OUTCOMES OF EDUCATIONAL INTERVENTION WITH STUDENTS WITH NEUROLOGICAL DISORDERS

by

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ABSTRACT

Academic outcomes are presented for nine students with severe learning problems, five with neurofibromatosis type I and four with various seizure disorders, who attended the laboratory classroom of a large metropolitan hospital. After receiving 120 hours of teacher-directed instruction in the Reading Mastery, Basic Fractions, Reasoning and Writing and Connecting Math Concepts programs (SRA), results from the Woodcock-Johnson Tests of Achievement-Revised (WJ-R) showed that, compared to the gains expected for an average normal student over the same period, the nine students had improved an average of 10.4 times more in Passage Comprehension, 4.5 times more in Letter-Word Identification, and 2.8 times more in Applied Problems. The students made significant gains in Passage Comprehension (p<.05) and Letter-Word Identification (p<.005) but not in Applied Problems (p>.05). Results are discussed in terms of the instructional needs of students with neurological conditions and the adequacy of the teacher-directed instructional programs in meeting these needs.
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Introduction

Conservative estimates indicate that eight to eleven out of 1,000 school age children suffer from some form of known neurological disorder (Guazo & Bahr, 1996; Bahr & Rosman, 1996; Williams, Richard & Hanesian, 1993; Berg & Linton, 1989). The extent to which these children exhibit impaired cognitive function is an important consideration in creating environments where their learning and achievement potential is optimized. Traditionally, the study of childhood neurological disorders has been an endeavor rooted in the medical paradigm. Although the medical literature has acknowledged various cognitive and psychological problems related to neurological disorders, historically such problems have not been the focus of their approach. Recent literature (Brandt, Caplan, Dichgans, Diener & Kennard, 1996; Berg & Linton, 1989; Teeter, 1989) reflects a more integrated, multidisciplinary approach in investigating neurological disorders, acknowledging the complex needs of affected children as well as the need for information which lends itself to clear and practical applications in the school environment.

An analysis of the effects of childhood neurological disorders on cognitive functioning may be useful in identifying learning handicaps as well as creating appropriate educational programming. Approximately 40% of a child's waking life is spent at school. For children affected by neurological disorders this time could well become part of their ongoing treatment. Surprisingly, an exhaustive search of the relevant literature revealed extremely sparse information as to appropriate instructional approaches for these children. There is little focus on the disruptive effects that the different factors (eg. medication,
seizures, learning disorders) associated with these neurological conditions have on academic functioning and the difficulty that teachers face in providing an integrated instructional program.

The goal of the present study was to (1) outline the educational needs of children with neurological conditions and associated learning difficulties and (2) evaluate the academic gains of children with neurologically based learning difficulties in a laboratory classroom that used a highly integrated, structured and systematically designed direct instruction approach; an approach which has repeatedly been shown to be effective in teaching children with special educational needs (Gregory, 1983; Gregory, 1985; Englert, 1984; White, 1988; Gersten, 1985). In addition to testing the overall effectiveness of this approach, the study was designed to determine if (a) any progress that occurs is more attainable in some academic areas more than others and (b) what, if any, modifications have to be made to a direct instruction approach to make it successful with these children.

**Psychoeducational Aspects of Neurological Conditions**

The task of designing appropriate instructional approaches for children with neurological conditions and associated learning difficulties must begin with understanding the nature of the cognitive and academic correlates of neurological disorders. In this section the current research relating to childhood neurological disorders will be presented and analyzed with a focus on the associated cognitive and psychoeducational variables. In order for a neurological disorder to be included in this discussion, the disorder must be (1) reported to affect children at or less than elementary school equivalent age and (2) reported to have possible effects on cognitive functioning and academic achievement.
Neurological conditions meeting these conditions include: (i) epilepsies, (ii) brain tumors, (iii) cerebral palsies, (iv) cerebral malformations, and (v) neurocutaneous disorders.

Appendix B includes a glossary of medical terms to make the nature of the medical conditions as clear as possible.

**Epilepsies**

Epilepsy is by far the most common childhood neurological disorder. It is estimated that up to 1% of the population of the United States has epilepsy. New cases appear at an annual rate of 40 per 100,000 (Hauser, Annagers & Anderson, 1983). The rate is highest in children under the age of 5 with another peak of incidence at the age of puberty. Characterized by sudden, recurrent, and transient disturbances of mental functions or body movements resulting from excessive brain discharges, epilepsy does not refer to a single disease but rather to a group of symptoms that may have different neurological causes (Williams, Richard & Hanesian, 1989). The cerebral disorders causing epilepsy may lead to impaired intellectual ability (Blennow, Heijbel, Sandstedt & Tonnby, 1990). Not all children diagnosed with epilepsy exhibit cognitive dysfunction.

Although the literature provides conflicting reports regarding the prevalence of learning difficulties among children with epilepsy, it is generally accepted that these children are at a greater risk than the general population for developing academic, attentional and behavioral problems (Thompson, 1987; Stores, 1987; Farwell, Dodrill & Batsel, 1985; Seidenberg Beck & Geisser, 1986). Approximately one third receive some form of special education, while learning problems occur in an estimated 5-50% of children with epilepsy (Thompson, 1987). Research suggests that a disproportionate
number may be underachieving in reading and perhaps to an even greater extent in mathematics. Attention and hyperactivity related behavioral problems are commonly reported among children with epilepsy. One study found that children with seizure disorders were almost 5 times more likely to exhibit behaviour problems compared to control children (McDermott, Mani & Krishnaswami, 1995). Due to the heterogeneous nature of this disorder, it is rather difficult and misleading to generalize about the learning problems experienced by students with epilepsy. Some studies suggest that arithmetic is the academic skill most impaired (Seidenberg, 1986; Aldenkamp, 1983, 1987), while others suggest that reading skills are most impaired (Stores, 1987; Mitchell, Chavez, Lee & Guzman, 1991).

The nature of cognitive impairment in children with epilepsy varies with the type, frequency, age of onset and localization of seizures. Age at onset of repeated seizures is the most commonly studied variable. Reports indicate that the later the age at onset, the better the mental abilities (Dodrill, 1992). Children with generalized tonic-clonic seizures have slightly lower mental abilities than those with partial seizures which are more localized in one area of the brain (Smith, Craft, Collins, Mattson & Cramer, 1986). The number of seizures also appears to be a significant factor. Patients with over 100 life time tonic-clonic attacks showed diminished intelligence (Smith et al., 1986).

The fact that normal cognitive functioning is negatively affected during seizures is undisputed. The concurrent effects of seizure activity are directly related to the locus and type of discharge. Tonic-clonic seizures, wherein there can be loss of consciousness for several minutes and confusion and fatigue during the recovery period that follows, may lead to loss of school time; however, research reports indicate that there is no direct link
between poor attendance due to medical reasons, and poor school performance in children with epilepsy (Hackney, 1976). Absence type seizures pose a potentially more serious problem in the school environment due to their more subtle manifestations. Absence seizures are generalized seizures characterized by brief 'blank spells', usually accompanied by eye blinking or rolling and stereotyped limb movements. During these seizures the child may appear to be in a trance and may be mistaken as being inattentive. These seizures pose a risk to school achievement as they are easily missed, misinterpreted, or simply not understood (Frank, 1985). It is this interruption of function that features most consistently in teachers' reports (Hackney, 1976).

The specific cognitive deficiencies experienced by epileptic students may be classified as: (i) memory deficit type with specific impairment in short term memory and memory span, related to temporal lobe dysfunction, (ii) attention-deficit type presumed to be related to a history of tonic-clonic seizures, and (iii) speed factor type characterized by slowing of information processing, especially in complex tasks (Aldenkamp, 1987, 1990; Frank, 1985). In general, verbal deficits have been linked to epileptiform activity in the temporal part of the left hemisphere, visual-spatial deficits correlate with disturbances in the right hemisphere, and attention problems have been associated with generalized epilepsies with foci in the upper brainstem.

Various measures of intelligence indicate that a number of children with epilepsy exhibit reduced ability, even in the absence of observable seizures (Dodrill, 1992). Recent findings relating to subclinical generalized discharges have called into question the seemingly clear cut distinction between ictal and interictal states. Most epilepsy research to date has focused on the psycho-physiological effects of seizures caused by clinical level
discharges. Clinical discharges have been defined as epileptiform activity originating in the brain matter and resulting in overt physiological manifestations. Such discharges can be detected with ease by most available EEG devices. With the relatively recent development of highly sensitive and portable EEG monitoring devices, it has been shown that subclinical or interictal discharges (subtle electrical discharges in the brain which occur in periods which were until recently believed to be free of any epileptiform activity) are often accompanied by more subtle, previously unrecognized, cognitive and behavioral events commonly known as 'transitory cognitive impairment' (TCI).

The observable manifestations of transitory cognitive impairment range from: (a) absence seizures or brief episodes of staring with impairment of awareness and responsiveness to (b) subtle changes in performance on academic tasks. TCI is more likely to be noticed on tasks involving working memory and language, which demand the student to be extended to the limits of his or her capability (Binnie & Martson, 1992). Lateralized, subclinical discharges produce cognitive impairment in areas associated with the affected hemisphere (Shewmon & Erwin, 1988). The effects of subclinical discharges on cognition, especially during short-term memory tasks, have been shown to be the greatest when they occur during stimulus presentation or in the 2 seconds preceding the stimulus (Binnie & Martson, 1992). Discharges during response had no effect on errors (Binnie, Kasteleijn-Nolst Trenite, Smith & Wilkins, 1987).

Reading has also been shown to be affected by subclinical discharges. EEG monitoring of children with epilepsy during reading tasks has shown that discharges were associated with an increased rate of errors, although the reading speed also increased (Binnie & Martson, 1992). An increased speed of reading coupled with increased errors
may not provide immediate clues to teachers about the nature of a child's reading difficulties and is easily misinterpreted as carelessness.

