.087	7.930	0.000
ZEXTNLT	0.534	0.087	6.129	0.000
ZBRIT	0.905	0.112	8.108	0.000
ZMIT	0.834	0.099	8.462	0.000

Categorical Latent Variables

C#1 ON				
EDSP_IEP	0.021	0.016	1.329	0.184
DIAGNOS	0.410	0.548	0.748	0.454
FREALL2	-0.006	0.007	-0.816	0.415
AEDNUM	-0.456	0.500	-0.912	0.362
ZIQFULSM	0.099	0.482	0.205	0.838
C#2 ON				
EDSP_IEP	-0.016	0.028	-0.578	0.563
DIAGNOS	0.185	0.533	0.347	0.729
FREALL2	-0.002	0.008	-0.223	0.824
AEDNUM	-0.278	0.523	-0.532	0.595
ZIQFULSM	0.416	0.458	0.908	0.364
Intercepts				
C#1	0.504	1.169	0.431	0.667
C#2	0.209	1.228	0.170	0.865

LOGISTIC REGRESSION ODDS RATIO RESULTS

	Estimate	S.E.	(Est. - 1) / S.E.	Two-Tailed P-Value
Categorical Latent Variables				
C#1 ON				
EDSP_IEP	1.021	0.016	1.315	0.189
DIAGNOS	1.507	0.827	0.614	0.539
FREALL2	0.994	0.007	-0.818	0.413
AEDNUM	0.634	0.317	-1.155	0.248
ZIQFULSM	1.104	0.532	0.195	0.845
C#2 ON				
EDSP_IEP	0.984	0.028	-0.583	0.560
DIAGNOS	1.203	0.641	0.317	0.751
FREALL2	0.998	0.008	-0.223	0.824
AEDNUM	0.757	0.396	-0.613	0.540
ZIQFULSM	1.516	0.694	0.743	0.457

ALTERNATIVE PARAMETERIZATIONS FOR THE CATEGORICAL LATENT VARIABLE REGRESSION

	Two-Tailed

	Estimate	S.E.	Est./S.E.	P-Value
Parameterization using Reference Class 1				
C#2 ON				
EDSP_IEP	-0.038	0.026	-1.456	0.145
FREALL2	0.004	0.006	0.672	0.502
DIAGNOS	-0.226	0.494	-0.457	0.648
AEDNUM	0.178	0.409	0.435	0.664
ZIQFULSM	0.317	0.455	0.697	0.486
C#3 ON				
EDSP_IEP	-0.021	0.016	-1.329	0.184
FREALL2	0.006	0.007	0.816	0.415
DIAGNOS	-0.410	0.548	-0.748	0.454
AEDNUM	0.456	0.500	0.912	0.362
ZIQFULSM	-0.099	0.482	-0.205	0.838
Intercepts				
C#2	-0.294	1.186	-0.248	0.804
C#3	-0.504	1.169	-0.431	0.667
Parameterization using Reference Class 2				
C#1 ON				
EDSP_IEP	0.038	0.026	1.456	0.145
FREALL2	-0.004	0.006	-0.672	0.502
DIAGNOS	0.226	0.494	0.457	0.648
AEDNUM	-0.178	0.409	-0.435	0.664
ZIQFULSM	-0.317	0.455	-0.697	0.486
C#3 ON				
EDSP_IEP	0.016	0.028	0.578	0.563
FREALL2	0.002	0.008	0.223	0.824
DIAGNOS	-0.185	0.533	-0.347	0.729
AEDNUM	0.278	0.523	0.532	0.595
ZIQFULSM	-0.416	0.458	-0.908	0.364
Intercepts				
C#1	0.294	1.186	0.248	0.804
C#3	-0.209	1.228	-0.170	0.865

ODDS RATIO FOR THE ALTERNATIVE PARAMETERIZATIONS FOR THE CATEGORICAL LATENT VARIABLE REGRESSION

	Estimate	S.E.	(Est. - 1) / S.E.	Two-Tailed P-Value
Parameterization using Reference Class 1				
C#2 ON				
EDSP_IEP	0.963	0.025	-1.484	0.138
FREALL2	1.004	0.006	0.670	0.503

