A Neuropsychological Study of Primary School-Aged Children with a History of Maltreatment

A research thesis submitted to the School of Social Sciences and Psychology, Faculty of Arts, Education and Human Development, Victoria University

In partial fulfilment of the degree of Doctor of Psychology
(Clinical Neuropsychology)

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Abstract

This study examined the cognitive functioning of a group of primary school-aged children with a history of maltreatment. Neuroimaging research has documented changes in the structure and function of the developing brain in children exposed to early trauma. There is also some evidence that these neural changes are reflected in changes to learning capacity, particularly observed in lower scores on standard intelligence tests and poor educational outcomes. The current study utilized a neuropsychological framework to assess a range of cognitive domains including intelligence, verbal and visual-motor skills, attention, executive functioning and memory. Twenty-eight children with a history of maltreatment were recruited through Take Two therapeutic service and Berry Street Home Based Care Services in Victoria, Australia, and compared to a control group of 28 children with no maltreatment history. Ages ranged between 6 and 11 years, and the groups were matched for gender and socio-economic status. Groups were compared on variables measuring general intelligence, verbal and perceptual reasoning, attentional and executive capacities, working memory, and verbal and non-verbal recall. Consistent with hypotheses, the study found significantly reduced functioning in the maltreated group in overall intelligence and verbal comprehension. A reduction in perceptual reasoning abilities was also found, contrary to predictions. Maltreated subjects performed more poorly on a task involving divided attention, and were rated on showing a greater level of executive dysfunction in everyday tasks. Finally, reduced verbal working memory and verbal immediate recall was observed in the maltreated groups. These findings may have significant implications for education, home adjustment and therapeutic strategies with maltreated children.

<u>Doctor of Psychology Declaration</u>

I, Helen Schirmer, declare that the Doctor of Psychology (Clinical Neuropsychology) thesis entitled "A Neuropsychological Study of Primary-School Aged Children with a History of Maltreatment" is no more than 40,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. The thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature:

Date:

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Tables and Figures

Neuropsychological Framework

There is growing evidence that maltreatment in childhood may result in changes in brain development, and in a higher risk of poor achievement in educational settings. This study investigated the cognitive development of a group of primary-school-aged children who had been placed in protective care due to experiences of maltreatment. A neuropsychological assessment framework was used to investigate the children's cognitive functioning in comparison to age norms and to a control group of non-maltreated peers.

At the foundation of this study is the principle that a child's cognitive abilities develop through an interaction between the brain and the environment, a process summarized by Bernstein (2000) under the three broad headings of context, brain and development. In this formulation, "context" refers to the social and environmental factors providing stimulus to the developing brain, including many of the factors directly or indirectly related to maltreatment. "Brain" represents an emerging biological system which may follow a typical course of development, but may also take an atypical course as a result of genetic endowment or injury. "Development" emerges from an interaction between the former factors, and may be considered as the child's observable cognitive and behavioural capacities. This last construct is not static, but a description of a process of change through the early part of the lifespan (Bernstein, 2000).

Defining and Measuring Maltreatment

Veltman and Browne (2001) noted that researchers have struggled to operationalize the various dimensions of maltreatment, including the nature, frequency, and severity of abusive experiences. One of the challenges in this is that the "events" of physical and sexual abuse typically occur within the context of a harmful relationship between caregiver and child, which in Glaser's (2000) definition may incorporate aspects of emotional abuse or neglect. Cicchetti, Lynch & Manly (2003) note that almost all forms of abuse result in negative psychological or emotional consequences for victims, suggesting that other forms of abuse might be considered emotionally abusive as well. However, emotional abuse can also occur without overt physical or sexual assaults on the child.

The most broadly used subtypes of abuse are sexual abuse, physical abuse emotional/psychological abuse and neglect; the Maltreatment Classification System

which has become more commonly used in research divides neglect into 'failure to provide', 'lack of supervision', and 'moral/educational neglect' (Barnett, Manly, & Cicchetti, 1993). Manly (2005) noted that when compared to the Maltreatment Classification System and the United States National Incidence Survey, child protective services reports tended to underrate the occurrence of emotional abuse, and to report single rather than multi-type abuse more frequently. It was also noted that children with unsubstantiated reports often have similar outcomes to those cases that are substantiated with investigation (Manly, 2005).

Higgins (2004) argues that efforts to study specific forms of abuse in isolation may result in misleading findings, as multiple forms of maltreatment frequently co-occur in a family unit. It is suggested that "multi-type child maltreatment" is more common than instances of abuse that are relatively circumscribed, and that a child's outcome could be better predicted by the overall extent and chronicity of negative or abusive events than by classifying them into a particular sub-type of abuse (Higgins, 2004). Case reports of maltreatment taken at one point in time are likely to underestimate the number of maltreatment types the child has been exposed to, while a more historical perspective may produce a more accurate picture of the child's overall maltreatment profile (Kinard, 2004).

Manly (2005) notes that researchers are still struggling to find the best way to analyse the variance associated with specific subtypes of maltreatment in cases where multiple forms are present. A single "pure" subtype research focus is argued to be inappropriate; there are limitations to considering maltreatment as a unitary concept. It is argued that where subtypes are thought to have similar effects on child outcomes, they can be treated as a unitary construct, but that analysis of different combinations of subtypes may yield better prediction of outcomes in some cases (Manly, 2005).

Beyond the type of abuse, other factors in a child's developmental context are frequently confounded with maltreatment. Manly (2005) notes that research definitions are broadening to investigate dimensions of maltreatment beyond subtype. These dimensions include the severity of abuse, the timing of onset, and the chronicity of maltreatment experiences (Manly, 2005).

The Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) is a consortium of research studies drawing on data collected by the United States National Data

Archive on Child Abuse and Neglect (NDACAN). The project collected data from five sites in the United States, involving more than 1300 children. Studies utilizing the data have considered aspects of maltreatment including severity, chronicity and maltreatment type, and their relationship to outcome.

Using the LONGSCAN data, Litrownik et. al. (2005) examined the predictive validity of severity as a dimension of maltreatment associated with behavioural outcomes. Utilizing the Maltreatment Classification System, they devised four different measures of severity, including the maximum severity by type of abuse, overall maximum, the total severity summed across types, and the mean severity. The study found that the best predictors of behavioural outcomes were the scores looking at maximum severity by type, in which the severity of each subtype of abuse was examined. However, all definitions were found to have some association with internalizing and externalizing behaviour scores. The conclusion argued that severity scores were most predictive when preserved within the specific domain of maltreatment, rather than averaged or combined into a total severity score (Litrownik et al., 2005).

English, Graham, Litrownik, Everson and Bangdiwala (2005) considered the impact of maltreatment chronicity on child outcomes. They developed definitions of chronicity based exclusively on frequency, along with categorical systems which rated abuse in five categories ranging from 'situational' to 'extended continuous', over periods of time defined either as developmental periods (e.g. infancy, toddlerhood) or calendar years. It was found that both frequency and the developmental definition of chronicity were associated with poorer externalizing behaviour outcomes, and all three definitions were associated with increased trauma symptoms. However, it was noted that the effects of chronicity as a predictor of childhood outcomes was small, and that different definitions tended to account for different aspects of outcome (English, Graham, Litrownik, Everson, & Bangdiwala, 2005).

Kinard (2004) attempted to integrate a number of dimensions of maltreatment in predicting the behavioural adjustment of maltreated schoolchildren. Dimensions considered included the type, severity, frequency and chronicity, and pattern of maltreatment, as well as age at first report, relationship to perpetrator, and the presence of multiple maltreatment types. It was found that in this study, frequency, chronicity and age at first report were highly correlated. These factors were also highly correlated with multiple maltreatment types (Kinard, 2004).

The study found no consistent pattern between overall maltreatment characteristics and child behaviour ratings, but significant relationships within specific subtypes of maltreatment. It was found that having a non-relative perpetrator and more severe physical abuse were the only significant predictors of maternal ratings of behavioural outcome. Teacher ratings of behavioural outcome were predicted by severity of physical abuse, greater frequency of abuse, and less severe moral/educational neglect. Child self reports of mood/affective changes were most consistently predicted by more severe failure-to-provide type neglect. The conclusion argued that type and severity of abuse are often highly correlated, and that the co-linearity between different dimensions of maltreatment may confound results when focussing on a specific dimension (Kinard, 2004).

Context

Rates of maltreatment in the state of Victoria, Australia

The Australian Institute of Health and Welfare (AIHW) (2006) reports that more than 11,000 child protection notifications were investigated in the state of Victoria, Australia in the 2004/05 financial year. Of the finalized investigations, 64% (or a total number of 7,398 cases) were substantiated. The data collected by the AIHW in the five years prior to 2006 indicate that around 7000 substantiated abuse cases were reported in Victoria every year. In 1999-2000, 33% of all notifications related to cases of neglect, with 32% reflecting emotional abuse, 24% physical abuse, and 11% sexual abuse (Victorian Department of Human Services, 2002). However, the AIHW (2006) report indicated that the majority of substantiated cases of maltreatment in 2004/05 were classified as emotional abuse (approximately 40%), with physical abuse and neglect each representing around 25% of substantiated cases.

Through the Department of Human Services, the Victorian Government produced a strategic plan to improve child protection services in 2002 (Victorian Department of Human Services, 2002). This report provided additional information on the characteristics of children and families involved in the Victorian child protection system in 1999-2000. Some characteristics relevant to this study include:

- Children aged between five and nine years represented 28% of cases where abuse or neglect was substantiated. This corresponds to a prevalence of 6 cases per 1000 children in that age group.

- 63% of parents depended on some form of pension or benefit for their income (41% on sole parent pension); a further 14% were in receipt of a low salary or wage.
- 73% of parents involved in child protection matters had at least one child maltreatment risk factor documented. These included:
  - 19% had a psychiatric disability, 3% had an intellectual disability, and 4% had a physical disability
  - 52% had experienced some form of family violence
  - 31% reporting alcohol abuse, and 33% reporting substance abuse
- Of the total number of notifications (not substantiated cases), 5.4% related to indigenous children and families, although this group represents only 0.9% of the under 18 population in Victoria. Substance abuse, alcohol abuse, and family violence were more commonly reported amongst indigenous parents when compared with non-indigenous parents.

The review also included an audit of children in out of home care. This review found that males and indigenous children were over-represented in this population, in comparison with general population proportions. It was also noted that there was a high ratio of children with aggressive/violent behaviour, mental health problems, disability, and contact with juvenile justice living in residential care. It was also noted that a significant number were likely to display risk behaviours such as drug use, suicide attempts or violent behaviour at some point during their placement in residential care (Victorian Department of Human Services, 2002)

Social context of maltreatment: poverty & neighbourhood effects

One of the recurring criticisms of early research into child abuse and neglect was that it was frequently confounded with low socio-economic status. In the past twenty years, research has focussed more closely on the relationship between poverty and child maltreatment. Research in the United States has also broadened to consider other socio-demographic factors such as race/ethnicity which are associated with both poverty and maltreatment, in efforts to identify risk factors for maltreatment.

Trickett, Aber, Carlson and Cicchetti (1991) identified the issue of socio-economic status as a core factor associated with both causes and effects of child abuse. Integrating data from two studies, they compared 58 four to eight year-old children with a history of maltreatment to seventy-three controls from the same age group.

The study demonstrated that socio-economic status interacted with abuse in predicting family characteristics, cognitive maturity, and behaviour problems. The researchers argued that while socio-economic status was associated with maltreatment, the children at risk came from poor homes with an emotional environment characterised by low expressed affection and a lack of encouragement. They also argued that the cognitive and behavioural effects of maltreatment could not be explained by socio-demographic factors alone (Trickett, Aber, Carlson, & Cicchetti, 1991).

Baumrind (1994) explored the social context of maltreatment in more depth. She argued that impoverished families were more exposed to scrutiny by government agencies, and therefore more vulnerable to official reports of abuse and neglect. However, she also noted that the association between poverty and abuse was not entirely a social construct or "reporting risk". Studies were cited in which socio-economic status was controlled for, and a significant relationship found between the extent of absolute poverty, and the incidence and severity of abuse (Baumrind, 1994).

Coulton & Korbin (1995) used census-based data to further explore the community level factors associated with child maltreatment. They noted that poverty at the individual level (within a single family unit) was generally associated with a diverse range of neighbourhood characteristics, including isolation from broader society, and a lack of resources within the neighbourhood. In addition, they argued that abusive or neglectful families within these resource-impoverished communities may be further impoverished in their social networks, for example lacking kinship or ethnic community ties (Coulton & Korbin, 1995).

There is evidence that the incidence of substantiated child maltreatment is unevenly distributed across neighbourhoods (Coulton, Korbin, & Su, 1999). In a United States study which stratified neighbourhood by race, dominant ethnicity and level of child care burden, parents of children under the age of eighteen were interviewed from each of the neighbourhoods selected. It was found that neighbourhood impoverishment, child care burden, and instability of population were weakly but significantly associated with the incidence of child maltreatment within a neighbourhood (Coulton et al., 1999).

A review of the literature on neighbourhood characteristics associated with child maltreatment reveals a relatively consistent pattern of factors (Freisthler, Bruce, & Needell, 2007). Rates of maltreatment were found to be consistently associated with neighbourhood poverty, housing stress (for example, more transient populations) and increased availability of alcohol and other drugs. Other factors that may have impacted on child maltreatment rates included unemployment rates and level of childcare burden, but these findings were less consistent across studies (Freisthler et al., 2007).

Social context of maltreatment: drug and alcohol use

As noted above, at least 30% of parents involved in child protection in the state of Victoria had a history of either alcohol or substance abuse as a risk factor (VDHS, 2002). Substance use may impact on a person's capacity to perform parental duties in a range of ways. For example, regular intoxication may need to neglect of a child's needs, or financial hardship due to the cost of acquiring substances. It may also result in disinhibited or aggressive behaviour that culminates in physical or sexual assault. Finally, children living in homes where illegal substances are used may be at greater risk of exposure to or involvement in criminal activity.

Young, Boles and Otero (2007) note that child welfare services in the United States have not systematically monitored the number of notifications where prenatal or post-natal substance abuse may be a factor in abuse or neglect. They reported that one study found that in investigated cases where children were not removed from care, 11.1% of parents were found to have substance dependence. However, they pointed out that this study did not consider the DSM-IV category of substance abuse (as opposed to dependence), and may have potentially missed cases where parents had some form of problematic substance use (Young, Boles, & Otero, 2007). In cases where children were removed from care, studies indicated that parental substance abuse was present in between 43 and 79% of all cases (Young et al., 2007).

Ammerman, Kolko, Kirisci, Blackson, and Dawes (1999) gave a questionnaire looking at child abuse potential to parents with and without a history of substance use disorder. The questionnaire found that parents with a current disorder showed elevated scores on the scale, and that there was no significant difference between past and present substance users. The study also found that parents with a partner with a substance use disorder history reported higher abuse potential, regardless of

their own histories of substance use (Ammerman, Kolko, Kirisci, Blackson, & Dawes, 1993).

A study of 117 foster care children between the ages of three and six considered the impact of maternal and paternal drug use on maltreatment and foster placement transitions (Smith, Johnson, Pears, Fisher, & DeGarmo, 2007). The study found that both maternal and paternal prenatal drug and alcohol use was associated with the child's reported maltreatment history, incorporating frequency of sexual and physical abuse, and measures of neglect including failure to provide adequate food and shelter, and lack of appropriate supervision. In addition, prenatal maternal substance use and postnatal paternal drug and alcohol use was found to be associated with a high number of placement transitions, which may be indicative of multiple notifications or poor child outcomes.

Substance abuse has also been specifically associated with neglectful parenting style (Dunn et al., 2002). Substance abusing mothers are noted to have many characteristics including a history of neglect in childhood, high impulsivity, difficulties with bonding, and higher risk of psychopathology, which may make them vulnerable to becoming neglectful of their own children. It is also noted that children of substance abusers are more likely to have difficult temperaments, and to be premature or low birth weight, which may be risk factors for neglect (Dunn et al., 2002).

Prenatal exposure to drugs and alcohol may represent a specific risk to a child, and in some cases can result in notifications to child welfare being made before birth (Young et al., 2007). Prenatal alcohol exposure, for example, can result in facial dysmorphology as well as low birth weight and adverse cognitive effects (Smith et al., 2007). The effects of prenatal drug exposure, although less well researched, is suggestive of deficits in a range of physical and cognitive domains, particularly for infants and children (Smith et al., 2007). There is also some evidence that binge drinking during pregnancy may increase the risk of negative affect in infancy and childhood depression (Jacobsen & Jacobsen, 2001).

Parental substance abuse may not only increase the risk of maltreatment, but may also independently contribute to the risk of adverse adult outcomes such as depression or other symptoms of psychopathology (Melchert, 2000). One study considered 4084 children of mothers entering treatment for substance abuse or

dependence (Conners et al., 2004). The children in this sample were found to be at greater risks of hearing and visual problems, as well as asthma. Seventeen percent of the children were reported to be receiving some form of educational support, while 24% of mothers reported being contacted due to a child's behavioural problems at school. More than 50% of the children were also exposed to a range of other risk factors, including poverty, living in a single-parent household, low maternal education, minority status, and maternal mental illness (Conners et al., 2004).

It is likely that at least a significant minority of children living in out-of-home care will have a history involving parental drug or alcohol abuse. This history may have contributed to their maltreatment and placement. For some of these children, maternal prenatal substance use may directly contribute to poor cognitive outcome due to the teratogenic effects of substances on the developing brain. In addition, parental substance use may represent an independent risk factor for poor academic and social adjustment, beyond the direct effects of maltreatment.

Social context of maltreatment: domestic violence

Over half of the cases of child maltreatment reported in Victoria in 2004/5 were associated with situations where other forms of family violence were present. Violence within the family home, and being a witness to domestic violence, may be an risk factor contributing to adverse outcomes for children entering protective care (Australian Institute of Health and Welfare, 2006).

A study of over 2500 mothers of first children examined the incidence of domestic violence in the first six months after birth, and subsequent physical and psychological abuse and neglect (McGuigan & Pratt, 2001). Domestic violence was found to be present in 16% of the families assessed during the first six months of a child's life. Child maltreatment was assessed as reports of child physical or psychological abuse or instances of neglect confirmed by the state protective services during the first five years of the child's life; some form of child maltreatment was identified in 6.1% of families. It was found that the relationships between domestic violence and physical abuse, psychological abuse, and neglect were all significant, after controlling for risk factors such as parental history of abuse, substance use, mental illness, and harsh parenting style (McGuigan & Pratt, 2001).

In a United States study, Cox, Kotch and Everson (2003) focused on families of low socioeconomic status identified as being at high-risk of abuse. Interviews of 184 mothers were conducted when their children were six and eight, and children were assessed on measures of psychological and cognitive functioning as well as interviewed about being a witness to violence and their experience of support in the home. The study found that maltreatment occurred in 19% of the cases where domestic violence was present, more than twice the frequency of non-domestic violence households. Beyond domestic violence, the strongest predictors of maltreatment reports were young caregiver age, low education, and low income. It was also found that the risk of maltreatment was significantly lowered if partners in a domestic violence relationship separated; this finding did not apply to families where no domestic violence was present (Cox, Kotch, & Everson, 2003).

Renner and Slack (2006) explored domestic violence and maltreatment in the context of intergenerational transmission of violence. The study showed that childhood physical and sexual abuse and neglect were moderately correlated with adult intimate partner violence. Childhood physical abuse was also found to increase the risk of allegations of harm being made in parenthood (Renner & Slack, 2006).

The presence of intimate partner violence may have an impact on children's psychological functioning, independent of maltreatment effects. Infants as young as one year have been shown to display trauma symptoms (for example, regression or loss of skills) in response to witnessing severe domestic violence, particularly if their mothers also displayed symptoms of trauma or depression (Bogat, DeJonghe, Levendosky, Davidson, & von Eye, 2006). Another review noted evidence that children and adolescents witnessing violence in the home were more likely to display physical aggression in other contexts such as school settings, and that they may be at greater risk of depressive symptoms (Osofsky, 2003). In addition, Huth-Bocks, Levendosky, and Semel (2001) found that 3-5 year old children who had witnessed domestic violence displayed significantly poorer verbal abilities than non-witnesses, when socio-economic status and child maltreatment were controlled.

Social Context of maltreatment: mental illness

Sociodemographic data indicate that about 19% of reported cases of child maltreatment in Victoria involved parents with some form of mental illness (Victorian Department of Human Services, 2002). One adult self-report study explored the

connection between child sexual and physical abuse and parental mental illness in a general population sample (Walsh, MacMillan, & Jamieson, 2002). Participants were asked to report their childhood experiences of sexual and physical abuse, and were also asked to respond to questions about parental symptoms of depression, bipolar disorder, schizophrenia, or antisocial personality disorder. The study found that 25.1% of 8548 respondents reported some exposure to physical abuse, and 8% reported some exposure to sexual abuse. Approximately 19% of respondents reported having a parent with symptoms of mental illness, with depression the most commonly reported illness. It was found that the presence of parental depression, bipolar disorder or schizophrenia significantly increased the risk of physical or sexual abuse. However, there was a greater association between antisocial personality disorder and maltreatment than was evident for other forms of mental illness (Walsh et al., 2002).

Windham et. al. (2004) focussed on the risk of maltreatment in the first three years of life, and its association with maternal depression, partner violence, and child characteristics. The study looked at outcomes for 585 families with children considered to be at high risk for physical and emotional abuse. After considering a range of risk factors involving both parental and child characteristics, maternal depression and partner abuse were the two factors most significantly correlated with serious physical abuse of the child. The child's age and low gestational weight were also associated with physical abuse. Similar risk factors were identified for emotional abuse of the child, with maternal depression and partner abuse being the main parental risk factors (Windham et al., 2004).

