Psychosocial sequelae of pediatric TBI: A subtype analysis using the Child Behavior Checklist (CBCL).

Susan Elizabeth. Hayman-Abello

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PSYCHOSOCIAL SEQUELAE OF PEDIATRIC TBI:
A SUBTYPE ANALYSIS USING THE CHILD BEHAVIOR CHECKLIST (CBCL)

by

Susan E. Hayman-Abello

A Thesis Submitted to the College of Graduate Studies and Research through the Department of Psychology in Partial Fulfillment of the Requirements for the Degree of Master of Arts at the University of Windsor

Windsor, Ontario Canada

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ABSTRACT

The present study was designed to identify subtypes of psychosocial functioning in a sample of children who had sustained traumatic brain injury (TBI). Child Behavior Checklist (CBCL) profiles were subjected to cluster analysis and then to Q-Factor analysis. The subjects consisted of 92 children and adolescents aged 12 to 18 who had been treated at either a community or an acute rehabilitation centre following a mild, moderate or severe TBI. Sixty-four of the subjects were classified into a four-category psychosocial typology using Q-Factor analysis. Based on the mean clinical scale elevations of the eight CBCL syndromes, the subtypes were labelled Normal (n = 32), Attention (n = 14), Delinquent (n = 10), and Withdrawn-Somatic (n = 8). This typology was found to overlap in part with previous TBI psychosocial typology (Butler et al., 1997) and with three of the clinical Profile types derived by Achenbach (1993) for the CBCL. The majority of subjects, including those who sustained severe TBI, were assigned to the Normal subtype. The overall level of psychosocial deviance was relatively mild in the other three subtypes. Some evidence suggested that children who were injured at younger ages were more likely to exhibit psychosocial problems compared to those who were injured later in their development. The results of this study support previous typology efforts and confirm the heterogeneous presentation of social and emotional functioning following TBI.
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Chapter I

INTRODUCTION AND LITERATURE REVIEW

Traumatic brain injury (TBI) is the leading cause of death in children and one of the major causes of long-term morbidity (Fletcher & Taylor, 1997). Despite the alarming prevalence of this largely preventable neurological disorder, the literature devoted to the investigation of TBI in children has only recently begun to match its adult counterpart. Just ten years ago, research specific to the sequelae of pediatric TBI was uncommon (Fletcher & Taylor, 1997). Significant differences between children and adults, and within children themselves, in terms of the etiology, neuropathology, and recovery characteristics associated with pediatric TBI justify the recent growth in research. However, much of the emerging psychosocial research lacks standardization. The results are relatively inconsistent and the associated conclusions are controversial.

The major concepts associated with TBI will be presented here including background information, etiology, epidemiology, mechanisms of injury, classification schemes, and pathophysiology. A brief summary of the neuropsychological literature will be followed by a detailed review of the psychosocial sequelae associated with pediatric TBI.

Background

Traumatic brain injury describes a physical injury to the brain caused by an external mechanical force which results in loss of consciousness (LOC), post-traumatic amnesia (PTA), neurological deficits or all three (Ragnarsson, 1993). While the major causes of TBI and mechanisms of injury may be the same for both adults and children, the pathophysiological sequelae and relationship to eventual outcome are not equivalent. Maturational changes in the skull and brain interact with the mechanism of injury such that direct comparisons between adults and children are prone to error. Similarly, comparisons between children of different ages may lead to inaccurate conclusions (Bruce, 1995). Continuous changes in brain anatomy, chemistry, and physiology throughout development, and changes in the protective capacity of the skull underscore the
heterogeneity of injury and outcome within the pediatric population.

**Etiology**

After birth, there are three distinct periods during which the incidence of TBI increases (Spreen, Risser, & Edgell, 1995). Specifically, infants and toddlers, the elderly, and young adults (aged 15 to 24) are more likely to sustain TBI but for different reasons. Falling is the main cause of brain injury in toddlers and the elderly, while young adults are more likely to be injured as the result of motor vehicle accidents (Annegars, 1983; Sosin, Sniezek, & Thurman; 1996; Spreen et al., 1995). Child abuse is also a common cause of TBI in very young children (Blackman, 1990; Fletcher, Ewing-Cobbs, Francis, & Levin, 1995; Spreen et al., 1995). Children aged four to 12 are commonly injured as a result of falls, sporting accidents, and motor vehicle accidents (Fletcher, Ewing-Cobbs et al., 1995).

**Epidemiology**

Epidemiological data gathered from pediatric injury research conducted between 1970 and 1990, suggested that the average incidence (i.e., number of new cases in the population of at-risk children during a given time period) of confirmed brain injury across four countries was 180 per 100,000 children per year (Kraus, 1995). Given the variances in injury definition and description, data sources, and subject recruitment techniques across these studies, Kraus suggested that data from local communities should be used to make more specific epidemiological estimates in situations where injury-reporting methods, medical admission standards, and risk levels vary substantially.

Kraus' literature review (1995) revealed that typically half of all acute traumatic deaths to children under age 15 involved injuries to the brain. Males tended to incur brain injury more frequently than females with ratios ranging from 1.3 to 2.2:1. More specific analyses separated this finding by age and revealed equal male-female ratios before the age of five followed by increasing incidence of brain injury in males only. Over 90% of TBI are of the "closed head injury" variety (Lezak, 1995; Spreen et al., 1995) and most are classified as "mild" (Ewing-Cobbs, Fletcher & Levin, 1995; Fletcher & Taylor, 1997; Kraus, 1995).
Mechanism

The majority of human traumatic brain injuries occur as a result of mechanical force (Gurdjian, 1975). The injuries may be categorized as closed or penetrating (i.e., direct damage to underlying brain tissue by penetration). Closed head injuries may occur through non-impact, acceleration/deceleration of the skull (e.g., whiplash) (Binder, 1986; Brown, Fann, and Grant, 1994; Sweeney, 1992). In each case, pressure gradients may be set up that cause wide spread damage to both grey and white matter. Injury classification can be further distinguished as focal or diffuse, the former lesions being visible to the naked eye including cortical contusions and haematomas (Cooper, 1982).

Classification

To aid prognostic and descriptive research, traumatic brain injuries are generally classified by physiological severity (Alexander, 1995). However, many measurements of acute physiological severity do not correlate well with recovery or accurately predict clinical outcome (Binder, 1986; Brown et al., 1994; Lezak, 1995) and many are not used in the manner for which they were designed (Bruce, 1995). Researchers investigating traumatic brain injuries may use one or a combination of widely used classification aids including the depth of coma (Glasgow Coma Scale (GCS)), duration of post-traumatic amnesia (PTA), duration of coma (assessed by response to commands), neuroimaging findings, and evoked potentials (Fletcher & Taylor, 1995; Lezak, 1995).

For example, the GCS represents patients’ scores in three domains of consciousness: eye opening, motor response and verbal response. Scores lower than 8 out of 15 are considered reflective of a “severe” injury. Scores between 9 and 12 reflect a “moderate” injury and scores greater than 12 suggest a “mild” brain injury (Ewing-Cobbs et al., 1995; Fletcher, Levin, & Butler, 1995; Spreen et al., 1995). Fletcher and Taylor (1997) suggested that the Motor scale of the GCS, used in isolation, is a superior index of injury severity in pediatric assessment. Specifically, if a child does not respond to commands within 24 hours the injury is classified as “severe”.

Alexander (1995) reported that GCS, PTA, and loss of consciousness (LOC) may
not be accurate in predicting outcome, particularly in cases of mild TBI. The GCS has limited utility in a pediatric population when developmental communication limitations preclude the accurate interpretation of a verbal response scale (Bruce, 1995). It is typically used only for children over three years of age (Fletcher & Taylor, 1997). Modifications of the scale for infant assessment have been reported including the Children’s Coma Scale and Adelaide Pediatric Coma Scale (Bruce, 1995) but little data has been accumulated regarding their utility. Use of PTA amongst children is also problematic due to lack of normative data regarding temporal orientation (Asarnow et al., 1995). The Children’s Orientation and Amnesia Test (COAT) is used to assess PTA in children and is a better estimator of memory functioning one year after injury than the GCS (Ewing-Cobbs, Levin, Fletcher, Miner, & Eisenberg, 1990). While over 80% of pediatric TBI cases are said to fall into a “mild” severity range (Bruce, 1995; Asarnow et al., 1995), agreement regarding classification methodology has not yet been achieved (Benton, 1995).

Pathophysiology

The adult human brain is an approximately three pound mass of neurons, supporting cells and blood vessels that behaves as a semi-elastic, semi-liquid material upon impact (Gurdjian, 1975). In contrast, the infant’s brain weighs approximately 400 grams, is not fully developed at birth, and must acquire further mass and neuronal connections during the first two years of life (Berg, 1986; Rourke, Bakker, Fisk & Strang, 1983). Specifically, the nearly life-long process of continuing myelination allows for increased inter- and intra-connectivity of the hemispheres (Rourke et al., 1983). Consequently, injuries affecting the very young brain produce more generalized rather than focal impairment (Berg, 1986).

Protection of the brain comes in the form of cerebral spinal fluid, meninges, skull, and scalp. In closed head injuries, neurological damage may result from a multi-step process which can be categorized by primary and secondary effects. Following an initial insult to the brain, primary pathophysiological changes may include skull fracture, mass effects, hemorrhage, and various forms of vascular and neural tissue compression,
stretching, and tearing (Binder, 1986; Cooper, 1982; Castejon, Velaero and Diaz, 1997; Maxwell, Povlishock, and Graham, 1997). Secondary injuries, include swelling, bleeding, scarring, pressure changes, and local or remote cell degeneration or death, may result in further neurological damage.

**Pediatric Variables**

The mechanisms responsible for neuropathology in the pediatric population vary with the type of trauma sustained and with age (Fletcher, Ewing-Cobbs, et al., 1995). The physiological changes that result from low-velocity impact (e.g., falling in young children) are quantitatively and qualitatively different than the damage sustained in a high-velocity trauma (e.g., motor vehicle accident). An infant’s smooth and unfused skull offers far less protection than does an adult’s one-quarter inch housing (Gurdjian, 1975; Spreen et al., 1995). Consequently, skull fractures and deformations are more prominent amongst infants, while the focal injuries attributed to the rough interior of the adult skull are less common (Spreen et al., 1995). Nonetheless, advances in neuroimaging techniques have demonstrated that children as well as adults experience focal injuries (Fletcher, Ewing-Cobbs et al., 1995). Other differences between the mechanical neuropathology suffered by children and adults have been proposed. Children’s small, partially myelinated brains may not be as vulnerable to the shearing forces that cause diffuse axonal injury (Spreen et al., 1995). In addition, young children are more likely to be involved in low-velocity falling injuries that do not necessarily produce the intensity of rotational force that antecedes diffuse axonal injury.

**Outcome**

Ewing-Cobbs et al. (1995) reported that morbidity and mortality rates were higher in children compared to adults, a proposition that was contrary to earlier research. When the outcome data was stratified by age group these researchers observed that children younger than six, especially when the injury was abuse-related, realized poorer cognitive and motor outcomes than older children. The Glasgow Outcome Scale has been proposed as a useful set of outcome categories (i.e., vegetative, severe disability, moderate
disability, and good recovery). These functional classifications may be useful for collapsing large samples of subjects for group analyses but they are highly subjective, not sensitive enough to describe and predict the behaviour of individuals, and must be modified for use with a pediatric population.

**Influence of Age at Injury**

The application of the Kennard Principle (i.e., the earlier a brain lesion is sustained, the more motor sparing will occur) to neuropsychological recovery from TBI has been poorly received. Isolated, well-developed abilities (e.g., word knowledge) may emerge intact or rapidly recover following a cerebral insult (Hartlage & Telzrow, 1986). However, a developing child is in a constant process of acquiring and refining neurocognitive abilities. Interference with the natural development of neuropsychological abilities at any 'critical period' can stunt or distort the optimal expression of that ability. Ewing-Cobbs and her colleagues (1995) stated that “skills in a rapid stage of development are more susceptible to disruption by acquired brain injury than are more over-learned and well-automatized skills” (p. 438). For example, Ewing-Cobbs and her colleagues in Galveston, Texas identified different types of language impairment depending upon what developmental stage was disrupted at the time of injury. That is, when infants and young children, who were developing the building blocks of expressive language, were injured they displayed significant impairment in basic expressive abilities. School-age children, on the other hand, exhibited deficiencies in written expression, while adolescents displayed impairment in tasks that demanded a more complex language component: semantic organization strategies.

Because children undergo multi-stage cognitive development, it is reasonable to presume that later-emerging higher-level abilities may be affected by earlier impairment in basic underlying skills. Many children are mislabelled as “recovered” before they have reached their developmental apex and the cognitive and interpersonal challenges that accompany the fully matured brain (e.g., need for increased cognitive flexibility and autonomy: Berg, 1986). The lack of immediate cognitive impairment does not preclude
changes in the order, rate, and level of future cognitive development (Berg, 1986). That is, impairment in the context of development means that the possibility of future changes must be acknowledged.

Studies of the specific sequelae of injuries sustained from birth to age two are rare as these children are typically grouped together with older children (Spreen et al., 1995), and often grouped with a large age range spanning all of childhood and adolescence (Berg, 1986). Before the age of 16, damage to the left hemisphere did not necessarily produce adult-like aphasic deficits (Berg, 1986). For example, Berg noted that severe damage to either hemisphere can disrupt language functioning temporarily. Less of a detrimental effect was endured after age five. In addition, aphasic-like symptoms were more likely to be transitory in children aged five to twelve who sustained left hemisphere injury. In other words, there are significant distinctions between the effects of similar injuries depending directly on developmental stage. Hartlage and Telzrow (1986) noted that when a broad range of neuropsychological sequelae were assessed, younger children evidenced more impairment than their older counterparts.