**Brain Tumors**

Tumors of the central nervous system are relatively frequent during the early years of life, with approximately 20% of childhood cancers being primary brain tumors (Menkes & Till, 1995). The incidence of intracranial tumors for children below the age of 15 ranges between 2 to 5 per 100,000 per year (Williams et al., 1993). It has been estimated that there are 600 new cases of childhood brain tumors annually in the United States (Till, 1975). The presenting symptoms, location, and representation of the various types of brain tumors in children differ from those of adults. In contrast to commonly held beliefs, it is unusual for children with brain tumors to present with symptoms of intellectual decline or behavioural change (Graham, 1983; Menkes & Till, 1995). Headaches and vomiting tend to be the most common symptoms which initiate the diagnostic process. While supratentorial tumors constitute the majority of brain neoplasms in adults, subtentorial tumors predominate in children. Approximately 60% of childhood brain tumors occur in the subtemporal part of the brain and most of them are either medulloblastomas or cerebral astrocytomas. The remainder consist of subtentorial tumors or tumors of the brain stem and adjacent structures (Berg & Linton, 1989). Although survival rates have increased in recent years, the prognosis for many forms of childhood brain tumors is far from promising. For one of the most common type of childhood brain tumor, medulloblastoma, the five year survival rate is estimated at about 40% (Laurent & Cheek, 1986; Berg & Linton, 1989); however, survival rates vary greatly depending on the type
and locus of tumor. Not all brain tumors occurring in children are malignant, yet most require surgical or radiological treatment.

Because of the predominance of infratentorial and midline locations, most brain tumors in children lead to the obstruction of cerebrospinal fluid and therefore increased intracranial pressure; hydrocephalus is therefore not uncommon among children with brain tumors. Many presenting symptoms of brain tumors are believed to be directly related to increased intracranial pressure (IICP). The most common symptoms of IICP are headache and vomiting. Headache is rarely localized and does not seem to differ in brain tumors from that seen in other conditions (Williams, 1993). Personality changes and cognitive dysfunction are also common symptoms and usually develop after the physical symptoms. These symptoms include restlessness and irritability, memory loss and academic impairment. Later symptoms may present including depression, lethargy, altered consciousness and generalized seizures (Williams, 1993). Increased intracranial pressure has been postulated to be responsible for some of the long term intellectual deficits seen with brain tumors; however, it does not seem to have a lasting impact after treatment (Mulhern, Crisco & Kun, 1983).

In examining the symptomology of childhood brain tumors, consideration must not solely be given to the presenting symptoms of brain tumors, but also to the symptoms secondary to the sequela of the tumor after treatment and to the treatment itself. Until recently very few studies have examined functioning after treatment by means other than neurological examination (Williams, 1993). Several studies employing more global measures of functioning have shown that many surviving children function at a near
normal level, some achieving at high levels, although 40-60% of survivors have intellectual and emotional disturbances (Bamford, Jones & Pearson, 1982).

Many investigations that reported functional and cognitive deterioration failed to isolate important variables, including tumor characteristics, age of the child, and treatment modalities (Mulhern et al., 1983). Tumors can be divided grossly into infratentorial or supratentorial locations. Impairments from infratentorial tumors vary; however visual motor problems predominate and there is about a 30-60% incidence of neuropsychiatric deficits, behavior disturbance and need for special education (Mulhern et al., 1983). These deficits are even more common with supratentorial tumors, with an estimated incidence of about 50-85% (Gjerris, 1976; Kun, Mulhern & Crisco 1983).

Mulhern et al. (1983) found impulse control problems and special education needs in five children with temporal lobe tumors. The deficits shown in these children were more severe than those in adults with similar tumors. In cases where diffuse CNS damage has occurred, the age at diagnosis and treatment appears to be positively correlated with better functioning. Younger children with focal injuries show better recovery than do older children (Eiser, 1981; Mulhern et al., 1983).

Cranial irradiation is a common treatment for children's brain tumors. This treatment modality has been shown to adversely affect intellectual functioning. By investigating the effects of irradiation on children with acute lymphocytic leukemia (ALL), it is possible to separate irradiation effects from those associated with the tumor and neurosurgery (Williams, 1993). Many children with ALL develop a post irradiation syndrome within 4-8 weeks of treatment. This syndrome includes somnolence, anorexia,
and lethargy. Long term changes consist of cerebral atrophy, distractibility, memory and attention deficits, and declining IQ and academic achievement test scores. These effects are dependent upon the dose of radiation, which increases with tumor severity (Halberg, Kramer & Moore, 1982; Mulhem et al., 1983).

Children with brain tumors are believed to be at an even greater risk for these symptoms, as radiation dosages are much higher than in children with ALL (Williams, 1993). Studies have shown pervasive performance and ability deterioration as well as selective performance and mathematics deficits (Kun et al., 1983). With increased rates of survival, these effects have become more noticeable and problematic. Younger children are more susceptible to the adverse effects of radiation treatment. Cognitive manifestations of these effects may take 2-5 years to be fully noted. In light of these findings educators need to be aware of possible repercussions of irradiation therapy and provide appropriate early intervention measures.

Cerebral Palsies (Static Encephalopathy)

The cerebral palsies are a group of conditions as opposed to a single clinical or pathological entity. The prevalence of cerebral palsies is approximately 2.5/1000 live births (Stanley & Alberman, 1984) and comprise motor disorders with neurological signs resulting from brain damage which is static (nonprogressive) and has occurred in early life. Due to its lack of specificity and its pejorative connotation, the term 'cerebral palsy' is not favored by neurologists; however, since the term is firmly engrained in medical literature and commonly used in the general community, there is little point in attempting to remove
Currently, for the purpose of clarity, pediatric neurologists use the term static encephalopathy (SE).

There are many underlying pathologies, genetic and nongenetic, including embryological defects, pre and post natal infections and injuries which can act alone or in combination to contribute to the syndromes of static encephalopathy (Neville, 1993). Most commonly, significant motor impairment is noticed in SE patients; however, the motor impairment rarely occurs without associated visual and cognitive deficits. In a large study involving the monitoring of over 45,000 children, known as The National Collaborative Perinatal Project, most children who were diagnosed with SE in the first year of life demonstrated another Central Nervous System (CNS) condition at age 7. Notably, 53% were found to be moderately to severely mentally retarded, 19% were hyperactive, 16% had speech and language delays, and 2% had been diagnosed as having a specific learning disability (Pirozzolo & Bonnefil, 1996). Other studies generally support these findings. It is estimated that mental retardation occurs in approximately 50-75% of patients, while more subtle problems such as learning disabilities are also frequently present (Scherzer & Tscharnuter, 1982). Evans, Elliot & Alberman (1985) studied the prevalence of disabilities among 527 SE children ages 4 to 8 years drawn from a register of the Southeast Thames Regional Health Authority. These children were grouped by physiologic and topographic type of SE: ataxic, spastic, dyskinetic and mixed. While mental retardation was a significant associated deficit regardless of SE type, specific learning disabilities were 2-3 times higher in ataxic SE children compared to any other type of SE. More specifically, 26% of ataxic SE children showed specific learning disabilities as compared to 14% of spastic SE and 8% of dyskinetic SE.
The relationship between the cognitive and motor deficits in cerebral palsy is not well understood. In a study by Rothman (1987), using an order of movement task designed by Piaget to measure spatial concepts, children with cerebral palsy exhibited significant delays in understanding order of movement. It is suggested that the physical and motor handicaps experienced by children with cerebral palsy affect their cognitive development and their spatial and sequential perception (Williams et al., 1993). In particular, disturbances of motility such as dis propelgia, which impair the progression of psychomotor development, are believed to affect the child's cognitive development (Pirozzolo & Bonnefil, 1996). However, many children without motor signs present with various degrees of cognitive dysfunction.

Malformations of the Central Nervous System

Many childhood neurological conditions result from disorders of the maturation of the nervous system. The majority of defects of the central nervous system ontogeny have been traced to the evolving anatomy of the fetal brain and spinal cord, from the initial induction of the neural tube (Encephaloceles, Meningomyocelles), to migration and organization of cellular constituents (Schizencephalies, Pachygyria) and myelin formation (Hypomyelination, Dysmyelination). With the exception of hydrocephalus, there is very little data regarding the clinical profile associated with the various types of malformations. Due to the relatively rare occurrence of each particular disorder, very few studies have addressed the clinical outcome of a large number of patients with particular malformations. Findings are difficult to generalize. One study (Barkovich & Kjos, 1992) assessed the clinical outcome of 20 children with schizencephalies, a malformation resulting in unilateral or bilateral clefts (open or fused lacerations in cortical matter)
extending through the entire cerebral hemisphere. The degree of impaired intelligence was found to vary significantly and was dependent on the size, location and type of cleft. With a unilateral cleft with fused lips, intelligence is often normal; with a unilateral cleft with open lips, there is usually mild to moderate retardation; with bilateral clefts there is usually severe retardation, seizures and major motor handicaps. Four of the children studied, were in special education classes at one time; however, they were all eventually mainstreamed, while two of the children were honor students. All of the children showing good prognosis had small unilateral clefts.

Hydrocephalus is the result of a diverse group of conditions that cause the accumulation of cerebrospinal fluid (CSF) within the head, leading to increased pressure and associated with ventricular enlargement. Hydrocephalus is rarely due to overproduction of CSF but is usually the result of obstruction to flow and therefore reduced absorption (McComb, 1983). The processes that may obstruct the flow of CSF and precipitate hydrocephalus fall into three broad categories: (I) congenital lesions and malformations, (ii) tumors and (iii) hemorrhage or infections (Guazzo & Bahr, 1996). Each entity represents a separate syndrome with unique pathogenesis, clinical evolution and response to treatment (Raimondi, 1994).