The combination of depression and parental history of childhood trauma may result in a compounded risk of child maltreatment. Banyard, Williams and Siegel (2003) found support for an intergenerational transmission of child maltreatment, in which high rates of trauma exposure (particularly physical abuse) was associated with low parenting satisfaction, neglectful behaviour, harsh physical punishment, and higher risk of protective services involvement. The study found that maternal depression mediated the relationship between trauma exposure and parenting satisfaction (Banyard, Williams, & Siegel, 2003).

Mullick, Miller and Jacobsen (2001) note that parental psychiatric disorders may in some cases have a heritable component, particularly for children who experience maltreatment or other stressors in childhood. In a group of women with mental

illness who had lost custody of their children, they found that insight into illness was protective factor in decreasing the risk of negative parenting behaviour. It was also noted that psychotic illness in particular is frequently associated with poor insight, and often poorer psychosocial outcomes (Mullick, Miller, & Jacobsen, 2001).

Summary: Risk factors and the ecology of child maltreatment

Children entering the protective care system are likely to have been living within a family system with at least one stressor additional to their experiences of maltreatment. Poverty, substance abuse, domestic violence and parental mental health issues may all have an impact on the developing child, adding to the impact of child abuse or neglect. Children may carry risks including the neurobiological and psychological effects of multiple stressors, a genetic predisposition towards mental illness, and/or the effects of prenatal exposure to teratogenic substances.

The Canada Incidence Study of Reported Child Maltreatment (CIS) examined the question of cumulative risk of maltreatment related to parental risk factors (Wekerle, Wall, Leung, & Trocme, 2007). The study considered the presence or absence of risk factors including socio-economic disadvantage, a childhood history of maltreatment, intimate partner violence, substance abuse, involvement in criminal activity, mental or physical health issues, and lack of social support. The study found that the total number of caregiver vulnerabilities, rather than any specific vulnerability, provided the most accurate estimate of risk of maltreating. The strongest individual risk factor relationship was found between substance abuse and neglect; however, cumulative risks were still a more accurate predictor. Domestic violence was found to be a strong predictor of maltreatment, and to moderate the relationship between cumulative vulnerability and maltreatment (Wekerle et al., 2007).

The pattern of cumulative risk of poor outcome is also evident in the later years of childhood (Appleyard, Egeland, van Dulmen, & Sroufe, 2005). Poor outcomes have been shown to be associated with a cumulative risk model that included child maltreatment, inter-parental violence, family disruption, maternal life stress, and socio-economic disadvantage. They found that the cumulative risk was the best model for predicting internalizing and externalizing behaviours in early and middle childhood, and that early childhood risk contributed to predicting behavioural outcomes in adolescence (Appleyard et al., 2005).

Stockhammer, Salzinger, Feldman, Mojica, & Primavera (2001) suggest that poor outcomes for a maltreated child can be understood through an ecological framework of proximal and distal risks. In this framework, the most proximal risks for a child are those which involve direct victimization, with the next level involving the witnessing of violence towards caregivers or siblings. More distal risks are those which directly affect family functioning, such as substance abuse and domestic violence, and those which influence the wider social context, such as exposure to violence within the neighbourhood. The study found that physical and verbal abuse contributed significantly to the prediction of problematic internalizing and externalizing behaviours, while more distal factors such as having a family member who was a victim of violent crime added to the prediction of higher ratings of problem behaviours. In contrast, witnessing family violence, particularly sibling abuse, appeared to decrease the rate of problematic behaviour reports, possibly as violence was more normalized than if the child was the only victim within the house (Stockhammer, Salzinger, Feldman, Mojica, & Primavera, 2001).

Sidebotham (2001) argues that an ecological model provides the best framework for understanding, researching, and preventing child maltreatment. The model emphasises that maltreatment always happens within a context where multiple factors are at play, not just at the individual level, but within family systems and the wider community. By identifying these multiple factors, a greater range of avenues for intervention and prevention can be accessed by social service systems working with families at risk (Sidebotham, 2001).

Brain

The contemporary view on the impact of maltreatment on neurodevelopment implicates an over-activated stress response system in triggering a sequence of neurochemical and morphological changes in the "maltreated brain". Some of the recently conducted studies utilize magnetic resonance imaging (MRI), electroencephalograms (EEGs) or other forms of imaging technology to observe structural or functional changes in brain development in maltreated children, comparative to controls. Other findings are extrapolated from animal models of childhood maltreatment; for example, determining changes in neurotransmission after exposing animals to enforced separation and isolation early in life. It is argued that stressors such as separation early in life will produce similar effects in the brain

to the acute stressor of maltreatment in human children. Animal studies have been important in understanding many of the neurochemical effects of child maltreatment; however, it is noted that they have some limitations in modelling the more specific effects of trauma which may impact areas such as language or visual processing (Teicher, Tomoda, & Andersen, 2006).

Research focused on children with a history of maltreatment has identified changes in the brain's developmental trajectory following early stressors, including:

1. the alteration of the brain's neurochemistry, including changes in the functioning of the hypothalamic-pituitary-adrenal axis (HPA axis)
2. Alterations in psychophysiological responsivity, including alterations in event-related potentials and startle responses
3. morphological changes occurring in specific regions of the brain, including the hippocampus and corpus callosum
4. direct lesions to the brain arising from physical assault (inflicted brain injury)
5. disturbance of brain development arising secondary to disrupted attachment patterns.

Changes in HPA axis

Gilles (1999) describes the human stress response system as a complex interactive circuit, integrating feedback loops which involve cortical and subcortical structures, as well as peripheral tissues and endocrine systems within the body. She describes two pathways of stress activation: the rapid response of the sympathetic nervous system through the secretion of epinephrine and norepinephrine; and the slower-acting regulatory responses of the hypothalamic-pituitary-adrenal axis (HPA axis).

Vermetten and Bremner (2002) highlight the role of the locus coeruleus in producing and secreting norepinephrine in response to stressful events, describing it as a generalized warning system alerting the brain to the presence of a stressor. They note that the locus coeruleus has reciprocal synaptic connections with the paraventricular nucleus of the hypothalamus, as well as regions throughout the cerebral cortex, the hippocampus and amygdala, the thalamus, and various nuclei in the brainstem. The locus coeruleus-norepinephrine system is thought to show sensitization effects in response to repeated exposure to stressors, resulting in an increased behavioural and physiological response to ongoing stressors (Vermetten & Bremner, 2002). For example, there is some evidence that maltreated children with

PTSD have significantly higher levels of urinary norepinephrine and dopamine compared to children with other psychiatric conditions and healthy controls (Watts-English, Fortson, Gibler, Hooper, & DeBellis, 2006).

The hypothalamic-pituitary-adrenal axis forms the slower-response aspect of the stress response system. When the paraventricular nucleus of the medial hypothamalus is activated, there is a resultant production of corticotrophin-releasing factor (CRF), which targets receptor sites in various brain regions, most notably the locus coeruleus and the anterior pituitary. When binding at the pituitary, CRF leads to the production of adreno-corticotrophin hormone (ACTH), which acts on the adrenal cortex to promote the release of glucocorticoids (cortisol and corticosterone).

When an individual is under stress, glucocorticoids act to regulate energy utilization, and over time will also inhibit growth processes, reproductive systems and inflammatory responses. Glucocorticoids bind to feedback sites in the central nervous system, including the pituitary gland, hypothalamus, hippocampus and frontal cortex (Vermetten & Bremner, 2002). When the stress system is functioning properly, the feedback of glucocorticoids to these structures is inhibitory; that is, it suppresses further release of CRF and ACTH, restoring the stress system to its basal state.

It is noted that while basal levels of glucocorticoids have an enhancing effect on the function of the hippocampus, stress levels have the opposite effect, blunting hippocampal excitability and disrupting synaptic plasticity (Sapolsky, Romero, & Munck, 2000). There is evidence that in times of prolonged or severe stress, the effect of elevated glucocorticoid levels can significantly alter neural plasticity, particularly in the limbic system.

Salpolsky (2003) argues that hippocampal-dependent cognition, particularly the declarative memory functions associated with the hippocampus, are selectively impacted by this alteration. There is some evidence that the administration of cortisol to patients with PTSD can lower the reports of intrusive memory retrieval, possibly by inhibiting the hippocampal pathway to memory recall (de Quervain, 2006). However, it is also suggested that glucocorticoids may enhance more implicit memory functions such as autonomic and fear conditioning. This may be a result of the facilitation of amygdala-dependent cognition, with some evidence found in animal models that

stress can result in extension of processes by neurons in the amygdala (Sapolsky, 2003).

These findings have led to speculation that glucocorticoid-mediated hippocampal atrophy might be a central mechanism of post-traumatic stress disorder. However, Salpolsky (2002) notes that in some studies of PTSD, glucocorticoid levels have been found to be lower, rather than higher. In addition, there is some evidence that small hippocampi might result in impairments in glucocorticoid regulation, and that small hippocampi might therefore be a predisposing factor for later dysregulation of the stress response (Sapolsky, 2002)

Davis et. al. (2003) propose that while the HPA axis mediates the stress response in its activated state, it also plays a role in growth and development in its basal state. They note that circadian variations in baseline HPA system activity occur in adults, with peak glucocorticoid production occurring shortly after waking, and the lowest point at the onset of sleep. This pattern is not apparent in newborns; the first signs of a circadian pattern appear at 2-3 months, while adult-like patterns emerge around the ages of 4 to 5 years.

There is evidence that chronic stress exposure early in life may lead to dysregulation of the HPA axis, resulting in alterations in the levels of circulating glucocorticoids. Davis et. al. (2003) report that disruptions of care in the early mother-child relationship in animals frequently leads to higher levels of circulating glucocorticoids, and a decreased number of glucocorticoid receptors in the brain, resulting in dysregulated HPA function. Few studies have been conducted in humans, but there is evidence from children in Romanian orphanages which suggests that deprivation of care in infancy can lead to a lack of circadian fluctuations in glucocorticoids, and elevations in overall glucocorticoid levels (Eisen, Qin, Goodman, & Davis, 2002).

Further studies have examined alterations in HPA axis functioning in maltreated children of preschool and primary school ages. For example, King, Mandansky, King, Fletcher, & Brewer (2001) looked at five to seven year olds who had been sexually abused, taking morning salivary samples to determine cortisol levels. It was found that when abuse had occurred within the previous two months, levels of resting cortisol were suppressed compared to controls (King, Mandansky, King, Fletcher, & Brewer, 2001).

A more recent study examined salivary cortisol in a group of primary-school-aged maltreated children in foster care in New York (Linares et al., 2008). The children provided six samples across two days, measuring morning, afternoon and evening cortisol. Twenty-four percent of the children did not show a typical cortisol secretion pattern (decreasing morning to evening). The atypical pattern was shown to be associated with failure to protect and exposure to domestic violence, and this group also displayed a high incidence of externalizing behaviours (Linares et al., 2008).

However, these findings have not been consistent. Glaser (2000) noted that studies focusing on children did not reveal a consistent pattern of stress responsivity to trauma, with some studies indicating a blunted HPA axis response to stress, others showing no difference between maltreated children and controls, and one study indicating elevated levels of cortisol across the day (this sample had been diagnosed with post-traumatic stress disorder). Amongst the limitations in the literature, it is noted that the majority of studies conducted in maltreated children have focused on baseline cortisol levels, rather than stress responsivity of the HPA axis (Tarullo & Gunnar, 2006). DeBellis (2001) argues that there are at least three patterns of HPA dysregulation evident in maltreated children:

1. increases in morning cortisol levels and a smaller decrease between morning and afternoon level in children who were currently or recently (within six months) experiencing maltreatment

2. A compensatory down-regulation in HPA functioning in children who had been abused in the past, related to a lack of pituitary responsivity to circulating CRF

3. Within subjects meeting criteria for PTSD, evidence of high concentrations of urinary cortisol, dopamine and norepinephrine.

Tarullo and Gunnar (2006) argue that the findings may also be at least partly explained by variations in psychiatric status. For example, they note that some studies show elevations in basal cortisol levels amongst depressed maltreated children, but not amongst those who were not depressed. Similarly, elevations have been noted for children with a PTSD diagnosis, while maltreated children with externalizing disorders do not show marked differences. It is also noted that the effects of early trauma may be masked or confounded with current life stressors, or with the degree of social support available to a child (Tarullo & Gunnar, 2006).

Yehuda (2006) argues that contradictory evidence regarding cortisol levels in post-traumatic stress disorder represents an important challenge to researchers. It is argued that different aspects of HPA alteration may be associated with different elements of PTSD symptomatology, including the risk of development of this disorder. It was also noted that in spite of variations amongst studies of HPA response patterns in PTSD, the majority of findings fall within the normal range, and are therefore not considered to be clinical markers of the disorder (Yehuda, 2006).

Rothbaum and Nemeroff (1994) note that alterations in HPA functioning do not occur exclusively in cases of early maltreatment. Hyperactivity of the HPA axis, measured by increased cortisol levels and decrease numbers of glucocorticoid receptors, has frequently been noted in individuals with major depressive disorder. In addition, depressed patients frequently show increased levels of CRF in cerebro-spinal fluid (Rothbaum & Nemeroff, 1994). Rothbaum and Nemeroff (1994) also assert that pituitary response to CRF is blunted in panic disorder and PTSD, but that there is no associated chronic HPA axis activity. They document evidence that cortisol levels may be inhibited in adult patients with PTSD, with associated increases in glucocorticoid receptors.

Alterations in psychophysiological responsivity

Rothbaum and Nemeroff (1994) document a number of alterations in arousal which are characteristic of PTSD in adulthood. These include an increased eye-blink startle response; increases in cardiac, electrodermal and muscular reactions in response to traumatic-reminder stimuli; elevated tonic heart rate and blood pressure in some samples; and impairments in habituation to fear-relevant stimuli. However, they noted that children with PTSD actually showed a decreased eye-blink startle response, a contrast to adult findings (Rothbaum & Nemeroff, 1994).

Cicchetti (2002) reported on studies of startle responses in maltreated children without a diagnosis of PTSD. Boys with a history of maltreatment were found to have startle blinks of smaller amplitude and slower onset latency than the control group. This effect was particularly marked in children with a history of physical abuse.

Studies of adults abused as children have also provided evidence of alterations in regional cerebral blood flow in response to exposure to traumatic stimuli. Positron emission tomography (PET) studies of women with post-traumatic stress disorder

secondary to childhood abuse have found alterations in regional blood flow on exposure to traumatic scripts, although not all studies have reflected identical patterns. For example, Bremner et. al. (1999) found that when exposed to scripts containing traumatic imagery, women with PTSD displayed increased activation in the posterior cingulate, and in anterior lateral prefrontal and motor cortex. In contrast, decreased activation was observed in the anterior cingulate, right hippocampus, and visual association cortex.

A smaller and uncontrolled study by Rausch et. al. (1996) found that subjects with PTSD displayed an increase in cerebral blood flow to right hemisphere structures including the medial temporal lobe, anterior cingulated gyrus, and amygdala. A followup study of sexually abused women found a different pattern, with increased blood flow to the orbitofrontal cortex and anterior temporal pole evident in women with post-traumatic stress disorder, while abused non-PTSD subjects showed increased activation in the anterior cingulated and insular cortex. In addition, women with PTSD displayed decreased activation in left hemisphere regions including Broca's area and the anterior frontal region (Shin et al., 1999).

Shin et. al. (2004) used PET imaging to explore hippocampal functioning during an explicit memory task, using eight subjects with non-child-abuse related posttraumatic stress disorder and eight controls. The groups showed no differences in recall accuracy; however, there were differences found between the two groups in the regional cerebral blood flow to the left hippocampus. In particular, there was increased blood flow within the PTSD group, which the authors suggested may represent a reduced efficiency during the performance of an explicit memory task (Shin et al., 2004).

Cicchetti (2002) also reported on experiments conducted into event-related potentials (ERPs) in response to emotional stimuli. They found that maltreated children showed amplified ERPs in response to pictures of angry faces, in contrast to happy faces; non-maltreated children showed no difference in response to the same stimuli. It was suggested that this response was specific to stimuli suggesting anger; a further study showed no increased ERP amplitude when fearful faces, along with happy and angry faces were shown (Cicchetti, 2002).

Glaser (2000) also reviewed a study by Ito et. al. (1998) which found EEG abnormalities in left hemisphere frontal and temporal regions in abused children,

when compared to other children on a psychiatric inpatient unit. Other research reported EEG changes, including increased right frontal lobe activity and relatively decreased left frontal activity, in infants (aged 1 week to 3 years) with depressed mothers. Right hemisphere activity has also been observed in PET studies involving adult females abused as children (Glaser, 2000).

MRI finding of altered morphology

DeBellis (2005) reviewed the normative processes of brain development in young children. He noted that prenatally, neurons are overproduced, and during the first four years of life there is extensive pruning of connections between neurons. Processes of myelination occur throughout childhood and adolescence, as neural networks are formed. The result of this is that the ratio of grey matter to white matter decreases steadily after the age of four, as cortical and subcortical grey matter reduces, while myelinated regions expand (Durston et. al., 2001). Some regions, such as the corpus callosum, have their peak development in early childhood (between 6 months and 3 years); other regions such as the limbic system and prefrontal cortex reach maturity in adolescence or early adulthood (De Bellis, 2005). Durston et. al. (2001) noted that in contrast to the pattern of reducing grey matter in the majority of the brain, the medial temporal regions (particularly the hippocampus and amygdala) continue to increase in volume through childhood. Geidd et. al. (1999) argued that grey matter does not increase and decrease uniformly, with frontal and parietal lobes peaking in grey matter volume around the age of 12, temporal lobe volumes at about age 16, and occipital grey matter volumes increasing throughout childhood and adolescence.

Early evidence of morphological changes associated with child maltreatment emerged from adult populations. Prior to this, magnetic resonance imaging had identified a pattern of reduced bilateral hippocampal volume in war veterans with chronic post-traumatic stress disorder (Gurvits, Shenton, Hokama, & Ohta, 1996). Follow up studies examined brain volumes in women with PTSD related to a history of physical and sexual abuse in childhood, finding a significant reduction in the left hippocampus, and a non-significant reduction in volume in the right hemisphere (Bremner, Randall, Vermetten, & Staib, 1997; Stein, Koverola, Hanna, & Torchia, 1997). It was hypothesized that the hippocampus may be particularly vulnerable to traumatic stress because it develops relatively late in life and continues to produce

neurons postnatally. In addition, it contains a high density of gluco-corticoid receptors, resulting in vulnerability to damage from chronic HPA axis activation (Teicher, 2002). It has been suggested that stress related hippocampal changes may be associated with the symptoms of PTSD characterised by memory dysfunction, either in explicit recall or in fragmented episodic recall of events (Bremner, 2006).

Other studies have questioned the proposed causal relationship between traumatic experiences and reduced hippocampal volume. For example, Pedersen (2004) questioned whether hippocampal reduction was a premorbid risk factor, or whether it was an effect of either trauma or post-traumatic stress disorder. Bonne et. al. (2001) found no evidence of reduced hippocampus or amygdala volume in adults after a recent traumatic event, and argued that reduced hippocampal volume may be associated with more chronic exposures, or alternatively may be the result of chronic alcohol or drug use (Bonne et al., 2001). Gilbertson et. al. (2002) conducted a twin study which found reduced hippocampal volume was present in both combat veterans with PTSD, and in their monozygotic twins without trauma exposure, arguing that smaller hippocampi may be a risk factor for PTSD, rather than an effect. Finally, Pedersen (2004) found no difference in hippocampal size between adults with early trauma history, early trauma history and PTSD, or non-traumatized controls.

Other parts of the brain have also been implicated in adult-onset posttraumatic stress disorder. Amygdala function has been shown to be altered in the direction of hyperresponsivity, although morphometric changes are not evident on imaging. Medial frontal regions also seem to be affected, particularly in the region of the anterior cingulate gyrus. A review of studies also reported consistent findings of reduced medial prefrontal activation during cognitive and emotional tasks, with lower activation of the medial prefrontal region potentially associated with greater symptom severity in PTSD (Shin, Rauch, & Pitman, 2006).

DeBellis et. al. (2001) sought to explore the patterns of limbic system volume in children with maltreatment-related PTSD. In a pilot study utilizing nine children with PTSD compared to sociodemographically matched controls, it was found that there was no difference between the groups in relation to temporal lobe, amygdala or hippocampal volumes. A follow-up measurement taken at least two years later (following pubertal development) resulted in similar findings (De Bellis et al., 2001).

While this evidence appears to suggest that children with a history of maltreatment do not evidence the hippocampal volume changes that have been found in adults with posttraumatic stress disorder, a recent longitudinal study challenged this (Carrion, Weems, & Reiss, 2007). Fifteen maltreated children between the ages of eight and fourteen were studied using MRI and salivary cortisol measures at a baseline assessment and a follow-up approximately twelve to eighteen months later. Cortisol levels and posttraumatic stress symptom severity were both correlated with the change in hippocampal volume between baseline and follow-up assessments. The authors argued that this supported decreased hippocampal volume as an effect of high stress levels and posttraumatic stress symptoms, rather than as a vulnerability factor placing individuals at risk of PTSD (Carrion et al., 2007).

A study of forty-three maltreated children with PTSD found alterations in the region of the superior temporal gyrus (De Bellis, Keshavan, Frustaci et al., 2002). Specifically, superior temporal grey matter volumes bilaterally were larger in the group with PTSD than the control group, while white matter volumes were smaller. In addition, there was evidence of alterations in normal asymmetries in this region, with a more pronounced asymmetry favouring the right hemisphere in the total and posterior volume analyses, while there was a decrease in the left greater than right asymmetry seen in the total, anterior and posterior gray matter analyses (De Bellis et. al., 2002).