Influence of Type of Injury

Early neuroimaging findings for children with TBI uncovered a high incidence of pathophysiological changes associated with diffuse injury and a worse outcome for children who sustained a diffuse injury (Ewing-Cobbs et al., 1995). It was concluded that pediatric TBI predominantly produced diffuse injury. However, later neuroimaging investigations documented more focal injuries than previously observed (in addition to diffuse damage), especially in the frontal lobes.

Influence of Injury Severity

It has long been recognized that the severity of a brain trauma is to a large degree influential in the eventual physical and cognitive sequelae. Children who sustain severe neurological insult typically experience greater impairment and a longer recovery than those whose injury is rated as mild. However, as within the adult literature, the outcome and prognosis of mild TBI is heavily debated and conflicting findings abound (Fletcher,
Levin, et al., 1995). The inconsistency in accumulated research can be partially attributed to the same methodological variables that plague adult research (Kibby & Long, 1996). These methodological inconsistencies and obstacles in pediatric studies include varying definitions of “mild”, excessive reliance on retrospective injury assessment, lack of neuroimaging in so-called mild cases, and confounding pre-injury variables (Fletcher, Levin, et al., 1995). Mild TBI outcome studies have concluded that a prognosis of full recovery is generally warranted with the possible expectations of subtle, short-term post-concussive symptoms (e.g., headache) (Asarnow et al., 1995). In contrast, severe TBI has been associated with a higher risk for problems with attention, short-term memory, motor skills, and behavioural changes (Fletcher, Levin, et al., 1995).

Overall, it appears that younger children are more vulnerable to the effects of severe brain injury with the age of six or seven representing the best separation of groups (Ewing-Cobbs et al., 1995). The influence of intervening variables in pediatric TBI outcome cannot be underestimated in anticipating the long-term effects of the injury. Parker (1996) characterized the possible patterns of cognitive outcome following TBI as follows: 1) immediate permanent deficits; 2) subclinical deficits following compensatory improvement; 3) initial progress with delayed expression of dysfunction or lack of development according to schedule; and 4) development followed by premature plateau.

**Methodology Issues**

Variations in outcome data may also be related to methodology. Fletcher, Ewing-Cobbs et al. (1995) delineated three methods of outcome data collection: qualitative clinical judgement (e.g., Glasgow Outcome Scale); quantitative psychometric assessment (e.g., neuropsychological assessment); and rating scales and interviews that condense qualitative observations into quantitative data (e.g., Vineland Adaptive Behavior Scales, Personality Inventory for Children- Revised). These authors noted that when outcome assessments were conducted using clinical judgement tools children appear to have better functional outcomes compared to adults. In contrast, the reverse was true when psychometric and rating scale techniques were employed (i.e., children’s outcomes looked
worse than adults). Interpretations of outcome must therefore take into account the type of assessment conducted and the potential variance in the obtained results. Fletcher & Taylor (1997) advised that an accurate assessment of injury severity must incorporate presenting neurological signs, neuroimaging findings, environmental demands and limitations, pre-existing conditions, and recovery characteristics. For less severe cases, these authors suggested that outcome may be more directly affected by the location and extent of focal injuries.

Neuropsychological Findings

While measures of overall intellectual functioning may improve rapidly amongst children with severe TBI, ultimate levels may not ‘catch up’ to those of their less injured peers (Fletcher, & Taylor, 1997). Deficits in memory, attention, and problem-solving may persist. Injuries that are severe and occur early in the course of ability development tend to have the most persistent effects on all neuropsychological abilities. One important difference between the eventual performances of children and adults is that injured children may be impaired in an ability that was in the process of being developed but never fully realized (Rourke et al., 1983). This type of ability deficit is fundamentally different from the impairments evidenced by adults who had the opportunity to fully develop an ability before their injuries. Recent research also suggests that younger children are more vulnerable to psychosocial problems following TBI, especially when the TBI is classified as severe.

PSYCHOSOCIAL FUNCTIONING

Introduction

The practice of neuropsychological assessment commonly includes the identification of children’s behavioural, motivational, and social traits (Fletcher & Taylor, 1997). This data is used in the analysis of test performance itself and as part of the broader picture of a child’s functioning. Assessment tools include child interview and observations, and parent or teacher rating scales (e.g., Personality Inventory for Children - Revised (PIC-R); Child Behavior Checklist (CBCL)). Specific instruments that address
adaptive behaviour (e.g., Vineland Adaptive Behavior Scales) may also be used in a TBI population (Fletcher & Taylor, 1997).

The psychosocial sequelae of pediatric TBI has received less research attention and has met with more controversy than research related to physical and cognitive changes. Research regarding the psychosocial sequelae of pediatric TBI frequently identifies problems in this group of children, particularly amongst those with severe injuries (Filley, Cranberg, Alexander, & Hart, 1987). Unfortunately, few comprehensive studies have been conducted and universal agreement has not been reached regarding expression of impairment, relationship to injury severity, or relationship to pre-injury characteristics. Variations in methodology, particularly in the operational definition of TBI may be partly responsible (Butler, Rourke, Fuerst, & Fisk, 1997).

Research Issues

Several issues are germane to the study of TBI and specifically to the assessment of psychosocial functioning. Shaffer, Chadwick & Rutter (1975) noted that acute measurements of behaviour may only reflect children’s short-term responses to trauma, reactions to hospitalization, and separation from parents. In addition, longitudinal assessments allow researchers to identify dynamic changes in psychosocial functioning.

Researchers also acknowledge the influence of pre-injury variables, both intrapersonal and extrapersonal, and their potential interaction with post-injury functioning. It makes intuitive sense that children’s extrapersonal environment including interpersonal relationships and quality of home life will be influential in their ultimate recovery from injury. In addition, children’s individual vulnerabilities (e.g., psychiatric status, developmental history, central nervous system and general health) must be considered as potential direct or indirect mediators of eventual psychosocial functioning.

There are numerous examples of assessment protocols and instruments in the psychosocial literature as reviewed below. Evaluation of functioning may occur from a parental report perspective and/or may incorporate child observation or direct child interview. Some researchers assert that personal interview of parents or caretakers has the
potential to insert a bias into parents' recall and description of their children's activities and behaviours (Knights et al., 1991). On the other hand, structured questionnaires leave little room for elaboration and can be susceptible to misinterpretation (Drotar, Stein, & Perrin, 1995). Some researchers have reported reduced sensitivity when using behaviour checklists (e.g., Fletcher, Ewing-Cobbs, Miner, Levin, & Eisenberg, 1990) while others (e.g., Donders, 1992) recommend standardized checklist instruments over non-standardized interview methods.

Part of the research controversy stems from methodology differences and inadequacies. Some research has relied upon unstandardized and vague judgements of psychosocial functioning in classifying outcome following brain injury. For example, Filley et al. (1987) used a retrospective review of outpatient records to determine outcome in several categories including “social behaviour”. A three-point rating scale was devised as follows: “good outcome” = normal behaviour or only minor behavioral disturbance; “moderate impairment” = a state of either mild under-arousal (apathy or poor motivation) or over-arousal (irritability or hyperactivity); “severe impairment” = marked under-arousal or over-arousal. Of the 24 children followed to three years post-injury, three were classified as having a “good” social outcome; ten were classified in the moderate impairment category (three mildly under-aroused and seven mildly over-aroused); and nine demonstrated severe impairment (six over-aroused and three under-aroused). There is a need to use well-standardized and descriptive instruments across studies.

Research results can be influenced by whether or not the results are compared to a matched control group, clinical control, or to standardized normative data. In addition, statistical techniques that analyze whole groups may mask potentially interesting individual differences (Knights et al., 1991).

Another large part of the controversy and disparity amongst current research stems from the very nature of TBI itself. Variations in injury pathophysiology, classification, medical management, and severity are difficult to control when conducting
research. PTA can be difficult to assess in a child. GCS may be artificially lowered in cases of therapeutic coma (i.e., medically induced reduction in consciousness) and may not accurately reflect injury severity. Further the initial indicators of injury severity may fluctuate during the early stages of recovery and children who were assigned to one severity group on the basis of an initial score may not be accurately placed.

A review of the current literature demonstrates that severity can be rated differently, making comparisons between studies very difficult. Also, there has been a recent controversy within the adult literature regarding the minimum level of behavioural and neurological change sufficient to represent a 'mild' brain injury. The injury location may also be considered as an independent and influential variable. While Shaffer et al. (1975) did not find a relationship between injury lateralization and risk of behaviour disorder, injury location may be influential in the type of behaviour disorder expressed (Rutter, 1981). Therefore, analysis of the possible relationships between injury parameters and patterns of psychosocial behaviour rather than the dichotomous presence or absence of pathology might yield more meaningful findings.

**Psychosocial Research in Pediatric TBI: The Literature**

Much of the first systematic research investigating the potential relationships between TBI and psychosocial sequelae was generated by a group of British psychiatrists, psychologists, and colleagues beginning in the middle to late 1970s. To determine the influences, if any, of age and injury location on psychiatric disorder, Shaffer et al. (1975) examined school age children who had sustained a compound depressed skull fracture with confirmed unilateral cerebral insult (i.e., penetrating head injuries only).

The children were studied at least two years post-injury to avoid the potential confounds of examining the behaviour problems associated with acute reactions to trauma, hospitalization, and separation from family. The children underwent mental status and neurological examinations. Ratings of the parents' psychiatric status and of the mothers' mental health were also obtained. One or both parents provided information on a wide
range of possible emotional and behavioural problems in a comprehensive standardized interview. Teachers also completed behaviour questionnaires for the children and for classmate controls. Five-point global ratings of children’s psychiatric handicap (i.e., “behaviour or emotions giving rise to distress in the child or restrictions of the child’s activities or having an adverse impact on the child’s family or community” p. 196; Shaffer et al., 1975) were made on the basis of parent interview, teacher comments and questionnaires, and by direct interview with the child.

Sixty-two percent of the children demonstrated psychiatric disturbance. There was a trend for right parieto-occipital lesions to manifest the least psychiatric disturbance but there were no other significant differences according to lesion laterality or localization. No significant relationships were found between age at injury or severity (as measured by loss of consciousness) and psychiatric outcome. Various social and family variables including marriage quality, contact with social agencies, parents’ mental health, and number of siblings, when combined into one ‘Disadvantage Scale’, were strongly associated with the presence of psychiatric disturbance in the injured child. Significantly more children in the brain injury group received deviant behaviour ratings compared to the controls on the teacher questionnaire.

In summary, nearly two thirds of children who sustained penetrating brain injury demonstrated psychiatric disturbance as measured by parent interview and teacher ratings. There was also a strong association between adverse environmental circumstances and psychiatric disturbance but no relationships for age at injury or injury severity. Subsequent researchers found interesting relationships between injury severity and psychosocial outcome using a prospective design.

A carefully constructed prospective, longitudinal study of children’s TBI was designed and implemented by Rutter, Chadwick, Shaffer, & Brown (1980). Three groups of children were examined for cognitive deficits (Chadwick, Rutter, Brown, Shaffer, & Traub, 1981; Chadwick, Rutter, Shaffer, & Shrout, 1981) and psychiatric sequelae (Brown, Chadwick, Shaffer, Rutter, & Traub, 1981) following TBI. Children who had
been admitted to neurosurgical units and experienced post-traumatic amnesia (PTA) of at least seven days were labelled as the "severe head injury" group. This group was compared to a control group of 28 children matched for age and gender who had sustained orthopaedic injuries. A third group of 29 children who sustained head injuries with an associated PTA of greater than one hour but less than seven days was labelled the "mild head injury" group.

Estimates of the children's premorbid behaviour, emotions, and family relationships were ascertained through semi-structured interviews conducted with the parents immediately after the accident (Brown et al., 1981). The initial interview also allowed for a systematic appraisal of family functioning before and after the child's injury. Parents completed the Conners' Parental Questionnaire (CPQ) and each child's developmental, medical, and school history were also recorded at that time. Subsequent psychiatric evaluations, consisting of a clinical interview and a parent questionnaire took place at four months, one year, and approximately two years post-injury. The children's teachers were also asked to complete behaviour rating scales reflecting pre-injury behaviour and behaviour at one year and approximately two years after the injury. Cognitive functioning was also assessed at each evaluation (Chadwick et al., 1981a, b). At the final follow-up, children in the severe group also underwent a neurological examination.

Psychiatric status was initially rated by a non-medical interviewer according to a three-point scale (0 = no disorder; 1 = trivial or dubious disorder; 2 = definite, socially handicapping psychiatric disorder) and then rated again by a psychiatrist. Complete agreement between the two raters occurred for 80% of the cases when using the three-point scale and increased to 90% if a dichotomous disorder/no disorder criterion was used. The investigators determined that the children in the mild head injury group had a higher rate of pre-injury behavioural disturbance than the orthopaedic control group. However, this difference did not increase over time and was non-existent at the two year follow-up, owing partly to an increase in control group behaviour disturbance.
The severe head injury group demonstrated a similar rate of behaviour disturbance to the orthopaedic control group before the injury. After the accident however, and in contrast to the children who sustained 'mild' injuries, the rate of behaviour disturbance for the children in the severe group was significantly increased. The rate of behaviour disturbance in children with severe injuries was two to three times that of the control group at four month follow-up and remained elevated at each subsequent evaluation.

Similar but less robust findings were elicited from the parents' and teachers' behaviour ratings. The smaller differences found when using the behavioural measures were attributed by the authors to two potential methodological confounds. The teachers may have underestimated behaviour disturbances by using a more deviant behaviour group as a reference point in making rating decisions. In addition, both the parent and teacher rating forms were thought to cover a narrower range of behaviour difficulties and might not be as sensitive to subtle behaviour changes as the comprehensive interview. According to both groups' ratings, hyperactivity rates did not change over time for either the mild or the severe group, but the mild group had the greatest level of hyperactivity pre-injury.