DIAGNOS	0.798	0.394	-0.513	0.608
AEDNUM	1.195	0.489	0.398	0.690
ZIQFULSM	1.373	0.625	0.597	0.551
C#3 ON				
EDSP_IEP	0.979	0.016	-1.343	0.179
FREALL2	1.006	0.007	0.813	0.416
DIAGNOS	0.663	0.364	-0.925	0.355
AEDNUM	1.578	0.790	0.732	0.464
ZIQFULSM	0.906	0.437	-0.215	0.830

Parameterization using Reference Class 2

C#1 ON				
EDSP_IEP	1.038	0.027	1.429	0.153
FREALL2	0.996	0.006	-0.673	0.501
DIAGNOS	1.253	0.619	0.409	0.682
AEDNUM	0.837	0.342	-0.476	0.634
ZIQFULSM	0.728	0.332	-0.820	0.412
C#3 ON				
EDSP_IEP	1.017	0.029	0.574	0.566
FREALL2	1.002	0.008	0.222	0.824
DIAGNOS	0.831	0.443	-0.381	0.703
AEDNUM	1.321	0.691	0.464	0.642
ZIQFULSM	0.660	0.302	-1.126	0.260

QUALITY OF NUMERICAL RESULTS

Condition Number for the Information Matrix (ratio of smallest to largest eigenvalue)	0.522E-04

TECHNICAL 11 OUTPUT

Random Starts Specifications for the k-1 Class Analysis Model

Number of initial stage random starts	20
Number of final stage optimizations	4

VUONG-LO-MENDELL-RUBIN LIKELIHOOD RATIO TEST FOR 2 (H0) VERSUS 3 CLASSES

H0 Loglikelihood Value	-1808.836
2 Times the Loglikelihood Difference	123.049
Difference in the Number of Parameters	15
Mean	47.867
Standard Deviation	68.407
P-Value	0.1098

LO-MENDELL-RUBIN ADJUSTED LRT TEST

Value	121.441
P-Value	0.1132

TECHNICAL 14 OUTPUT

Random Starts Specifications for the k-1 Class Analysis Model

Number of initial stage random starts	20
Number of final stage optimizations	4

Random Starts Specification for the k-1 Class Model for Generated Data

Number of initial stage random starts	0
Number of final stage optimizations for the initial stage random starts	0

Random Starts Specification for the k Class Model for Generated Data

Number of initial stage random starts	5000
Number of final stage optimizations	1000
Number of bootstrap draws requested	Varies

PARAMETRIC BOOTSTRAPPED LIKELIHOOD RATIO TEST FOR 2 (H0) VERSUS 3 CLASSES

H0 Loglikelihood Value	-1808.836
2 Times the Loglikelihood Difference	123.049
Difference in the Number of Parameters	15
Approximate P-Value	0.0000
Successful Bootstrap Draws	5

PLOT INFORMATION

The following plots are available:

- Histograms (sample values, estimated values, residuals)
- Scatterplots (sample values, estimated values, residuals)
- Sample means
- Estimated means, medians, modes, and percentiles
- Sample and estimated means
- Adjusted estimated means
- Observed individual values
- Estimated individual values
- Estimated means and observed individual values
- Estimated means and estimated individual values
- Adjusted estimated means and observed individual values
- Adjusted estimated means and estimated individual values
- Estimated overall and class-specific distributions
- Estimated probabilities for a categorical latent variable as a function of its covariates

SAVEDATA INFORMATION

```
  Save file
    \\sscwin\dfsroot\Users\Lwilliams25\Documents\Mplus\lcaprobe2.sav

  Order of variables

    ZIQFULLS
    ZREADSTN
    ZSPELSTN
    ZARITSTN
    ZTOTCOM
    ZINTLT
    ZEXTNLT
    ZBRIT
    ZMIT
    EDSP_IEP
    FREALL2
    DIAGNOS
    AEDNUM
    ZIQFULSM
    CPROB1
    CPROB2
    CPROB3
    C

  Save file format           Free

  Save file record length    10000


DIAGRAM INFORMATION

  Mplus diagrams are currently not available for Mixture analysis.
  No diagram output was produced.


     Beginning Time:  13:54:29
        Ending Time:  14:03:58
      Elapsed Time:  00:09:29



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