An additional study compared twenty-eight children with maltreatment related PTSD with sixty-six non-maltreated controls matched for age, gender, handedness, physical development, and socioeconomic status. Overall intracranial and cerebral volumes were found to be reduced by about six percent in the maltreated-PTSD group. In addition, there was a reduction in volumes of prefrontal cortical white matter, prefrontal cortex as a whole, and corpus callosum subregions (particularly midsaggital and posterior areas). Cerebral volumes were found to be significantly correlated with duration of maltreatment, age of onset, and with Full-Scale and Performance IQ. Finally, there were some gender differences, with males in the maltreated group showing greater differences in ventricular volumes and in total cerebral volumes (De Bellis, Keshavan, Shifflett et al., 2002).

Further evidence of reduction in normal hemispheric asymmetries has been documented by Carrion et. al.(2001). A sample of 24 PTSD-diagnosed children between ages 7 and 14 were given MRI scans comparing total brain volume and

specific regions of the cerebrum. It was found that PTSD subjects displayed smaller total cerebral volume, and significant attenuation of the normal R>L frontal lobe asymmetry (Carrion et al., 2001).

A study by DeBellis and Keshavan (2003) further explored the gender differences between maltreated males and females with chronic PTSD. It was found that both males and females who had experienced maltreatment displayed a reduction in the midsaggital area of the corpus callosum splenium region; and increased volume of CSF in the prefrontal lobes. It was noted that while both males and females with PTSD did not display age-appropriate increases in corpus callosum area, the finding was more prominent in maltreated males. In addition, males in the clinical group displayed smaller cerebral volumes, and reductions in areas one and six of the corpus callosum (DeBellis & Keshavan, 2003).

Teicher et. al. (2004) found significant support for corpus callosum reduction associated with maltreatment in a sample without post-traumatic stress disorder. Twenty-eight children with a history of abuse or neglect were compared with non-maltreated referred for psychiatric evaluation, and with healthy control subjects. The study found a 17% reduction in corpus callosum in abused or neglected children compared to healthy controls, and 11% reduction when compared to children with a psychiatric history. In addition, it was found that neglect was the factor most consistently associated with reductions in corpus callosum size, and there were some gender differences in associations as sexual abuse was more predictive of corpus callosum reductions in females, while neglect was most predictive in male subjects (Teicher et al., 2004).

A more recent study focussed on the posterior regions of the brain, noting that previous literature had neglected posterior fossa volumes (De Bellis & Kuchibhatla, 2006). Fifty-eight maltreated children with posttraumatic stress disorder were compared to children with anxiety disorders and healthy non-abused subjects. Posterior fossa regions including the left and right cerebellum and pons/brain stem region were found to be significantly smaller in the PTSD group than in control groups. Differences in cerebellar regions remained significant when controlling for age, socioeconomic status, cerebral volume and full-scale IQ. Trauma age of onset and duration were correlated with cerebellar volume; IQ scores were correlated with the volume of the cerebellar vermis, and to a lesser extent with brain stem measurements (De Bellis & Kuchibhatla, 2006).

Direct brain lesions following physical assault

Inflicted acquired brain injury is a term used to describe brain injuries acquired through physical assaults in early childhood. Libby, Sills, Thurston and Orton (2003) conducted a study examining the causes of injury in a sample of 1097 children under the age of three presenting at hospitals with head injury. Of these children, 283 had sustained an inflicted head injury. Another study conducted by Keenan et. al. (2003) examined a population-based sample of children up to the age of two. Within this sample, 152 children were identified with serious or fatal brain injuries, and 53% of these injuries were the result of inflicted head injury. This study also noted that many cases of milder inflicted head injury go unreported, and that unreported brain injuries may be identified on scans later in life (Keenan et al., 2003).

Inflicted acquired brain injuries, like other types of brain injury, may affect any part of the brain depending on the mechanics of the impact. Ewing-Cobbs et. al. (1998) compared twenty children under the age of six with inflicted brain injuries to twenty with non-inflicted brain injuries, and compared their injuries as identified on CT or MRI imaging. In 45% of the inflicted brain injury group, there was evidence of pre-existing brain injury. Other distinguishing characteristics of inflicted brain injury included a higher rate of subdural haematomas, seizures, and retinal haemorrhage (Ewing-Cobbs et al., 1998).

There are no studies currently available focussing on the neuropsychological sequelae of inflicted acquired brain injury; although growing knowledge of the mechanisms and cognitive consequences of other types of closed head injuries suggest that brain injuries resulting from being shaken or assaulted as an infant may have enduring developmental consequences for children's cognition. Johnson and Rose (2004) noted that there are numerous barriers to understanding prognosis, including a lack of routine follow-up for children with inflicted brain injuries, the difficulties of tracking children in families where maltreatment or neglect may be occurring, and the lack of general understanding about early brain development and plasticity following injury early in life. They also argue that neuropsychological research on other types of childhood brain injury has not been applied in the field of inflicted brain injury (Johnson & Rose, 2004).

Effects of disrupted attachment on brain development

While the majority of the studies above have focussed on individuals who have been exposed to acute stressors or traumatic events, there is also evidence that more chronic early experiences of disengaged or inconsistent parent-child relationships may lead to alterations in the brain's development. Researchers focusing on attachment have provided some evidence, mostly drawing from animal models, that disturbed attachment patterns in early life may manifest in altered patterns of brain neurochemistry and structure.

Attachment is a biologically adaptive motivational mechanism that causes an infant to seek a relationship involving physical proximity, a sense of safety, and the foundation of an internal working model of a "secure base". In early stages of development, the social-behavioural emergence of attachment occurs at the same time as a significant period of brain development, involving neuronal overproduction and pruning that allows for many experience dependant pathways to be established in the brain. Amongst these pathways are the circuits responsible for memory, emotion, behaviour and interpersonal relationships, frequently associated with the limbic system and frontal lobes of the brain (Siegel, 2001). There is evidence that children who achieve secure attachment also display advantages in emotional flexibility, social functioning, and cognitive abilities, while young people with a disorganized/disoriented attachment style (often arising from early trauma or neglect) are likely to display impairments in social and cognitive functioning. Siegel (2001) argues that traumatised children may display behaviours driven by the impulses of lower brain regions such as the brain stem and limbic system, lacking the more reflective and flexible response mediated by the frontal regions of the brain.

Joseph (1999) notes that the limbic system in early life is plastic and frequently "experience-expectant", anticipating social-emotional experiences to guide its development. Abnormal conditions, such as early experiences of neglect or social deprivation, can result in atrophy of limbic nuclei. This can also contribute to aberrant development of the anterior cingulate and orbital frontal lobes, which may manifest behaviourally as poor impulse control and impaired social behaviour. Disconnection syndromes are also hypothesised in which loss of pathways between the limbic system and frontal regions lead to blunting of social behaviours, higher levels of avoidance, and difficulties showing appropriate emotional responses (Joseph, 1999).

Balbernie (2001) emphasised the importance of the orbitofrontal cortex, particularly in the right hemisphere, in establishing homeostatic regulation through parent-infant regulatory systems. Orbitofrontal-limbic circuits are established in the first two years of life, allowing infants to firstly recognize emotional states, and then to regulate feelings. These circuits are generally established through external and affectionate feedback from the parent, who provides emotional regulation for the infant in early stages of life. Maltreatment compromises the child's exposure to these learning and feedback experiences, resulting in hyperarousal and poor affect regulation (Balbernie, 2001).

In early development, overactivation of the amygdala may particularly influence neurotransmitter pathways between the limbic system and prefrontal cortex. Mayes (2006) reported that early acute or chronic stress may have lasting impacts on the activation thresholds in dopaminergic and noradrenergic systems. This may influence not only conditioned fear responses, but also affect the social and affiliative aspects of amygdaloid functioning (Mayes, 2006).

Schore (2002) argued that in early development, mechanisms such as the limbic system and hypothalamic-pituitary-adrenal axis are most closely interconnected into developing right hemisphere structures, and that these interconnections lead to right-brain dominance for social-emotional information. In particular, the right orbitofrontal region is critical for the inhibitory control of emotional states, as well as regulation of the autonomic nervous system. Children exposed to significant abuse or neglect in early life may manifest "disorganized" attachment, including rapid shifts of emotional state and confused approach/avoidance behaviour towards their parents. This may relate to impairments of the orbitofrontal system, and reflect the overpruning of the corticolimbic pathways that limit higher-level regulation of the limbic and autonomic systems (Schore, 2002).

Studies of children raised in environments of significant deprivation, such as orphanages where contact from caregivers is denied, have shown that such children often exhibit marked changes in behaviour, including disinhibited attachment patterns and stereotypic self-soothing behaviours. There is some evidence that these changes may be mirrored by alterations in neurohormonal functioning. In particular, the neuropeptides oxytocin and vasopressin have been investigated, due to their association in animals with social affiliation, parental care, social recognition and pair

bonding (Lim & Young, 2006). In one study, it was found that children raised in an orphanage and adopted in childhood showed lower levels of vasopressin than family-reared children, and did not display an increase in oxytocin after contact with their adoptive parents (Fries, Ziegler, Kurian, Jacoris, & Pollack, 2005).

Development

Research suggests that childhood experiences of maltreatment are associated with a range of adverse developmental outcomes, affecting areas such as language and cognitive development, behaviour in children and adolescence, and mental health in adolescence and adulthood. Children with a history of abuse or neglect are likely to be at very high risk of unstable attachment patterns, contributing to impaired social and emotional development. The neurobiological effects of acute stress may contribute to a chronic state of hypervigilance and fearfulness, or alternatively to a disengagement and apparent apathy, both characteristics of post-traumatic stress disorder. It is noted that children entering protective care may show impairments affecting areas including motor skills, cognition, language function, self-care, emotional well-being, coping skills, relationships to others, and behavioural regulation (American Academy of Pediatrics, 1993).

Chalk, Gibbons and Scarupa (2002) noted that media representations and popular opinion regarding maltreatment often fails to grasp the complexities of the problem. There are numerous adverse impacts on children's health and well-being, including higher risk of brain injury, and the risk of sexually transmitted diseases in sexual abuse. Children may also be at higher risk of poor school adjustment and achievement, along with antisocial behaviour and physical aggression. Adolescents may be more vulnerable to teenage pregnancy, substance abuse, or running away from home following maltreatment (Chalk, Gibbons, & Scarupa, 2002).

Psychological Outcomes: Adult findings

As awareness of child abuse has grown, there has been a growing awareness of its relationship to adult mental health disorders. Child abuse and neglect have been independently associated with the emergence of depression and anxiety disorders, and posttraumatic stress disorder. There is also evidence for a link between maltreatment and personality disorders (Hagele, 2005).

A study by Afifi, Brownridge, Cox, & Sareen (2006) found a link between a history of physical punishment, physical abuse or sexual abuse and later mental health outcomes in a community sample of 5877 people. Of the total number of participants, 35.5% reported no history of punishment or abuse, 48% reported punishment only, and 16.5% reported a history of physical abuse or sexual abuse. It was found that both physical punishment and child abuse were associated with the presence of a number of psychiatric disorders, including major depression, alcohol abuse or dependence, and externalizing disorders. Abuse was also associated with the presence of some form of anxiety disorder (including generalized anxiety disorder, panic disorder, social phobia and posttraumatic stress disorder). Individuals who were abused as children were found to be at much higher risk of experiencing two or more disorders concurrently (Afifi, Brownridge, Cox, & Sareen, 2006).

The findings of Tonmyr et. al. (2005) support the findings of an association between childhood maltreatment and adult psychopathology. This Canadian study interviewed 4239 women regarding both their history of child maltreatment and their current experiences of psychiatric disability, as defined by their experience of impairments in daily tasks of living or occupational/academic limitations. The study found that 3% of women identified as having some form of psychiatric disability. Women with a disability were significantly more likely to have a low income, and to have a history of parental psychiatric disorder and/or substance abuse. The study found that 50% of disabled women reported some history of physical or sexual abuse, in comparison with 26.8% of the non-disabled sample. This indicated a statistically significant association between childhood abuse and later psychiatric disability (Tonmyr, Jamieson, Mery, & MacMillan, 2005).

Associations have also been found between a history of childhood abuse and neglect, and adult experiences of psychotic disorder. Janssen et. al. (2004) examined a large community sample in the Netherlands, interviewing them to determine experience of childhood maltreatment. They were then followed up three years later to determine the incidence of psychotic symptoms emerging since the initial interview, based on a diagnostic interview, rating scale, and assessment of need for care. The study found a very low incidence of psychosis in the overall sample (below 1%). However, it was found that a history of child abuse increased

the risk of psychosis as assessed by the criteria of any psychosis, pathology-level psychosis, and need for care (Janssen et al., 2004).

Kaplow & Widom (2007) considered not only the broad impact of abuse, but also the implication of age of onset on later mental health outcomes in adults. The study followed up a group of 496 adults, including some who had experienced abuse or neglect as children and a group of matched controls. The study investigated a range of psychiatric symptoms and diagnoses, including substance abuse/dependence, major depression, antisocial personality disorder, generalized anxiety disorder, and posttraumatic stress disorder. The study found that individuals with an abuse age of onset below five were more likely to report symptoms of anxiety and depression. In contrast, individuals with an older age of onset were more likely to report a history of antisocial personality disorder or substance abuse (Kaplow & Widom, 2007).

In summary, a link has been established between early maltreatment and adult psychopathology. The experience of child abuse or neglect is a significant risk factor for a range of adult mental illnesses, including depression, a spectrum of anxiety disorders, and psychosis. In addition, adults with a history of abuse may be more likely to manifest symptoms of personality disorder or substance abuse.

Psychological outcomes: Findings in children

Given the strong association between child maltreatment and poor adult mental health outcomes, it could be anticipated that children who have been maltreated may also display some signs of poor psychological adjustment. There have been a number of studies conducted which are suggestive of mental health impairments in sexually abused children. In addition, there is a growing body of data on mental health issues and service usage amongst young people involved with child welfare systems.

Tyler (2002) reviewed forty-one studies examining various social and emotional outcomes arising from the experience of childhood sexual abuse. She noted that many studies conducted in this field were limited in their scope, due to gender imbalances in the samples, lack of appropriate normative samples, lack of standardized measures, and a lack of theoretical models to guide researchers. The review found that the majority of studies focused on adolescence, and that there were limited findings in early to middle childhood years. Amongst the studies that did address these age groups, sexual abuse was found to be associated with

internalizing and externalizing behaviours, and inappropriate sexual behaviour, in early and middle childhood. In addition, during middle childhood sexual abuse history was associated with depression and suicidal ideation, posttraumatic stress disorder, and sexual anxiety (Tyler, 2002).

Another review of risks and outcomes associated with childhood sexual abuse found that children were at increased risk of poor mental health outcomes, consistent in some domains with adult outcome data (Putnam, 2003). For example, studies were noted in which abused children were found to be at higher risk than their non-abused peers for major depression and suicide attempts. In addition, a strong association was noted between child sexual abuse and sexualized behaviours, with the most pronounced effects being amongst younger children. However, Putnam (2003) also noted that psychiatric disorder is far from a universal outcome of sexual abuse, with up to 40% of children asymptomatic at the time of report. However, a significant minority may also qualify for two or more psychiatric diagnoses at some point in time, indicated diversity in outcome following sexual abuse (Putnam, 2003).

McCrae, Chapman and Christ (2006) extended the understanding of the relationship between childhood abuse and mental health problems, by examining the interactions between abuse, the age of the child, and other risk factors in the environment. It was found that amongst abuse victims between the ages of three and seven, depressive symptomatology was associated with environmental risk factors such as domestic violence and parental mental illness. In contrast, depressive symptoms amongst eight to eleven year olds was associated with severity of abuse and multiple family problems, while posttraumatic stress disorder was related to chronic and unresolved abuse (McCrae, Chapman, & Christ, 2006). This study highlights the impact of multiple factors in determining outcomes following abuse.

While these studies focus on the effects of a specific type of abuse, other researchers have attempted to define the population of maltreated children more broadly. In particular, a number of studies have focused specifically on children coming into contact with child welfare services, to determine the impact of abuse on their mental health functioning. Other studies have focussed on a subset of this population, such as children residing in foster care.

Burns et. al. (2004) took a broad perspective in surveying the mental health needs and mental health service use of children in care. Mental health need was

determined using internalizing and externalizing problem behaviour scores from the Child Behaviour Checklist (CBCL). Of the young people surveyed, 47.9% scored in the clinical range on at least one of these measures, with higher rates of behavioural disorder amongst teenagers (11-14 years) than preschoolers (2-5 years). Placement in non-relative or residential care, and worker reports of poor parenting skills, were additional risk factors associated with high scores, while neglect was associated with lower rates of problem behaviour than other forms of abuse. In relation to service use, it was found that approximately 15% of the sample was currently receiving services, with the majority of that number comprising those who experienced clinical need. However, this rate still suggested that less than one in four of those reporting problematic internalizing or externalizing behaviours were in receipt of mental health services (Burns et al., 2004).

Burge (2007) examined the relationship between mental health disorders, maltreatment, demographics and placement situation amongst a group of 429 wards of state in Ontario, Canada. Based on child records, the study examined the child's diagnostic history, including both physical and mental disorders. It was found that 31.7% of the children had at least one psychiatric diagnosis recorded, based on the DSM-IV diagnostic system. The majority of these (20.7% of the total sample) had been diagnosed with attention-deficit hyperactivity disorder (ADHD), with a further 7.5% meeting the diagnostic criteria for mental retardation or a pervasive developmental disorder. Anxiety, mood and attachment disorders were also noted in 2-5% of the total sample, along with oppositional defiant disorder and disruptive behavioural disorder. Presence of mental disorder was associated with a history of maltreatment, and was also associated with a reduced likelihood of having a long term placement plan (Burge, 2007).

Similar studies have been carried out in Australia, examining particularly children placed in non-kinship foster care (Tarren-Sweeney & Hazell, 2006). One study focused on four to nine year olds living in foster care in New South Wales, with a final sample of 347 children included. Once again, the Child Behaviour Checklist was used as the primary measure of psychopathology, along with the Assessment Checklist for Children which focuses more directly on psychiatric symptomatology. Around 53% of girls and 57% of boys were found to have at least one score from the CBCL in the clinical range, with the most characteristic problems including elimination problems, sexual problems and conduct problems. On the Assessment Checklist for Children, around one third of children were reported to display

inappropriate sexual behaviour, and there were also high levels of inappropriate (non-reciprocal or disinhibited) social behaviour and insecurity in relationships. A minority of children were also found to show signs of self-injury, abnormal responses to pain, and food maintenance behaviours (Tarren-Sweeney & Hazell, 2006).

Another study conducted in South Australia looked at both the prevalence of mental health problems, and the rates of mental health service use, compared to the general rates for children of the same ages in the community (Sawyer, Carbone, Searle, & Robinson, 2007). The study focused on children between the ages of six and seventeen, and examined the prevalence of internalizing and externalizing problems, depression, suicidal ideation, and caregiver perceptions of need for professional help. 326 children in care participated overall. This study found that their were high rates of externalizing behaviour problems compared to a community normative sample, and that twice as many children in care displayed externalizing problems than internalizing problems. Children in foster care also displayed significantly higher depression scores, with the difference being more marked for boys, and were more likely to have attempted suicide. Around half of the children living in foster care were reported to need professional help, and around half of these children were reported to have received some professional help (Sawyer et al., 2007).

In summary, many studies using behavioural questionnaires find high reported rates of internalizing and externalizing behaviours suggestive of psychopathology in children with a history of abuse. Depression, suicide attempts, and anxiety disorders including post-traumatic stress disorder occur frequently amongst children with a history of abuse. In addition, there is clear evidence that children in care are vulnerable to both internalizing and externalizing mental health problems.

It has been argued that the high levels of externalizing and internalizing behaviour disorders found in traumatized children may be related to the stress-related changes occurring in brain mechanisms in response to trauma (Weber & Reynolds, 2004). In particular, early stressors may affect the brain's development of capacities to regulate and modulate behaviour, contributing to later emergence of maladaptive behaviours and emotional distress. This may contribute to the trend for children with a maltreatment history to show a broad range of psychiatric symptoms, which may be difficult to diagnose (Weber & Reynolds, 2004).

Psychological outcomes: Attention Deficit Disorder, Behavioural Disorders, and Posttraumatic Stress

As noted previously, there is some evidence that the diagnosis of attention deficit-hyperactivity disorder (ADHD) occurs more frequently amongst maltreated children than the general population. For example, in Burge's (2007) study the diagnosis of ADHD was given to approximately 20% of maltreated children in care. Other symptoms of externalizing behaviour are also observed more frequently in maltreated children, suggesting features of disorders such as oppositional defiant disorder and conduct disorder. Weber and Reynolds (2004) argue that careful assessment of behavioural symptoms is needed to distinguish externalizing disorders from PTSD, and to ensure that the treatment given is appropriate to the condition.

Weinstein, Staffelbach and Biaggio (2000) noted that sexually abused children are frequently diagnosed with both ADHD and posttraumatic stress disorder, and that the two diagnoses may have some symptom overlap. Their review noted that behavioural problems, including sexualized behaviour, hyperactivity, aggression and sleep disturbances, were all common consequences of sexual abuse. Symptoms such as difficulty with concentration, restlessness, and impulsivity can be features of both disorders, and argued that trauma symptoms may be misperceived as signs of ADHD. The authors argued that children presenting with ADHD symptoms should be routinely screened for trauma history, and that a more comprehensive study of symptoms may be necessary to prevent misdiagnosis and inappropriate treatment with psychostimulants (Weinstein, Staffelbach, & Biaggio, 2000).

Ford et. al. (2000) proposed that there may be multiple interactive relationships between disruptive behaviour disorders, maltreatment and posttraumatic stress. For example, children with difficult behaviours may be at greater risk of interpersonal conflict with adults, sometimes resulting in maltreatment. In addition, the impact of trauma may compound or exacerbate symptoms of ADHD or oppositional defiant disorder, especially given the high level of overlap between symptoms such as disinhibition and self-regulation deficits in these populations. There may also be co-morbid disorders such as posttraumatic stress occurring alongside attention deficit disorders. The study assessed 165 children with a history of attention deficit or oppositional defiant disorder for the presence of trauma history, PTSD symptomatology, and PTSD diagnosis. It was found that 73% of children with comorbid ADHD/ODD had been exposed to physical trauma, and 31% to sexual

trauma; children with ODD or ADHD alone also had significantly higher rates of trauma exposure. Children with a diagnosis of ADHD or ODD were also more likely to display posttraumatic stress symptoms following trauma than children with an adjustment disorder (Ford et al., 2000).