No difference was found between the mild head injury group and the orthopaedic control group in the rates of new behaviour problems post-injury. In contrast, approximately half of the children in the severe head injury group, two to three times more than in either the mild or orthopaedic control group, developed new psychiatric problems. No relationship was found between age at injury, gender, or physical disability and the development of psychiatric disorders. A dose-response association was apparent between duration of PTA and the presence of behaviour disorders, and to a lesser extent between psychiatric disturbance and each of neurological abnormality and intellectual impairment. Interestingly, significant behaviour disorders were also observed in children who sustained severe head injuries but who evidenced no frank neurological abnormalities and in children without intellectual impairment.

New psychiatric disorders were also found most frequently among those children
in the severe group whose families had high scores on a psychosocial adversity index. There was also an association between pre-injury behaviour problems and the development of psychiatric disturbance following severe head injury. Given the heterogeneous relationships amongst mediating variables, the authors suggested that the relationship between brain injury and psychiatric sequelae may operate through both direct and indirect mechanisms. These authors noted that this finding differed from the consistently direct effect of brain injury on cognitive functioning (Chadwick et al., 1981a).

To better understand the expression of brain-injury induced psychiatric disorders, the researchers also examined the specific types of new disturbances manifested amongst injured children to identify any patterns or distinctions. Amongst severely injured children who developed psychiatric disorders post-injury, psychiatric disturbances most frequently manifested as social disinhibition and socially inappropriate behaviour. In addition, none of the children in the comparison group received a 'disinhibited state' diagnosis. Other severely injured children were assigned a diagnosis of emotional, mixed, conduct, or psychotic disorder but none was labelled hyperkinetic.

In summary, the children who sustained mild head injury (as assessed by PTA < 7 days) evidenced higher rates of pre-injury behaviour problems than children in an orthopaedic control group or children who experienced severe injuries (PTA ≥ 7 days). Children in the severe group displayed more psychiatric problems beginning at four months and at each assessment point throughout the two-year follow-up. The authors concluded that severe, but not mild, brain injury results in increased prevalence of psychiatric disorders. Support for a direct and causal link between brain injury and psychiatric sequelae was suggested by moderate relationships between three indices of cerebral dysfunction (duration of PTA, neurological abnormalities, intellectual impairment) and the rate of psychiatric disorder. Evidence for the influence of indirect factors in the eventual demonstration of psychiatric problems was generated from the associations between psychiatric disturbance and both pre-injury behaviour problems and adverse psychosocial environment. The only discernable pattern of disturbance was of
increased problems with social disinhibition in the severe group.

Fletcher, Ewing-Cobbs, Miner, Levin, & Eisenberg (1990) designed a study to assess the longitudinal behavioural adjustment of children with TBI. These authors used comprehensive estimates of injury severity, well-standardized measures of behaviour and adaptation, and they screened subjects for a variety of pre-injury, potentially confounding variables. Forty-five children, aged three to 15, were selected from the in-patient cases of two urban hospital neurosurgery services. Subjects were excluded from the study on the basis of previous head injury, acquired or congenital CNS insults (e.g., epilepsy, tumor), previous psychological disorder or service need, and evident developmental disability (e.g., learning disability, attention deficit disorder, mental retardation). Severity ratings incorporated Glasgow Coma Scale (GCS) scores (range = 3 to 18), duration of impaired consciousness (LOC), and neuroimaging (CT scan) findings.

A rating of mild severity was given to children who sustained a LOC of < 20 minutes together with no evidence of mass lesion, brain swelling, or skull fracture, and a GCS score of ≥13 with no subsequent deterioration. Moderate injury was defined as GCS scores of 9-12 (or 13-15 in the presence of skull fracture), mass lesion, or indication of specific brain injury. Children in the severe group had GCS scores between 3 and 8. After the resolution of PTA (as assessed using the Children’s Orientation and Amnesia Test), children were administered neuropsychological testing and parents completed the behavioural ratings with instructions to reflect on pre-injury behaviour. Follow-up assessments also occurred six and 12 months after the initial assessment.

The children’s scores on behavioural measures for each assessment period were analyzed using a repeated measures MANOVA. The Vineland Adaptive Behavior Scales (VABS) composite score (reflecting overall adaptive behaviour) revealed a significant decline from the baseline assessment (thought to measure pre-injury behaviour) to each of the follow-up assessments for the severely injured group only. The scores for the mild and moderate groups did not differ significantly over time or when compared to each other. A similar pattern was evident for the communication, daily living, and socialization
domain scores. In contrast, all scores on the CBCL (i.e., Internalizing and Externalizing factors; Social Competency scales: Activities, Social, and School) fell within average limits for each of the three severity groups. Analysis revealed that the children in the severely injured group engaged in fewer activities and had a higher frequency of school problems. No group differences were noted on the Internalizing, Externalizing, or Social scales. No significant differences were found between groups of younger children (younger than 7 years) and older children (older than 7 years) on VABS or CBCL scores.

There were small but nonsignificant correlations between neuropsychological measures and the behaviour measures but there was a stronger relationship between each of these and consciousness ratings. The duration of impaired consciousness correlated significantly with the VABS composite score at six and at 12 months. Similarly, there was a significant correlation between length of coma and performance on memory tests at the one year follow-up.

In summary, severely injured children obtained significantly poorer adaptive scores on the VABS than the mild and moderately injured children. They also had more school problems and were less socially active according to scores on the CBCL. Fletcher et al. (1990) proposed that the lack of significant post-injury behaviour problems detected through assessment with the CBCL was due to reduced instrument sensitivity. Specifically, they suggested that parents may have been more forthcoming about difficulties during the nondirective VABS interview format than during a forced-choice response rating scale. Further, they noted a lack of brain injury specific items on the CBCL. An informal analysis of the types of concerns reported by parents yielded a range of psychosocial disturbances including withdrawal, hyperactivity, and aggression.

Taken together with the results of Brown et al. (1981), these authors highlighted the combined absence of findings linking mild injury with deleterious behavioural sequelae. Before comparing the studies it must be noted that most children classified as moderately injured by the criteria used in Fletcher et al. (1990) would have been grouped in the mild injury group according to the Brown et al. (1981) severity criteria. Brown et
al. showed significant pre-injury behaviour problems amongst children who sustained ‘mild’ injuries together with no change in disorders post-injury. When Fletcher et al. excluded children with pre-existing behaviour problems from the study, they also found no evidence of novel psychosocial problems amongst children with mild or moderate injuries (a comparable severity rating to that of Brown et al. (1981)).

Asarnow, Satz, Light, Lewis, and Neumann (1991) called attention to the heterogeneity of extant studies and suggested that methodological alterations could more rigorously test the hypothesis that brain injury results directly in psychosocial impairment. They attempted to overcome three perceived methodological limitations: 1) by excluding children with premorbid psychosocial problems, prior CNS damage, or significant developmental delay; 2) by evaluating children at least one year after injury to avoid transient sequelae; and 3) through the use of well-standardized behaviour measures (i.e., CBCL).

Children aged 4 to 11 who sustained medically documented closed head injuries were included in the study if they had a resolution of PTA at least one year before testing, had adequate use of at least one hand, had no gross hearing or vision deficits, and had a minimum level of cognitive functioning at the time of the assessment (at least 30 months on the Kaufman Assessment Battery for Children (K-ABC)). Children were included in the mild injury group (n=10) if they experienced concussive symptoms and some period of PTA following the injury but no coma. Children assigned to the severe injury group (n=11) experienced a coma of at least nine days’ duration. Retrospective descriptions of behaviour, medical problems, development, and school problems were obtained by interviewing the children’s primary caregivers. Parents who were most knowledgeable about children’s current levels of functioning completed the CBCL and survey form of the VABS. Children’s scores (internalizing, externalizing, and total behaviour problems from the CBCL; socialization, communication, daily living skills, and adaptive behaviour composite) were analyzed with respect to expected base rates of disorder in the general population.
Rates of behaviour problems significantly exceeded the expected base rate of 10% for children with mild and severe injuries on each of the CBCL broad band scales as well as for the total behaviour problems score. There was no difference between the mild and severe groups. The children in the severe group only had lower than expected adaptive behaviour levels on all four measures of the VABS. There was also a significant difference between the proportion of children with moderate VABS domain impairment for the severe and mild injury groups.

Thus, Asarnow et al. (1991) documented increased psychosocial problems in children with mild and severe brain injury one year following the resolution of PTA. Children in the severe group also had significant problems with adaptive functioning compared to the normative sample and to the mild injury group. These results are consistent with previous research in demonstrating significant psychosocial and adaptive behaviour problems following severe brain injury. Also congruent with previous research (e.g., Fletcher et al. (1990)), children with mild injuries did not evidence adaptive behaviour problems. However, in contrast to the findings of Fletcher et al. (1990) and Brown et al. (1981) children who sustained mild injuries also demonstrated significant and new psychosocial problems.

Donders (1992) attempted to clarify the existing controversy regarding pre-injury behaviour problems and risk factors amongst children who sustain TBI. Children aged six to 16 who were diagnosed with a TBI including documented LOC were assigned to three severity groups according to GCS and neuroimaging findings. Mild injury (n=9) was defined as initial GCS between 13 and 15, and no evidence of mass lesion or skull fracture. Children who had GCS scores between 9 and 12 (or >12 when accompanied by mass lesion on CT scan) were classified as having sustained a moderate injury (n=16) and those who obtained initial GCS scores of three to eight had severe injury (n=60).

Donders found that significantly more children in the severe injury group had been injured as passengers in motor vehicle accidents (MVA). Relatively more children in the mild and moderate groups combined had been engaging in higher risk activities (i.e., cyclist
or pedestrian versus MVA, falls, and recreational injuries) at the time of their injuries. However, there was no difference between the low-risk and high-risk children’s CBCL scores on measures of social competence or total behaviour problems.

Donders also did not find any statistically significant differences between mild/moderate and severe groups on pre-injury scores of social competence or behaviour problems, which all fell within normal limits. There was a nonsignificant trend for more children in the mild injury group (20%) to have clinically elevated scores (i.e., scaled score >90th percentile) on the CBCL compared to the severe group (approximately 7%). To unmask any clinically interesting effects obscured by normal range global problem and competence scores, Donders analyzed the summary scales individually. He noted that while only 9 children (11%) were clinically identified using strict criteria (i.e., T scores in the clinical range for both the Total Social Competence Scale and the Total Behavior Problem scale), 18 children had clinically significant elevations on either the Internalizing or Externalizing subscales. This finding emphasizes the utility and importance of unmasking group effects to identify individual differences.

Donders’ findings of near normal premorbid adjustment levels amongst children who sustain brain injury lie in contrast to the previous work of Brown et al. (1981). The methodology discrepancies between these two studies, including the use of different severity indicators and classification protocol, as well as the use of standardized assessment materials, was thought to contribute to the disparate results obtained. It was also noted that the selected sample for Donders’ study was comprised of rehabilitation referrals which typically constitute more severe injuries than from an acute hospital setting. Nevertheless, this study showed that children who were injured in designated high-risk activities sustained mild injuries while children who were less instrumental in the circumstances of their injury were more frequently found in the severe injury group. None of the children, regardless of injury severity level, exhibited pre-injury behaviour problems beyond what would be expected in the normal population.

Pelco, Sawyer, Duffield, Priors, & Kinsella (1992) also attempted to delineate
potential relationships between pre-injury behaviour and mild closed head injuries. English-speaking children, aged 5 to 16, who were consecutively admitted to a hospital neurosurgery department were included in the study if they were admitted for >24 hours subsequent to a closed head injury and had no history of prior brain injury or neurological disorder. These children were assigned to a mild injury group (n=41) or a severe injury group (n=20) based on whether their length of impaired consciousness was shorter or longer than one hour, respectively. One comparison group was made up of children who were referred to a psychiatric clinic (n=64) and the community comparison normative data was extracted from a large epidemiological study of the CBCL.

Children’s parents and teachers completed the associated CBCL and Teacher Report Form (TRF) with instructions to note children’s behaviour during the six months preceding the injury. Parents of the psychiatric referral group were asked to complete the CBCL based on their children’s behaviour prior to their first or second psychiatric appointment. There was no significant difference on the Internalizing, Externalizing, Total Behavior Problems, and Social Competence scores between the mild and severe injury groups and both groups had significantly lower scores than the psychiatric referral group. None of the scores for the children in the brain injury groups were significantly higher than the comparable ratings in the general community sample.

In summary, Pelco et al. (1992) found no difference in premorbid behaviour problems between a group of children who sustained mild brain injury and children in the general community. The finding that children who sustain mild brain injuries are no more likely than average to have premorbid behavioural problems challenges previous research findings (e.g., Brown et al., 1981) and supports the work of Donders (1992).

Knights et al. (1991) studied 76 hospital-admitted children, aged 5 to 17 years, to investigate the relationship of brain injury severity to subsequent neuropsychological and behavioural changes. Severity classifications were made using initial GCS score, duration of coma, neuroimaging findings, and neurological signs. The mild injury group (n=32) was comprised of children who had an initial GCS score \( \geq 13 \), LOC \( \leq 20 \) minutes or no LOC
in the presence of a linear skull fracture. The moderate injury group (n=18) included children who had GCS scores between eight and 12, LOC > 20 minutes, and a CT scan or EEG finding including skull fracture with contusions, haemorrhage, or neurological findings. Children in the severe injury group (n=26) had: GCS scores of seven or less; intracranial haematoma; depressed skull fracture with neurological deficit; bruising, contusion, or brain tissue loss; subarachnoid haemorrhage; or evidence of edema on CT scan.