Hydrocephalus usually presents with enlargement of the head and various other cranial malformations. Cognitive delay is not an uncommon clinical feature. In one study of children presenting with hydrocephalus, it was found that 37% of students exhibited various degrees of cognitive delay (Kirkpatrick, Engelman & Minni, 1989). One finding is consistently supported in the literature. It has been repeatedly shown that there is a significant discrepancy between verbal and nonverbal skills in children suffering from
hydrocephalus. While both verbal and nonverbal cognitive skills are underdeveloped, nonverbal performance is lower relative to verbal performance, as measured by various ability scales (Fletcher, Bohan, Brandt, Brookshire, Beaver, Francis, Davidson, Thompson & Miner, 1992).

**Neurocutaneous Disorders**

The skin, eye and central nervous system share a common neuroectodermal origin. The neurocutaneous disorders or phakomatoses are a complex group of conditions affecting two or three of these systems simultaneously. Most neurocutaneous disorders are genetic (Bahr & Rosman, 1996). Systematic manifestations of these disorders include skeletal overgrowth, skin abnormalities and vascular malformations which can involve the skin, eye or the central nervous system. Varying degrees of cognitive dysfunction are commonly noted among neurocutaneous disorders. There are five known neurocutaneous disorders which affect children: neurofibromatosis (type I and II), tuberous sclerosis, Sturge-Weber syndrome, VonHippel-Lindau disease and ataxia telangiectasia.

**Neurofibromatosis.**

Neurofibromatosis Type I (NF1) is one of the most common neuro-genetic disorders, occurring in approximately 1 infant per 3,000 live births. The most common NF1 manifestations include small pigmented areas of the skin generally known as cafe-au-lait spots and neurofibromas, benign tumors occurring along nerves and surrounding fibrous tissue. Neurofibromatosis Type 2 is genetically and clinically distinct from neurofibromatosis 1. It is a far less common disorder, with an incidence of 1 :33,000 - 40,000. Neurofibromatosis 2 is characterized by the development of central nervous
system tumors known as bilateral vestibular schwannomas. Skin lesions such as cafe au fait spots and neurofibroma are less common than in neurofibromatosis type 1.

Learning disabilities and behavioral problems are reported in 25% to 50% of children with NF1. The physiological processes that are assumed to underlie these problems are presently unclear. Current research identifies visuo-spatial deficits in the majority of children with NF 1, generally correlated with lesions and increased EEG activity in the right posterior hemisphere (Eliason, 1986; Holman et. al., 1994; North et. al., 1994). Impaired motor coordination and ADHD like attention problems are commonly reported in the psychoeducational profiles of children with NF 1 (Varnhagen, Lewin, Das, Bowen & Klimek, 1988; Eliason, 1986; Spaepen, 1992). Research aimed at identifying the LD profile of NF 1 children emphasizes an unusually high rate of nonverbal learning deficits. Reflected in a significant discrepancy between verbal and performance IQ, this pattern of nonverbal learning disabilities contrasts with the predominantly verbal deficits found in the general LD population. The relatively low performance IQ scores of children with NF 1 are commonly attributed to visual-perceptual-motor impairments characteristic of the disorder, however the presumed academic correlates of this condition do not always follow (Hofman et. al., 1994). Some children may develop compensatory cognitive mechanisms in order to overcome the learning consequences of reduced visuospatial ability (Stine & Adams, 1988). When mediated by 'verbal cognition mechanisms', NF 1 children improve at integrating and abstracting spatial information that is presented visually (Varnhagen, et. al., 1988).
Tuberous sclerosis

Tuberous sclerosis is a congenital disorder with an estimated incidence of 1 per 100,000 to 1 per 170,000. It manifests clinically in a variety of severe skin lesions and fibromas, and pathologically by cerebral sclerotic masses and tumors in various organs. Although skin lesions are the most common abnormalities found on examination, central nervous system manifestations are the more common as presenting symptoms (Lee, 1986). Seizures occur in the vast majority of patients. They usually begin early in life and become more frequent and severe with progressing age. Mental retardation occurs in 60-80% of patients and becomes apparent between 8 and 14 years of age (Monaghan, KraLchic, MacGregor & Fizz, 1981). There appears to be a definite relationship between mental status and the presence or absence of seizures. Age of seizure onset in affected children also seems to be an important variable in determining cognitive function. Children with a seizure onset in the first two years of life appear to be at a higher risk for developing mental dysfunction (Lee, 1986).

Sturge-Weber syndrome

Sturge-Weber syndrome is a rare congenital disorder characterized by a port-wine vascular nevus on the upper part of the face, generalized or focal seizures and a high incidence of mental retardation. Although a port-wine stain on the face is a relatively common malformation, occurring in about 3 per 1,000 births, only 5% of infants affected with this cutaneous lesion have Sturge-Weber Syndrome (Menkes & Till, 1995). The initial neurological manifestations of this disorder usually consist of seizures in the first
year of life. Estimates suggest that 75-90% of affected children develop focal or generalized seizures. The development of seizures as well as the age of onset are shown to be directly related to the level of intellectual functioning in children with Sturge-Weber. In an extensive study (Gomez & Bebin, 1987) it was found that 67% of patients with a unilateral lesion and seizures were mentally handicapped. Other reports indicate that approximately half of affected children, with seizures, exhibit signs of mental retardation (Harding & Kleiman, 1996). By contrast, all patients without seizures were mentally normal (Gomez & Bebin, 1987). Other studies confirm these findings. Sujanski & Conradi (1995), found that all patients without a history of seizures, and 90% of those with an onset of seizures at age 4 and older had normal early development, attended regular classes, and earned high school diplomas. In contrast, if onset of seizures was during the first year of life, only 40% achieved nominal early development milestones, 20% did not require special education, and 44% earned a high school diploma. Patients with an onset of seizures between 1-4 years of age showed an intermediate prevalence of cognitive development problems.

**Educational Implications**

**The Unique Educational Needs of Children with Neurological Disorders**

The current educational paradigm supports a 'non-categorical' approach to the management of developmental learning disorders (Aldenkamp, Alpherts, Dekker & Ovenveg, 1990). In this approach there is a belief that despite the distinctness of the many conditions which can lead to learning difficulties, those affected experience similar challenges and stressors in their school environment. However, this approach can lead to
overlooking the special needs of children with neurologically based learning difficulties. A distinction should be made between the group of children diagnosed with medical conditions and associated learning difficulties and children with a primary diagnosis of learning disorders. The nature of neurological disorders as well as the specific and restrictive correlates of abnormal neurological functioning suggest the need for development of specialized instructional approaches. The progressive nature of many neurological disorders (Pirozzolo & Bonnefil, 1996; Williams et al., 1993; Berg & Linton, 1989) requires continued monitoring of response to instruction in conjunction with ongoing consultation with health professionals. In order for this to become possible, appropriate infrastructures must be created and teacher instruction provided with respect to childhood neurological illness.

Secondly, unlike children with learning disabilities (LD), children who suffer from neurological disorders have known pathologies of brain dysfunction. Localization of affected brain areas can give educators more information about the possible effectiveness of various modes of instruction. Commonly used remedial approaches may be less effective with children whose neurological makeup prevents them from learning in particular ways.

Thirdly, children with neurological disorders are commonly prescribed medication as part of their ongoing treatment/management plan (Williams et al., 1993). In many cases, medication has been shown to have adverse effects on children’s response to instruction (Besag, 1987). Educators must be well aware of the cognitive and behavioral consequences commonly associated with particular medication, in order to administer appropriate instruction. Finally, teachers’ expectations of a child diagnosed with a
neurological disorder may arguably be lower than that of a child with no known medically related impairment. Teacher expectations have been shown to be positively correlated to academic achievement (Corbidge, 1987). This strongly points to the need for well developed networks of communication between parents, teachers and health care professionals wherein the special educational needs and learning potential of children with neurological disorders can be properly addressed.

Neurological disorders have been shown to have a wide range of possible consequences with respect to children's cognitive functioning. The available data obviates the difficulty of developing a generalizable academic and cognitive profile for children with neurological disorders. Indeed, the type and degree of impaired intellectual functioning resulting from neurological abnormalities greatly depends upon the locus of the affected area and varies with the neurological condition. Yet within each disorder examined, there is a group of children with various specific-learning-difficulties, a group with moderate to severe mental retardation as well as a group of children who exhibit a normal or near normal level of academic and cognitive functioning (Guazo & Bahr, 1996; Bahr & Rosman, 1996; Williams, Richard & Hanesian, 1993; Berg & Linton, 1989, Brandt et al., 1996; Berg & Linton, 1989; Teeter, 1989). For each one of these groups of children, a unique educational approach must be adopted. Children with neurological conditions who display potential for learning yet encounter specific difficulties in academic functioning are of concern to educators and health care professionals alike. The literature provides examples of children who overcome specific learning handicaps and go on to achieve or surpass educational expectations; however, it fails to document the specific educational models and approaches which undoubtedly contributed to their success (Barkovich &
Kjos, 1992; Sujansky & Conradi, 1995). Such information would greatly benefit teachers and provide them with the confidence needed to successfully teach children with neurological conditions and associated learning difficulties.

**Teachers' Attitudes**

Bannon, Wildig & Jones (1992) conducted a study involving 142 teachers using a questionnaire designed to determine teachers' current attitudes and awareness of childhood epilepsy. It was found that despite a commendable depth of general knowledge of childhood epilepsy, teachers demonstrated an overall lack of confidence in teaching children with epilepsy. Respondents were asked if they could evaluate their overall levels of confidence when teaching or supervising epileptic children. Only 5% felt very confident when dealing with children who had epilepsy, 31% felt quite confident, and 64% replied that they did not feel confident. The study also found an alarmingly low level of communication between parents, teachers and health professionals with regards to the child's medical condition. Out of 81 teachers who to their knowledge had taught a child with epilepsy, 30% first learned of the child's epilepsy when the child had a seizure in school, 49% were first made aware of the child's epilepsy by prior discussion with parents, and only 14% had discussed the child's medical condition with the school's nurse or doctor.