Endo, Sugiyama, and Someya (2006) looked at psychiatric diagnoses in 39 abused children admitted for treatment in a Japanese hospital. It was found that dissociative disorders were the most common diagnosis, given to 59% of the sample. Sixty-seven percent of the sample met the first criteria for attention deficit hyperactivity disorder; however, only 27% of these children were thought to have met the criteria prior to their abuse experiences, while the others were reported to have ADHD symptoms emerging post-abuse. The authors argued that this may have been related to the high prevalence of dissociative symptoms contributing to inattention, and the alterations in neurophysiological reactivity that are associated with maltreatment experiences (Endo, Sugiyama, & Someya, 2006).

Pine et. al. (2005) looked at the impact of threatening stimuli (pictures of neutral, angry or happy faces) on the orienting attentional capacities of maltreated children compared to controls. It was found that significant bias was present amongst physically maltreated children, who tended to direct their attention away from the perceived "threat" stimulus of an angry face. In contrast, children with a history of neglect only did not show a bias away from threatening stimuli. Post-traumatic stress disorder was also associated with attentional bias (Pine et al., 2005).

In summary, children with a diagnosis of ADHD frequently have a history of childhood trauma. There is an argument that externalizing behaviours may place children at risk for parental abuse; however, there may also be some overlap between symptoms of post-traumatic stress disorder and externalizing behaviour disorders. PTSD is believed to affect aspects of attention, resulting in specific attentional biases in processing emotional stimuli.

Behavioural Effects: Borderline Personality Features and Affect Regulation

Borderline personality disorder is amongst the common diagnoses made in adults with a history of childhood abuse, especially childhood sexual abuse. Some statistics suggest a history of some form of abuse in between 60 and 80 percent of individuals with a diagnosis of borderline personality disorder (Graybar & Boutilier, 2002).

Haugaard (2004) argues that some characteristics of this disorder can be observed emerging in school aged children and adolescents. These characteristics may include difficulties forming attachments (including unpredictable behaviour in relationships), poor capacity to regulate emotional states (including aggressive or antisocial outbursts), and impulsive or risk taking behaviours (Haugaard, 2004).

Rogosch and Cicchetti (2005) investigated evidence of vulnerability for borderline personality disorder amongst maltreated and non-maltreated children attending a summer camp. They developed a composite score of BPD vulnerability, utilizing scores associated with emotional lability, conflict with teachers, peer ratings of demandingness, relational aggression and dislike, representations of self, and endorsement of items relating to suicidal and self-harming thoughts and behaviours. It was found that the majority of these indicators differentiated between maltreated and non-maltreated children. It was also found that children with high ratings of BPD vulnerability displayed specific attentional deficits associated with attention to conflicting stimuli, suggestive of difficulties with executive control of attention (Rogosch & Cicchetti, 2005).

Coolidge, Segal, Stewart, & Ellett (2000) compared twenty-one children with borderline personality features to a group of controls rated as having features of another personality disorder. They used a caregiver rating scale to assess symptoms of personality and neuropsychological disorders in the children. It was found that children with borderline personality features were reported to have more symptoms of neuropsychological and behavioural dysfunction, including symptoms of attention deficit hyperactivity disorder, executive functioning deficits, minor neurological deficits, oppositional defiant disorder and conduct disorder. The authors argued that frontal lobe dysfunction may be an underlying feature of many of these reported neuropsychological difficulties (Coolidge, Segal, Sewart, & Ellett, 2000).

One of the central features of borderline personality disorder is impairment in the ability to regulate aspects of behaviour (impulsivity) and emotion (affect regulation). Skodol et. al. (2002) suggest that the impulsive features of BPD may be related to dysregulation of the serotonergic system in the brain, secondary to dysfunction of the hypothalamic-adrenal-pituitary axis following trauma. Cholinergic and noradrenergic system changes have also been associated with instability of mood and with sensation seeking in BPD patients (Skodol et al., 2002).

Dahl (2003) suggests that the regulation of affect involves the ability to modulate feelings in adaptive ways. This may include both the regulation of emotional behaviour, such as tone, expression and action, and the regulation of the internal state.   It was noted that the development of cognitive control and affective regulation occur in tandem from early childhood, with additional development occurring through adolescence. The regulation of affect was noted to be linked to anxiety disorders in children, as well as to other mood disorders (Dahl, 2003).

Skuse, Morris, and Lawrence (2003) note that the amygdala plays a significant role in the regulation of basic emotions, such as fear and anger, as well as in the processing of social information. It was noted that children who have experienced abuse often display altered event related potentials when asked to attend to angry faces, and may be more likely to over-interpret facial expressions they perceive as threatening. It was argued that the connections between the amygdala and inhibitory circuits in the prefrontal cortex enable appropriate responses to facial expressions, including the regulation of fear responses. In maltreated children, this regulation may be altered by the experiences associated with particular facial cues such as anger (Skuse, Morris, & Lawrence, 2003).

Koenen (2006) argued that self-regulation may also be a significant predisposing factor for posttraumatic stress disorder. Emotional processing and executive functioning skills may both play a role in the construct of self-regulation, while impaired self regulation may contribute to the onset of posttraumatic stress disorder following trauma exposure in adulthood. Emotional processing deficits were proposed to emerge from over-activation of the amygdala, while executive deficits may lead to a lack of inhibition of the amygdala, both resulting in an exaggerated fear response. Experiences of child maltreatment, along with the presence of childhood disorders such as conduct disorders, may be significant risk factors for reduced self-regulatory capacities, and therefore increase the risk of adult psychopathology (Koenen, 2006).

In summary, researchers have proposed that maltreated children may display deficits in emotional regulation, and other behavioural and social symptoms that are suggestive of an "emergent" borderline personality disorder. There are some links between these symptoms and neuropsychological dysfunction, especially in the areas of executive functioning and attentional deficits. Some of this evidence indicates that the social and emotional deficits evident may be related to dysfunction

in the prefrontal cortex, and in the connections between the limbic system and frontal regions of the brain.

Scholastic Outcomes

Numerous studies have found an association between child maltreatment and poor academic achievement. The majority of these studies have focused on children with a history of either physical abuse or neglect. Rowe and Eckenrode (1999) suggested that maltreated children were at higher risk for both grade repetition and for poor grades in English and Mathematics. Eckenrode, Laird & Doris (1993) studied a large sample of children in the education system, and found that those with a history of neglect alone or neglect with physical abuse were significantly more likely to have low grades or a history of grade repetition. In addition, children with a history of physical abuse were at increased risk for disciplinary problems or reports of previous suspensions (Eckenrode, Laird, & Doris, 1993).

Another study by Kendall-Tackett and Eckenrode (1996) found that children with a history of neglect not only had lower average grades and more grade repetitions, but also a higher number of suspensions and disciplinary referrals in their academic context. Perez and Widom (1994) conducted a retrospective study of adults abused in childhood, and found that they were more likely to report a history of repeated grades, higher truancy rates, suspensions, and less years of education overall than matched controls.

The findings are more equivocal in studies with sexually abused children. Trickett, McBride-Chang, and Putnam (1994) found that a history of sexual abuse was negatively correlated with a child's self-rating of academic competence, and with their overall academic performance. An Australian study did not find significant decrements on the average achievement scores of sexually abused children, but noted that three of twenty-one participants displayed some academic underachievement, and a further three had qualified for learning support in their school context (Jones, Trudinger, & Crawford, 2004). Reyome (1993) compared a group of sexually abused children with neglected children and controls drawn from families on public assistance or from lower-middle class backgrounds.   Using measures of achievement, she found that sexually abused children did not differ significantly from children receiving public financial assistance on measures of

internalizing or externalizing behaviour, although there was a significant difference between the sexually abused and middle-class children on externalizing behaviour scores. In relation to achievement measures, it was noted that sexually abused children showed a higher proportion of low grades in English and mathematics, and a higher proportion of grade repetition, in comparison to both control groups (Reyome, 1993).

Zolotor et. al. (1999) used a prospective design to explore the risk of academic underachievement associated with maltreatment. Children at risk for maltreatment were identified at birth, and their educational adaptation was reviewed at the ages of six and eight years. The total sample size at age 8 was 181 children, with forty percent of these children reported for at least one instance of neglect (with or without abuse) prior to the age of six. The study endeavoured to control for a range of sociodemographic variables, including age, sex, race, number of siblings, maternal years of education, maternal depression and stress, household income, and presence/absence of a father figure. Ratings of behaviour and school performance were collected through teacher reports of academic performance, learning, behaviour, child happiness and peer status. They found that substantiated maltreatment associated with reduced academic performance and adaptive functioning, with a substantiated maltreatment report representing the strongest predictor of academic performance scores and poor behavioural adaptation (Zolotor et al., 1999).

Boden, Horwood and Fergusson (2007) considered longer term academic outcomes associated with child sexual and physical abuse. They looked at a group of young adults who were part of a New Zealand longitudinal study; this group were asked at ages 18 and 21 to give retrospective reports of any exposure to childhood sexual or physical abuse. They then compared this group with the broader sample on academic outcomes including whether or not they had completed high school, obtained a high school certificate, attended university, and gained a university degree before age 25. The study found a significant relationship between abuse exposure and poor academic outcomes; however, after adjusting for demographic and socioeconomic influences, only limited significant associations remained (Boden, Horwood, & Fergusson, 2007).

Shonk and Cicchetti (2001) noted that in some studies, there have been mixed findings of academic deficits depending on the measures of academic achievement

utilized and the method of analysis used. For example, while not all studies have found lower grades amongst maltreated children, some have found differences on standardized tests of achievement, or on other indicators such as grade repetition or placement in special education classes. They studied a group of 229 low-SES children, with 146 having a documented history of maltreatment. Data was gathered through observation, teacher reports and school records. They found that the maltreated children in their sample showed greater evidence of academic maladjustment, as defined by repeated grades, poor attendance, access to special education services, and low achievement scores. They also found that academic engagement (teacher ratings of perceived competence, effort, and classroom orientation) mediated the relationship between maltreatment and academic maladjustment, while measures of ego resiliency and social competency mediated the relationship between maltreatment and behavioural maladjustment (Shonk & Cicchetti, 2001).

Other research has added support to the idea that children placed in out-of-home care arrangements tend to display poorer school adjustment. Zima et. al. (2000) conducted a comprehensive review of behaviour problems, academic delays, and school failure amongst 302 six to twelve year-old children in various out-of-home placements. The study found that 69% of the children had some history of either academic delays, failure to achieve at school, or a behaviour problem. Children who scored in the clinical range for internalizing and/or externalizing behaviour problems were more likely to have been suspended or expelled from school. Twenty-three percent of children were found to have some academic delay in either reading or maths, while 25% had experienced either a suspension/expulsion, or had to repeat a grade at school. Ethnicity was the greatest risk factor for academic delays amongst children in care, with instability of placement also contributing to risk. Group home placement, age, and behaviour problems were all predictors of school failure (Zima et al., 2000).

Mitic and Rimer (2002) compared children in care in grades four, seven and ten to national averages on standardized tests of academic achievement. Almost 40% of grade four children in care were below expectations in their reading ability, compared to 20.3% of the general population. In writing skills, 18.1% of grade four children in care were below expectations, and only 8.8% of their age peers. In numeracy skills, the comparison figures for below expected performances were 42.4% of children in care, and 20.2% of other children. The rates of children in care falling below

expectations increased in the later grades, and were consistently well above the rates in the general school population (Mitic & Rimer, 2002).

Fantuzzo and Perlman (2007) considered the interactions between out-of-home placements, child maltreatment and homelessness in their impact on school achievement. The study utilized a cohort of second grade students within a single city. Standardized assessments of early literacy, reading accuracy, fluency and comprehension, vocabulary and language, and maths and science were obtained. School adjustment was also assessed, considering both the child's classroom work habits, and their social skills development. Out-of-home placement was found to be significantly related to reduced performance a number of literacy measures, and to a lower level of science knowledge. It was also associated with poorer school adjustment, in both work habits and social skills. It was found that maltreatment mediated the effects of the relationship between placement status and school achievement measures, and had similar effects on the relationship between placement and school adjustment (Fantuzzo & Perlman, 2007).

Evans (2004) sought to determine whether foster care placement had a positive, neutral, or negative impact on cognitive development, as measured by IQ and academic achievement scores. It was found that there was no significant differences between most measures of academic ability and achievement between initial foster care placement and assessment on re-entry into care; however, written expression skills showed some improvement over time after placement. It was also noted the children with higher levels of academic achievement may be at risk of some decline following entry into care arrangements, and it was argued that this highlighted the need for all children to receive educational assessment and monitoring (Evans, 2004).

Crozier and Barth (2005) note that while academic impairments in maltreated samples are commonly found, the mechanisms by which these impairments arise are unknown. Risk factors include genetic and prenatal risks; the influence of chaotic, violent or deprived living circumstances; and sociodemographic factors such as race and socio-economic status. They assessed 2368 maltreated children aged six to fifteen on measures of intelligence, achievement and behaviour, considering a range of risk factors including age, gender, race, maltreatment type, family poverty, prior involvement with welfare services, caregiver mental health, and clinical behaviour problems. They found that children with a history of maltreatment were more likely to

receive a standardized score below 85 on achievement tests in comparison to the general population; with 32.9% scoring below 85 on a reading test, and 46.4% below 85 on a mathematics test. They also found that gender, age, race and maltreatment type were not significantly related to achievement scores; but that poverty and previous welfare services were significant risk factors for poor achievement. In addition, parental mental illness and clinically significant behaviour problems (as reported by parents and teachers) were risk factors specifically for poor mathematics outcome. The study also provided evidence of cumulative risks, that is, that children with more than one risk factor (poverty, receipt of welfare services, caregiver mental health, clinical behaviour problem reports) were at higher risk for poor academic outcomes (Crozier & Barth, 2005).

In summary, there is cumulative evidence that maltreatment is associated with poor academic outcomes, as measured by a range of standardized tests and educational indices. Academic achievement is reduced in children with a history of neglect and physical abuse, and there is some indication that sexually abused children may also show signs of reduced academic performance. There is evidence that behavioural problems, poverty, and academic competence all affect academic outcomes. However, there appears to be little research investigating the impact of cognitive status on academic outcomes. The next section reviews research into the general cognitive capacity of children with maltreatment, a variable which may be expected to impact on their academic and social functioning.

Maltreatment and Cognitive Capacity

There is a long-standing link in the literature between child maltreatment and below average performance on standardized intelligence testing, with reviews from over a decade ago noting trends for abused children to display lower IQ scores (Armsworth & Holaday, 1993; Kolko, 1992). Hoffman-Plotkin and Twentyman (1984), however, noted that much of the early research confounded maltreatment with socio-economic status, and that many lacked adequate control groups. Their study found that abused and negected children scored approximately twenty points lower than matched controls' intelligence (Stanford-Binet) and receptive vocabulary (Peabody Picture Vocabulary Test) scores (Hoffman-Plotkin & Twentyman, 1984). In contrast, Harwicke and Hochstadt (1986) found no differences between abused-neglected children and a comparison group composed of chronically ill children.

More recent research, utilizing control groups matched on demographic and socio-economic variables, has found further support for intellectual deficits in maltreated children. Carrey et. al. (1995) found a significant difference between abused children and a reference group on full-scale and verbal IQ measures using the WISC-R, and further noted that scores on these scales were related to the severity of abuse experienced. DeBellis et. al. (1999) also found lower IQ scores amongst maltreated children with post-traumatic stress disorder, and noted that scores appeared negatively correlated with the duration of abuse. Crozier and Barth (2005) found a higher than expected percentage of maltreated children (33.9%) scored below eighty-five on the Kaufmann Brief Intelligence Test. They also found that race and a history of poverty were significant risk factors for low scores on intelligence tests. Strathearn et. al. (2001) also noted that referral to protective services for neglect was associated with cognitive delays in low birth-weight infants. Substantiated neglect in this population also contributed to cognitive decline over time (Strathearn, Gray, O'Callaghan, & Wood, 2001).

Saltzman, Weems and Carrion (2006) considered the relationship between maltreatment, posttraumatic stress disorder, and intellectual functioning in fifty-nine children and adolescents aged between seven and fourteen. The study found that verbal IQ scores were significantly associated with both the number of traumas experienced, and with re-experiencing symptomatology associated with PTSD. Full-scale IQ was also significantly predicted by post-traumatic stress symptoms, with a particular association with re-experiencing symptoms. It was argued that lower verbal abilities may predispose children towards posttraumatic stress disorder, as they are less able to process and form a narrative about the traumatic events. However, it was noted that this study lacked pre-morbid comparison data to support such a hypothesis (Saltzman, Weems, & Carrion, 2006).

In a different approach, Pears, Kim and Fisher (2008) considered the impact of different types of maltreatment on cognitive outcomes. Based on a sample of 117 three- to six-year-olds in foster care, the study categorized four different profiles of multiple types of maltreatment: supervisory neglect/emotional maltreatment; sexual abuse/emotional maltreatment/neglect; physical abuse/emotional maltreatment/neglect; and sexual abuse/physical abuse/emotional maltreatment/neglect. The study found that neglect and physical abuse were associated with poorer cognitive outcomes comparative to the sexual abuse/emotional maltreatment/neglect group (Pears, Kim, & Fisher, 2008).

Similar findings were noted in a study into the cognitive performance of traumatised children with PTSD conducted by Saigh et. al. (2006). This study utilized two control groups, a traumatised group without PTSD, and a non-exposed control group. It was found that significantly lower verbal IQ scores were evident in the PTSD group in comparison to the control groups. In contrast, trauma-exposed children without PTSD did not differ significantly from non-exposed controls. The authors suggested that early identification and treatment of PTSD might enable some correction of deficits, and assist in reducing later adverse academic outcomes (Saigh, Yasik, Oberfield, Halamandaris, & Bremner, 2006).

Veltman and Browne (2001) conducted a wide-ranging review of cognitive outcomes in school-aged maltreated children. Ninety-two studies were identified in this review relating to cognitive and academic outcomes for maltreated children; sixty-five of these addressed intelligence or cognitive development as a variable. The majority of these studies (75%) found delays in cognitive development in maltreated children when compared to controls. However, it was noted that in the majority of studies from Great Britian (four of a total of five), no differences in intelligence were found between maltreated children and controls. Some of the limitations of the studies reviewed included a high number (26%) with no control group, and an appreciable proportion of studies examining children from North American schools, many of them representing children for whom low socio-economic status and associated issues may be impacting on cognitive development. Veltman and Browne (2001) noted that causal associations between maltreatment and IQ are limited by the lack of knowledge about premorbid functioning, as children growing up in a chaotic, impoverished or violent milieu have little opportunity to develop to their potential.

Recent studies have demonstrated that while IQ scores are largely associated with genetic factors in children from affluent families, they are more significantly impacted by environmental influences in families of lower socio-economic status, even when very young children are tested (Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003);(Harden, Turkheimer, & Loehlin, 2007). The impact of maltreatment experiences, often occurring in low SES environments, may represent a further environmental variable modifying general intelligence. Thus, while it is difficult to infer cause and effect, a case can be made for treating IQ scores as a dependant variable in children who are growing up in circumstances of socio-economic and emotional adversity.

It has been noted that the verbal indices of standardized intelligence tests (i.e. VIQ scores) are particularly affected by experiences of abuse. Putnam (1997)argues that language skills, both expressive and receptive, are likely to be delayed following traumatic experiences. Veltman and Browne's (2001) review identified 42 studies addressing language development, with 36 of these finding delays language skills, both expressive and receptive. However, it was noted that many of these studies drew conclusions from findings from the verbal scales of intelligence tests, which utilize learned knowledge. It was also emphasized that in more systematic investigations dividing samples by type of maltreatment, language delays are most consistently associated with neglect (Veltman & Browne, 2001).

It is questionable whether reduced VIQ scores can be validly interpreted as reflecting a specific language disorder. Lezak, Howieson and Loring (2004) note that there is a trend towards an increasing discrepancy between VIQ and PIQ as full-scale intelligence scores decrease, with lower scores on the verbal than performance scale. In contrast, individuals with a high full-scale IQ are more likely to have a higher VIQ than PIQ. In addition, it is argued that a reduction in VIQ has not consistently been related to left-hemisphere injury (Lezak et. al., 2004). Groth-Marnat (2003) also notes that discrepancies between verbal and performance scales are not diagnostic of lateralized damage. He highlights that higher scores on performance measures in comparison to verbal measures have been associated with impaired timed performance, low academic achievement, delinquency, and low socioeconomic status; as well as with language deficits or poorly developed auditory conceptual skills (Groth-Marnat, 2003).

In summary, there is evidence of impaired performance on measures of general cognitive ability amongst maltreated children. The majority of these findings come from research in North American settings, and at times have failed to control for relevant socio-demographic variables such as poverty and race. Within the literature, there is some evidence that verbal intelligence is reduced relative to performance IQ in maltreated children, and that verbal skills are more likely to be impaired in children with a history of neglect. The significance of these differences are unclear, as issues such as low socioeconomic status and delinquency are also associated with differences in verbal and performance IQ. Thus, while there is some indication of cognitive dysfunction emerging from measures of general cognitive ability, the cognitive functioning of abused children may contain a more complex pattern of

strengths and deficits that are not apparent on global measures. The next section reviews studies which examine neuropsychological functioning of abused children in more detail.

Neuropsychological functioning in maltreated children

A limited number of studies addressing the neuropsychological functioning of abused children have been published, and those that have emerged have been in some cases limited by small sample size, and by a limited range of abuse types and ages covered. However, the data they provide give some indication regarding patterns of cognitive strengths and deficits in maltreated children.