Children were administered a neuropsychological test battery when consciousness levels were no longer considered to be impaired (i.e., GCS = 15). Parents and teachers completed behavioural ratings using the Conners’ Parent Questionnaire (CPQ) and Conners’ Teachers Questionnaire (CTQ) at time of hospital discharge (referring to pre-injury behaviour) as well as three and nine months later. The CPQ yields eight factors of adjustment (conduct problem, anxiety, impulsive-hyperactive, learning problem, psychosomatic, perfectionism, anti-social, and muscular tension) while the CTQ produces four factors (conduct problem, inattentive-passive, tension-anxiety, and hyperactivity). Parents were also asked to complete a nonstandardized behaviour checklist one year after the injury to identify outstanding differences from premorbid behaviour.

Significant differences were found when the learning problems and impulsive-hyperactive factor scores for the severe group were compared to the mild and moderate groups but no other significant differences were evident. Consistent with previous research (e.g., Brown et al., 1981) the authors observed that the pre-injury impulsivity-hyperactivity ratings of children who sustained mild injuries was (non-significantly) higher than for children in the moderate or severe groups. One year after injury, 89% of the children in the severe group were rated as having at least one behaviour problem and 39% had three or more problems. In contrast, less than one third of the mild injury group had one behaviour problem and none of the children had three or more. It is interesting to note that within the non-standardized checklist (which also included memory, learning,
and physical problems) psychosocial problems (i.e., irritable mood, inattentive/distractible, peer problems) were represented at least once in the mild injury group, as well as in the moderate and severe groups. A relatively equal distribution of psychosocial problems was endorsed at each severity level, supporting previous research that demonstrates heterogeneous psychosocial sequelae.

In summary, Knights et al. (1991) identified increased learning problems and hyperactivity-impulsivity in severely injured children, compared to mild and moderate groups, at three months and nine months post injury. Given that many of the scales were not elevated, these authors noted that statistical analysis based on group differences often masks underlying individual psychopathology. When reviewing specific cases, the authors found that many parents’ had seemingly adapted to their children’s level of functioning and may have been more tolerant of or accustomed to behaviour, physical, and learning problems. Similarly, teachers who are used to dealing with a higher base rate of problems in a special education class may have been reluctant to classify a child as experiencing unusual impairment relative to the other children. At one year after initial testing, nearly 90% of severely injured children were experiencing at least one behaviour problem as reported by their parents compared to only 30% of the children in the mild injury group.

Michaud, Rivara, Jaffe, Fay and Dailey (1993) investigated the relationship between brain injury and subsequent placement in special education classes for behaviour disorders. All Grade One through Grade Five school children who received special education services for behaviour disorders during some part of the 1988-89 school year were identified (n=165). Students in the same school districts matched for grade, age, gender, race, and SES who were not receiving special education services served as the control group (n=191). All parents completed a questionnaire assessing the incidence of medical events that may have contributed to behaviour problems and they noted episodes of concussion or physical head trauma that resulted in loss of consciousness. Details of any such events were collected including the child’s age at injury, mechanism of injury,
number of injuries, and whether or not medical attention was sought.

Children receiving special education for behaviour disorders were 3.3 times more likely to have sustained a brain injury than the children in regular learning environments. Of the children who sustained head injuries, children with behavioural disorders were almost 9 times as likely to have been injured before age five. A wide variety of psychosocial problems were reported in 75% of the children who had sustained injuries. The most prevalent were distractibility/poor concentration, poor anger control, irritability, low frustration tolerance, aggression, anxiety, and hyperactivity. Fewer non head-injured children in the special education classrooms were described by their parents as hyperactive or aggressive compared to their classmates who sustained brain injuries. In contrast, there were no significant differences between the reported frequencies of behaviours amongst the children with and without brain injuries in the regular classroom. All of the behaviour problems described in the regular classrooms were reported with less frequency than for children in the special education classrooms.

Michaud et al. (1993) thus illustrated a significant increase in the rate of brain injury amongst behaviourally disabled children compared to their regular classroom peers. They concluded that children who sustain brain injuries, especially preschool age children, have an increased risk for behaviour disorders sufficient to warrant special educational consideration. They acknowledged that they were unable to determine the absolute risk associated with experiencing behaviour problems following a brain injury as they used a retrospective case-control design.

Recently, several research groups have attempted to more clearly specify the pattern and nature of behavioural changes following TBI. Ewing-Cobbs and her colleagues conducted a study to evaluate the potential relationship between TBI and the behavioural manifestations of Rourke's nonverbal learning disability (NLD) syndrome (Ewing-Cobbs, Fletcher, Levin, & Boudousquie, 1993, cited in Ewing-Cobbs et al., 1995). Previous research has demonstrated associations between neuropsychological performance, white matter pathology and psychosocial functioning (Rourke, 1995). Seventy-five children,
aged 5 to 15, were followed as part of a longitudinal study of recovery from pediatric TBI. Children were screened on the basis of having a pre-injury learning disability or special education need, psychiatric disorder, or non-English primary language. The mild injury group (n=14) consisted of children who had GCS scores ≥ 13 without evidence of brain injury on CT scan. Moderate injury (n=17) was defined as having GCS scores between 9 and 12, or between ≥ 13 when accompanied by positive neuroimaging findings, and the severe group was comprised of children who had GCS scores between 3 and 8 or who had LOC >24 hours.

Subjects were grouped by academic achievement patterns to emulate established learning disability subtype characteristics (Rourke, 1989). One group was comprised of children who had Wide Range Achievement Test (WRAT) Arithmetic, Spelling, and Reading scores all above 90 and a moderate or severe brain injury (group NI; n=27). Group RSA (n=9) included children who had all three WRAT scores ≤ 90. Children with arithmetic disability (group A; n=17) obtained a WRAT Arithmetic score ≤ 90 and at least one standard deviation below either Reading or Spelling scores.

There were no significant differences between the groups in terms of GCS or duration of coma, but neuroimaging data and surgical reports revealed different patterns of pathology location. Ninety percent of Group A subjects had either focal right hemisphere, bilateral pathology, or primarily diffuse injury. Seventy-seven percent of children in Group RSA had focal left hemisphere or bilateral pathology. Group NI children demonstrated a relatively even distribution of focal, bilateral, and diffuse pathology.

A repeated measures ANOVA was used to compare children’s performance on the standard domains of the VABS. The VABS Communication mean scores were significantly lower for Group RSA, possibly consistent with the focal left and bilateral injuries evident in this group. Group A children obtained significantly lower scores on the Daily Living Skills domain compared to the NI group. The scores for groups A and RSA were significantly lower than group NI on the Socialization domain and fell in the low
average to borderline range. Significantly more problem behaviours were identified amongst children in Groups A and RSA compared to Group NI children. To elucidate the nature of the behaviour disorders exhibited by the three groups, the Internalizing and Externalizing scales of the CBCL were compared by repeated measures ANOVA. A significant interaction effect was obtained in which the RSA group had significantly higher Externalizing scores than group NI. No significant differences were revealed on the Internalizing scale. There was no interaction between severity levels and group scores on the internalizing or externalizing scales of the CBCL or on the maladaptive behaviours scale of the VABS. The severely injured children obtained significantly lower scores on all of the VABS domains compared to the mild injury group. The authors concluded that the children with academic achievement patterns most closely resembling the Arithmetic learning disability subtype did not exhibit a psychosocial deficit pattern consistent with the NLD pattern described in the learning disability literature. It was noted that using arithmetic achievement scores to classifying children in this study may not have accurately identified children who exhibit the basic primary and causal underpinnings of NLD. The authors noted that the heterogeneity and complexity of TBI pathophysiology, etiology, severity, in combination with developmental variables necessitate a multivariate approach to interpreting neurobehavioural data.

Butler examined the relationships between brain injury and psychosocial functioning by using the Personality Inventory for Children - Revised (PIC-R) (Butler et al., 1997). The PIC-R is a comprehensive, empirically derived 420-item questionnaire that is completed by children’s primary caretakers. Sixteen (out of a possible 33) scales are typically used including 3 validity scales, 12 clinical scales (Achievement, Intellectual Screening, Development, Somatic Concern, Depression, Family Relations, Delinquency, Withdrawal, Anxiety, Psychosis, Hyperactivity, and Social Skills), and one general measure of psychosocial adjustment (Adjustment). This exploratory study was designed to better elucidate the patterns of psychosocial sequelae by generating psychosocial subtypes through cluster analysis.
Children, aged 6 to 16, were selected from consecutive referrals made to urban neuropsychological assessment practises on the basis of suspected cerebral dysfunction. Cases were excluded from the study if they met any of the following criteria: 1) no medical consultation following injury, 2) prior head injury, 3) prior CNS damage history or disease (e.g., tumor, epilepsy), 4) evidence of learning disability, attention-deficit hyperactivity disorder, mental retardation, or other developmental disorder, 5) premorbid psychosocial or behaviour problems, 6) evidence of educational or cultural deprivation, 7) evidence of child abuse, or 8) incomplete or invalid PIC-R profiles. Mild injury (n=36) was defined as LOC ≤ 20 minutes; no evidence of mass lesion, brain swelling, or skull fracture; and initial GCS 13 to 15 with no deterioration in level of consciousness. Cases in which children experienced a short PTA post-injury with concussive symptoms but without coma were also classified as mild. Children in the moderate group (n=55) obtained an initial GCS between nine and 12, or ≥ 13 if accompanied by indication of specific brain injury (e.g., skull fracture, mass lesion). The severe injury classification was assigned to children who had an initial GCS score of three to eight; intracranial haematoma, depressed skull fracture with neurological deficit, bruising, contusion, or loss of brain tissue; subarachnoid hemorrhage; CT findings (e.g., edema); or LOC ≥ 48 hours.

To identify similarities amongst PIC-R profile patterns, the 12 clinical scales were included in a cluster analysis technique. This methodology had been used previously in identifying psychosocial subtypes within a learning disability population (e.g., Porter & Rourke, 1985; Fuerst, Fisk, & Rourke, 1989; Fuerst, Fisk, & Rourke, 1990; Rourke & Fuerst, 1991; Fuerst & Rourke, 1993; Tsatsanis, Fuerst, & Rourke, 1997). Subjects' clinical scale scores were standardized (i.e., standard z scores replaced subjects' clinical scale scores) such that profile elevation and dispersion were eliminated. Five separate clustering methods (Ward's Minimum-Variance method; the complete linkage method; the weighted pair-group method using arithmetic averages; the unweighted pair-group method using arithmetic averages; and the more recent equal variance maximum likelihood method (EML)) were applied to the same data to assess the internal validity of the resulting
subtypes. Rand's statistic and correlation procedures were used to assess agreement between the various solutions.

Examination of the results suggested the presence of seven distinct psychosocial subtypes (i.e., groups of children who have PIC-R profiles that are similar to each other and significantly different from the profiles of children in other subtypes). The descriptive labels Normal, Cognitive Deficit, Somatic Concern, Mild Anxiety, Internalized Psychopathology, Antisocial, and Social Isolation were applied to each of the subtypes based on the major features of each profile. Correlations between the subtypes were at least .64 when the different clustering techniques were compared and the majority were at or better than .94.

Four subtypes (Cognitive Deficit, Internalized Psychopathology, Somatic Concern, and Mild Anxiety) were highly correlated with similar subtypes derived in the learning disability literature (Normal (r=.91), Internalized Psychopathology (r=.91), Somatic Concern (r=.79), and Mild Anxiety (r=.71), respectively). Compared to the learning disability sample, fewer children in the TBI group were assigned to the Cognitive Deficit and the Internalized Psychopathology subtypes.

To determine the relative severity of each psychosocial disturbance, the T scores on each of the 12 clinical scales were summed within subtypes. The ranking of degree of psychopathology from most serious to least disturbed was as follows: Internalized Psychopathology, Antisocial, Social Isolation, Somatic Concern, Mild Anxiety, Cognitive Deficit, and Normal. The severely injured children did not dominate either of the two most severely disturbed psychopathology subtypes as expected. In fact, children with severe injuries were under-represented in the Internalized and Antisocial subtypes compared to their less severely injured counterparts. Of the 13% of children who were assigned to the Social Isolation subtype, a disproportionate number of children had sustained severe injuries. The mean PIC-R profile of this subtype contained significant elevations on the scales associated with cognitive problems which may explain the increased representation of children with severe injuries.
Additional analyses were conducted to determine whether or not children with severe injuries who displayed psychosocial sequelae would demonstrate higher profile elevations within subtypes. Within the Antisocial subtype, children who sustained mild injuries obtained significantly lower mean profile elevations on the 12 clinical scales than did the moderate or severe injury groups. Mildly injured children obtained significantly higher profile elevations within the Mild Anxiety subtype compared to children who sustained moderate injuries; severely injured children fell in between the other groups. There was also a trend for children in the moderate injury group to obtain significantly higher profile elevations within the Cognitive Deficit subtype compared to severely injured children; mildly injured children fell in between the other groups.

There were significant differences between age at injury and psychosocial subtype membership for the Antisocial, Normal, and Somatic subtypes. Generally, children assigned to these subtypes were older when injured compared to children assigned to the Social Isolation, Cognitive Deficit and Mild Anxiety subtypes. Analysis of the relationship between psychosocial functioning and time since injury revealed that children who were assigned to the Social Isolation subtype exhibited significantly longer time since injury compared to the Antisocial and Normal subtypes. There were no significant differences in psychosocial membership assignment, or on individual clinical scales, in children who received a second assessment approximately one year later.

In summary, Butler et al. (1997) identified seven distinct, psychosocial subtypes amongst a group of children who sustained TBI. Three of the subtypes appeared to be unique to the TBI population whereas four subtypes overlapped with subtypes derived previously amongst children with learning disabilities. Significant relationships were found between subtype membership and 1) injury severity (severely injured children were not disproportionately assigned to the most pathological subtypes but there was a relationship between injury severity and proportional representation within one subtype), 2) age at injury (children injured at younger ages did not display worse psychosocial functioning overall but were more likely to be assigned to the Social
Isolation, Cognitive Deficit, and Mild Anxiety subtypes), and 3) length of time between injury and assessment (more time since injury had passed for children who were assigned to the Social Isolation subtype).