Educators are expected to respond with understanding to the psychological as well as the medical circumstances of students with learning difficulties associated with neurological conditions. Studies which have assessed the educational needs of children with neurological conditions have repeatedly emphasized the need for establishing
efficiently administered communication networks aimed at designing case specific remedial approaches (Henriksen, 1990; Besag, 1987; Spaepen, Borghgracph & Fryns, 1992; Gourley, 1990). While knowledge and attitudes of teachers who have taught children with epilepsy seems to be improving, the level of communication between parents, teachers and health professionals appears to be unchanged over the last 20 years. Bannon's findings mirror those of Holdsworth and Whitemore (1974) who demonstrated similar lack of communication. As epilepsy is one of the more common neurological disorders of childhood, one can expect similar or less well developed educational environments for dealing with the variety of other neurological conditions and associated learning difficulties of school age children.

Appropriate Instruction

Service Models and Remedial Programs

Appropriate service models for children with medical conditions and associated learning difficulties, can be conceived as comprising of two interdependent systems: (1) a hierarchical network and setting designed for facilitating communication between parents, teachers and health care professionals, and (2) effective instructional approaches which allow for close monitoring of student's response to instruction and take into account the specific needs of children with neurologically based learning difficulties. Cooperation between students, teachers, parents, doctors and social workers on a case by case basis can lead to an overall perspective of student problems and forms the basis of appropriate remedial education. However, educators and psychologists alike are faced with the difficult task of developing and implementing instructional approaches with no reference
to reliable educational plans for children with neurological conditions and learning difficulties. A study intended to assess the types of learning problems of children with epilepsy (Aldenkamp et al., 1990) revealed that none of the special schools for epilepsy use specific remedial techniques. This finding reflects the current practice of teaching children with neurological conditions and related learning impairments by means of methods designed for LD students having no known neurological disorder.

How do we choose appropriate instruction for children with neurologically based learning difficulties? In the absence of literature pertaining to the systematic analysis of this population's learning needs, research examining the response to instruction of children with medical conditions and associated learning difficulties must be initiated. The first step in arriving at appropriate instructional models for children with neurologically based learning difficulties should involve a systematic evaluation of the existing educational programs which have been shown to be effective in teaching children with special educational needs. The effectiveness of each program must be examined with respect to a variety of neurological conditions. By making the instructional approach the independent variable we can study its efficacy and the efficacy of its various components in teaching children with neurological conditions, and make modifications, where needed, in order to suit the specific educational needs of this population.

Ideally, individualized programs may be the optimal method of instruction (Henricksen, 1990; Besag, 1987) for children with neurological conditions; however, from an experimental perspective this method offers no reference point of a common and consistently used set of instructional methods from which to evaluate effectiveness and to pinpoint necessary modifications. Further, reliance on individualized methods ultimately
may not be feasible in the present climate of inclusion. Given the need of children with neurological conditions for behavioral control of the attentional problems that frequently accompany their conditions (Eliason, 1986, Varnhagen et al., 1988; Spaepenn et al., 1992, Thompson, 1987), much repetition (Rugland, 1990), frequent use of examples, and instruction that is highly sequential and systematic, Direct Instruction programs (Gregory, 1983; Gregory, 1985; Englert, 1984; White, 1988; Gersten, 1985) were selected as the treatment of choice in the present study. These programs consist of the high degree of “structure” which seems to be represented by the list of instructional characteristics deemed essential for children with neurological conditions, while at the same time typifying an approach that is tailored for group instruction.

**Direct Instruction Research with Special Education Students**

The Direct Instruction model (DI) conceived by Engelmann and his colleagues (Engelmann & Carnine, 1982, Becker, Engelmann, Carnine & Rhine, 1981) has prompted rigorous analysis of how curriculum materials should be constructed and sequenced in effective teacher directed instruction. Originally developed by Engelmann and Becker at the University of Oregon the model was derived from their late 1960's experimental preschool and behavioural research in classroom management. Their theory of instruction gave rise to DISTAR (Direct Instruction System for Teaching and Remediation) Reading, Arithmetic and Language programs which were Oregon University's contribution to the Project Follow Through. Following the successful implementation of DISTAR, members of the Oregon team have produced a number of other programs using DI principles.
Several components of DI are common to many behavioral education models:

using reinforcement and mastery learning principles, assessing regularly, breaking tasks into small components and teaching of prerequisite skills (Kinder and Carnine, 1991).

However, DI differs from other behavioural educational approaches in its degree of (1) emphasis on precise teacher wording in presentation, examples and corrections as well as (2) the theoretically based juxtaposition of the building blocks of curriculum (Engelmann & Carnine, 1982). The scripted step by step teaching strategies employed in DI have been empirically field tested and systematically adjusted in an effort to maximize the educational attainment of students at all levels of achievement (Gersten, Woodward & Darch, 1986).

The cornerstone of DI programs is deceptively simple: for all students to learn, both the materials and teacher presentation of these materials must be clear, overt and unambiguous. The common misconception is that this is an inherent quality of most instructional designs commonly used in our school systems. However, many instructional programs and particularly the common basal materials, are not designed with the precision necessary for children with learning impediments to succeed (Gersten et al., 1986).

Direct Instruction programs have been repeatedly shown to be effective in teaching reading, language and arithmetic to low performing students with special educational needs (Gersten, 1985; Gersten et al., 1986; Englert, 1984; White, 1988; Gregory, 1985; Gregory, 1983; Maggs & Maggs, 1979; Lloyd, Cullinan, Heins & Epstein, 1980). A meta-analysis conducted by White (1988) examined 25 studies involving special education students which compared the outcome of DI with various other commonly used instructional methods. Not one of the 25 studies showed results favoring comparison groups. Over half of the measures significantly favored DI with an average magnitude of
.84 standard deviation units. These results were well above the .25 to .33 standard used for educational significance. Math studies' effect was .50 lower than reading, decoding and comprehension, but still significant. There was no significant difference in the mean effect size between studies of students with moderate and those with severe handicaps, indicating effectiveness across a range of handicapping conditions.

Gersten (1985) reviewed six studies which examined the effects of DI on the academic gains of special education students by way of matched comparison groups, and norm referenced comparisons. The six studies clearly indicated that DI tends to produce higher academic gains for handicapped students when compared to traditional approaches. One of the studies reviewed by Gersten and conducted by Gersten and Maggs (1982) used a norm referenced evaluation design (Horst, Tallmadge & Wood, 1975) to assess the cognitive and academic progress over 5 years of a sample of 12 adolescents and pre-adolescents whose initial IQ would place them in the high to moderate range of retardation. Where a matched control group is not available, the norm referenced evaluation design compares the effects of treatment on a sample to the expected gains of a norm group comprised of a nationally representative sample of children in the same percentile rank (Gersten, 1985; Horst, Tallmadge & Wood, 1975). In the Gersten and Maggs (1982) study, the students were engaged in all three levels of DISTAR Language programs. The standardization sample of the Stanford-Binet served as a comparison standard. The progress of the sample was compared to those in the Stanford-Binet norm group with similar IQ. The gain was both statistically and educationally significant. The moderately retarded children in this sample were found to have gained at a significantly faster rate than their peers with similar IQ from the normative sample.
The reported success of DI with intellectually handicapped children raises questions as to the effectiveness of this program for children with neurological conditions and associated learning difficulties. Such investigations would provide the basis for developing appropriate service models for this population. The strong behavioural components of DI programs may provide the appropriate control of the attention difficulties commonly reported among children with neurological disorders (Eliason, 1986; Varnhagen et al., 1988; Spaepen, 1992; Thompson, 1987). The highly structured and systematic instructional procedures employed in this program make it a highly suitable baseline or reference point for examining the response to instruction of children with neurologically based reading handicaps.

Addressing the Needs of Children with Neurological Disorders

Specialized classrooms for children with neurological disorders may be an ideal setting for advancements in service model and would provide excellent research opportunities which can undoubtedly aid our understanding of the various neurological disorders, their effects on cognition and how to teach to the resulting academic problems. Although the wide implementation of such classrooms may prove to be an unrealistic goal in the present educational climate, 'model' or experimental classrooms designed to optimize the learning potential of children with neurological conditions may point to ways in which the present service model can be improved. Indeed, many children with various medical conditions have been shown to be dysfunctional in the present educational system (Brandt, Caplan, Dichgans, Diener & Kennard, 1996; Berg & Linton, 1989; Teeter, 1989). The
extent to which these children's difficulties can be explained by mismatched instruction is presently unknown. The following questions could help us understand the necessary elements in an educational service model for children with neurological disorders and associated learning difficulties: can children with neurological disorders who don't achieve in their regular school setting learn in an educational environment adjusted to their special needs? If so, which elements of instruction and/or the educational setting could account for their success?

**The Present Study**

The purpose of the present study was to evaluate the reading and mathematics academic gains of children with neurological conditions and associated learning problems in a diagnostic laboratory classroom using a highly structured and systematic DI approach. In light of the current lack of literature pertaining to the effectiveness of specific service models for children with neurological disorders and learning difficulties, this study was intended to (a) gather baseline information regarding the effectiveness of a DI approach in teaching reading and mathematics to children with neurological conditions who have shown little progress in their community schools, (b) determine if any progress that occurs is more attainable in some academic areas more than others and (c) determine what if any modifications may have to be made to a DI approach to make it successful with these children.

Standardized tests of academic achievement were used to assess the learning outcomes of the specific instructional approach employed. The statistical and educational
significance of students' academic gains was assessed by way of a norm-referenced evaluation design (Horst, Tallmadge & Wood, 1975; Gersten 1985), where participants' gains were compared to a nationally representative sample of students in the same percentile ranking.