Palmer et. al. (1999) hypothesized that psychological trauma early in life may affect cognitive structures related to learning and acquisition; and more specifically that memory and "higher cognitive functioning" would be reduced in abused children. Twenty sexually abused girls and twenty controls were assessed, using the WISC-III and the Test of Memory and Learning (other tests of attention and executive functioning were also used, but results were not reported in this paper). The WISC-III verbal and full-scale IQ scores were used as measures of higher cognitive functioning, while the verbal, non-verbal and delayed memory indices were used as measures of memory. It was found that memory scores did not predict group membership; this finding was contrary to adults with post-traumatic stress disorder, who have been shown in some small studies to have impaired short-term verbal memory. The abused and non-abused groups differed significantly on their verbal intelligence scores, which is consistent with the literature discussed above; there was a non-significant trend towards lower scores in the abused group on full-scale IQ (Palmer et al., 1999).

Porter, Lawson, and Bigler (2005) compared 25 sexually abused and 24 non-abused children on both behavioural and neuropsychological measures. Behavioural measures included parent reports on the Personality Inventory for Children, Conners Parent Rating Scale, and the Trauma Symptom Checklist for Children. Neuropsychological measures included a short form of the WISC III (used to estimate verbal, performance and full-scale IQ), the Tests of Memory and Learning battery (used to derive nine indices relating to memory, recall, learning and attention/concentration), and the Stanford Achievement Test. The findings indicated a difference between maltreated and control groups on verbal IQ scores, once again

consistent with previous research. Depending on the method of analysis used, the difference in performance IQ between maltreated and non-maltreated participants was approaching significance. The findings on the memory scales suggested differences between groups on verbal memory, attention/concentration, sequential recall and free recall indices. However, when controlling for socioeconomic status and full-scale IQ, these group differences were no longer significant. A broad range of emotional and behavioural difficulties were reported in the sexually abused group, including internalizing and externalizing features suggestive of generalized psychopathology. Porter et. al. (2005) concluded that significant cognitive deficits in the domain of memory were not evident in this group; and noted that while there were significant differences between the abused and control groups on intelligence measures, the abused group were functioning in the average range, while the control group were actually in the high average range. This factor makes it difficult to interpret the findings as a deficit related to maltreatment (Porter, Lawson, & Bigler, 2005).

Beers and De Bellis (2002) considered the neuropsychological functioning of fourteen children with maltreatment-related post traumatic stress disorder, with an average age of 11 years. The findings were suggestive of deficits in attention and executive functioning, with impairments evident on tasks relating to freedom from distractibility, sustained attention, semantic organization, and conceptual set-shifting abilities (Beers & De Bellis, 2002).

Pears and Fisher (2005) focused their research on pre-school aged children, reviewing their physical growth as well as a range of neuro-cognitive abilities. Ninety-nine maltreated children in foster care were compared with non-maltreated controls from similar socio-economic backgrounds. They hypothesized that there would be a more uneven profile of cognitive development in abused children than controls, reflecting domain-specific developmental delays. They also hypothesized a relationship between growth variables (head size, height for age, and weight for height) and cognitive development. They utilized a range of measures including the NEPSY developmental neuropsychological assessment (containing attention/executive, visuospatial, sensorimotor, language and memory scores), WPPSI-R, preschool language scales, the Stroop and Card Sort tasks as measures of executive functioning. The study did not find the expected variability in abused children, with the intercorrelations between domains similar in the foster care and control groups. The groups were found to differ on the measures of visuo-spatial

functioning, language, and general cognitive functioning; there were no significant differences between the groups on weight for height, sensorimotor tasks, memory or executive functions (Pears & Fisher, 2005).

Nolin and Ethier (2007) studied the functioning of children between the ages of 6 and 12 with a history of neglect or neglect and physical abuse in comparison to controls. They utilized a developmental neuropsychological battery incorporating tests of motor performance, attention, memory and learning, visual-motor integration, language, executive functions, and intelligence. They found that tests of auditory attention and response (involving sustained and selective attention and ability to modify and inhibit responses) and visual-motor integration discriminated abused and neglected children from controls; in contrast, only children with a history of physical abuse performed worse than controls on tasks of abstraction, planning and problem-solving. The study concluded that children with a history of maltreatment are vulnerable to specific information processing deficits, and that these may vary with abuse type (Nolin & Ethier, 2007).

Another recently published study examined the neuropsychological functioning of children with a specific history of neglect, operationalized as a Department of Social Services report of neglect without sexual abuse (De Bellis, Hooper, Spratt, & Woolley, 2009). The study examined IQ, academic skills, and a range of neurocognitive domains as measured by the NEPSY neurodevelopmental assessment. Twenty-two children with a history of neglect and diagnosis of PTSD were compared to 39 with neglect (no PTSD) and 45 healthy controls. The study found a significant difference between controls and both neglect groups on full-scale IQ, language measures, visual-spatial processing, memory and learning, and visual attention and planning measures. The study found that there were few deficits associated specifically with PTSD, and that neglected children with and without the diagnosis performed similarly on most cognitive tasks (De Bellis et al., 2009).

DePrince, Weinzierl, and Combs (2009) focused specifically on the executive functioning of children with varying experiences of trauma. This included 44 with exposure to what they termed "familial trauma" (that is, occurring in the family of origin), 38 with exposure to "non-familial trauma", and 28 with no trauma exposure. They looked at performances on a range of tasks including intelligence, working memory, processing speed, inhibition, auditory attention and interference control. The study found that children exposed to familial trauma displayed poorer

performances on tasks of working memory, inhibition, auditory attention and processing speed. They also found that while socio-economic status predicted some variance in intelligence scores, it did not contribute to unique variance in executive functioning. Conversely, in this study trauma status predicted unique variance in executive functioning, but not in IQ scores (DePrince, Weinzierl, & Combs, 2009).

Mezzacappa, Kindlon, and Earls (2001) took a more naturalistic approach to studying executive functioning in maltreated (physically and/or sexually abused) males, in comparison to non-abused children with a history of emotional or behavioural problems (therapeutic non-abused), and a normal control group (public school). The children were assessed using the Revised Problem Behaviour Checklist, and experimental tasks designed to assess the capacity to inhibit behaviour in progress; and the capacity to avoid responses associated with adverse consequences (passive avoidance learning). In addition, they considered the number of times the child required redirection back to tasks. Their findings suggested that children with maltreatment histories demonstrated a greater difficulty with passive avoidance learning than both the "therapeutic non-abused" and "public school" control groups, and noted that the differences between groups became more notable with increasing age (Mezzacappa, Kindlon, & Earls, 2001).

The neuropsychological studies conducted to date display a number of limitations. Firstly, a number of them are based on samples claiming to represent relatively "pure" abuse types; this is inconsistent with the most common presentation of children in care, many of whom have experienced multiple types of maltreatment in their early development. Many studies also use limited numbers; while these studies are important, they may be lacking in power due to the high number of dependent variables involved in comprehensive neuropsychological assessment. In addition, all studies reported to date have been conducted in North America. This raises the question of generalizability of findings to the Australian context, as secondary risk factors such as levels of poverty and community violence, and the practices of the care systems supporting such children, may differ significantly between countries.

In summary, there is a limited amount of research into the neuropsychological functioning of primary-school aged children with a history of maltreatment. The finding of reduced verbal IQ is robust in the context of these studies, and some deficits on other measures of verbal abilities were also found amongst preschool aged children. In samples with an older mean age, there was some evidence of

executive dysfunction, although preschool aged children did not show difficulties on standardized executive functioning tasks. Although a number of studies predicted deficits in memory and learning, these were not apparent in the findings of the studies reported here. Finally, in preschool aged children, visuospatial functioning was also impaired in comparison to the control group. There are some limitations noted regarding the research done to date.

Summary: Context-Brain-Development

The challenges faced by children with a history of maltreatment are numerous, and research into this group has presented a range of challenges. It is not possible to experimentally control the variable of maltreatment; it typically occurs within a complex context which poses multiple risk factors to a child's cognitive, social, and behavioural development. There is a growing understanding of the impact that these associated risk factors have on brain development, but still many outstanding questions regarding the meaning of these changes and how they manifest at different developmental stages. Similarly, there are many gaps in the research on childhood development and the impact of child maltreatment specifically, particularly in understanding the pathways between early abuse and neglect and subsequent adolescent and adult outcomes.

In reflecting on context, it is recognized that the effects of maltreatment may be impacted by multiple dimensions relating to the abuse itself, and to the wider context in which it occurs. It is difficult to rigorously research the effects of abuse based on typology, as many maltreated children are exposed to multiple forms of abuse and neglect. The effects of variations in the severity, frequency, duration, and age of onset at which maltreatment occurs are even more poorly understood. Other factors within the home, such as parental mental illness, history of trauma, drug use or intimate partner violence may further confound the effects of maltreatment specifically. Finally, wider social factors such as socio-economic status, housing stress, and lack of neighbourhood resources may increase the risk of abuse, and result in poorer outcomes for children.

Research into the impact of maltreatment on the brain increasingly suggests that there are observable changes in the size of brain structures, and in neurochemical and neurohormonal functioning. There is evidence that the chronic stressor of early maltreatment may have some impact on the functioning of the HPA axis; however, findings between adults and children vary, and the findings in children show

variations from normal, but not a single consistent pattern. Similarly, imaging findings of brain morphology suggest reductions in size in a number of brain regions in children, including the corpus callosum, superior temporal gyrus, and parts of the cerebellum. However, these findings are not consistent with the adult finding of reduced hippocampal volume. In addition, it is noted that maltreatment can result in direct physical trauma to a child's brain; however, studies are limited to extreme cases of infant non-accidental brain injury, and it is not known how frequently milder cases of injury may occur, or how such lesions might impact childhood development.

Developmental research suggests that maltreated children may be at risk for poor social, emotional, behavioural and cognitive outcomes, which may be related to the alterations in brain functioning noted earlier. Children may manifest higher rates of externalizing behaviours and attentional deficits, although these may be confounded by the presence of post-traumatic stress symptoms. They may also display impairments in the regulation of affect, possibly related to deficits in developing cortico-limbic circuits. There is evidence that children who have experienced abuse or neglect; however, poor academic achievement and school adjustment has rarely been linked to evidence of alterations in brain development. Furthermore, there has been limited exploration of cognition beyond measures of general intelligence in children, although those studies that have explored other dimensions of cognition suggest that there may be selective deficits in children with a maltreatment history.

Research Goals and Hypotheses

Framework and Goals

The primary goal of this study was to document the cognitive functioning of a sample of primary school-aged children who had experienced documented maltreatment, including physical abuse, emotional abuse, sexual abuse, and/or neglect; and to compare the performance of these children with a sample drawn from the general population matched for age, gender, and socio-economic status. The study sought to extend the understanding of cognitive functioning in maltreated children beyond the analysis of IQ scores, by utilizing a selected range of psychometric tests focusing on specific dimensions of cognitive functioning. This project conceptualized a child's cognitive development from a neuropsychological framework; breaking down "cognition" into a number of domains of functioning associated with particular brain systems.

Participants were given cognitive assessments that addressed a range of domains, providing measures of:

- General cognitive capacity, including verbal and visual-perceptual reasoning
- Expressive and receptive language
- Visual-motor integration
- Processing speed
- Selective, sustained, divided attention & switching/attentional control
- Working memory
- Verbal and visual recall
- Executive functioning

The theoretical framework underpinning the study was that the contextual experiences of maltreatment would have a defining impact on the child's developing brain, and that this impact would be observable in developmental measures of cognitive ability. Furthermore, the current knowledge base regarding brain development in maltreated children allowed predictions to be made relating to potential impairments in specific domains of cognition, as well as areas where preserved functioning might be anticipated.

A major focus of the study was to examine the functioning of cognitive attributes associated with the frontal lobes and frontal-subcortical circuits in the brain (collectively referred to as "executive functions"). Based on the research presented above, it was thought that these functions may be especially vulnerable to developmental impacts associated with early trauma. The study sought to characterise in more detail attentional and executive deficits potentially associated with dysfunctions of these brain systems.

Methodological Issues

A decision was made in this study to treat general intelligence as a dependent variable, rather than as a control measure. This decision was made based on the belief that potential decreases in IQ are part of the phenomenon being studied; that is, the impact of maltreatment on the child's cognitive development. Dennis et. al. (2009) argue that attempting to treat IQ scores as a co-variate in studies of neuro-developmental disorders misrepresents the nature of the scores, and can lead to anomalous and overcorrected findings in children with specific neuro-developmental limitations. They suggest that in children, IQ should be understood as an outcome

measure reflecting the interaction of genetic potential, biology, education and experience (Dennis et al., 2009).

In addition, there was consideration given to various methods of measuring executive functioning in the current sample. It was decided to use a parent report questionnaire (the Behaviour Rating Inventory of Executive Functioning, or BRIEF), as well as attentional measures with an executive component. This decision was made based on the lack of normative data for many of the available executive tests been developed for adult populations. In addition, many executive tests which have developed normative data for children show poor reliability in the younger age ranges. The adoption of an ecological-behavioural approach was selected to obtain data on the child's functioning in everyday life, and possible behavioural manifestations of executive dysfunction. This also adds to existing literature on executive and behavioural dysfunction in maltreated children, providing carer observations of problematic behaviour specifically characteristic of executive dysfunction.

Attention in this study was not treated as a unitary construct. Previous research has provided evidence for multiple attentional systems functioning in the human brain (Manly et al., 2001; Posner & Petersen, 1990). This study selected measures designed to capture differential functioning of selective and sustained attentional systems. In addition, tasks with variable levels of executive (or attentional control) demands were included, allowing comparison of basic level attentional functioning with performance on tasks with competing attentional demands.

Beyond these issues, test selection was guided by a number of principles, including:
- Utilizing tests with Australian normative data, where available
- Utilizing tests with demonstrated ecological validity, where available
- Utilizing tests with high internal and test-retest reliability, meeting or exceeding psychometric standards of r=0.7.

Hypotheses

Based on previous research into the cognitive functioning of children and adults with a history of maltreatment, the following hypotheses were framed:

1. That, consistent with previous research into the Full Scale IQ scores of children with a history of maltreatment, the clinical group would score significantly lower than controls on FSIQ.

2. That children with a history of maltreatment would score significantly lower controls on language-based reasoning tasks, as measured by the WISC-IV Verbal Comprehension Index, but not on perceptual or non-verbal reasoning tasks, as measured by the WISC-IV Perceptual Reasoning Index.

3. Based on numerous lines of evidence suggesting that early experience of abuse and neglect may disrupt the development of the executive control of cognition and behaviour, it was predicted:

    a. That children with a history of maltreatment would perform more poorly than controls on tasks requiring executive attentional control, as measured by the attentional switching and divided attentional subtests of the Test of Everyday Attention for Children (TEA-Ch).

    b. That on attentional tasks with lower executive demands, as measured by focusing (Sky Search Targets) and sustaining (Score!) attention tasks on the TEA-Ch, performance would be equivalent between the clinical and control groups.

    c. That children with a history of maltreatment would have higher ratings than controls on the parent/carer BRIEF questionnaire instrument describing everyday executive dysfunction.

4. Based on evidence from MRI volumetric analysis of hippocampal volumes, and on previous neuropsychological studies looking at memory in children with a history of maltreatment, it was predicted that in the domain of memory:

    a. Groups would differ significantly on working memory tasks as measured by the WISC-IV Working Memory Index

    b. there would be no significant differences between groups on explicit verbal and visual memory tasks, as measured by the WRAML2 Verbal and Visual Memory Indices.

Methods

Participants

The participants for this study were twenty-eight children currently receiving services from the Take 2 Berry St program, and twenty-eight control subjects recruited from schools, with groups matched for gender and socio-economic status. Exclusion criteria included a history of severe language disorder, severe reading deficits, uncorrected visual and auditory deficits, history of non-abuse related traumatic brain injury (e.g. serious car accident), history of major organ/systemic disease affecting the central nervous system, identified psychiatric disorder, and severe behaviour problems.

Recruitment procedures and selection criteria for each of the groups are described below.

Clinical (maltreatment) group

Participants were recruited through the Take Two and Berry Street Home Based Care Services. Take Two is an intensive therapeutic service providing services to children and adolescents who have experienced abuse and neglect, and are currently clients of Child Protection in Victoria. Home based care services provide placement and support for children living out of home in foster care arrangements. All children participating in the project were required to be residing in a stable care situation, defined as a long-term placement of at least three months duration.

Participant recruitment involved several steps. Case workers from Berry Street and Take Two programs were informed about the aims and processes of the project, and asked to identify children who might be suitable as participants from their case load. Parents/guardians and children were then provided with information forms; parents or guardians were asked to provide written consent for their child to participate, while children were asked to give verbal consent at the time of commencement of assessment.

There were a total of 33 referrals to the study. Two children were excluded on the basis of behavioural disorder history, one on the basis of a language disorder, one due to placement breakdown and one due to a recent psychological assessment using similar measures to this study. The final sample therefore comprised 28 children, including 22 males (78.6% of total) and 6 females (11.4% of total). The

mean age of the group was 9.79 years (SD=1.68 years); the mean socio-economic status rating on the Australian Socioeconomic Index 2006 (AUSEI06) (McMillan, Beavis, & Jones, 2009) was 30.24 (SD=16.56). Five of the 28 participants (17.8%) reported Aboriginal or Torres Strait Islander backgrounds, and 2 (7.1%) reported having one or both parents born overseas.

Control (non-maltreatment) Group

The control participants were recruited through public school services in the northern and inner western suburbs of Melbourne. Invited schools were selected in areas matching the socio-economic profile of the clinical group participants. A letter was sent to principals of these schools, requesting their participation and explaining the aims and processes of the study. If the principal agreed to the school participating, information regarding the study was distributed to parents of students. Parents were then able to contact researchers directly to request further information and consent forms; those who chose to volunteer were asked to forward consent forms to the researcher or school.

The participants in the control group were twenty-eight children aged between six years and eleven years eleven months, including 23 boys (82.1%) and 5 girls (17.9%). The mean age of the group was 8.47 years (SD=1.4 years); the mean socio-economic status rating on the Australian Socioeconomic Index 2006 (AUSEI06) (McMillan, Beavis, & Jones, 2009) was 34.04 (SD=15.64). No participants reported Aboriginal or Torres Strait Islander background, and 11 (39.2%) reported having one or both parents born overseas.

Tests and Measures

The dependant variable measures associated with each hypothesis are listed in Table 1. The table also includes a list of demographic and supplementary measures included within the study. These measures are discussed in more detail below.

Table 1

Dependant and supplementary measures used in the study.

	Variable tested	**Measure used**
Hypothesis 1	Full-scale IQ	WISC-IV FSIQ
Hypothesis 2	Verbal reasoning	WISC-IV VCI
	Perceptual Reasoning	WISC IV PRI

Hypothesis 3a	Selective/focused attention	TEA-Ch Sky Search – Targets
	Sustained attention	TEA-Ch Score!
Hypothesis 3b	Switching accuracy	TEA-Ch Creature Counting – Accuracy
	Switching speed	TEA-Ch Creature Counting – Timing
	Divided attention	TEA-Ch Sky Search – DT
Hypothesis 3c	Behavioural executive functioning	BRIEF Global Composite Index
Hypothesis 4a	Working memory	WISC-IV WMI
Hypothesis 4b	Verbal recall	WRAML2 Verbal Memory Index
	Visual recall	WRAML2 Visual Memory Index
Demographic Measures	General demographic and medical history	Semi-structured Interview (See Appendix A)
	Abuse history	Maltreatment Classification System
Supplementary Measures	Expressive Language	WISC-IV Vocabulary subtest
	Receptive Language	PPVT4
	Visuo-motor Integration	Beery VMI5
	Executive - Behaviour Regulation	BRIEF Behaviour Regulation Index
	Executive - Metacognition	BRIEF Metacognition Index

Demographic measures

Demographic history

A brief semi-structured interview developed by researchers was used to record background data regarding gender, age, education, and language/cultural background. The interview also included a question regarding parents' occupations, which was used as the basis for calculation of socio-economic status. Finally, screening questions were listed about the child's medical history, including history of major illnesses, head injuries, and developmental disorders.

The semi-structured interview was completed using information from parents/guardians, and where appropriate combined with information based on

review of case records, and discussions with referrers. A copy of the semi-structured interview is included in Appendix 1.

Socioeconomic status: AUSEI06 Scale

Socio-economic status was determined based on parental occupational status, utilizing the Australian Socioeconomic Index 2006 (AUSEI06) (McMillan, Beavis, & Jones, 2009). This is the most recent revision of the ANU scales, which have been used as a research tool to define meaningful occupational status scores. The AUSEI06 conceptualizes occupation as a mediating variable between education and income, and utilizes information from the 2006 Australian Census of Population and Housing to generate a rating based on variables including age, sex, educational attainment, labour force status, income, and hours worked per week. This measure also offers the advantage of allowing coding of individuals not in paid employment based on highest level of education completed (McMillan, Beavis & Jones, 2009).

For the purposes of this study, information about the occupation of both parents was recorded where appropriate, or for the care-giving parent in single-parent families. Occupations were rated according to the AUSEI06, on a scale ranging from 0 (for unspecified labourers) to 100 (medical practitioners). The measure is designed so that occupations of low SES were ranked toward the lower end of the scale, scoring nearer to zero, whilst occupations of high SES yielded a rank closer to the value of 100 (McMillan, Beavis & Jones, 2009). In two parent families, an average score was obtained using the data from both parents; in single parent families, the occupational ranking of the caregiving parent was used.

Abuse history: Maltreatment Classification and Rating System

Information about abuse history for the experimental group was taken from the child's case record, supplemented if needed through consultation or clarification with their case worker at Take Two or Berry Street Home Based Care.   The data collected was then coded according to the Maltreatment Classification and Rating System (Barnett et al., 1993; Cicchetti et al., 2003). It allows for child maltreatment to be coded according to both type and severity. A brief description of the maltreatment types is included below, and Table 1 provides examples of descriptions for each abuse type based on severity level.