Of the 56% of children who displayed disturbed psychosocial functioning, children who sustained more severe injuries, and those who were injured at younger ages, were more frequently assigned to the "Social Isolation" subtype. Further, the children who were assessed at longer intervals following their injuries were more likely to be assigned to this group. Overall, children experienced psychosocial disturbances that ranged from normal to mildly disturbed in isolated areas (e.g., anxiety, intellectual or academic problems, or somatic complaints) to more severe problems including antisocial behaviour and internalized psychopathology (i.e., depression, anxiety, emotional lability, inappropriate affect, reality testing, and social isolation). Most notably, over half of the children, including those who sustained severe injuries, did not evidence serious psychopathological sequelae post-injury. In other words, a dose-response relationship was not globally supported between injury severity and the severity of psychosocial disturbance. Patterns were identified within some subtypes which suggested that within the group of children who did develop psychosocial sequelae, younger, more severely injured children were at higher risk for developing certain patterns of psychosocial functioning.

The authors acknowledged that the behavioural characteristics identified in this study were generated on the basis of parental concern which may not have been reflective of actual behaviour. Nonetheless, it is worthwhile to note that twenty-seven percent of the children with traumatic brain injuries were assigned to the Normal psychosocial subtype and a further 29% had profiles lacking in concern for psychosocial functioning (Cognitive Deficit and Somatic Concern). Thus, over half of the children, including those who sustained a severe injury, gave no cause for psychosocial concern and only mild, isolated, problems were reported for an additional 12% of the children. Only one third of the children who sustained TBI demonstrated serious psychosocial disturbances.
Given the numerous parameters that are associated with TBI, it makes clinical sense that the psychosocial sequelae are heterogeneous in presentation. This finding is also supported by the extant literature in which a wide variety of psychosocial disturbances have been reported including social disinhibition (Brown et al., 1981), both internalizing and externalizing disorders (Asarnow et al., 1991), internalized, social isolation, and antisocial (Fletcher et al., 1990), and learning problems, and impulsivity-hyperactivity (Knights et al., 1991).

CBCL & Other Neurological Problems

Carpentieri, Mulhern, Douglas, Hanna, & Fairclough (1993) studied the social and behavioural adjustment of children who were long-term brain tumor survivors using the CBCL. Significant elevations were evident on the Behavior Problems scales relative to non-clinical norms. To disentangle the general psychosocial problems experienced by children with cancer from those experienced by children who have central nervous system (CNS) involvement, scores were compared to a matched control group of children surviving non-CNS cancer. Both groups of children evidenced behaviour problems with significant elevations evident on the Somatic Complaints, Internalizing, Externalizing and on Total Problem Behaviors. However, stepwise regression analysis demonstrated a predictive relationship between abnormally increased brain volume and high risk of Internalizing, but not Externalizing problems. No statistically significant regression model could be constructed for the cancer control group. This finding lends support to the association between cerebral pathology and internalized, as opposed to externalized, behaviour disorders such as those emphasized in the Butler et al. (1997) research.

SUMMARY

The literature devoted to the assessment of pediatric TBI is virtually in its infancy compared to its adult counterpart. Investigations of the psychosocial sequelae of pediatric TBI are just beginning to accompany the more plentiful studies of physical and cognitive
outcome. Within the psychosocial domain, research efforts rarely share a common methodology which renders interpretation across studies difficult and potentially misleading. In addition, the interpretation of research findings is hindered by the heterogeneity of brain injury pathophysiology, severity taxonomy, and assessment practises. Increased use of neuroimaging techniques has contributed to the assessment and classification of injury severity in more recent studies although relationships between severity levels and psychosocial functioning remain uncertain.

From the current literature review, it is apparent that the majority of researchers have demonstrated significant psychosocial changes following severe brain injury (Asarnow et al., 1991; Barry, Taylor, Klein, & Yeates, 1996; Brown et al., 1981; Butler et al., 1997; Ewing-Cobbs et al., 1995; Fletcher et al., 1990; Green, Foster, Morris, Muir, & Morris, 1998; Knights et al., 1991; Shaffer et al., 1975). Evidence has also been generated that psychosocial changes follow mild brain injuries (e.g., Asarnow et al., 1991; Butler et al., 1997; Shaffer et al., 1975). This latter finding has been challenged by research that delineates pre-injury behaviour problems amongst these children (Brown et al., 1981; Knights et al., 1991) but this too is not a universal finding (Donders, 1992; Pelco et al., 1992).

Similarly, conflicting results have been reported when age at injury is studied. The majority of studies have found no significant differences in global psychosocial outcome based on the age at injury (Brown et al. 1981; Butler et al. 1997; Shaffer et al., 1975). Although Butler et al. (1997) observed no differences when all subjects were pooled together they identified certain age-related patterns when the children were analyzed within subtype.

Specifically, younger children were more likely to be assigned to the Social Isolation, Cognitive Deficit, and Mild Anxiety Subtypes while older children were more frequently found amongst the Antisocial, Normal, and Somatic Concern subtypes. The authors reasoned that children are more likely to experience disruptions in the social developmental tasks that are being mastered at the time of the injury. To rephrase,
preschoolers who are injured when they are attempting to master the social intricacies of forming friendships may tend to withdraw as a result of cerebral injury. On the other hand, when adolescents are injured in a time of natural struggle with authority and quest for independence, they may display more disruptive and externalizing behaviours. It is thus important to note that in some research efforts, clinically relevant individual effects of age and/or injury severity were unmasked when otherwise misleading group findings were challenged statistically (Butler et al., 1997; Donders, 1992).

Amongst the studies that concur about the existence of post-injury psychosocial disturbance, little agreement has been demonstrated in the nature and presentation of psychopathology. Knights et al. (1991) noted a relatively even frequency of parent-reported specific psychosocial problems in each of mild, moderate, and severely injured children one year post injury, in addition to increases in hyperactivity and learning problems. Both internalizing- and externalizing-spectrum disorders have been uncovered in some lines of research (Asarnow et al., 1991; Fletcher et al., 1990; Green et al., 1998; Michaud et al., 1993) while other studies have reported more specific sequelae including social disinhibition (Brown et al., 1981), anger (Barry et al., 1996), and social isolation (Fletcher et al., 1990).

Butler et al. (1997) found seven distinct patterns of psychosocial sequelae ranging from mild to severe and from withdrawal to delinquency. They highlighted a relatively consistent relationship between the Social Isolation subtype (characterized by cognitive and academic concerns, social isolation, and emotional lability) and a variety of TBI variables, suggesting that this particular pattern might be more consistent and persistent in certain injured children. Overall however, there has been a conspicuous absence in the literature of a uniform psychosocial presentation following pediatric TBI.

A wide variety of assessment protocols has been employed in the investigation of psychosocial sequelae including comprehensive and structured, child and parent interviews (Brown et al., 1981; Shaffer et al., 1975), and parent- and teacher-completed behaviour questionnaires (Brown et al., 1981; Shaffer et al., 1981). A more recent research
tendency involves the use of well-standardized measures of behaviour and adaptation (e.g., CBCL, VABS, PIC), either with or without control groups (Asarnow et al., 1991; Butler et al., 1991; Donders, 1992; Fletcher et al., 1990; Green et al., 1998; Pelco et al., 1992). Several researchers have suggested that parent interview protocols are more sensitive in identifying subtle or mild psychosocial sequelae than paper-and-pencil checklists and that the CBCL in particular is insensitive to certain TBI symptoms (Fletcher et al., 1990; Green et al., 1998).

Despite these cautions, the CBCL was the most frequently used assessment tool of the studies reviewed for the current project. The CBCL is widely used as a clinical screening inventory in pediatric and psychiatric clinics as well as for many studies of neurological disorders (e.g., Donders, 1992; Fletcher et al., 1990; Green et al., 1998). It has been translated into 55 languages and has been the subject of over 2400 research articles published prior to April 1998 (Vignoc & Achenbach, 1998). The popularity of this instrument as a clinical and research tool lies also in the relative ease and efficiency of administration and scoring.

Conclusions

Based on the current literature review three following general conclusions can be made. First, traumatic brain injury has the potential to cause psychosocial disturbance. However, it should be noted that a significant number of children, including those who sustain even severe injuries, do not develop psychosocial sequelae. Second, there is considerable heterogeneity of psychosocial outcome which appears to be influenced by a combination of a) substantial disparity in brain injury parameters (e.g., severity, location, classification), b) individual differences (e.g., pre-injury adjustment, family and social environment), and c) differences in research methodology. Third, behaviour checklists and rating scales such as the CBCL are used frequently to assess psychosocial sequelae in this population.
Rationale

Relatively few studies exist that investigate the psychosocial sequelae of pediatric TBI, and only a handful of studies focus on the CBCL, a widely used behaviour checklist. Shaffer (1995) noted that recall bias (i.e., attributing otherwise occurring behaviour problems to the injury or becoming biased by remorse or litigation) can be minimized "by using structured or semi-structured assessment procedures that require a full definition of the symptoms of interest". Butler et al. (1997) noted that although clinicians are aware that psychosocial sequelae from pediatric TBI are heterogeneous, researchers continue to assess psychosocial functioning with narrow, single, measures using statistical methods that obscure differences between individuals. They added that the application of cluster analytic techniques to a pediatric TBI sample (the first of its kind) contributed significantly to the existing body of literature. Therefore, a second application of cluster analytic techniques using a second instrument and another sample of TBI should also be beneficial.

Research studies that have used the CBCL to assess the psychosocial sequelae of TBI have generated conflicting results. Employing a cluster analytic technique with the CBCL in a pediatric brain injury population may provide support for the heterogeneity of brain injury sequelae.

With respect to excluding or including children with preexisting psychiatric or developmental disorder, Shaffer (1995) noted that the exclusion of these children limits the study population available, making the research more difficult. Further, potential interactions between preexisting behaviour problems and brain injury could be overlooked. While a certain amount of experimental control is relinquished in this case, potentially obscuring significant results, the benefits of obtaining relevant information from a 'true' clinic sample are evident from a clinical perspective. In considering methodological shortcomings of brain injury research, Shaffer also suggested that research samples should ideally be generated from multiple treatment centres within the same
geographic area to reduce ‘assignment biases’ that may exist at one centre. To this end, the data collected for the current study will be generated from both an acute rehabilitation centre and a community-based treatment centre both serving the Metro Toronto area.

Donders (1992) noted out that summary scores (e.g., Total Behavior Problems) can obscure individual patterns of difficulties (i.e., Internalizing, Externalizing). Therefore, the evaluation of profile patterns within a given measure may unmask misleading global findings (e.g., Butler et al., 1997). Therefore the purpose of this study will be to generate a reliable and valid typology of psychosocial functioning using cluster analysis techniques on the syndrome scales of the CBCL to better illuminate and describe the heterogeneous problems experienced by children post-TBI.

Butler et al. (1997) found no relationship between severity of injury and individual clinical scale elevation when all the children were assessed as a group. However, when the analyses were conducted using subtype membership significant differences emerged. Specifically, within the Antisocial subtype (one of the more severe pathologies), moderate and severely injured children had higher elevations. Also, in one of the least severe pathologies (Mild Anxiety), children with mild injuries had higher elevations. Taken together, this opposing pattern may have obscured significant results when all subject profiles were combined. Therefore, one must assess the contribution of severity level, and other brain injury parameters within subtypes.
Hypotheses

The current investigation is designed to examine the psychosocial functioning of children who sustain TBI by using the CBCL. CBCL profiles were subjected to cluster analyses, an approach which has not to this author’s knowledge occurred in the TBI literature. The current study is modelled after a similar study (Butler et al., 1997) that used the more comprehensive PIC-R. Given the results of that study and the findings from the current literature review, the following tentative hypotheses are offered for this exploratory research.

1. Subtype Generation

The major purpose of this investigation is to use cluster analysis to determine whether or not any reliable and valid subtypes of psychosocial functioning can be derived using the CBCL in a sample of children who sustained traumatic brain injuries. It is hoped that the properties of the well-standardized CBCL will facilitate this analysis and that the derivation of distinct subtypes will add to our understanding of the current research controversies.

(a) It is expected that distinct subtypes of psychosocial functioning will be derived from the current study and that some of these subtypes will match the clinical correlates of the subtypes generated by Butler et al. (1997).

(b) Given criticisms in the literature that the CBCL i) is not sensitive to subtle and/or mild psychosocial problems and neurological concern (Drotar et al., 1995; Fletcher et al., 1990) ii) may not solicit accurate or clear information from respondents (Drotar et al., 1995; Fletcher et al., 1990; Green et al., 1998); and iii) does not show sensitivity in identifying anxiety or acting-out disorders compared to the PIC-R (Green et al., 1998), the results of the present subtyping exercise are not expected to be as robust as those reported using the PIC-R. That is, relatively fewer children overall are expected to be assigned to pathological subtypes when using the CBCL.
(c) Butler et al. (1997) recovered few frankly externalized or hyperactive subtypes compared to the psychosocial subtypes generated in a learning disabled population. Taken together with other research demonstrating a lack of these disorders (Brown et al., 1981), this suggests that groups of children who experience TBI display externalizing disorders less frequently than internalizing disorders. In this study it is predicted that, more children from the group will be assigned to subtypes that are characterized by internalizing rather than externalizing disorders.