The practical significance of participants' academic gains was also assessed by comparison with the improvement expected for an average normal student based on test norms obtained over a comparable interval of time. It was hypothesized that students would show academic gains. Whether these gains would be of a magnitude comparable to or even greater than that expected from a normal student was to be determined by this study.
Method

Participants

Five children, 3 males and 2 females, diagnosed with Neurofibromatosis Type 1 and four children, 1 male and 3 females, with various forms of epilepsy participated in the present study. All participants were referred to a laboratory classroom of a large metropolitan hospital for psychoeducational assessment and were selected for inclusion in this program following assessment in their community schools. They were accepted into the laboratory classroom on the basis of being referred by their community schools due to lack of academic progress and, with the exception of one participant, demonstrating underachievement below the 25th % ile on one or more of the Passage Comprehension, Letter-Word Identification and/or Applied Problems subtests of the Woodcock Johnson Tests of Achievement (WJ-R) (Woodcock, Mather & Johnson, 1991).

Table 1 shows the age, gender, medical diagnosis, grade and school placement of the sample. The majority of participants were enrolled in Learning Disabilities programs in their community schools, characterized by small classroom size (8 to 12 students) and adjusted curriculum.
### Table 1

**Demographic Data for Participants**

<table>
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<tr>
<th>Participants</th>
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<th>Age</th>
<th>Medical Diagnosis</th>
<th>Grade</th>
<th>School Placement</th>
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<td>10.8</td>
<td>NF1^b</td>
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<td>LD^c</td>
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<tr>
<td>nf(4)</td>
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<td>8.6</td>
<td>NF1</td>
<td>3</td>
<td>LD</td>
</tr>
<tr>
<td>nf(5)</td>
<td>m</td>
<td>8.7</td>
<td>NF1</td>
<td>4</td>
<td>Regular</td>
</tr>
<tr>
<td>sd(1)^d</td>
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<td>12.3</td>
<td>Tonic Clonic/Sturge Weber</td>
<td>6</td>
<td>LD</td>
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<tr>
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<td>11.1</td>
<td>Partial Complex</td>
<td>6</td>
<td>LD</td>
</tr>
<tr>
<td>sd(3)</td>
<td>f</td>
<td>9.5</td>
<td>Tonic Clonic</td>
<td>3</td>
<td>Regular</td>
</tr>
<tr>
<td>sd(4)</td>
<td>m</td>
<td>12.3</td>
<td>Tonic Clonic</td>
<td>7</td>
<td>LD</td>
</tr>
</tbody>
</table>

^a nf(x) = Participant diagnosed with Neurofibromatosis Type 1 where (x) is an arbitrary number (ranging from 1 to 5) assigned to each participant in this condition

^b Neurofibromatosis Type 1

^c Learning Disability class

^d sd(x) = Participant diagnosed with seizure disorders where (x) is an arbitrary number (ranging from 1 to 4) assigned to each participant in this condition
All participants were white except for one female student who was of Afro-American descent. Based on their parents' occupation, participants were of a middle class socio-economic background (Blishen, Carroll & Moore, 1987). Participants ranged in age from 7 yrs, 7 months to 12 yrs, 4 months (see Table 1). All the participants with seizure disorders were receiving one or more of the following anti-convulsive medications at the time of the study: Epival, Valporic Acid, Tegretol and/or Dilantin. Psychoeducational assessments, conducted at a child development service of a large Metropolitan Toronto hospital, showed that participants displayed language learning disabilities that significantly affected their academic functioning. Although actual IQ scores were not available for all participants, assessment reports of IQ testing, mainly using the Wechsler Intelligence Scale for Children - Revised (Wechsler, 1974) or the Wechsler Intelligence Scale - Third edition, described participants as functioning in the 'average' to 'low average' range of intelligence.

**Apparatus**

**Remedial Program**

Direct Instruction (DI) programs published by the SRA Division of Macmillan/McGrawHill School Publishing Company formed the basis of the Classroom curriculum. DI programs provide the teacher with instructional and correctional scripts aimed at consistent, clear and unambiguous student-teacher communication. The programs consist of a series of teacher directed tasks which are sequenced and designed to minimize student error and elicit students' mastery, provide systematic rehearsal and foster generalization of specific academic skills. Instructional materials included: Reasoning and

**Academic Achievement Measures**

Pretest-posttest academic ability was measured by the Passage Comprehension, Letter-Word Identification and Applied Problems subtests of the WJ-R, form A and form B, respectively. The Passage Comprehension subtest measures a participant’s skill at identifying missing key words in a passage by requiring him/her to state a word that would be contextually appropriate. In order to do this, the participant must exercise a number of comprehension and vocabulary skills. The Letter-Word Identification subtest requires a participant to phonetically identify letters, words and letter forms presented in large fonts and in order of increasing difficulty. This subtest measures a participant’s skills at phonetic decoding of letter patterns. The Applied Problems subtest presents the participant with a practical mathematical problem involving simple calculations and a number of extraneous pieces of information. The subject is expected to choose the procedure to be followed and perform the necessary calculations using the appropriate data. In order to successfully complete an item, the participant must utilize a variety of problem solving and mathematical skills. This test may also be used as a measure of quantitative ability (Woodcock et al., 1991). The above subtests were chosen under the
premise that they offer a general measure of academic achievement in the areas that the participants received DI, yet they are independent of the actual curriculum content taught.

The Woodcock-Johnson Psycho-educational Battery - Revised (WJ-R) was designed to sample various cognitive and academic achievement abilities for individuals ranging from 2 to 95 years. The WJ-R was not intended to be administered in its entirety, but rather in a selective fashion, allowing the examiner the option of using the battery's various subtests to gain specific information regarding academic ability. Various reviews (Lee, 1991; Cummings, 1991; Cummings, 1984) have noted WJ-R's 'exceptional' psychometric proprieties and have shown the Passage Comprehension, Letter-Word Identification and Applied Problems subtests to be valid and reliable measures of academic achievement ability. Split-half internal consistency reliabilities for the Passage Comprehension, Letter-Word Identification and Applied Problems subtests, as presented in the technical manual, are $r = .902$, $r = .918$ and $r = .913$, respectively. Likewise, test-retest reliabilities indicate adequate stability of the achievement subtests (Cummings, 1991). To assess concurrent validity, the BASIS, the Kaufman Test of Educational Achievement, the Peabody Individual Achievement Test, and the Wide Range Achievement Test-Revised were administered to samples of children ages 9 to 17. Studies which have examined the pattern of intercorrelations among the scales provide support for the WJ-R domains as they are labeled (Cummings, 1991).

On an ongoing daily basis, response to instruction was also assessed through curriculum based testing, classroom observations and video-monitoring. For the present study, data from these measures had not yet been coded and analyzed and therefore was not available. The Child Behavior Checklist (CBCL - Achenbach & Edelbrock, 1983) was
used as a standardized pretest-posttest measure of participants' problems and competencies in the social-emotional area, but not enough of these completed forms were returned by teachers at posttest to permit analysis.

**Procedure**

Ethical approval to use the data collected in the laboratory classroom for the present study was received from the hospital Research Ethics Board. Based on the board's approval and following the recommendation of the theses supervisor (Appendix A), the University of Toronto’s Ontario Institute for Studies in Education agreed to bypass any further ethical review. The classroom is an ongoing clinical service that also serves a clinical research function. The author of this study was a volunteer in the laboratory classroom where he assisted with some of the teaching under the supervision of the classroom teacher.

Each participant attended the classroom for 24 days (120 hours) in one of two terms between January and June 1995. The classroom operates three eight week blocks of classes over the academic year. Each block consists of five to six students with diagnosed medical conditions and associated learning and behavioral problems. Participants attended the classroom three days a week and spent the other two days in their community school. Instruction in both terms was provided by the same, sole special education (M.Ed.) teacher who had extensive training and experience in the implementation of DI methods. The laboratory classroom teacher consulted with the participant’s regular teacher and visited each participant’s community school at least once prior to or during the period of the present study.
Participant selection for each term was determined by the age, medical condition and academic functioning of available candidates. The criteria for inclusion in the program attempted to homogenize the group for each term as much as possible with respect to age, medical condition and academic functioning. The sample size of this study reflects the reality that the number of children with neurological conditions and associated academic difficulties who could have been considered for inclusion in this classroom is small. The children selected for this study were those who were not progressing in their regular schools. In each case, both participants' parents and schools were seeking a form of alternative educational opportunity for them at the time of selection. All the students exhibiting neurological conditions and academic underachievement who were known to the staff of the laboratory classroom at the time the study was conducted, were included as the treatment group. The staff did not have access to other students who both satisfied the study entry criteria and were available as no-treatment controls.

While some curriculum adjustments were made between the two terms, in order to match the academic needs of the students involved, the key aspects of the DI approach remained unchanged. Performance and behavioural expectations were clearly and explicitly stated in the beginning of and throughout the 24 days of instruction. Negative reinforcement techniques were used to control aberrant behaviour. A point system was employed for each work period and visibly displayed on the classroom wall. Students could lose points for (i) failing to follow directions given to the group, (ii) needing more than one warning, (iii) inappropriate behaviour during transition time and (iv) repeated off-task behaviour. Clearly established, realistic and achievable work goals were set for each student. An 'I do it, we do it, you do it' routine was consistently employed in
teaching new tasks, effectively modeling appropriate task performance. Well defined work
sheets accompanied each lesson, helping participants be aware of how much work must be
completed during a set period. Positive reinforcement was used to maintain these
performance goals; participants were awarded points for successful, task specific,
academic performance.