Types of maltreatment identified fall into six categories:

- Physical abuse – "when a caregiver or responsible adult inflicts a physical injury on a child by other than accidental means" (Cicchetti, Lynch & Manly, 2003, 77)

- Sexual abuse – "any sexual contact or attempt at sexual contact between a carer or other responsible adult and a child, for purposes of the caregiver's sexual gratification or financial benefit" (Cicchetti, Lynch & Manly, 2003, 78)

- Emotional maltreatment – "persistent or extreme thwarting of children's basic emotional needs" (Cicchetti, Lynch & Manly, 2003, 86), including needs for psychological safety and security, acceptance and self-esteem, and age appropriate autonomy.

- Physical neglect (Failure to provide) – any failure to exercise a minimum degree of care in meeting a child's physical needs (e.g. food, clothing, shelter, hygiene, medical and dental care) (Cicchetti, Lynch & Manly, 2003, 80)

- Physical neglect (Lack of supervision) – "when a caregiver does not take adequate precautions to ensure a child's safety inside or outside the home" (e.g. exposing the child to dangerous situations, and failing to take adequate precautions to assess the competency of caregivers or ascertain the child's whereabouts) (Cicchetti, Lynch & Manly, 2003, 83).

- Moral-legal/educational maltreatment – "any behaviours on the part of the caregiver…that fail to demonstrate a minimum degree of care in assisting the child to integrate with the expectations of society, which includes insuring the child's adequate education" (Cicchetti, Lynch & Manly, 2003, 89).

Each of these variables was assigned a number between 0 and 5, with 0 representing "no instances of abuse of this type", and 5 representing severe abuse of this type. In each category, the measure provided examples representing the severity score.

Table 2

Categories and Severity Ratings for the Maltreatment Classification and Tating System (Barnett & Cicchetti, 1993; cited and documented in Cicchetti, Lynch and Manly, 2003).

ACTS OF COMMISSION			
	Physical Abuse	*Sexual Abuse*	*Emotional*

			Maltreatment
Severity			
1	Minor non-accidental marks on body	Exposure to explicit sexual stimuli (no direct involvement).	Inappropriate responsibility, undermining relationships, frequent belittling, ignoring child's bids for attention, using fear and intimidation
2	Numerous or non-minor marks on body	Direct requests for sexual contact with child	Preventing age-appropriate socialization, role-reversal, infantalizing, rejecting of needs for attention, exposure to marital conflict.
3	Marks on child's head, face or neck; serious bruises or minor lacerations	Engages child in mutual sexual touching	Blames child for family problems, inappropriate expectations, threats to injure child, derogatory names, binding hands and feet, extreme/unpredictable behaviour, pattern of hostility towards child.
4	Hit with an object likely to result in serious injury; choking or smothering, serious burns	Attempts to penetrate child or actually penetrates child	Threatens suicide or abandonment, exposure to extreme marital violence, long confinement or isolation, restrictive methods of binding for up to 2 hours.
5	Injury requiring hospitalization; or permanently disfiguring injury	Forced intercourse or prostitution of child.	Suicide attempt in child's presence, homicidal attempt against child, abandons child for >24 hours, uses restrictive methods to bind child for

			>2 hours
ACTS OF OMISSION			
	Lack of Supervision	*Failure to Provide*	*Moral/Educational Neglect*
Severity			
1	Failure to provide supervision for short periods with no immediate source of danger.	Occassional failure to provide meals, clean clothing; poor hygiene; missing medical appointments or behaviour consultations	Exposure to activities under age; often allowed to stay home from school (less than 15% of reported period)
2	No adequate supervision for 3-8 hours; allowed to play in unsafe areas for up to 3 hours.	Meals missed 2-3 times per week; inappropriate clothing; no sleeping arrangements; no attempts to fix infestations in house	Participates in illegal activity with child's knowledge; allowed to miss 15-25% of school days
3	Failure to provide adequate supervision for 8-10 hours; allowed to play in unsafe area for 3-8 hours.	Frequently missed meals; no adequate provisions for shelter; does not seek medical treatment for moderately severe medial problems; unsanitary living conditions; uses drugs or alcohol in pregnancy	Does not intervene when child is involved in illegal activities; keeps child out of school for 26-50% of year
4	No supervision for extensive periods; allowed to play in a very dangerous area; no supervision in spite of destructive behaviours.	No adequate shelter; living conditions unhealthy; failure to seek treatment for life-threatening illness; failure to thrive	Adults encourage or force participation in illegal activities; child misses significant periods of school (over 50%)
5	Failure to provide adequate supervision for	Severe malnutrition; congenital drug addiction; gross	Child involved in felonies; encouraged to drop out of school or does not attend

	more than 12 hours; Child placed in a life-threatening situation	inattention to medical needs; no help for life threatening emotional problems (e.g suicide attempt).	at all

For the control group, child maltreatment status was determined via a screening question included on the demographic questionnaire. Potential participants were excluded from the study if a history of maltreatment was reported.

Dependent measures

Wechsler Intelligence Scale for Children IV (WISC-IV) Australian Language Version

The WISC-IV (Wechsler, 2003) is a measure of general intelligence for children between the ages of six and sixteen. The Australian language version comprises minor adaptations of items into Australian English as appropriate, and provides norms based on an Australian sample of 851 children (426 males and 425 females), divided into eleven age bands to match the original United States sample. The sample used was selected to reflect Australia's geographic distribution of population, and parental education level.

The measure is composed of ten compulsory subtests and five optional subtests, each taking a few minutes to complete. For the purposes of this research project, only the compulsory subtests were used. These subtests were used to calculate a full-scale IQ score (a measure of general intelligence) and four index scores: verbal comprehension, perceptual reasoning, working memory, and processing speed. The full-scale IQ (FSIQ), Verbal Comprehension (VCI) and Perceptual Reasoning (PRI) indices were used in the analysis as measures of general cognitive capacity. The Working Memory Index (WMI) was also included in the analysis as a measure of one aspect of memory functioning.

Based on statistics calculated from the Australian sample, the internal reliability coefficients of subtests are 0.8 and above; the only exception was the Symbol Search subtests which had a internal consistency coefficient of 0.79. The internal consistency coefficients for the full-scale IQ and four index scores ranged from 0.85

for the Processing Speed index to 0.95 for Full-scale IQ (Wechsler, 2003). Test-retest stability ranged from 0.84 for processing speed, to 0.95 for full-scale IQ scores (Wechsler, 2003). Validity was evidenced through internal item inter-correlations, through factor analytic studies, and through comparisons between performance on this measure and on other measures of similar constructs. The results of these studies are detailed in the WISC-IV Technical and Interpretative Manual (Wechsler, 2003).

In this study, administration and scoring were carried out according to the procedures outlined in the WISC-IV Administration and Scoring Manual (Wechsler, 2003).

Test of Everyday Attention for Children (TEA-Ch) – Screening Version

The Test of Everyday Attention was originally a test for adult populations developed to simulate attentional tasks reminiscent of those encountered in everyday life. The Test of Everyday Attention for Children (Manly, Anderson, Robertson, & Nimmo-Smith, 1999) provided a child-appropriate modification of these tasks, using stimuli modelled on video-games to assess four dimensions of attention: focused attention, sustained attention, attentional control/switching, and divided attention. Nine subtests are included in the full battery; each test is designed to "stand alone" and no global indices are calculated. The first four subtests can be used as a screening version for the four component dimensions (Manly et. al., 1999). In this study, only the first four subtests were given, and selected standard scores from each task were used in data analysis, as shown in Table 1.

Normative data for the test was based on a sample of 293 Australian school children between the ages of six and sixteen, stratified into six age bands. The youngest age band (six years to six years eleven months) contained 38 children; the other age bands relevant to this study contained between 54 and 58 children.

The reliability data for this test does not include information about the internal consistency of the tests, which Strauss, Sherman, and Spreen (2006) attribute to the speeded nature of the tasks involved. Test-retest reliabilities are moderate to strong, ranging from 0.57 to 0.81 for the subtests included in this task. The test manual (Manly, Roberston, Anderson, & Nimmo-Smith, 1999) provides evidence of construct validity via factor analysis, and convergent validity via relationships to other related measures. The factor analysis presented provides a three factor model, with factors

labelled selective attention, attentional control/switching, and sustained attention (incorporating both sustained and divided attentional tasks). Subtests showed moderate to high correlations with tests measuring similar aspects of attention, including a Stroop task, Trails Test, and the Matching Familiar Figures Test.

In this study, the subtests were administered and scored based on the instructions outlined in the test manual (Manly, Roberston, Anderson, & Nimmo-Smith, 1999).

Behaviour Rating Inventory of Executive Functioning (BRIEF)

The BRIEF (Gioia, Isquith, Guy, & Kenworthy, 2000) was designed as a measure of executive functioning in children, utilizing parent and teacher questionnaires containing items that assess the child's everyday behaviours. The scale is divided into eight clinical domains: Inhibition, Shifting, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Self Monitor.

These clinical scales are combined to form two composite indices: the Behavioural Regulation Index and the Metacognition Index, as well as a Global Executive Composite score. The Behavioural Regulation Index describes the child's capacity to modulate emotions and behaviour via inhibitory control. It is composed of three clinical scales: Inhibit, Shift, and Emotional Control. The Metacognition Index represents the child's capacities for initiation, planning and organization, and problem solving. It incorporates five clinical scales: Initiate, Working Memory, Plan/Organize, Organization Of Materials, and Monitor. Scores are reported as T scores, with a mean of 50 and a standard deviation of 10, with higher scores representing higher levels of dysfunction.

For the purposes of this study, the scores that were used were based on the Parent Form. The Global Executive Composite was used as the dependant measure of behavioural executive functioning, with supplementary analyses done on the two index scores.

The BRIEF Parent Form was normed based on 1419 respondents, weighted to reflect estimated proportions for ethnicity and gender in the US population. The respondents were parents of children aged between five and eighteen. Significant differences were found on the Parent Form based on the child's age and gender. For

this reason, the norms provided for the tests are stratified by age and gender, with four age bands covering the ages 5-7, 8-10, 11-13 and 14-18.

Internal consistency co-efficients for the Parent Form Index scores were 0.94 for the Behavioural Regulation Index, and 0.96 for the Metacognition Index. Test-retest correlation was 0.84 for the Behavioural Regulation Index and 0.88 for the Metacognition index, suggesting that parent ratings were relatively stable over a short time period. Validity studies indicated moderate relationships between the BRIEF and informant report measures of attention and self-regulation, and divergent relationships with measures of emotional functioning. Theoretical factor analysis indicated that a two factor-solution accounted for 74% of the variance; higher numbers of factors produced factors with single variables, and were deemed unviable. Principal factor analysis confirmed the two factor solution, and provided support for a separation of executive functioning constructs from externalizing and internalizing behavioural functions as measured by report scales such as the Children's Behaviour Checklist and the Behavioural Assessment of the School-Aged Child.

Wide Range Assessment of Memory and Learning II (WRAML2, Screening Version)

The WRAML2 (Sheslow & Adams, 2003) is the 2003 edition of a memory battery which allows assessment across the lifespan, with normative data for a population age range of 5-90. The normative data for the WRAML2 was developed based on a standardization sample of 1200 children and adults, with 80 participants included in each of 15 age bands. The standardization sample was matched to US Census data for gender, race/ethnicity, educational attainment and geographic region.

The full battery incorporates six subtests in its core battery, including two verbal memory, two visual memory, and two attention/concentration subtests. The manual (Sheslow & Adams, 2003) also suggests a screening version which utilizes the two verbal and two non-verbal subtests:

- Verbal memory index– list learning and story memory
- Visual memory index – Picture recall and design memory

These two memory indices are the scores which will be used for data analysis in this research.

The median internal consistency co-efficient for the verbal memory index is 0.92; across the age groups included in this study it ranges from 0.9 to 0.91. The median internal consistency measure for the visual memory index is 0.89; across the age groups included in this study it ranges from 0.82 to 0.87. Test-retest reliabilities indicate stability over time, but appreciable gains in performance with repeat assessment over the short term, indicating a learning effect on items.

A number of lines of evidence for the validity of the WRAML2 were presented in the Examiner's Manual (Sheslow & Adams, 2003). Exploratory factor analysis provided a three factor solution with the factors labelled as "visual memory", "verbal memory" and "attention/concentration." Confirmatory factor analysis supported this model as the best fit for the data, with goodness-of-fit measures falling in the >0.95 range of "highly supportive" scores. External validity data was also provided through comparing WRAML2 with other memory tests including the Wechsler Memory Scale III, the Children's Memory Scale, the Test of Memory and Learning, and the California Verbal Learning Test. The findings indicated moderate to high convergent and divergent validity amongst the scales and subscales.

In this study, subtests were administered and scored according to the processes outlined in the WRAML2 Examiner's Manual (Sheslow & Adams, 2003).

Supplementary Measures

WISC-IV vocabulary subtest

This subtest requires subjects to define the words presented, and is considered a reliable and valid measure of word knowledge. The standard score from this measure was used in data analysis. Based on statistics calculated from the Australian sample, the Vocabulary subtest of the WISC-IV has a high (0.85) internal reliability coefficient, and a very high (0.9) test-retest reliability. It is highly correlated with other measures of verbal capacity (Wechsler, 2003).

Peabody Picture Vocabulary Test 4 Form A (PPVT4A)

The Peabody Picture Vocabulary Test is a measure of receptive vocabulary; the current edition was published in 2007 (Dunn & Dunn, 2007). The test requires participants to select one of four pictures that best represents the stimulus word presented. The test provides both standard scores (represented with a mean of 100

and a standard deviation of 15) and developmental norms (represented as a developmental age or grade level based on the score achieved).

The PPVT4 normative data is based on a standardization sample of 3540 people, ranging in age from two years six months to ninety years. A sub-sample of two thousand and three cases ranging from kindergarten to grade twelve were used to develop grade norms. The sample was structured into twenty-eight age groups, and recruited to match the US population in representation of gender, race/ethnicity, socio-economic status, geographic region, and special-education status. In the age groups addressed by this study, normative data was based on samples of 125-200 children in each age band.

Internal consistency coefficients for the age groups addressed by this study were greater than 0.95, indicating that the test items are reliable. Test-retest reliabilities were all greater than 0.9, providing support for the stability of scores across time. The PPVT4 displayed moderate to high convergent validity with tests of oral language, expressive vocabulary, and reading comprehension.

In this study, administration and scoring were carried out according to the directions in the PPVT4 Manual (Dunn & Dunn, 2007).

Beery-Buktenica Developmental Test of Visuomotor Integration (Beery VMI)

The Beery VMI 5th Edition (Beery, Buktenica, & Beery, 2006) is the latest revision of the Beery-Buktenica Test of Visuomotor Integration. It assesses the development of hand-eye co-ordination in children by asking them to copy a series of geometric forms, and provides a screening measure to allow early identification of visuo-motor difficulties. Normative data for the most recent edition was obtained based on a sample of 2512 children from the United States, selected to reflect demographic characteristics consistent with 2000 US Census data. The internal consistency alpha of the test was determined to be 0.82, while odd-even split-half correlation was 0.88. Inter-scorer correlations were measured at 0.92. The test was found to be moderately correlated with other tests of drawing and copying, and demonstrated construct and predictive validity.

The full (30 item) form of the Beery VMI was administered to participants. Tests were administered and scored according to the guidelines in the Administration, Scoring and Teaching Manual (Beery, Buktenica & Beery, 2006).

Procedure

When informed consent from parents/guardians was obtained, arrangements were made to commence assessment. Children were tested in a range of settings. The majority of children from the clinical group were tested in a consulting room (with a table and chairs) or therapy room (containing table, chairs, and play space) at the office of the referring clinician, or in a quiet room at the child's school. All children in the control group were tested in a quiet and vacant room on the school grounds. Assessments were scheduled in school hours. At the commencement of the first session, the child was provided with a verbal explanation of the purposes and procedures involved in the assessment, and asked for verbal consent to participate.

Assessments were divided into two sessions, which took most children between an hour and ninety minutes to complete. All children were monitored for signs of fatigue or distractibility, and were given short (2-5 minute) breaks within the course of the session as needed. The order of the tests, and the order of sessions, was rotated from child to child. Original and counterbalanced orders are presented in Table 3.

Table 3

Original and counterbalanced orders for test administration

	Session 1	Session 2
Child 1	Beery VMI, WISC-IV	TEA-Ch, WRAML2, PPVT4
Child 2	TEA-Ch, WRAML2, PPVT4	Beery VMI, WISC-IV
Child 3	WISC-IV, TEA-Ch	WRAML2, PPVT4, Beery VMI
Child 4	WRAML2, PPVT4, Beery VMI	WISC-IV, TEA-Ch

A number of children were not available for testing on more than one occasion, either due to distances involved in travelling to the assessment, or other transport constraints. In this situation, the two sessions were held on a single day, with the child provided with time for an extended break between the two sessions.

Parent/carer questionnaires were either mailed or given to parents or carers by the referring case worker, or by the researchers. When mailed, parents/carers were asked to return the questionnaire in a reply-paid envelope; otherwise they were asked to return the questionnaire to the case worker or to bring it to the second assessment session.

Ethical Approval

This study was approved by the Victoria University Human Research Ethics Committee; the Victorian Department of Human Services Human Research Ethics Committee; Berry St Victoria; and the Department of Education and Early Child Development Research Ethics Committee (See Appendix 2).

<center>**Results**</center>

Process of Analysis

Descriptive statistics were used to characterize the two groups on the variables of age, gender, and socioeconomic status. Descriptive data regarding type and severity of abuse was also analysed for the clinical group.

For experimental variables, descriptive statistics were initially determined for each variable of interest, and normality assumptions tested. Hypotheses were then tested using independent samples t-tests, and descriptive statistics reported where appropriate using supplementary measures within the cognitive domain (Field, 2009). As a total of thirteen dependent variables were being considered, and there were a limited number of participants in each group, significance was determined based on a Bonferroni-adjusted alpha level of 0.0038. When significant differences were found between groups, effect size was calculated using Cohen's d statistic. Standard cutoffs were used to characterise effect size, with d≥0.2 indicating a small effect size; d≥0.5 indicating a moderate effect size; and d≥0.8 representing a large effect size (Cohen, 1988).

Further descriptive analysis was also carried out to determine the percentage of subjects presenting with scores denoting clinical risk (as determined by a score in or below the "borderline" range on psychometric tests; or in the "clinical" range on the BRIEF).

All statistical analyses were conducted using SPSS 16.0 statistical software.

Demographics of samples

Statistics related to age, socioeconomic status and gender are reported in Table 4. Based on the final samples, a one-way ANOVA indicated that difference in age between maltreated children and controls was statistically significant, $t(54)=3.209$, $p=0.002$. There was no significant difference between groups on Socio-Economic Status, $t(54)=-0.882$, ns; or on gender distribution within the samples, $t(54)=0.331$, ns.

<center>75</center>

Table 4

Demographic Data for Age, Gender and SES of Each Group

	Maltreated Group	**Control Group**
No. of Participants (n)	28	28
Age		
Range	6y1m-11y11m	6y4m-11y5m
Mean	9.797	8.470
Standard Deviation	1.68	1.40
ANOVA		$F(1,54)=10.295, p>0.002$
Socio-Economic Status		
Range	7.9-77.3	11.0-84.6
Mean	30.245	34.04
Standard Deviation	16.56	15.64
ANOVA		$F(1,54)=0.777$, ns
Gender		
No. of Males	22	23
No. of Females	6	5
ANOVA		$F(1,54)=0.109$, ns

Abuse characteristics

There were no reported instances of abuse or neglect in the control group. The clinical group presented with a range of abuse types, with all children reported to have experienced neglect, as well as physical, sexual or emotional abuse (acts of commission). The mean total severity score, based on the highest severity rating of each child for any abuse/neglect type, was 3.5 (SD=0.64). The mean number of abuse types reported for each child was 4.36 (SD=0.91).

Table 5 presents the total number of cases and mean severity score for each type of abuse, as per Barnett & Cichetti's (1993) classification. The most common form of

abuse reported was emotional abuse, reported in the histories of all experimental participants. The mean emotional abuse score was 2.85 (SD=1.044).

Table 5

Total Cases, Means and Standard Deviations for Type and Severity of Abuse in Maltreated Group (N=28)

Abuse Type	Number of Cases	Mean Severity Rating	Standard Deviation
Physical Abuse	22	1.89	1.37
Sexual Abuse	11	1.00	1.41
Emotional Abuse	28	2.85	1.044
Neglect: Failure to Provide	24	2.39	1.28
Neglect: Lack of Supervision	24	2.00	1.09
Moral-Educational Neglect	13	1.00	1.24

Twenty-two children were reported to experience physical abuse, with a mean physical abuse score measured at 1.89 (SD=1.37), and the mean score for non-zero responses being 2.41. Eleven children were reported to have a history of sexual abuse. The mean severity for the total experimental group was 1.00 (SD=1.41), while the mean for non-zero responses was 2.55.

Instances of neglect were also frequently reported on the three neglect subscales. Twenty-four children scored on the dimension of Failure To Provide. The mean severity score for the total group was 2.39 (SD=1.28). The same number of children were reported as being exposed to Lack of Supervision, with a mean severity score of 2.00 (SD=1.09). Thirteen children were also reported to have a history of Moral-Educational Neglect. The mean severity score in this area was 1.00 (SD=1.24), while the mean for non-zero responses was 2.15.