2. Age at Injury and Psychosocial Subtype

Ewing-Cobbs et al. (1995) noted that rapidly developing skills are more vulnerable to the effects of brain injury than are well developed skills. Previous studies have not identified a significant relationship between age at injury and psychosocial sequelae perhaps when subtle individual effects are masked during whole group analysis. Based on demonstrated interactions between age at injury and psychosocial subtype, Butler et al. (1997) suggested that children who sustain a TBI may experience disruption specifically in the developmental tasks at hand. For example, children who are entering school and struggling with academic novelty and the need to integrate socially may manifest problems with social isolation, anxiety and cognitive concern. On the other hand, adolescents who are in the midst of a struggle to attain independence may act out and disrupt existing relationships. In the current study it is predicted that children’s psychosocial sequelae will follow this pattern with younger children obtaining higher elevations on the Internalizing scale and two of its syndrome scales (Withdrawn and Anxious/Depressed) while older children will obtain higher scores on the Externalizing scale and its associated syndrome scales (Delinquent and Aggressive Behaviour).

3. Relationship between Injury Severity and Age of Injury

The literature suggests that when severe injuries occur early in the course of ability development, they tend to have more persistent effects on neuropsychological
abilities. Many researchers have noted that severe brain injuries have the potential to negatively affect psychosocial functioning (Asarnow et al., 1991; Barry et al., 1996; Brown et al., 1981; Butler et al., 1997; Ewing-Cobbs et al., 1995; Fletcher et al., 1990; Green et al., 1998; Knights et al., 1991; Shaffer et al., 1975). Additional research suggests that, when the heterogeneity of psychosocial presentation is considered, injuries that occur in younger children have differential psychosocial sequelae compared to their older counterparts (Butler et al., 1997). In this study, it is expected that there will be a significant relationship between age at injury and psychosocial functioning. Specifically, it is predicted that younger, more severely injured children will be differentially represented in the psychosocial subtypes.
CHAPTER II

METHOD

Subjects

Prospective subjects were selected from consecutive patients admitted to an adolescent acquired brain injury unit at an acute rehabilitation centre in a large urban city and from the consecutive referrals to a community-based, private TBI rehabilitation clinic serving the same geographic region. Two hundred fifty-nine (259) cases were considered for inclusion in the present study. Only those subjects who sustained a "traumatic" brain injury (i.e., not cerebral vascular accident, tumor, encephalitis or other acquired brain injury) were included (n=200). Eighty-three subjects (83) were rejected because a completed Child Behavior Checklist was not available in the neuropsychology assessment file. Ten children who did not receive a confident brain injury diagnosis or classification by the criteria presented below and/or by the neuropsychological assessment report were also excluded from the sample. Subjects aged 4- to 18-years-old at the time of the assessment were considered for inclusion in the present investigation to accommodate the age range for the administration of the CBCL.

The exclusion of subjects who exhibit pre-injury psychosocial, developmental, and/or CNS disorders allows researchers to describe the psychosocial sequelae of pediatric TBI under more controlled, empirical conditions thus allowing for a more "pure" assessment of the influence of cerebral insult. To this end, subjects were also divided into two groups based on the presence or absence of the following variables: 1) history of prior brain injury or other central nervous system (CNS) pathology; 2) evidence of developmental disorder or delay (e.g., learning disability, attention-deficit disorder, mental retardation); 3) evidence of pre-injury psychosocial problems; 4) evidence of cultural or educational deprivation; and 5) evidence of child abuse. Previous research has demonstrated that premorbid risk factors such as these can affect the expression of psychosocial sequelae (Brown et al., 1981; Knights et al., 1991). Forty (40) children met one or more of these exclusion criteria. However, excluding these children entirely could
limit the ultimate generalizability of the research for practising clinicians, who work in clinical settings where children of all backgrounds sustain injuries. Where feasible, analyses were conducted both with these subjects included in the total subject pool (i.e., Included group; \( n = 103 \)) as well as excluded from the total (i.e., Excluded group; \( n = 63 \)). A subset of each of these groups, aged 12 to 18, was retained for the current analyses in an attempt to increase within sample homogeneity and to facilitate comparison with one of the predefined normative CBCL age groups.

To facilitate comparison with previous studies, severity classifications were made following previously recommended standards for retrospective coding (Winograd, Knights, & Bawden, 1984) with modifications as needed to reflect recent recommendations (American Congress of Rehabilitation Medicine (ACRM), 1993; Fletcher, Ewing-Cobbs, Francis, & Levin, 1995). Injury severity was classified on the basis of initial GCS scores, duration of LOC, and neuroimaging data where available. Mild injuries were defined as LOC \( \leq 30 \) minutes with: a) no evidence of mass lesion, brain swelling, or skull fracture; b) lowest GCS scores of 13 to 15; and c) no deterioration in consciousness. In cases where no coma was evident but a history of post-concussive symptoms and a short period of PTA (\(< 24 \) hours) were documented, the injury was also classified as mild (ACRM, 1993). Moderate injury was defined as a lowest GCS score between nine and 12 or \( \geq 13 \) when accompanied by skull fracture, mass lesion, or other indication of specific brain injury. Severe injuries included children with: a) lowest GCS score between three and eight, or between nine and 12 with motor scale score below six for more than 24 hours; b) intracranial haematoma; c) depressed skull fracture with neurological deficit, bruising, contusion, or loss of brain tissue; d) subarachnoid hemorrhage; e) CT findings such as edema, or f) duration of impaired consciousness (i.e., GCS motor score \(< 6 \)) for more than 24 hours.

The gender, injury etiology and injury severity for the Included group are presented in Table 1. Fifty-seven (62%) of the subjects in the Included group were male and 35 (38%) were female which falls within the reported male:female injury frequency
ratios. The mean age at assessment was 15.3 (SD = 1.7) and the mean time since injury was 0.92 years (SD = 1.89). Seventy-two percent of the included subject group were from the Acute rehabilitation setting and 28% of the subjects were from the Community sample. While it has been reported that most traumatic brain injuries are classified as "mild" (Ewing-Cobbs et al., 1995; Fletcher & Taylor, 1995; Kraus, 1995), the majority of children in the current sample experienced a "severe" brain injury (71%). This bias may reflect the fact that data were collected from rehabilitation settings that are more likely to serve children who have experienced more severe injuries. Three quarters of the subject group (75%) were injured in motor vehicle accidents, either as drivers (8%), passengers (30%), pedestrians (25%), or cyclists (12%), which is consistent with etiological research for this age cohort.

The means (with standard deviations in parentheses) for Wechsler Intelligence test scores were Full Scale IQ 88.78 (12.22), Verbal IQ 91.61 (13.37), and Performance IQ 87.70 (13.14). Taken as a group, the children's scores on the CBCL did not indicate psychosocial problems (i.e., where normalized T scores ≥ 65 may indicate dysfunction: Total T Score M = 57.73 (SD = 11.93); Internalizing T Score M = 56.88 (SD = 12.52); Externalizing T Score M = 55.14 (SD = 10.26).
<table>
<thead>
<tr>
<th>Etiology</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>TOTAL</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA-driver</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>(7.6%)</td>
</tr>
<tr>
<td>MVA - pass</td>
<td>2</td>
<td>7</td>
<td>19</td>
<td>28</td>
<td>(30%)</td>
</tr>
<tr>
<td>MVA - ped</td>
<td>2</td>
<td>6</td>
<td>15</td>
<td>23</td>
<td>(25%)</td>
</tr>
<tr>
<td>MVA - bicycle</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>11</td>
<td>(12%)</td>
</tr>
<tr>
<td>Assault</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>(6.5%)</td>
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<tr>
<td>Fall</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>(3%)</td>
</tr>
<tr>
<td>Other TBI</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>14</td>
<td>(15%)</td>
</tr>
</tbody>
</table>

| TOTAL            | 7    | 20       | 65     | 92    |
| (percentage)     | (7.6%) | (21.7%) | (70.6%)|

Table 1. Etiology and Severity for children in the Included group (n = 92)
Measures

The Child Behavior Checklist (Achenbach, 1991; Achenbach & Elderbrock, 1983) is a widely used, standardized psychological instrument used to assess the competencies and problems of children and adolescents aged 4 to 18. Parents or other caregivers are asked to complete a behaviour problems inventory and a seven-part social competency checklist (not used for the current study). The behaviour inventory consists of 113 specific statements for which respondents are asked to choose “0: not true”, “1: somewhat or sometimes true”, or “2: very true or often true” with respect to the past six months. Eight syndrome scales are generated (i.e., Aggressive Behavior, Attention Problems, Delinquent Behavior, Social Problems, Somatic Complaints, Thought Problems, Anxious/Depressed, and Withdrawn) (see Table 2). Scores on the Withdrawn, Anxious-Depressed, and Somatic Complaints syndromes contribute to the overall Internalizing summary score while scores on the Aggressive and Delinquent syndromes comprise the Externalizing summary score.

Raw scores are converted to standard \( T \) scores which can be compared to normative data drawn from a sample of 2,368 “nonreferred” children (i.e., the “normative” sample). These normalized \( T \) scores were assigned to the distribution of raw scores on each syndrome scale, separately for children 4 to 11 and 12 to 18. The CBCL was designed primarily to detect clinically deviant behaviour rather than to differentiate amongst subtle behaviour problems at the low end of the normal range. To this end, low scores were truncated at \( T = 50 \) to represent scores obtained by half or fewer of the normative sample (e.g., the Aggressive Behavior scale for boys assigns \( T = 50 \) to raw scores 0 to 7). A normalized \( T \) score less than 67 (<95th percentile) is considered to be within the normal range. \( T \) scores between 67 and 70 fall in the designated borderline-clinical range, and \( T \) scores above 70 (>98th percentile) represent the clinical range. In addition, each raw score is converted to a clinical \( T \) score which represents the placement of that score with respect to a matched sample of 1,818 children who had been referred for behavioural/emotional problems (i.e., the “clinical” sample). These clinical \( T \) scores
were not truncated at the lower ranges of behaviour problems and were therefore used in
the current data analysis to preserve the differentiation among low normal raw scores.

Achenbach (1993) also reported six empirically derived taxonomic profiles that
were developed from a cluster analysis of CBCL profile types within a sample of 1912
12 to 18-year old clinically referred children. The analysis was limited to profiles that had
total problem scores ≥ 30. The profile types were labelled according to peak elevations as
follows: Withdrawn, Somatic, Social, Delinquent-Aggressive, Social-Attention, and
Delinquent. These six profile types are presented in Figures 1 through 6. It should be
noted that these profile types are defined by clinical $T$ scores such that a $T$ score of 50
reflects the mean score obtained on a syndrome by all children in the clinical sample.
Clinical $T$ scores that are below 50 in this sample would be above average in a sample of
nonreferred children.
Syndrome  
**WITHDRAWN**
- Would rather be alone than with others
- Refuses to talk
- Secretive, keeps things to self
- Shy or timid
- Stares blankly
- Sulks a lot
- Underactive, slow moving, or lacks energy
- Unhappy, sad, or depressed
- Withdrawn, doesn’t get involved with others

**SOMATIC**
- Feels dizzy
- Overtired
- Physical problems without known medical cause:
  a) Aches or pains (not headaches)
  b) Headaches
  c) Nausea, feels sick
  d) Problems with eyes¹
  e) Rashes or other skin problems
  f) Stomachaches or cramps
  g) Vomiting, throwing up

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**Table 2.** The Eight syndrome scales from the CBCL and the associated items

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¹ Rater asked to describe symptom or behaviour further and assigned score is determined on this basis; e.g., if behaviour is noted twice, only most specific is scored
ANXIOUS/

DEPRESSED
Complains of loneliness
Cries a lot
Fears he/she might think or do something bad
Feels he/she has to be perfect
Feels or complains that no one loves him/her
Feels others are out to get him/her
Feels worthless or inferior
Nervous, highstrung or tense
Too fearful or anxious
Feels too guilty
Self-conscious or easily embarrassed
Suspicious
Unhappy, sad, or depressed
Worries

SOCIAL
Acts too young for his/her age
Cling to adults or too dependent
Doesn’t get along with other kids
Gets teased a lot
Not liked by other kids
Overweight
Poorly coordinated or clumsy
Prefers being with younger kids

Table 2. The Eight syndrome scales from the CBCL and the associated items (cont’d)
THOUGHT PROBLEMS
Can’t get his/her mind off certain thoughts; obsessions
Hears sounds or voices that aren’t there
Repeats certain acts over and over: compulsions
Sees things that aren’t there
Stares blankly
Strange behavior
Strange ideas

ATTENTION
Acts too young for his/her age
Can’t concentrate, can’t pay attention for long
Can’t sit still, restless, or hyperactive
Confused or seems to be in a fog
Day-dreams a lot or gets lost in his/her thoughts
Impulsive or acts without thinking
Nervous, high strung, or tense
Nervous movements or twitching
Poor school work
Poorly coordinated or clumsy
Stares blankly

DELINQUENT BEHAVIOUR
Doesn’t seem to feel guilty after misbehaving
Hangs around with others who get in trouble
Lying or cheating
Runs away from home

Table 2. The Eight syndrome scales from the CBCL and the associated items (cont’d)
Sets fires
Steals at home
Steals outside the home
Swearing or obscene language
Thinks about sex too much
Truancy, skips school
Uses alcohol or drugs for nonmedical purposes
Vandalism

**AGGRESSIVE BEHAVIOR**

Argues a lot
Bragging, boasting
Cruelty, bullying, or meanness to others
Destroys his/her own things
Destroys things belonging to his/her family or others
Disobedient at home
Disobedient at school
Easily jealous
Gets in many fights
Physically attacks people
Screams a lot
Showing off or clowning
Stubborn, sullen, or irritable
Sudden changes in mood or feelings
Talks too much

Table 2. The Eight syndrome scales from the CBCL and the associated items
(cont'd)
Teases a lot
Temper tantrums or hot temper
Thinks about sex too much
Unusually loud

Table 2. The Eight syndrome scales from the CBCL and the associated items (cont'd)
CBCL WITHDRAWN Profile

Figure 1. Centroids of CBCL Withdrawn Profile Type
CBCL SOMATIC Profile

Figure 2. Centroids of CBCL Somatic Profile Type
Figure 3. Centroids of CBCL Social Profile Type
CBCL DEL-AGG Profile

Figure 4. Centroids of CBCL Delinquent-Aggressive Profile Type
Figure 5.  Centroids of CBCL Social-Attention Profile Type
CBCL DELINQUENT Profile

![Graph showing clinical T scores for different behaviors and syndromes.]