New concepts and constructs were gradually and systematically introduced,
expanded and generalized. In an effort to teach children in a most effective and direct
manner, concept formation was promoted by way of systematically sequenced
unambiguous examples accompanied by short and clear verbal instructions. For example,
in introducing the concept of a fraction the teacher drew two circles on the blackboard,
each divided into four parts. The teacher pointed to each circle and said: 'This is a whole.
Lets figure out how many parts are in each whole. I'll touch the parts and you count them',
the group of students counted out loud as the teacher pointed to each part in the first
whole 'How many parts in this whole?'. The procedure was repeated for the second whole,
followed by the question: 'How many parts in each whole?' Having been explicitly taught
that the bottom number of a fraction 'tells how many parts in each whole' the teacher
wrote the number four under a fraction line. The students were directed to their workbook
where a series of similar exercises were presented. After repeating the above teaching
procedure for the first exercise in the workbook, the teacher instructed the group to finish
the worksheet independently. This exact sequence was repeated a number of times in the
following days ensuring that task mastery was reached before integrating 'denominator
counting' into slightly more advanced concepts involving fractions. All the procedures
used in the DI instructional approaches involve this kind of systematic approach, have
been subjected to extensive field testing and have been chosen for their effectiveness in communicating academic concepts to children at their distinct level of information processing.

Instruction was also focused on improving linguistic skills and reading comprehension. Students were systematically pretaught vocabulary of reading material by way of contextually appropriate definitions or synonyms. Interjected questions were posed by the teacher in order to promote text processing at a level necessary for reading comprehension. Phonetic and structural analysis was systematically directed at improving decoding skills. The reading material was controlled for words which the participants had mastered with the aim of improving reading fluency and text processing skill.

The Passage Comprehension, Letter-Word Identification and Applied Problems subtests of the WJ-R were administered to each student by one of three psychology assistants, within a week prior to instruction. Alternate forms of the same subtests were administered by one of the same three available examiners within one week following completion of the instructional term.
Results

Descriptive Analyses

Individual WJ-R pretest scores in the NF-1 and SD groups (Table 2) showed considerable variability between participants on each of the subtests used. Within subject discrepancies between subtest scores were also noted. One of the nine participants showed a relative weakness (i.e. < 25th % ile) in all three academic areas measured, six were weaker in two areas, two in one area, and one participant did not show a weakness in any area according to this criterion.
### Table 2

<table>
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<tr>
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<tr>
<td>Applied Prob.</td>
<td>113</td>
<td>112</td>
<td>81</td>
<td>79</td>
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*WJ-R is Woodcock-Johnson Psycho-educational Battery - Revised (Woodcock & Matheson, 1991)

Participant nf(2) was included in the study on the basis of underachievement on a daily basis in his community school classroom despite not performing below the 25th % ile on any of the three WJ-R subtests.
Examination of individual student pretest-posttest scores in the two medical conditions (Table 2) revealed a strong improvement in Passage Comprehension for four out of five NF-1 participants, who showed an increase of 9 to 27 percentiles. One NF-1 student decreased by 3 % iles. Comparably, three out of four SD participants showed an increase of 16 to 21 % iles on Passage Comprehension, and one student decreased by 14 % iles.

All NF-1 and SD participants showed gains in Letter-Word Identification, except for one participant in the SD group. Individual gains on the Letter-Word Identification subtest ranged from 5 to 21 % iles in the NF-1 group and 3 to 21 percentiles in the SD group, with the one participant with SD showing a decrease of 6% iles. Variable gains were noted in the NF-1 group on the Applied Problems subtest, with two participants showing increases of 26 and 28 % iles and three participants showing a decrease in their scores that ranged from 1 to 12% iles. Relatively weak improvements were noted in Applied Problems for the SD group. Three out of four participants in the SD group showed increases on the Applied Problems subtest ranging from 2 to 8 % iles and one student showed a decrease of 2 % iles. Table 3 presents means of the pretest, posttest and pre-post difference scores for the whole group and the SD and NF-1 subgroups.
Table 3

Mean WJ-R Pretest, Posttest and Pretest-Posttest Difference Scores for the Whole Group, Neurofibromatosis Type 1 and Seizure Disorders Groups

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Standard Score</th>
<th></th>
<th>Percentile</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Seizures disorders group (n=4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comp</td>
<td>79.0</td>
<td>21.6</td>
<td>92.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Letter Word Id.</td>
<td>87.3</td>
<td>15.4</td>
<td>92.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Applied Prob</td>
<td>92.3</td>
<td>19.7</td>
<td>94.3</td>
<td>17.7</td>
</tr>
<tr>
<td>Neurofibromatosis type 1 group (n=5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comp</td>
<td>94.6</td>
<td>4.1</td>
<td>98.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Letter Word Id.</td>
<td>87.4</td>
<td>6.0</td>
<td>93.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Applied Prob</td>
<td>86.2</td>
<td>5.9</td>
<td>89.6</td>
<td>8.9</td>
</tr>
<tr>
<td>Whole group* (n=9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comp</td>
<td>87.7</td>
<td>15.8</td>
<td>97.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Letter Word Id.</td>
<td>87.3</td>
<td>10.3</td>
<td>92.7</td>
<td>9.5</td>
</tr>
<tr>
<td>Applied Prob</td>
<td>88.9</td>
<td>13.2</td>
<td>91.7</td>
<td>12.7</td>
</tr>
</tbody>
</table>

*Participants with seizure disorders and participants with Neurofibromatosis Type 1
Statistical Significance

To test for the statistical significance of improved performance, a norm referenced evaluation model was used (Gersten, 1985; Horst, Tallmadge & Wood, 1975). In cases where a comparison or control group is unavailable, this model is regarded as an adequate estimate of the significance of the treatment effect. Participants were compared to the normalization group of the WJ-R, comprised of a (U.S.) nationally representative sample of 6,359 children and adults in over 100 geographically diverse U.S. communities. The sample was composed of 705 participants 2-5 years of age and not enrolled in kindergarten, 3,245 participants enrolled in kindergarten to 12th grade, 916 participants enrolled in college/university and 1,493 participants 14-90 years of age not enrolled in secondary school or college (Woodcock et. al., 1991). Participants were randomly selected within a stratified sampling design that controlled for 10 specific community and subject variables (not all applicable to the school age sample of children enrolled in kindergarten to 12th grade). The norming variables for the school age sample consisted of Census Region (north-Central, northeast, south, west), Community Size (central city, urban fringe, rural and outside urban), Gender, Race (white, African American, Native American, Asian Pacific and ‘other’) and Hispanic (Hispanic and non-Hispanic). For the school age sample, data were gathered continuously from September 1986 to April 1988. The continuous-year procedure of testing resulted in norms that are based on data gathered throughout the school year, not on data gathered at one or two points in the year and interpolated for intermediate times.
Similar to a comparison to a no treatment condition where children attend their regular schools, the norm referenced evaluation model (Gersten, 1985; Horst, Tallmadge & Wood, 1975) assumes students who have received treatment will maintain, at posttesting, the same achievement status (i.e. percentile ranking) with respect to the norm group as they had at pretest. The “no-treatment effect” expectation is, therefore, that at posttest the participants will maintain their pretest percentile ranking. The standard score at posttest that corresponds to their pretest score percentile is used as their “expected” posttest score. Using a one tailed t-test, this expected posttest standard score is compared to their actual observed posttest standard score to determine if their observed posttest score is significantly greater (p<.05) than their expected posttest score. This outcome would be indicative of a positive treatment effect. This comparison of posttest scores avoids the various sources of error involved in comparing pretest-posttest gain scores (Borg & Gall, 1989).

The mean observed and expected posttest standard scores of all nine participants are presented in Table 4 for the Passage Comprehension, Letter-Word Identification and Applied Problems subtests. Participants’ observed posttest scores were significantly higher than their expected posttest scores for Passage Comprehension (t = 2.22, df = 8, p < .05) and Letter-Word Identification (t = 4.45, df = 8, p < .005). The results were not significant for Applied Problems (t = 1.1, df = 8, p > .05). Due to the very small sample sizes, separate t-tests were not done for the children with seizure disorders and children with Neurofibromatosis Type 1. Nevertheless, the pattern of scores that has been described for individual participants having each of these disorders is consistent with these outcomes for the whole group. The majority of participants having each type of disorder
showed gains in Passage Comprehension and Letter-Word Identification. In contrast, for Applied Problems, more participants with NF-1 showed decreases than increases in scores, while any of those with SD who showed increases made only very small gains (see Tables 2 and 3).
Table 4

**Observed Mean Posttest Standard Scores* and Mean Expected Posttest Standard Scores for the Whole Group of Participants**

<table>
<thead>
<tr>
<th>WJ-R subtest</th>
<th>Observed $\bar{M}$</th>
<th>Expected $\bar{M}$</th>
<th>t - score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Comprehension</td>
<td>97.0</td>
<td>87.8</td>
<td>2.2*</td>
</tr>
<tr>
<td>Letter-Word Id.</td>
<td>92.7</td>
<td>87.3</td>
<td>4.45*</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>91.7</td>
<td>88.9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

*Standard Scores have a mean of 100 and a standard deviation of 15

$^b\bar{M}$ is the whole group mean standard scores

*p<.05

**Practical Significance**

In order to express what the magnitude of this improvement represented in practical terms, the WJ-R 'W' score was used descriptively as a measure of how much the students actually learned in the laboratory classroom compared to average normal students over an equal time period. W scores are not usually reported with WJ-R results, however they play a crucial intermediate role in test interpretation. Rather than comparing students to one another, W scores represent how much of the total learning domain has been mastered. The mean standard score for each age group is 100. However, a standard score of 100 for a 17 year old represents mastery of much more material than the same score for a 10 year old. W scores provide a common scale of equal interval measurement of task related ability across WJ-R subtests.
The WJ-R provides expected age related gains for the average students based on large scale normalization tests. By converting raw scores into W-scores it was possible to compare the current results to expected results for the average normal student over an equal time interval of eight weeks corresponding to the treatment. This is a more stringent test as gains for the sample are being compared to those expected for normally achieving students, not students with learning problems.