Hypothesis 1: Full-scale IQ

The first hypothesis stated that Full-scale IQ as measured by the WISC-IV would be significantly lower in the maltreated group than in controls. The mean WISC IV full-scale IQ and index scores for each group are displayed in Figure 1.
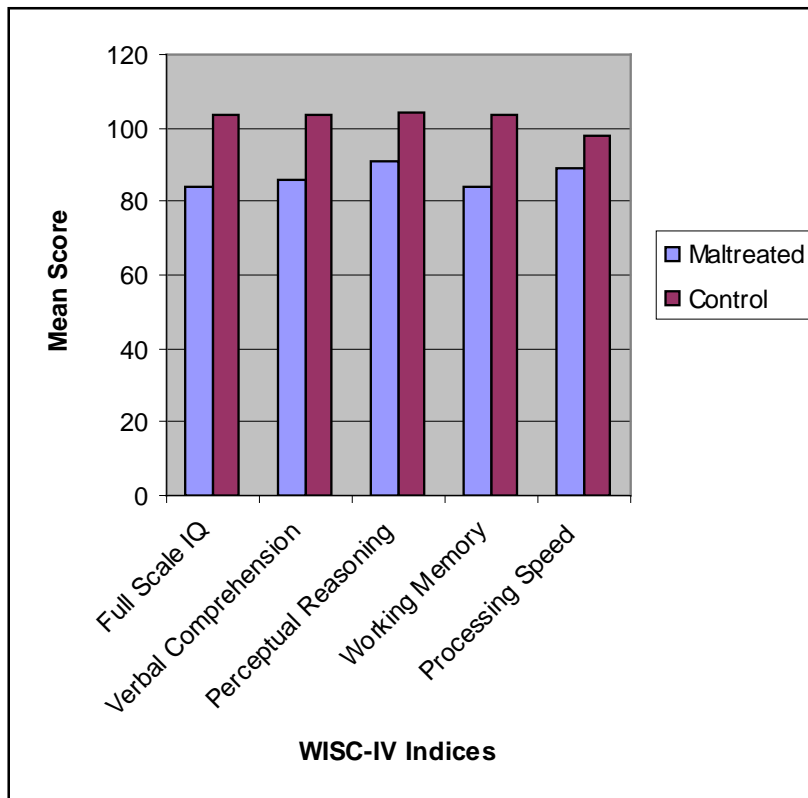
Figure 1. Mean WISC-IV Full-Scale and other Index scores by group.

The mean Full-Scale IQ score for the maltreated group was 84.21 (SD=8.86); the mean for the control group was 103.71(SD=11.22). It was found that as predicted, the difference between groups calculated using one-way ANOVA was significant, t(54)=-7.216,p<0.001. The effect size, calculated using Cohen's d statistic, was 1.95, indicating a large effect based on Cohen's (1988) threshold values.

Hypothesis 2: Verbal and Visual Processing

The second hypothesis stated that children with a history of maltreatment would score significantly lower than controls on language-based reasoning tasks, but not on perceptual/non-verbal reasoning tasks. Group comparisons were conducted based on the Verbal Comprehension and Perceptual Reasoning indices of the WISC-IV. The mean verbal comprehension score for the control group was 103.29 (SD=11.45), compared to a mean for the maltreated group of 86.11 (SD=9.64). Consistent with the hypothesis, it was found that the difference between groups was significant, t(54)=-6.074, p<0.001. Based on Cohen's threshold values, this represented a large difference between groups, d=1.64.

The mean Perceptual Reasoning Index score was 103.93 (SD=10.95) for control subjects, and 90.96 (SD=11.33) for maltreated subjects. One-way ANOVA indicated a significant difference between groups after controlling for age, t(54)=-4.353, p<0.001. This finding was not consistent with the hypothesis that children with a maltreatment history would display age appropriate perceptual reasoning abilities. Effect size between the groups was large, d=1.17.

Supplementary measures of Verbal and Visuo-motor processing

Supplementary measures of language and visuo-motor abilities were also included in the assessment battery given to children. The language measures included receptive (Peabody Picture Vocabulary Test) and expressive (WISC-IV Vocabulary Subtest) vocabulary measures. The mean scores for each group on these measures are found in Table 6.

The analysis shows that children in the clinical group consistently performed more poorly than children in the control group. However, it is also noted that on the PPVT4, children in the control group performed at the high end of the average range (M=112.71, SD=11.89), while children in the clinical group scored well within a standard deviation of the population mean (M=94.04, SD=10.86). Similarly, the control group mean on the expressive vocabulary subtest was above the standardized test mean (M=11.42, SD=2.74), although the maltreated group scored at the lower end of the average range (M=7.04, SD=1.71).

Table 6

Means and Standard Deviations for the Peabody Picture Vocabulary Test and WISC-IV Vocabulary subtest between maltreated and control groups

		Peabody Standard Score	Vocabulary Standard Score
Maltreated	Mean	94.0357	7.0357
	Std. Deviation	10.86442	1.71015
Non-Maltreated	Mean	112.7143	11.4286
	Std. Deviation	11.89415	2.74103

Figure 2 shows the number of participants in each group performing at or below the 'borderline' range on the vocabulary measures listed above. The chart indicates that although there were significant differences between groups, only two children from the clinical group and none from the control group performed at clinically at-risk levels on the Peabody Picture Vocabulary Test, suggesting that the higher than expected performance by control group participants influenced the significance of findings. In contrast, 12 of the 28 maltreated children performed in the borderline range on the expressive vocabulary task; compared to only one from the control group.
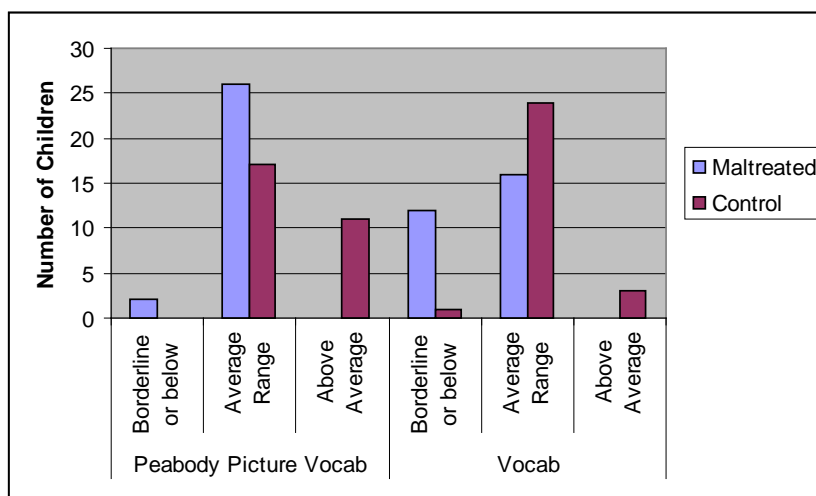
Figure 2. Number of participants performing in at-risk or age expected levels on supplementary language tasks, by group.

Visuo-motor integration was assessed using the Beery Butkenica Visuo-Motor Integration Test. The mean score for maltreated children on this measure was 84.82 (SD=10.78); the mean score for the control group was 94.67 (SD=10.39). As shown in Figure 3, a higher number of children from the maltreated group (N=8) performed at clinically at-risk levels on the Visuo-Motor Integration Test, compared to 2 children from the control group.
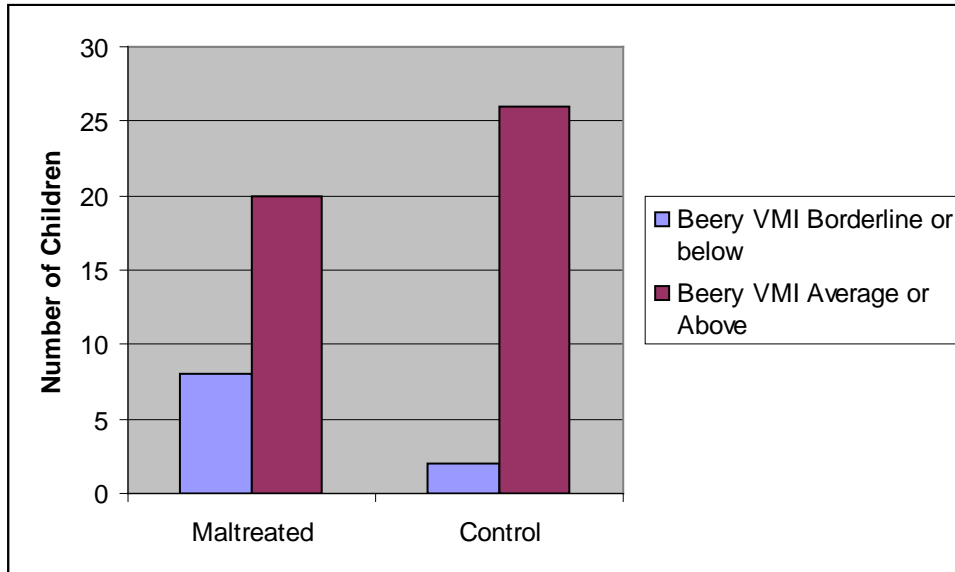
Figure 3. Number of participants performing in at-risk or age expected levels on a supplementary visuo-motor test, by group.

Hypothesis 3: Attention and Behavioural Executive Measures

The third hypothesis predicted that children with a history of maltreatment would perform at an equivalent standard to controls on attentional tasks with lower executive demands (TEA-Ch Sky Search and Score! subtests), but would show relative decreases in performances on attentional tasks with higher executive demands (TEA-Ch Creature Counting and Sky Search Dual Task subtests). It was further predicted that executive difficulties would be evident in the parent/carer behavioural rating on the BRIEF.

Basic speed of information processing was also measured using the WISC-IV Processing Speed Index. This index might be conceptualized as measuring a low-level information processing ability, specifically the capacity to locate a stimulus and produce a written response in a timely way. Many children with neurological conditions including acquired brain injury evidence deficits in speed of processing that may affect their performance on cognitive tasks. Given that other tasks of attention used in this study have timed components, processing speed was considered a variable of interest for this area. The study found that children with a history of maltreatment had a mean score of 89.25 (SD= 12.92). Control children scored a mean of 98.18 (SD=13.41). The difference between scores was not significant at the Bonferroni-adjusted alpha level, $t(2,54)=-2.537$, $p=0.014$, ns.

Table 7 displays the means and standard deviations for the two groups on the tests from the TEA-Ch that measured lower level attentional skills, focusing and sustaining attention. Consistent with the hypothesis that basic attentional functioning would not be impaired in children with a history of maltreatment, no significant differences were found between experimental and control groups on these measures.

Table 7

Means and Standard Deviations for Sky Search (focus) and Score (sustain)
attentional tasks from the TEA-Ch, and significance

		Sky Search - Targets	Score!
Maltreated	Mean	9.64	8.46
	SD	2.30	3.05
Control	Mean	9.93	9.61
	SD	3.28	3.49
Significance of Difference		t=-0.378, ns	t=-1.305, ns

On the focusing measure (TEA-Ch Sky Search-Targets SS), the maltreated group received an average scale score of 9.64 (SD=2.30), compared to a mean score of 9.93 (SD=3.28) for control children. The difference between groups was not significant, t(54)=-0.378, ns.

On the sustained attention measure (TEA-Ch Score! SS), the mean score for the clinical group was 8.46 (SD=3.05), compared with a mean score for the control group of 9.61 (SD=3.49). No significant difference was found, t(54)=-1.305, ns.

Table 8 shows the means and standard deviations by group for the Creature Counting and Dual Task measures from the TEA-Ch. These measures reflect more complex aspects of attention, requiring a greater executive control of attentional abilities.

Table 8

Means and Standard Deviations for Creature Counting (attentional control/switching) and Sky Search Dual Task (divided) attentional tasks by group

		Creature Counting – Timing	Creature Counting – Total Correct	Sky Search - Dual Task
Clinical	Mean	5.71	8.00	3.71
	SD	3.63	3.19	3.16
Control	Mean	8.21	9.96	7.14
	SD	4.16	2.95	4.07
Significance of Difference		t=-2.394, ns	t=-2.394, ns	t=-3.520, p=0.001

On the Creature Counting (Switching/Attentional Control) measure, it was found that contrary to the hypothesis, there were no significant differences between groups on timing or accuracy. The mean accuracy score for children with a history of maltreatment was 8.00 (SD=3.19), compared to a mean for control children of 9.96 (SD=2.95). The difference between groups was not significant, $t(54)=-2.394$, $p=0.02$. The average scale score for length of time to perform switches was 5.71 (SD=3.63) for the maltreated group, while the average score for control children was 8.21 (SD=4.16). One-way ANOVA found no significant difference between groups at the Bonferroni-adjusted alpha level of 0.0038, $t(54)=-2.394$, $p=0.02$.

The Sky-Search Dual Task measure measures children's capacity to divide their attention between simultaneous tasks, one requiring attention to auditory stimuli, and one requiring visual scanning. The mean scale score for experimental children on this task was 3.71 (SD=3.16), while the mean score for control children was 7.14 (SD=4.07). As predicted, there was a significant difference between groups, $t(54)=-3.520$, $p=0.001$. The effect size using Cohen's threshold level was found to be large, $d=0.95$.

In regard to the clinical significance of these findings, Figure 4 presents the number of cases from each group scoring at or below the borderline range on complex attentional measures. It was evident that a majority of children in the maltreated group displayed significant difficulties with the divided attention task, while both

groups had a high number of children performing poorly on the timed Creature Counting task.
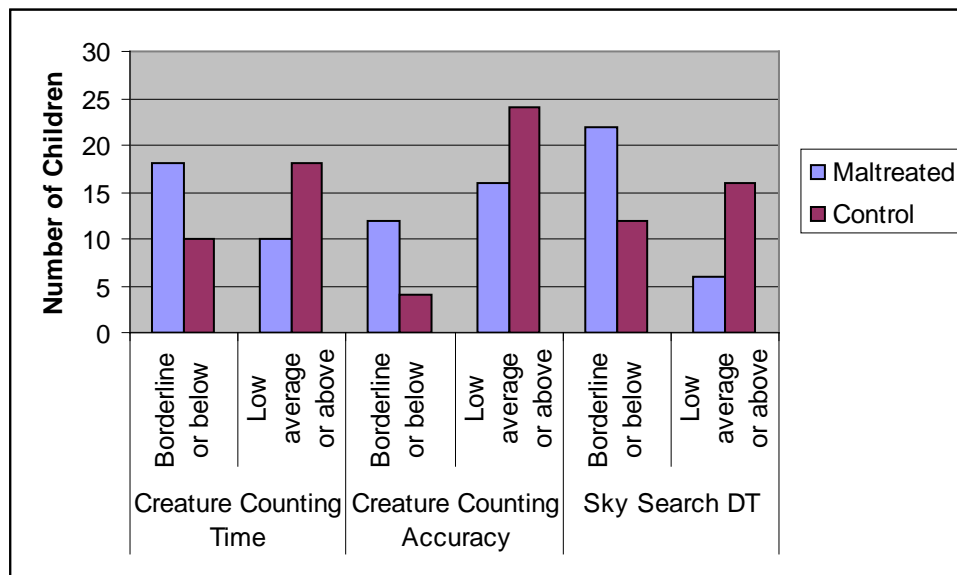
Figure 4. Number of participants performing at or below the borderline range on executive-attentional measures.

In addition to measuring attentional executive capacities on cognitive tasks, a behaviour rating of executive function was also obtained using the Behaviour Rating Inventory of Executive Functioning (BRIEF), completed by the child's parent or carer. All of the inventories sent out for participants in the experimental group were returned; however, in the control group only 25 of the 28 questionnaires were returned, representing a return rate of 89.28% for the control group and 94.64% overall.

The scores presented here are T-scores with a group mean of 50 and standard deviation of 10. Higher scores on the scale indicate a greater level of dysfunction, and the BRIEF Professional Manual (Gioia et al., 2000) recommends that scores above 65 should be considered as representing areas of potential clinical concern.

Table 9

Means and Standard Deviations for Global and Index scores on the BRIEF by Group

Group		BRIEF-Behaviour Regulation	BRIEF - Metacognition	BRIEF-Global Composite
Maltreated	Mean	72.6071	66.6786	70.1071
	Std. Deviation	12.26358	10.12534	10.35782
Control	Mean	49.6800	49.4000	49.1200
	Std. Deviation	10.10247	10.98863	10.65880

As seen in Table 9, the mean Global Composite score for the clinical group was 70.1071 (SD=10.35); the mean for the non-maltreated children was 49.12 (SD=10.66). Consistent with the hypothesis, it was found that the difference between groups was significant, $t(51)=7.264$, $p<0.001$. Based on Cohen's threshold values, this once again represented a large difference between groups, $d=-2.02$.

On the Behaviour Regulation Index, it was found that the mean score for maltreated children was 72.61 (SD=12.26). In comparison, the mean for the control group was 49.68 (SD=10.10).   The average score for experimental participants on the Metacognition Index was 66.68 (SD=10.13), while the mean for control children was 49.4 (SD=10.99). It swas observed that a high percentage of children in the maltreated group returned scores in the clinically significant range on the index scores, as shown in Figure 5. In particular, a majority of maltreated children (n=20) were reported to display clinically significant problems with behavioural regulation, compared to only one of the control children.
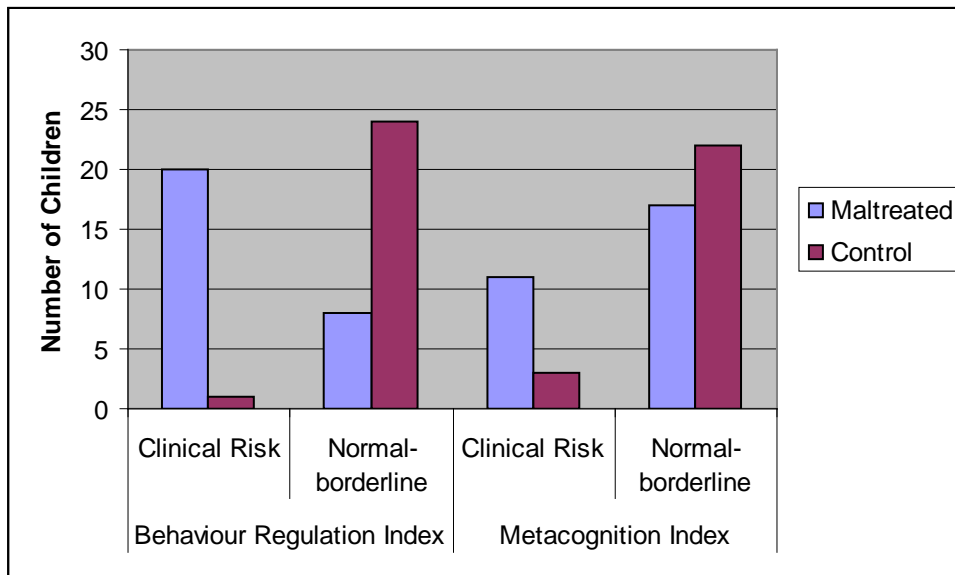
Figure 5. Number of children reporting BRIEF index scores in the clinically at-risk range, by group.

Hypothesis 4: Memory

In the domain of memory, it was hypothesized that children with a history of maltreatment would perform more poorly on working memory tasks, but would not show any significant differences from controls on task of verbal and visual recall.

The WISC-IV Working Memory Index assessed children's capacity to maintain a limited amount of information and to manipulate that information according to task requirements, an ability that integrates attentional, memory and executive control skills. Children with a history of maltreatment received a mean index score of 84.18 (SD=8.65) while children from the control group scored an average of 103.61 (SD=11.42). Consistent with the hypothesis that children with a history of maltreatment would display impairments with such tasks, a one-way ANOVA found a significant difference between groups, $t(54)=-7.299$, $p<0.001$. Based on Cohen's threshold values, this also represented a large difference between groups, $d=1.97$.

The Verbal and Visual Indices of the WRAML2 provide an assessment of children's abilities to recall a supraspan amount of information immediately after presentation. The means and standard deviations for the two indices for each group are provided in Table 10.

Table 10

Means and Standard Deviations for Verbal and Visual Memory Indices of the
WRAML II by Group

		Verbal Memory	Visual Memory
Maltreated	Mean	95.11	89.96
	SD	12.70	11.41
Control	Mean	107.61	95.61
	SD	11.99	10.56
Significance of Difference		t=-3.787, p<0.001.	t=-1.921, p=0.06

As noted in Table 10, the control group performed well on the Verbal Memory Index, scoring a mean of 107.61 (SD=11.99). In comparison, maltreated children scored an average scale score of 95.11 (SD=12.70). Although the hypothesis predicted no difference between groups, a significant difference was found on one-way ANOVA, t(54)=-3.787, p<0.001. Once again, this represented a large effect size, d=1.02.

On the Visual Memory Index, children in the maltreated group scored an average scale score of 89.96 for visual recall (SD=11.41), while control children scored on average 95.61 (SD=10.56). Consistent with predictions, the difference between groups on visual memory tasks was not significant, t(54)=-1.921, p=0.06, ns.

Discussion

This study sought to examine whether a group of children with a history of maltreatment would display evidence of cognitive impairments on standardized cognitive assessment instruments. It was predicted that impairments would be found in areas the areas of full scale IQ, language, attentional-executive performance, and working memory. Broadly speaking, support was found for the majority of hypotheses put forward, with findings suggesting perhaps a greater spectrum of impaired performances than was originally predicted.

The first two hypotheses predicted that children with a history of maltreatment would display relative impairments in full scale IQ and in performance of verbal comprehension tasks, but not on tasks assessing perceptual reasoning abilities. Contrary to this prediction, it was found that along with reductions in both measures of overall cognitive ability and verbal comprehension, perceptual reasoning abilities were also reduced compared to controls.

Secondly, it was predicted that more executively demanding aspects of attention (divided attention and rapid switching) would be reduced, while lower level attentional abilities would be comparable to controls. Consistent with this hypothesis, it was found that basic capacities to focus and sustain attention were equivalent between groups, while divided attentional abilities were significantly different. However, the hypothesis that rapid switching would be impaired in maltreated children was not supported.