CBCL syndrome

Figure 6. Centroids of CBCL Delinquent Profile Type
Data Analysis

Following the method outlined by Fuerst (1991), children's scores on the 8 syndrome scale scores of the CBCL (i.e., Withdrawn, Somatic Complaints, Anxious-Depressed, Social Problems, Thought Problems, Attention Problems, Delinquent Behavior, Aggressive Behavior) were subjected to cluster analyses. Individual profile elevation and dispersion were eliminated by converting the clinical T scores to standard (z) scores within subjects (i.e., \( z = \frac{X - \mu}{SD} \); \( X \) = subject's T score; \( \mu \) = mean of that subject's profile; \( SD \) = standard deviation of that subject's profile).

Outliers were detected using the density-based methodology and SAS program developed by Fuerst (1991). Briefly, the Euclidean distance between one subject and each of the other subjects in the sample was calculated. Each subject was given a running frequency count of the number of next closest subjects that fell within a spherical distance of a predetermined radius. Subjects with low frequency counts were designated as outliers as they were presumably located in low density regions of the sample. The number of outliers removed from the data depended upon the density of the sample and the optimum performance of the hierarchical clustering techniques (see Fuerst 1991 for a complete description of rationale and procedure.)

The objective of cluster analysis is to group subjects into maximally homogenous groups or "clusters" while simultaneously maximizing the differences between the groups that are formed. The cluster generation procedure employed in the current research was based on the methodology reported in Fuerst (1991) with modifications to allow for the techniques available within the SPSS Base 9.0 software. Subjects' standardized T scores were clustered using five hierarchical clustering techniques (i.e., Ward's, Average Linkage (Within Groups), Median, Complete, and Centroid). The number of clusters retained from the various solutions was determined by the internal reliability of the solution (see below), predictions from prior research, and the clinical interpretability of the CBCL profiles at various partition levels (i.e., from two to ten clusters).
One disadvantage of using hierarchical techniques to generate clusters is that once a subject has been added to a cluster the subject cannot be reassigned to a better grouping later in the analysis. To address this potential problem, both hierarchical and non-hierarchical (i.e., k-means) clustering techniques were employed together in a complementary manner (Sharma, 1996). That is, to allow for the potential reassignment of subjects, each hierarchical solution was subjected to a k-means relocation pass. Essentially, the mean profile scores generated from the hierarchical solutions were used as "seeds" in subsequent k-means analyses to refine the assignment of subjects to clusters.

Cluster analysis research is exploratory by nature and particular emphasis must be placed on generating reliable and valid solutions. The reliability of the subtypes that are generated by any one technique must be evaluated by replicating the solution, either across different samples or across different clustering techniques, and/or by validating the subtypes against an existing external taxonomy (see Fuerst et al., 1989 for a more detailed discussion.) The agreement between solutions generated in the present study (i.e., internal reliability) was determined by i) assessing subject assignment to clusters across different hierarchical methods by using cross-tabulation tables, and ii) evaluating the similarity of the resulting CBCL profile shapes by calculating correlations between the mean profile scores generated by each of the methods.

To determine whether or not the subtypes generated in the current study were meaningful with respect to what is known from the literature about children's psychosocial functioning following TBI (i.e., external validity), reliable solutions were compared to the TBI subtypes generated using a different questionnaire (i.e., PIC-R, Butler et al., 1997). Further, the CBCL profile subtypes generated in the current study were also evaluated with respect to an existing CBCL profile taxonomy that was derived from a large sample of children who had been referred for behavioural and/or emotional problems (Achenbach, 1993). For these comparisons, the children’s clinical T scores were used to facilitate a direct comparison with the published CBCL taxonomy which
was derived using the clinical sample. The similarity between the CBCL profile shapes and those generated from the clinically referred sample was assessed by calculating and comparing correlations between the mean clinical $T$ scores on the eight syndrome scales.
CHAPTER III:

RESULTS

The five hierarchical techniques were run with variations in number of outliers removed, changes in similarity/distance measures, number of clusters retained (i.e., from 2 to 10), and inclusion of subjects with premorbid emotional and/or behavioural problems. Various cluster analysis solutions held promise and were clinically interesting but they were not replicable using enough of the hierarchical techniques to be considered reliable. The cluster analysis method, as originally outlined, was rejected and, instead, Q-Factor analysis was employed in the manner described below. Unfortunately, condensing the subject group by eliminating cases that met the exclusionary criteria did not alter the results sufficiently to justify the significant reduction in sample size. For the remainder of the analyses children were not excluded from the sample on the basis of premorbid characteristics.

Using the method for outlier detection as outlined above, 7 subjects (8%) were identified as outliers and excluded from further analyses. To determine whether or not the TBI sample as a whole demonstrated significant psychosocial problems, mean normalized T scores were plotted for the group and compared with normative data provided by Achenbach (1991). The profiles for Achenbach's non-referred and referred sample groups are displayed in Figure 7 together with the mean profile for the current research group. The mean syndrome scale scores for the current TBI sample fell directly between the non-referred and clinically referred children with the exception of the Somatic Problems scale which matched that of the referred children (see Figure 7).
TBI Sample Mean Profile
compared with CBCL normative and clinical samples

Figure 7. Mean profile scores for all subjects compared with CBCL norms
Subtype Identification

To identify subtypes in the subject sample, the data was subjected to a Q-type factor analysis. The matrix of CBCL clinical T syndrome scores was transposed and product-moment correlations were calculated across subjects. This correlation matrix was factored using principal component analysis. Orthogonal rotation to a varimax criterion was applied to emerging factors which yielded eigenvalues greater than the following ratio: number of subjects/number of measures (i.e., 85 subjects/8 syndrome scales = 10.625). To enhance the assignment of subjects to subtypes, one additional factor (eigenvalue = 10.142) was retained and rotated orthogonally, but not retained in subsequent analyses.

Four factors accounting for 77% of the common variance were identified. In other words, the results indicated that the sample was comprised of four distinct groups of children that differed from one another with regard to psychosocial functioning. Upon inspection of the data, the mean Somatic Problems syndrome score appeared to be uniformly high across profiles. Q-factor analysis was repeated without the Somatic Problems scale in an attempt to increase subtype differentiation. Although the elimination of the Somatic Problems syndrome scale changed subject assignment slightly, there were no appreciable differences between the resulting mean clinical T-score profiles and the inclusion of the variable was not considered to detract from the final solution.

Subjects with at least one factor loading $\geq 0.50$, and with an interval $\geq 0.1$ between their highest and the next highest loading, were retained for further analysis. Subjects with negative loadings were not assigned. The groups then represented subtypes within the sample. Of the 85 subjects, 64 (75%) met the criteria for assignment to subtypes and were divided into groups according to the factor on which they loaded most highly.
Of the remaining 21 subjects, 17 failed to exhibit a factor loading ≥ 0.50 and 4 did not demonstrate sufficiently different factor loadings to be assigned to only one factor. Subject assignment can be summarized as follows:

Subtype 1: 32 subjects (50 % of those assigned)
Subtype 2: 14 subjects (22 % of those assigned)
Subtype 3: 10 subjects (16 % of those assigned)
Subtype 4: 8 subjects (12 % of those assigned)

Subjects’ mean normalized T scores on the 8 CBCL syndromes were calculated and are plotted for each subtype. To review, the normalized T scores are based on a sample of non-referred sample of children. T scores ≥ 65 are questioned as clinically significant and T scores above 70 are more clearly in the clinical range. The corresponding profiles are plotted in Figures 8 through 11. To facilitate further discussion, the subtypes were labelled according to the most prominent features associated with each profile pattern. The four subtypes were thus characterized as Normal, Attention, Delinquent and Withdrawn-Somatic.

The mean normalized T scores within each subtype were also obtained to provide an indication of overall profile elevation for each psychosocial subtype. The mean subtype elevations in ascending order (i.e., from least to greatest psychopathology) were: Normal - 53.88, Delinquent - 58.49, Withdrawn-Somatic - 58.74, and Attention - 60.28. A one-way ANOVA with psychosocial subtype as the independent variable and mean normalized T score as the dependent variable was statistically significant (F (2, 60) = 9.24, p = .000). Post-hoc comparisons using Tukey’s HSD method revealed that the overall elevation for the Normal subtype was significantly lower than the overall elevations of the remaining subtypes. No significant differences were identified amongst the three higher subtype elevations.

The mean profile elevations for each of the CBCL empirically derived profile
types were calculated to indicate their overall severity level. This results in the following rank-order of the profile types from least to greatest psychopathology: DELINQUENT, WITHDRAWN, SOMATIC, SOCIAL-ATTENTION, DELINQUENT-AGGRESSIVE, SOCIAL. For comparison purposes, the mean clinical $T$ scores for these six CBCL profile types are presented together with the mean clinical $T$ elevations for the four derived TBI subtypes as shown in Table 3.

Comparison of TBI Subtypes with CBCL Profile Types

The mean CBCL syndrome scores for each of the subtypes obtained in the current study were compared to the mean CBCL syndrome scores for a) a large sample of non-referred boys and girls ($n = 1164$) (Achenbach, 1991); b) a large sample of clinically referred children ($n = 959$) Achenbach (1991); and c) the 7 empirically derived subtypes derived by Achenbach (1993) through cluster analysis.

It should be reiterated that the comparisons between the four subtypes derived in the current research and Achenbach’s various profile types were made on the basis of correlations between mean clinical $T$ scores. The clinical $T$ scores were derived in relation to a large clinical sample and indicate the degree to which children’s scores deviate from those of clinically referred peers. Thus, the relative elevations on each of the TBI subtype syndromes appear lower than when the same subtypes are plotted using normalized $T$ scores.

Subsequent to visual matching, the correlations between the mean CBCL profile scores for each of the subtypes generated in the current study and the mean profile scores for Achenbach’s (1993) seven taxonomic profiles were generated. The mean clinical $T$ scores of the children assigned to the Normal subtype did not correlate strikingly with any of the existing CBCL profiles but were closest to the CBCL SOMATIC subtype ($r = .695$) (see Figure 12). For descriptive purposes, this profile was given the label “Normal” reflecting its lower overall elevation and reduced dispersion compared to other factors. However, the correlations between this Normal group and the CBCL non-referred girls
and boys groups are not high and in fact are not even positive ($r = -.503$ and $r = -.364$ respectively).

The Withdrawn-Somatic subtype from the current study matched well with Achenbach's CBCL WITHDRAWN subtype ($r = .703$) and also with Achenbach's CBCL SOMATIC subtype ($r = .777$). The mean profiles for these comparison profiles are plotted in Figure 13 and Figure 14. The Delinquent subtype from the current study correlated well with Achenbach's DELINQUENT profile pattern ($r = .827$) (see Figure 15). Finally, the Attention profile was somewhat unique. The relative peak on Attention and lower scores on the Delinquent and Aggressive scales make it a reasonable match with Achenbach's SOCIAL-ATTENTION profile. However, there is an elevation on Somatic Problems in the TBI sample, rather than Social Problems in the Achenbach sample, which explains its positive, but less robust, correlation with this subtype ($r = .457$). These two profiles are plotted in Figure 16.

The proportional assignment of subjects to each of these subtypes cannot be directly compared to the subtypes generated by Butler et al. (1997) because two different instruments were used. However, the categorical descriptions of the profiles suggest that roughly equal numbers of subjects (i.e., approximately half of the assigned subjects) were assigned to a "normal" subtype with the next most prominent behaviour category being Internalizing problems (see Table 4 below). While Butler did not detect any subtypes that were characterized predominantly by externalizing behaviour, approximately 16% of the current TBI sample were assigned to a "delinquent" subtype.
Figure 8.  Mean Normalized T-scores for Subtype 1 (Normal)
Figure 9. Mean Normalized T-scores for Subtype 2 (Attention)
Figure 10. Mean Normalized T-scores for Subtype 3 (Delinquent)
Figure 11. Mean Normalized T-scores for Subtype 4 (Withdrawn-Somatic)
<table>
<thead>
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<th>Subtype</th>
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<th>Profile Type</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
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<td>1. DELINQ</td>
<td>44.23</td>
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<td>4. Attention</td>
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<td>5. DEL-AGG</td>
<td></td>
<td>5. DEL-AGG</td>
<td>48.87</td>
</tr>
<tr>
<td>6. SOCIAL</td>
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<td>53.80</td>
</tr>
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</table>

Table 3. Mean Profile Elevations (Clinical T scores) for TBI subtypes derived in current study and CBCL profile types
Figure 12. Mean Profile T Scores for TBI Normal subtype and CBCL SOMATIC profile ($r = .695$)
Subtype 4 WITHDRAWN-SOMATIC
compared with CBCL WITHDRAWN  $r = .703$

Figure 13. Mean Profile T Scores for TBI "Withdrawn-Somatic" subtype and
CBCL WITHDRAWN profile ($r = .703$)
Subtype 4 WITHDRAWN-SOMATIC
compared with CBCL SOMATIC $r = .777$

Figure 14. Mean Profile T Scores for TBI “Withdrawn-Somatic” subtype and CBCL SOMATIC profile ($r = .777$)
Subtype 3 DELINQUENT
compared with CBCL DELINQUENT  $r = .827$

Figure 15. Mean Profile T Scores for TBI "Delinquent" subtype and CBCL DELINQUENT profile ($r = .827$)
Subtype 2 ATTENTION
compared with CBCL SOCIAL-ATTENTION  r = .457

Figure 16. Mean Profile T Scores for TBI “Attention” subtype and CBCL SOCIAL-ATTENTION profile (r = .457)
| 'Normal' | Internalizing | | Externalizing | |
|----------|--------------|-------------|---------------|
| Butler et al. (1997) | Normal 27% | Mild Anxiety 12% | | |
| | Cognitive 17% | Somatic Concern 12% |  |
| | | Social Isolation 13% | |
| | | Antisocial 11% | |
| | | Internalized-Psychopathology 7% | |
| TOTAL | 44% | | 56% | 0% |

<table>
<thead>
<tr>
<th>Current Study</th>
<th>Normal 50%</th>
<th>Attention 22%</th>
<th>Delinquent 16%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Withdrawn-Somatic 12%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>50%</td>
<td></td>
<td>34%</td>
</tr>
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</table>

Table 4. Percentages of Subjects Assigned to Butler et al. (1997) Subtypes and CBCL Subtypes Derived in the current TBI sample
Subtype Membership and Injury Severity

Frequency cross-tabulations for subtype membership and injury severity categories were calculated and compared. The mild and moderate TBI groups were collapsed into one Mild-Moderate group for comparison purposes. Figure 17 shows the percentage of subjects who experienced Mild/Moderate or Severe injuries as assigned to each of the four subtypes. The results of a chi-square test comparing injury severity and subtype membership could not be validly interpreted because greater than 20% of the cells had expected frequencies of less than five. Visual inspection of Figure 17, however, reveals that half (52%) of the children who sustained severe injuries were assigned to the Normal psychosocial subtype. The next most frequent subtype for the severely injured children was Attention, followed by Withdrawn-Somatic. The fewest severely injured children were assigned to the Delinquent subtype. Similarly, nearly half (44.4%) of the children in the Mild-Moderate group were assigned to the Normal psychosocial subtype. The next most frequently assigned were the Delinquent and Attention subtypes. The fewest children in the Mild/Moderate group were assigned to the Withdrawn-Somatic subtype.
Subtype Membership by Injury Severity

![Bar chart showing subtype membership by injury severity.]