An examination of mean 'W' gains and expected gain scores for whole group (Table 5) indicated participants improved more than an average normal student would be expected to improve, in all three areas tested by the WJ-R. Expected W gain scores are low because of the short time period. Participants improved an average of 10.4 times more than that expected for the average normal student in Passage Comprehension, 4.5 times more in Letter-Word Id. and 2.8 more times in Applied Problems.

The most notable difference between groups was in Passage Comprehension. Average improvement in Passage Comprehension was found to be 20.5 times more than expected in the SD group compared to 6.8 times more in the NF-I group. Relative to the average normal student's expected gains, SD participants improved an average of 7.6 times more in Letter-Word Identification and 2.0 times more in Applied Problems, whereas in these same areas NF-I participants improved 3.9 times and 3.3 times more respectively.
### Table 5

**Mean Observed W Score Gains and Mean Expected W Score Gains on the WJ-R**

**Subtests for the Seizures Disorders, NF1 and Whole Groups**

<table>
<thead>
<tr>
<th>WJ-R Subtest</th>
<th>M W score gains&lt;sup&gt;b&lt;/sup&gt;</th>
<th>M W score expected gains&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seizure disorders group (n = 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>20.5</td>
<td>1</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>9.5</td>
<td>1.25</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>2.5</td>
<td>1.25</td>
</tr>
<tr>
<td>Neurofibromatosis type 1 group (n = 5)</td>
<td>13.6</td>
<td>2</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>13.6</td>
<td>2</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>11</td>
<td>2.8</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>6.6</td>
<td>2</td>
</tr>
<tr>
<td>Whole group (n = 9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>16.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>9.4</td>
<td>2.1</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>4.8</td>
<td>1.7</td>
</tr>
</tbody>
</table>

<sup>a</sup>Participants with seizure disorders and participants with Neurofibromatosis Type 1

<sup>b</sup>Mean W score gain of participants

<sup>c</sup>Mean of expected W score gains for average normal students over the same period of time represented by the pretest-posttest differences. Expected gains were based on the normalization data provided by the WJ-R
High standard deviations indicated considerable variability among participants in terms of their improvement. Individual participant data in the NF-1 and SD groups showed that 3 out of 4 SD participants improved more than the average normal student in Passage Comprehension, Letter-Word Identification and Applied Problems. In the NF-1 group, 4 out of 5 participants improved more than that expected for an average normal student in Passage Comprehension, 5 out of 5 in Letter-Word Id. and 2 out of 5 in Applied Problems.

Overall, 7 out of 9 participants improved more than the average normal student in Passage Comprehension, 8 out of 9 in Letter-Word Identification and 5 out of 9 in Applied Problems. Furthermore, the results indicate that all of the participants improved more than the average normal student would be expected to improve in at least one of the academic areas tested.
Discussion

The participants examined in this study were referred to the laboratory classroom on the basis of perceived lags in academic performance. They were not learning in their school placements. This study has shown that despite their previous educational histories of little progress, these students made significant academic gains directly related to the areas of instruction provided in the laboratory classroom where, in most cases, the ratio of teacher to students was about the same as in their community school classrooms. Furthermore, their gains surpassed those expected for an average student over the same period of time. Each child showed more gains than the average student in at least one of the academic areas tested. This study indicates that children with neurological conditions and associated learning difficulties can learn and respond favorably to DI techniques.

Participants made their greatest gains in Letter-Word Identification and Passage Comprehension. Participants’ gains in Applied Problems were not significant, although the mean gain on this subtest was positive. In this study, a relatively equal amount of time was spent on teacher directed instruction in mathematics and reading (approximately 30 minutes a day for each); although, reading was taught to smaller groups of two to three students whereas math was taught to the whole class. Considering that the classes consisted of only five students, this difference between whole class and small group teaching would not be expected to account for the relatively low Applied Problems gains observed. More participants with NF-1 showed decreases than increases in scores on the
Applied Problems subtest, while any of those with SD who showed increases made only very small gains.

The NF-1 literature strongly suggests deficits in performance IQ compared to verbal IQ for children with Neurofibromatosis type 1, a difference mainly attributed to the high prevalence of visuo-spatial dysfunction present in this sample (Stine et al., 1988; Varnhagen et al., 1988; Rugland, 1990; Eliason, 1986). Visuo-spatial deficits have been postulated to negatively affect academic performance in mathematics, where the visual recognition of numeric patterns, spatial organization of quantitative data and quantitative relations play an important role in the successful apprehension of arithmetic procedures (Varnhagen et al., 1988; Eliason, 1986). Stine et al. (1988) reports findings of a study of 18 children with Neurofibromatosis where a significant difference was found between low WISC-R digit span, coding, arithmetic, and block design scores and the relative higher scores of the remaining seven subtests, which themselves were not different from each other. The same study also reported lower academic performance in mathematics compared to spelling and reading recognition. The psychoeducational reports available for each student with NF-1 who participated in the present study showed visuo-spatial-motor dysfunction. In light of the available literature and their clinical profiles, the relatively small gains made overall in Applied Problems by NF-1 participants in the present study could be attributable to the visuo-spatial deficits.

The laboratory classroom teacher modeled new tasks and verbally instructed students in completing arithmetic problems; however, worksheets and copying material from the blackboard played an important role in the instructional model used. In particular, worksheets were designed to visually represent mathematical concepts, for
example, using a circle to represent 'a whole' and dividing it into parts in order to teach fractions. Students were later expected to use this visual representation in order to understand what the 'bottom' of a fraction represents. Perhaps this approach relied too heavily on the visuo-spatial skills of children with NF-1. Stine & Adams (1989) suggest that some children with NF-1 may develop compensatory cognitive mechanisms in order to overcome the learning consequences of reduced visuo-spatial skills; when mediated by 'verbal cognition mechanisms' NF 1 children improve at integrating and abstracting spatial information that is presented visually (Varnhagen, et. al., 1988). A teaching approach geared more towards the verbal representation of mathematical procedures and problem solving strategies may be more effective for children with NF-1.

The literature pertaining to the academic performance of children with seizure disorders and associated learning difficulties is not as clear as the NF-1 literature in defining specific problem areas. Some studies report that children with seizure disorders show a tendency to perform poorly in reading related tasks (Mitchell, Cavez, Lee & Guzman, 1991; Stores, 1987), whereas other studies suggest that these children show the most difficulty in mathematics (Seidenberg, 1986; Aldenkamp, 1983, 1987). It is generally accepted that there is at least one subgroup of children with seizure disorders who show a specific arithmetic impairment (Aldenkamp et al., 1990). It is possible that some children in the present sample may have had this specific learning disability and thus did not benefit from the type of arithmetic instruction administered in the laboratory classroom. The effectiveness of other instructional models in teaching these children should be explored in an effort to pinpoint the exact nature of their specific mathematics difficulties.
Due to a small sample size no conclusions could be drawn about differences in learning between students with Neurofibromatosis Type 1 and students with seizure disorders. It was therefore informative to discuss the performance of individual cases. The majority of participants made substantial gains in reading comprehension and decoding skills. In some cases the improvement was dramatic as in the case of two participants, both with seizure disorders (participants SD1 and SD 2), who started at below the 1 percentile level and improved by over twenty percentile points in reading comprehension. Both participants received daily and systematic instruction in word decoding through phonetic and structural analysis coupled with teacher directed instruction in text processing skills where the teacher would ask (scripted) comprehension questions at predetermined points in the passages read by the students. These questions were very gradually faded out as students themselves learned to ask similar questions during their reading. The combination of decoding skills and text processing instruction used as a means to achieving reading comprehension was reflected by the consistent and substantial improvement in Letter-Word Identification shown by participants and the considerable improvement in Passage Comprehension found for both the NF-1 and SD participants.

Given the positive results of this study it is important to try to isolate the factors which could conceivably account for the students' considerable gains. Conceivably, small classes facilitate student monitoring and allow a higher frequency of student teacher interaction. The fact that students in this study were instructed in small groups could be a factor contributing to their success; however, the majority of children in this study were referred from small LD classes in their school boards because of a lack of academic gain and therefore, class size per se does not seem to account for the differences. The
instructional technique used in this study was designed to be administered by any teacher in a standard, scripted way. Thus, while the teaching expertise of the particular laboratory classroom teacher might be cited as the reason for the students’ success, it is expected that any teacher should be able to deliver the program with about the same degree of skill. Therefore, it is possible to argue that results are attributable more to the instructional design of the DI program per se than to the unique characteristics of a teacher. The systematic implementation of DI programs, coupled with a focus on behavioural management, appears to represent a salient factor responsible for the students' academic gains.

The majority of children examined in this study presented substantial behavioural problems resulting in difficulties maintaining and focusing on-task attention, as well as increased distractibility in group instruction situations. This finding is consistent with the high incidence of attention related problems among children with neurological disorders reported in the pediatric literature (Eliason, 1986; Varnhagen et. al., 1988; Spaepen, 1992; Thompson, 1987). The implementation of systematic, consistent and repetitive DI instructional routines in a highly structured and predictable learning environment may have benefited students with attention problems by: (a) making sure that even though a student may have missed information presented at a particular time, that information was likely repeated and by (b) facilitating a student’s re-engagement in the course of instruction, following a brief period of inattention. The DI teaching method was designed to consistently minimize students’ errors on new tasks and achieve clear and unambiguous communication between the teacher and students. Conceivably, this method aided the learning of students who typically experience anxiety about their learning by providing
them with a teaching environment in which they always knew what to expect and in which their confidence was boosted by the fact that they could come up with a correct answer more times than they would with an incorrect one. Likewise, clearly established rules and behavioral expectations facilitated on-task performance and helped control any aggressive behavior or social problems.