Figure 17. Subtype Membership and Injury Severity
**Subtype Membership and Age at Injury**

It was hypothesized that there would be a significant interaction between age at injury and psychosocial subtype. Unfortunately, there were not enough CBCL profiles available in the sample to construct two separate age groups to replicate the divisions of Butler et al. (1997). Instead, the 12 to 18 year-olds were divided into three groups on the basis of when they were injured: before age 12, between age 12 and 15, and after age 15. Table 5 shows the percentage of subjects who were assigned to each of the four subtypes as a function of the age at which they were injured. The results of a chi-square test comparing injury severity and subtype membership could not be validly interpreted because greater than 20% of the cells had expected frequencies of less than five. However, visual inspection of Table 5, suggests that age at injury was somewhat influential in subtype assignment. That is, none of the children who were injured before age 12 were assigned to the Normal subtype. In contrast, the majority of the 12 to 15 year old group and nearly half of the children who were injured after age 15 were assigned to the Normal subtype. Although the overall sample size is too small to make a reliable inference, it is interesting to note that three of the five children who were injured before age 12 were assigned to the Attention subtype (i.e., 60%) whereas only 25% or fewer of the other age groups were assigned to this subtype.
### Age at Injury and Psychosocial Subtype

<table>
<thead>
<tr>
<th>Subtype</th>
<th>&lt; age 12</th>
<th>age 12 to 15</th>
<th>&gt; age 15</th>
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<tr>
<td>Normal</td>
<td>0 (0%)</td>
<td>20 (64.5%)</td>
<td>12 (42.9%)</td>
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<tr>
<td>Attention</td>
<td>3 (60%)</td>
<td>4 (12.9%)</td>
<td>7 (25.0%)</td>
</tr>
<tr>
<td>Delinquent</td>
<td>1 (20%)</td>
<td>2 (6.5%)</td>
<td>7 (25%)</td>
</tr>
<tr>
<td>Withdrawn-Somatic</td>
<td>1 (20%)</td>
<td>5 (16.1%)</td>
<td>2 (7.1%)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>5 (100%)</td>
<td>31 (100%)</td>
<td>28 (100%)</td>
</tr>
</tbody>
</table>

**Table 5.** Percentage of subjects assigned to subtypes by Age at Injury
CHAPTER IV
DISCUSSION

The present study was designed to identify distinct patterns of psychosocial functioning in children who have experienced traumatic brain injury. The major goal was to uncover subtypes of psychosocial functioning by subjecting CBCL scores to cluster analyses. Following an established methodology that has uncovered reliable and valid subtypes of psychosocial functioning amongst children who have been diagnosed with a learning disability (Rourke & Fuerst, 1991), the current research was the second study of this kind to focus on the emotional and behavioral changes that follow traumatic brain injury.

It was predicted that: a) several reliable subtypes of psychosocial functioning would be identified in a new TBI sample; b) at least some of these subtypes would be similar to the PIC-R subtypes identified by Butler et al. (1997); c) children would predominantly be assigned to Internalized subtypes. However, it was anticipated that the subtypes would not be as robust or exhaustive as those obtained with the PIC-R given the CBCL’s relative insensitivity to mild psychosocial dysfunction. The subtypes derived in the current study were further evaluated in terms of external validity by comparing them to an existing CBCL taxonomy. Lastly, the potential contributions of injury severity and age at injury to psychosocial subtype assignment were assessed.

Typology Characteristics

Overall, the mean normalized T scores on all CBCL syndromes for the children in the current TBI sample were higher than those obtained by non-referred children, but were lower than the mean scores obtained by children in a clinical sample. In other words, while these children were reported by their parents to exhibit more behaviour problems than parents of non-referred children, they did not, as a group, exhibit frankly pathological psychosocial functioning. The exception to this finding was that children in the current study obtained a mean normalized T score on the Somatic Concern syndrome that
paralleled that of the clinical sample. Given that TBI itself is a physical injury and that children who sustain TBI typically also sustain other bodily injuries, it is not unusual to find this elevation. In fact, the CBCL has been criticized (see below) for ambiguity and confusion in rating the somatic problems of children who have sustained actual physical injury.

Four distinct clusters or subtypes were derived using a Q-factor analysis, labelled Normal, Attention, Delinquent, and Withdrawn-Somatic, which allowed for a more specific description of these children in terms of heterogeneous patterns of psychosocial functioning. Three-quarters of the children in the research study were assigned to one of these four subtypes. The overall severity level of the subtypes derived in the current study indicated that the children assigned to the Normal group had significantly lower overall profile elevation compared to the other three subtypes. When compared to the severity levels of the Achenbach (1993) empirically derived profile types, the overall elevations of the TBI subtypes from the current study fell at the lower end of the severity range.

No relationships were found between the subtype to which children were assigned and the severity of their brain injuries. Over half of the severely injured children displayed adequate psychosocial functioning. This finding supports the assertion by Butler et al. (1997) that injury severity does not directly affect the presence or absence of psychosocial problems. Age at injury did not statistically influence subtype assignment but the small sample size precluded a thorough analysis of this variable.

**External Validity**

Interestingly, the TBI subtypes derived in the current study matched well with four subtypes also derived by Q-factor analysis in the early psychosocial typology research on children with learning disabilities. Porter and Rourke (1985) reported that a sample of children with learning disabilities could be assigned to one of four distinct psychosocial subtypes: Normal (44% of assigned subjects); Somatic Concern (13% of
assigned subjects); Externalized (17% of assigned subjects) and Internalized (26% of assigned subjects). This allocation of subjects to subtypes is similar, both in terms of proportion of subjects assigned and in subtype characteristics, to the distribution of subjects to the subtypes in the current research.

Three of the TBI subtypes derived in the current research (i.e., Normal, Attention, Withdrawn-Somatic) reflected the same general psychosocial functioning patterns and proportions that were evident in the Butler et al. (1997) TBI psychosocial typology. That is, nearly half of all children in both studies, including those who were severely injured, were assigned to a subtype with adequate psychosocial functioning. Further, the next most frequent set of psychosocial attributes in both TBI samples were reflective of internalized problems. In other words, when children did exhibit psychosocial problems subsequent to TBI they were mostly problems of isolation, somatic complaints, depression, and anxiety rather than delinquent or aggressive problems. The Delinquent subtype in the current study did not match any of Butler's seven TBI subtypes.

Other researchers have identified so-called externalized behaviour among children who have sustained TBI (e.g., Asarnow et al., 1991; Fletcher et al., 1990; Green et al., 1998). The presence of one “externalizing” subtype in the present study may emphasize and confirm the heterogeneous nature of psychosocial sequelae of TBI. It may also reflect an increase in risky, high-energy premorbid behaviour that has been linked to children who sustain traumatic brain injuries (Brown et al., 1991; Knights et al., 1991). Children in the current study were not excluded on the basis of pre-morbid psychosocial problems as they were in the Butler et al. (1997) study and no formal assessments of pre-injury behaviour were obtained. Therefore this issue cannot be addressed within the design of the current study.

With respect to an existing CBCL taxonomy, the Delinquent and Withdrawn-Somatic subtypes derived from the current research appeared to match well with existing CBCL Profile types in terms of both profile shape (as measured by correlation of mean syndrome scores) and overall profile elevation (as suggested by overall profile mean).
According to Achenbach (1991), isolated elevations on the Delinquent syndrome represent a developmentally variable set of behaviours that are not as stable as the more trait-like behaviours associated with an elevated score on the Aggressive Problems syndrome. Children's scores on the CBCL Delinquent syndrome are correlated with Antisocial and Conduct Problems on the Connors Parent Questionnaire ($r = .77$ and $.72$ respectively) and with the Socialized Aggression and Conduct Disorder scales of the Quay-Peterson Revised Behavior Problem Checklist (BPC) ($r = .59$ and $.73$ respectively). Few correlates of the CBCL profile types have been published (Achenbach 1993). When examining information gathered from other sources, Achenbach reported that children who matched the DELINQUENT Profile type were also judged by teachers and parents to be less competent, less academically successful, less adaptive, and less happy as compared to their peers. These children also obtained high scores on school behaviour problems, police contacts, and total disturbance on the Achenbach Teacher Report Form (TRF) (Achenbach, 1993).

The Withheld-Somatic subtype derived in the current study appeared to be a combination of two similarly named Achenbach (1993) Profile types. Children's scores on the CBCL Withdrawn syndrome correlate $r = .66$ with scores on the Anxiety-Withdrawal subscale of the BPC. Achenbach (1993) reported that the characteristics of the CBCL Withdrawal syndrome most closely approximate the Avoidant Disorder categories in the Diagnostic and Statistical Manual of Mental Disorders (DSM) series. He further described scores on this syndrome as relatively stable characteristics and reported a strong negative association with the development of aggressive behaviour.

Comments and Limitations

It must be emphasized that the CBCL is a parent-response questionnaire and as such can only provide one individual's perception of a child's behaviour. It should be kept in mind that the scores obtained by this method of information gathering may not accurately reflect the actual behaviour or emotions of the child. The CBCL and other
similar informant-based inventories are well-researched and normed and allow researchers to formulate opinions about patterns of children’s behaviour. It is incumbent upon clinicians to combine information obtained from this primarily research-oriented questionnaire with information from other sources, including from the children themselves, to obtain the most meaningful and reliable assessment of behaviour and emotional functioning. Achenbach (1991) endorses a cross-informant system of assessment which includes information from parents or caregivers, teachers, and the children themselves.

The CBCL has been criticized for an inability to describe and distinguish amongst subtle behaviour and emotional problems. This reduced sensitivity may have influenced the current findings and contributed to the delineation of fewer subtypes overall compared to similar research conducted with the PIC-R. Further, several of the items on the questionnaire itself are ambiguous (e.g., physical symptoms) and have the potential to be misinterpreted by the informants. In addition, certain subjectivity is inevitable in item scoring. For example, scorers are asked to judge whether or not the respondent understood the intent of several questions and must change the scores accordingly. With respect to traumatic brain injury assessments specifically and acute behaviour changes in general, there can be confusion regarding the time period to be covered by the questionnaire. Without close supervision, parents’ responses to the activity and behaviour problems questions sometimes oscillate between descriptions of pre- and post-injury behaviour.

No effort was made in the current investigation to determine how time since injury might have affected psychosocial membership. The majority of the final TBI sample in the current study was obtained from an acute rehabilitation setting where children were evaluated relatively soon after a TBI. Similarly, it was not feasible to conduct age at injury analyses using the current sample. A broader sample of children, including more younger children, and more children who had been injured many years before, would be preferred.
Summary and Future Directions

The current investigation identified four distinct psychosocial subtypes in a group of 12- to 18-year-old children who had sustained a traumatic brain injury of varying severity levels. External validity was demonstrated by comparing the obtained subtypes to existing taxonomies. These findings support the theoretical construct of heterogeneous psychosocial functioning following TBI. The practical implications of this research include a better awareness amongst clinicians about the patterns of psychosocial functioning potentially exhibited by children who sustain TBI. The majority of children exhibited "normal" psychosocial functioning as assessed using the CBCL. However, it must be emphasized that this questionnaire is not sensitive to subtle behaviour problems and no consideration was made for changes in psychosocial functioning over time. Furthermore, the sample was restricted to children aged 12 to 18. Careful examination of the potential influence of age at injury, and time since injury are important considerations for future research.
REFERENCES


Susan Hayman-Abello (née Hayman) was born on January 9, 1968 in London, Ontario. She completed a B. Sc. (Honours) degree in Psychology at Queen's University in Kingston (1990). Susan completed a Diploma in Child Study (Assessment and Counselling) at the University of Toronto (1994) and worked as a psychometrist at the Center for Traumatic Brain Injury Rehabilitation for three years. Susan is currently a candidate for a Master’s degree in Clinical Neuropsychology at the University of Windsor where she hopes to complete her doctoral degree.