The results of this study support the findings of Gersten and Maggs (1982), who found that moderately challenged students taught by DI methods were gaining at a significantly faster rate than their nonhandicapped peers who received regular instruction. The authors used a norm referenced design similar to the one used in the present study to assess, over 5 years, the cognitive and academic progress of a sample of 12 adolescents and preadolescents whose initial IQs placed them in the high-moderate range of retardation. After completing the same reading and arithmetic programs which, comparatively speaking, were only briefly used in the present study, these children showed a mean IQ of 50.6 (SD = 5.4) where the expected IQ based on normed data was 44.8. Over a dozen other published studies have evaluated the impact of DI programs and teaching techniques with handicapped students. Each of them have been consistently supportive, at significant levels, of increased academic gains as compared to gains produced by alternative remedial methods (Gersten, Woodword & Darch, 1986; White, 1988). Although relating to a different population, in the present study, the current findings do support the effectiveness of the DI teaching method in instructing children with special educational needs and suggest the need for further testing of its effectiveness with other groups of children with neurological disorders and associated learning difficulties.
Limitations of the Study

The task of creating learning environments in which the special educational needs of children diagnosed with neurological disorders and associated learning difficulties are competently addressed must begin with an understanding of what types of instructional models are best suited for these children. The present study documented the results of using DI methods to teach children with neurological conditions who were not achieving in their regular schools. The results showed that the children examined were able to learn. However, the interpretation of these findings is limited by a small sample size and therefore, a group of participants who may not be adequately representative of the population of children with neurological disorders and associated learning problems. The positive results of this study serve to validate the need for examining the effects of systematic instruction on a larger, more representative sample of children with neurological disorders and learning difficulties in an effort to provide service models in which their learning and achievement potential is fully explored and maximized.

The lack of a control group of children with neurological conditions who did not receive DI is also a limitation of this study. Despite the fact that it was possible to make meaningful and informative comparisons to expected scores based on the normative sample of the test measures, this did not constitute a comparison group matched on key variables. Another limitation is the lack of systematic follow-up of the participants to determine if they maintained their gains. Follow-up by the laboratory classroom did occur, but on a more informal consultation basis by the classroom teacher.
Conclusion

For children with neurological problems who have associated learning difficulties, lack of academic progress can be a chronic problem. Although individualized remedial programming which addresses the unique medical and academic needs of these children may seem to be the most obvious solution, effective methods remain to be discovered and the trend towards inclusion may not always make such individualized assistance possible. As a start on determining methods for instructing these children that are both effective and practical, the results of the present study demonstrated that the highly structured, scripted and sequential components of DI programs taught at a small group level can be used successfully in meeting some of the shared needs of these children. At the same time, there was considerable variation in performance among participants. Some made more gains than others. Greater gains were found in reading than in mathematics. Thus, while the utility of DI methods was clearly demonstrated, modifications to such approaches also seem to be necessary not only to maximize instructional efficacy in subject areas such as mathematics that may be more problematic for children with neurological conditions in general, but also to satisfy individual needs where necessary.
References


APPENDIX A

Ethical Approval

The Hospital For Sick Children

Memorandum

TO: Dr. Stan Zlotkin
FROM: Dr. Tom Humphries
DATE: June 14, 1995
SUBJECT: MA Thesis Proposal by Catalin Colinaescu. Evaluating the CDC Clinical Classroom

I am writing in support of a Masters student in the Department of Applied Psychology at OISE. I am seeking guidance about how best to proceed with his proposed Masters thesis from a human experimentation viewpoint. I would be his supervisor.

A draft proposal that the student prepared is attached. Basically, the study will be a pilot, retrospective in nature and descriptive in terms of analysis and interpretation. The Child Development Clinic has been running a Clinical Classroom in the hospital since last September for students with medical conditions (e.g. epilepsy, neurogenetic disorders). The purpose of the classroom is to assess these students’ learning and behavioural needs as a function of how they respond to teaching. The information obtained is shared with parents and the students’ teachers back in their home school, especially with a view to helping the teacher better understand the students’ medical condition, learning and behaviour problems that may be associated with the condition and how to teach to these problems. The classroom functions totally as a clinical service and the parents and teachers receive a clinical report based on our findings.

The Masters student in question wishes to examine the clinical information in order to compare the nature of the academic and behavioural profiles of students presenting with different medical conditions, the progress made by the students while in the class and whether the students’ teachers find the entire service of assistance. Even the teachers’ evaluation of the classroom’s benefit to them and their student is information we gather clinically.

The Masters student’s investigation of these various features of our clinical program would be of great benefit to us in evaluating our clinical service. As much as possible the student should report group trends, but changes in individual cases would also be informative. The Masters student has been a volunteer in the classroom and therefore is already known to some of the parents and their children.

As I have indicated, this pilot project is retrospective and would not require any further testing of the children. Nevertheless, use would be made of our clinical data. What kind of permission should we seek in addition to observing certain safeguards in reporting the findings (i.e. confidentiality, anonymity)? What findings from the project would we share with the parents and children?

Thanks in advance for any guidance you can give me regarding what I feel would be a very worthwhile pilot study.

Tom Humphries, Ph.D., C.Psych.
Director, Child Development Clinic

enc.
June 21, 1995

Dr. Tom Humphries
Director, Child Development Clinic
Division of Neurology
The Hospital for Sick Children

Dear Dr. Humphries:

Re: Evaluation of CDC Clinical Classroom

Thank you for your memo of June 14, describing the proposed evaluation of the Clinical Classroom by a Masters student at OISE. I have reviewed the proposal and conclude that, as this evaluation involves only data that has been collected previously for clinical purposes, and no new information will be gathered specifically for the evaluation, the project does not require formal REB approval.

Thank you for bringing your question to the Board.

Sincerely yours,

[Signature]

Stanley H. Zlotnik, MD, PhD, FRCP
Chair, Research Ethics Board
Letter from The Graduate Office of the Ontario Institute for Studies in Education

August 20, 1994

To whom it may concern,

The University of Toronto, Research Institute, University of Toronto, Affiliated Research Institution

A proposal for the above mentioned project was submitted for ethical review to the Research Ethics Board.

The proposal was reviewed and approved by the Research Ethics Board on June 21, 1991. Based on the board's decision and the supervisor of this thesis project, I feel that further ethical approval is not necessary.

Sincerely,

[Signature]

Dowd Humphries, Ph.D.
Child Development Centre, Hospital for Sick Children, Associate Professor, Department of Psychology, University of Toronto.
Glossary of Medical Terms

ataxia telangiectasia: also called the Louis-Bar syndrome, this is an autosomal recessive disorder and the gene locus has been mapped to the long arm of chromosome 11. Symptoms include: the delay of motor and sexual development, delay of growth, and mild mental retardation (in some cases). Patients have impassive faces and a tendency to drool. Their speech is slow and slurred.

ataxic static encephalopathy: a cerebral palsy characterized by a severe difficulty to coordinate voluntary muscular movements.

brain neoplasm: new growth of brain tissue resembling more or less the tissue from which it arises but serving no physiologic function and being benign, potentially malignant or malignant in character.

astrocytoma: a brain tumor composed of astrocytes (star shaped cells). They are usually white, infiltrating growths which may occur at any age, and in either the cerebral or the cerebellar hemispheres. They grow slowly, and the average survival period after the first symptom is usually 67 months in the case of the former and 89 months in the case of the latter. In particular, the cerebellar astrocytoma of childhood is considered to be relatively benign, as it often leads to a more favorable prognosis.

generalized seizures: seizures which begin with a widespread, excessive electrical discharge simultaneously involving both sides of the brain.

ictal state: referring to the time during an epileptic seizure.

interictal state: referring to the time in between epileptic seizures.
**lymphocytic leukemia**: a variety of leukemia characterized by an uncontrolled proliferation and conspicuous enlargement of lymphoid tissue in various sites (lymph nodes, spleen, bone marrow, lungs), and the occurrence of increased numbers of cells of the lymphocytic series (white blood cells) in the circulating blood and in various tissues and organs.

**medulloblastoma**: brain tumors consisting of neoplastic cells that resemble the undifferentiated cells of the primitive medullary tube. These are rapidly growing tumors which most often occur in the cerebellum in children, but are rarely seen in adults. The medulloblastoma is one of the more malignant gliomas (tumors derived from the glial cells), but surgical removal followed by radiotherapy gives 10 and 15 survival rates of 41 percent.

**neuroectodermal**: relating to the central region of the early embryonic ectoderm which on further development forms the brain and spinal cord and also evolves into the nerve cells of the peripheral nervous system.

**partial seizures**: seizures which begin with an abnormal electrical discharge restricted to one region of the brain.

**subtentorial tumor**: a brain tumor situated or occurring under the tentorium of the brain.

**supratentorial tumor**: a brain tumor situated above or affecting the structures overlying the tentorium of the brain.

**tentorium**: (tentorium cerebelli) an arched fold of dura mater covering the upper surface of the cerebellum (a large dorsally projecting part of the brain that is concerned especially with the coordination of muscles and the maintenance of equilibrium). The tentorium separates the cerebellum from the basal surface of the occipital and temporal lobes of the cerebral hemisphere.
**tonic-clonic seizures**: convulsive, generalized seizures in which the person briefly stiffens and loses consciousness, falls, and often utters a cry (caused by air being forced through the contracting vocal chords and not by pain). The stiffening is followed by jerking of the arms and legs. The seizures usually last 1 to 3 minutes.

**upper brainstem**: the brainstem is the lower, axial part of the brain which controls sleep-wake cycles, breathing and heartbeat. The upper part of the brainstem contains the thalamus (serving as a relay station to send messages about bodily sensations) and the hypothalamus (part of the brain which controls the hormone gland).

**Von Hippel-Lindau disease**: a small tumor usually situated in the periphery of the retina and supplied by an enlarged artery and vein.