In addition, it was predicted that children with a history of maltreatment would display behavioural signs of executive impairment, characterized by higher parent/carer reports of impairments in behavioural regulation. Based on scores on the BRIEF behaviour rating questionnaire, it was found that groups differed significantly on global ratings of executive function, with maltreated children displaying a high rate of clinical impairment on both behavioural regulation (inhibition, switching and emotional control) and metacognition (initiation, self-monitoring, planning and organization and working memory).

Finally, it was hypothesised that there would be evidence of decreased working memory in children with a history of maltreatment, but that there would not be

significant differences between groups on measures of verbal and visual recall. It was found that working memory abilities were indeed decreased in children with a history of maltreatment. However, the study also found a significant difference between groups on immediate verbal recall. The clinical significance of this finding must be considered in the light of the high verbal scores achieved in the control group, as noted in a discussion of supplementary measures.

Importance of IQ deficits

Veltman and Browne (2001) highlight that the gap observed between children with a history of maltreatment and their same aged peers on general intelligence measures is difficult to interpret. They note that the weakness in arguing for a causal relationship is the lack of knowledge about the status of children prior to experiencing maltreatment; to demonstrate a causal relationship researchers would need to show a reduction from "pre-maltreatment" cognitive abilities.

This argument strikes at the heart of the challenge in researching maltreatment outcomes; that abuse happens within a context often incorporating multiple risk factors, and these factors are often impacting the child from the earliest stages of their development. It may, in fact, be inappropriate to treat IQ in this situation as a measure of 'acquired injury', reflecting a change from pre-morbid status. Rather, a neurodevelopmental model would suggest that the brain's potential capacities are modified early in development, and that poor IQ scores and other markers of cognitive dysfunction are reflective of these developmental disturbances. Teicher et. al. (2003) advanced a similar argument, proposing that children with a history of maltreatment might be conceptualized as being on an 'alternative neurodevelopmental pathway'. They argued that the brain responds to exposure to early stress by developing connections adapted to potential life-long stress or deprivation; these pathways may present as maladaptive in a more benign environment, manifesting as physical or psychiatric vulnerabilities. Similarly, with more of the brain's resources directed towards survival and responding to perceived environmental threats, there might be an expectation of lower skills in the complex reasoning and problem solving tasks presented in intelligence tests.

Veltman and Browne's (2001) critique also raises questions about the treatment of IQ scores as an expression of genetic potential in young children; as a pure score of "innate ability" uncomplicated by early environmental influences. As noted

previously, there is evidence that IQ scores have been found to express greater heritability in children from more affluent families, while in children living in poverty up to 60% of variance in IQ is associated with environmental factors (Turkheimer et. al., 2003). Turkheimer et. al. (2003) noted that impoverished environments may represent a major modifier of developing intelligence, although it was noted that it was difficult to determine whether the variability observed was a result of greater genetic expression in favourable environments, or a tendency towards more unpredictable outcomes in poor environments. A replication of the study in an adolescent group also found a tendency for environmental influences to play a greater role in IQ outcomes in poorer families, while genetic contributions to variability rose in higher income families (Harden, Turkheimer, & Lohen, 2007). In the latter study, however, the pattern was less robust, possibly reflecting the fact that less of the adolescents studied were living in extreme poverty. It is also noted that heritability of cortical thickness in regions associated with complex cognitive skills (e.g. language and executive function) becomes more marked with greater maturation into adolescence; younger children show higher environmental variability (Lenroot et al., 2009).

The children examined in this study face not only the potential vulnerabilities of an impoverished home environment, but a more extreme experience of deprivation in the form of neglect, involving both the lack of physical resources associated with poverty, and a lack of nurturing and social support. In particular, neglect may involve failure to provide appropriate nutrition, shelter, and stimulation; poor supervision and exposure to unsafe environments; and limitations in educational opportunities and medical care. In addition, many of the children assessed had been exposed to interpersonal violence or threats of harm, and a significant portion had experienced physical or sexual abuse.

The circumstances of maltreatment may present children with reinforcement for learning a different skill than that assessed by academic-intelligence tests. In an environment where parents are disengaged, neglectful, or potentially volatile, children are unlikely to be encouraged to express themselves or engage in conversation, and may even be fearful of expressing their needs. They may also be less likely to be exposed to written verbal material. It is therefore unsurprising that they display limitations in the development of language and verbal reasoning skills. Similarly, the development of problem-solving skills is likely to be applied to basic survival needs; for example, getting food, or avoiding violence. The application of

these skills to more abstracted, less emotionally-charged reasoning tasks may well be limited, and such tasks may be perceived as illogical or irrelevant.

The fact that verbal IQ in particular tends to be lowered in children with a maltreatment history emphasises the fact that the effects of maltreatment on cognition should be viewed as neurodevelopmental impairments, not as acquired injuries. In adult research, the Wechsler verbal IQ score, and particularly the Vocabulary subtest, is viewed as a "hold" test of acquired knowledge that is unlikely to be affected by brain injury except in cases of frank aphasia. For a child the acquisition of verbal and semantic knowledge is in formation; disruptions in neural development caused by extreme environmental stressors do not match well to an acquired brain injury model.

This does not discount the complexity of factors that may lead to low IQ scores in maltreated children. There may be genetic vulnerabilities in many children towards lower functioning; whilst only 3% of parents reported for child maltreatment have a frank disability (Victorian Department of Human Services, 2002), it is likely that low average and borderline IQ scores may be over-represented in parents of low socio-economic status, and reported neglect or abuse of children may represent a marker of limited cognitive resources available to the parents, as well as poor coping and support systems in other ways.

In addition, the finding highlights the effects of environmental opportunity at critical developmental periods on subsequent cognitive outcome. As noted by Coster et.al. (1989), interactions between neglectful mothers and their infants are often characterised by reduced reciprocity and limited verbal interaction; longer term studies of children's language suggest deficits in verbal reasoning and in complex aspects of language such as speech organization and syntax (Coster, Gersten, Beeghly, & Cicchetti, 1989; McFadyen & Kitson, 1996).

Language Skills

This study examined the difference between children with a history of maltreatment and controls on language-based tasks. Whilst the primary measure used in this comparison was the Verbal Comprehension scale of the WISC-IV, descriptive comparisons were also performed between performance on single-word expressive and receptive vocabulary measures.

Consistent with the global pattern of performance, children with a history of maltreatment performed below controls on both expressive and receptive language measures. However, it was noted that on both tests, the control group performed above population means. This was an unexpected finding, and calls for some caution in interpreting the findings given the limited numbers involved in this study.

Comparing the groups to population means, it was evident that in the area of receptive vocabulary in particular, the difference between groups was more indicative of higher than expected performances of control children, with almost 40% (11 in total) scoring significantly above the population average. In contrast, the majority of children in the maltreatment group were within population norms, with only two displaying a clinically significant deficit (scores in the range of 70-80). This suggests that while there may be subtle decreases in receptive vocabulary performance across the population of maltreated children, this rarely reflects a clinical vulnerability or frank receptive language disorder.

A comparison of children's expressive vocabulary to population norms, however, yielded a different picture. Based on performances on the WISC-IV Vocabulary subtest, children with maltreatment had significant limitations in their ability to explain the meanings of words. Twelve of the twenty-eight maltreated children (42%) performed below the population average range; only one of the control children performed as poorly.

The findings of this study therefore lend support to the proposition that children with a history of abuse and neglect are vulnerable to speech and language disorders, with this study indicating that expressive language in particular is negatively impacted by maltreatment experiences. A social-interactional or attachment model is often employed in interpreting the limited language skills of maltreated children. In Greenough & Black's (1992, cited in Glaser, 2000) model of development, the process of language development might be considered as experience-expectant; when caregivers fail to offer the verbal stimulation at appropriate developmental stages, language development may be placed on an abnormal pathway, leading to longer term deficits in expressive communication.

Functionally, this may have significant impact on children's adaptation to the social and academic demands of school life. A child who cannot communicate clearly may

struggle to negotiate interactions with peers, and may present as immature or withdrawn. They may also have difficulties with requesting help from teachers, and with work that involves oral presentation. Unfortunately, they may also rely on behavioural communication, and express their feelings and frustrations with explosive outbursts. Children with a history of maltreatment, who are likely to have witnessed parents being physically and verbally abusive towards themselves or others, will be particularly vulnerable towards applying these expressions of anger to their own frustrations and peer conflicts.

Perceptual and Visuo-Motor Skills

An unexpected finding in this study was that children with a history of maltreatment displayed poor perceptual reasoning and visuo-motor skills in comparison to controls. In general, previous studies have found that on standardized IQ tests, maltreated children show a pattern of impaired full-scale and verbal IQ, but relatively preserved performance IQ or perceptual reasoning skills (Veltman & Browne, 2001).

The finding of reduced performances for maltreated children in this study may reflect, at least partially, refinements in the conceptualization and measurement of perceptual or "performance" intelligence. Previous forms of the Wechsler intelligence scales defined two indices, the auditory-verbal tests which were believed to reflect "crystallized" or acquired semantic knowledge, and performance or non-verbal tests which were conceptualized as an index of "fluid" knowledge or learning ability. Recent refinements to the Fourth Edition of the scale involved factor analysis across a range of populations, with a finding that the subtests of the scale best fit a four-factor model, involving fluid (perceptual) and crystallized (verbal) reasoning measures, as well as indices of working memory and processing speed (Wechsler, 2003).

As a result, the WISC-IV Perceptual Reasoning index used in this study is not directly comparable with the Performance IQ measures used in other studies based on previous editions of the WISC. In particular, it does not incorporate subtests involving processing speed. It may be that the more refined measure of fluid intelligence represented by the Perceptual Reasoning Index makes apparent differences between maltreated children and controls that were not as evident on the more global performance IQ.

However, it is also noted that while PIQ differences have not been consistently found in previous research, at least one study working from a neuropsychologically oriented framework identified deficits in visuo-spatial processing in preschool aged children with a history of maltreatment (Pears & Fisher, 2005). The current study found further evidence that children with a maltreatment history may have some difficulties with understanding visual information and developing grapho-motor skills.

Just as expressive language skills are generally lateralized to the left hemisphere of the brain, visual-spatial processing is frequently lateralized to right hemisphere. Teicher et. al. (2003) note the consistent finding that children exposed to early trauma show delays in myelination of the corpus callosum, which may have an ongoing impact on hemispheric integration and organization. There is evidence amongst children exposed to maltreatment of a tendency towards a reversal of the usual L<R signal coherence on EEG, suggestive of a reduction in left hemispheric development and a reversal of normal left hemisphere dominance in abused children (Ito, Teicher, Glod, & Ackerman, 1998). In addition, the normal frontal lobe asymmetry (R>L) has been found to be attenuated in children with a maltreatment history (Carrion et. al. 2001). It may be that the difficulties with visual-spatial and visual-motor performance are amongst the clinical manifestations of this structural cortical disorganization.

In other neurodevelopmental disorders, reductions in white matter volume (including/particularly in the corpus callosum) have been associated with a cluster of deficits sometimes referred to as non-verbal learning disability. The primary features of this syndrome include difficulties with the acquisition of mathematical skills, poor fine motor co-ordination and frequently with difficulties reading social situations. These deficits can emerge spontaneously, or as a result of a condition such as hydrocephalus or agenesis of the corpus callosum, affecting the white matter tracts within the right hemisphere or between hemispheres.

Functionally, difficulties with visual-perceptual reasoning and visual-motor integration may further disadvantage children in the acquisition of key academic skills. Visual-spatial reasoning abilities are particularly fundamental to many mathematical concepts, and impairments may present as difficulties acquiring numeracy and arithmetical knowledge. In addition, the co-ordination of visual and motor systems is an important component of developing writing skills, and children who struggle with

visuo-motor integration may therefore have difficulty with learning letter formation and handwriting.

Given that there is neurophysiological and emerging neuropsychological evidence that children with a history of abuse may display white matter deficits similar to those observed in non-verbal learning disorders, it is possible that this syndrome is over-represented in children with a maltreatment history. Although this study did not investigate the social aspects of this disorder (for example, difficulties with non-verbal communication such as interpreting gesture and tone), further research may clarify whether deficits displayed by some maltreated children are consistent with the core features of this disorder, and may shed further light on the nature of social and behavioural difficulties reported in maltreated children.

Memory after Abuse

This study also found evidence of difficulties in memory and learning in children with a maltreatment history. These difficulties extended beyond the predicted difficulties with working memory, and affected the learning and recall of verbal stimuli.

To interpret these observed deficits, it is important to acknowledge that they may reflect the interplay of many cognitive processes. It is notable that the maltreated group performed more poorly in their acquisition and recall of auditory-verbal material; given the findings noted above regarding receptive and expressive language abilities, it is possible that maltreated children may have been relatively disadvantaged in their ability to understand the verbal material presented to them, and in their capacity to articulate the content, particularly on narrative recall tasks. This is relevant given a comparison of the two groups' average scores on the Verbal Memory scale of the WRAML2, in comparison to population norms. The maltreated group performed within the average range on verbal tasks; the control group was at the higher end of the average range. This mirrors to some extent the pattern observed on receptive (and to a lesser extent expressive) language tasks, suggesting that children in the control group were able to benefit from their stronger verbal abilities in tasks requiring them to process verbal material.

However, on the Working Memory Index of the WISC-IV, a different pattern of results was observed relative to population norms, with children in the maltreated group performing on average more than a standard deviation below population means.

This index offers an insight into a complex skill, which involves a child's ability to attend to and retain a basic amount of information in their immediate memory, and to be able to hold this information in mind whilst reordering it. As such, the tasks require an integration of attention, immediate memory, and executive control skills. It is noted that imaging studies have found evidence that performance of working memory tasks is related to activation of prefrontal brain regions (Passingham & Sakai, 2004), and that acute stress can reduce the level of activation in the prefrontal cortex during the performance of such tasks (Qin, Hermans, van Marle, Luo, & Fernández, 2009).

Previous neuropsychologically framed studies examining memory functioning have not consistently found deficits in this domain. For example, the recent study by DeBellis et. al. (2009) found that children with a history of neglect showed deficits in verbal memory, based on tests drawn from the NEPSY battery. In contrast, Nolin & Ethier (2007) did not find that a test of verbal learning (CVLT-R) contributed significantly to discriminating between maltreated children and controls, or between children experiencing different types of maltreatment.

Although the hippocampus plays an important role the neurochemical response to stressful events, imaging studies of the hippocampus in abused children do not indicate significant volumetric changes comparative to those observed in adults abused as children. While hippocampal volume should not be considered entirely as a measure of function, it fits with findings from some studies that children with a maltreatment history do not appear to have significant memory impairments.

It may therefore be considered that although the hippocampus is involved in both stress and memory, there is stronger evidence for a non-hippocampal memory deficit; that is, that maltreated children are not impaired in the biological processes of acquisition and consolidation of memory. Rather, it could be argued that the deficits found in some studies (including this one) reflect difficulties with the organization and strategic retrieval of information on demand, potentially associated with the frontal lobe and associated pathways.

There is evidence from other neurological insults, including alcohol-related brain injury and traumatic brain injury, that memory deficits can arise when there is no significant injury to the hippocampal complex, particularly when there is significant frontal and white matter damage. Imaging studies lend support to the proposition

that in maltreated children, brain tissue developing post-natally (including the frontal cortex and the myelination of white matter pathways) are substantially affected by chronic stress responses. The evidence that working memory tasks are particularly compromised in children with a history of maltreatment lends some support to a frontal deficit. However, further research may help to clarify the nature of memory deficits in abused children, by investigating in more detail childrens' performances on immediate and delayed recall tasks, and the impact if any of being provided with strategic cues, organizing strategies, and recognition prompts to support recall.

Finally, it is noted that this study did not address the complex question of autobiographical memory in children with a history of maltreatment. These issues are relevant to concerns regarding suggestibility, false memories, and dissociative experiences of traumatized children. A recent review by Howe, Cicchetti & Toth (2006) argues that in the area of suggestibility, as in other forms of recall, there is little evidence that maltreated children differ significantly from those who are not maltreated. A study by Eisen et. al. (2007) notably found that decreased cognitive functioning predicted a higher level of suggestibility when children were asked questions regarding stressful events, but did not affect photograph identifications. This study proposed that lower cognition has the greatest impact on a child's recall when they are being presented with complex verbal demands. They also noted that there was no evidence of errors of omission, which may have been reflective of poor encoding, a function of hippocampal processing (Eisen, Qin, Goodman, Davis, & Crayton, 2007).

Importance of Attentional/Executive Dysfunction for Learning

This study found some variability in children's ability to attend to information, but offered some support for the hypothesis that more executively demanding aspects of attention, specifically the ability to divide attention between competing stimuli, would be impaired. However, no difference between groups was observed on another measure of attentional control, requiring children to rapidly switch between two modes of response as required by the stimuli. It was also noted that, as predicted, less demanding aspects of attention (including the capacity to focus on locating a specific stimuli and to sustain attention on a relatively unstimulating task over time) were not reduced in maltreated children in comparison to controls.

The findings of this study indicate a more circumscribed set of attentional deficits than has been reported in previous neuropsychologically-oriented studies. The majority of studies which have included measures of attentional functioning have found at least some deficits, including deficits in sustained attention and inhibition (Nolin & Ethier, 2007; DePrince, Weinzierl, and Combs, 2009), visual attention (DeBellis et. al., 2009), and sustained and selective attention (Porter, Lawson & Bigler, 2005). In contrast, this study showed that tasks related to selective attention, or focusing, and sustained attention, were relatively similar in controls and maltreated children, with both groups scoring close to the population mean.

This absence of primary attentional deficits, although consistent with hypotheses, may be considered surprising given that in many other domains, the current sample of maltreated children performed more poorly than expected. It is also surprising given that other research has indicated that children with a maltreatment history are frequently characterised as having attentional problems, and have a high rate of diagnosis of ADHD (e.g. Burge, 2007). However, the pattern of performance observed in this study on the TEA-Ch is not entirely consistent with performances of non-maltreated children with a diagnosis of ADHD.

In particular, a number of studies using the TEA-Ch to assess children with ADHD comparative to controls describe deficits particularly in the subtests labelled as 'sustained attention' and 'attentional control' tasks. For example, a small sample of boys with ADHD were found to perform worse than the normative sample on TEA-Ch measures including Score, Score DT, Sky Search DT, and Opposite Worlds (Manly et al., 2001). Heaton et. al. (2001) confirmed this finding in a larger (and mixed mediation-status) sample, using the full test battery. Sutcliffe, Bishop, and Houghton (2006) documented similar deficits in children with ADHD on a more limited set of subtests, but noted that many of these differences between groups on subtests became insignificant when ADHD subjects were retested on stimulant medication.

In contrast, in the current maltreatment sample, children presented with a clear but more circumscribed deficit on a task of divided attention (Sky Search DT). Within a structural equation model presented based on normative data (Manly et. al., 2001), this test loaded on the 'sustained attention' factor; however, it represents a more complex measure compared to the Score subtest, requiring children to focus on auditory and verbal stimuli simultaneously. This test might therefore be conceptualized as having a higher executive demand, requiring greater frontal

mediation of attentional processes. As predicted, children with maltreatment histories performed poorly on this task compared to controls, and a majority performed significantly (more than two standard deviations) below population norms.

Deficits in divided attention, particularly to the extent observed in this sample, are likely to have significant functional consequences in the real world, particularly as children progress through school. There is frequently an expectation that children will be able to attend to multiple simultaneous stimuli-and-response tasks, such as listening whilst note-taking. A child who has difficulty with this skill is likely to appear distractible and potentially inflexible to school staff, and may show a pattern of missing important information.

Against these confirmatory findings, children with a maltreatment history did not perform significantly differently from controls on the Timing or Accuracy measures of the Attentional Control task (TEA-Ch Creature Counting). Although a majority of maltreated children performed poorly compared to population norms on the timing measure, a significant minority of control children also had difficulty with this task, and differences were not significant at the conservative alpha of 0.0038. It is possible that using this conservative level is masking a true difference between groups. However, given the data presented here, it is also possible that functional attentional deficits are relatively circumscribed in maltreated children, and limited to situations where there are multiple sensory-response demands.

If this is the case, it is uncertain as to what would drive this specificity. The research done into information-processing and attentional biases in PTSD may yield some insights. Research with adults indicates that PTSD-related biases are evident on attentional tasks with emotionally salient stimuli; for example, in the Emotional Stroop task where individuals are unable to inhibit the process of emotionally salient words (Constans, 2005). There are also reports of deficits in vigilance or sustained attentional tasks in adults with PTSD, but it is noted that these findings are not consistent across studies, but vary according to task demand and populations (Vasterling & Brailey, 2005). The same review noted that working memory deficits are well documented across studies of adults with PTSD. IT is possible that in the current maltreatment sample, information processing biases associated with PTSD symptoms (clinical or sub-clinical) may be affecting attentional performance, particularly on a complex task requiring the allocation of significant attentional resources.

It may be useful for future research to further explore the profiles of children with maltreatment histories in comparison to non-maltreated ADHD children, to further clarify and perhaps differentiate the attentional deficits evident in these populations. Many maltreated children are currently being diagnosed with ADHD, and treated with stimulant medication. If post-traumatic stress and anxiety symptoms are found to be having a significant impact on maltreated children's attentional functioning, a different treatment pathway might be recommended. Research using emotionally-salient and emotionally-neutral attentional tasks in both populations may assist in determining and shaping better treatment responses to attentional difficulties.

The difficulties noted on the divided attention task should also be considered in reference to the findings of impaired executive functioning in everyday contexts as documented by the BRIEF parent/carer report. As with the Score DT and Creature Counting (Timing) tasks, a significant majority of maltreated children were reported to have clinically significant problems on this measure, compared to population norms and to the control group. The dysexecutive problems noted ranged across both behavioural regulation and metacognitive domains, contributing to a significantly elevated average global score. This evidence of impaired executive functioning is consistent with other studies using both cognitive assessment tasks (Beers & De Bellis, 2002; DePrince, Weinzierl, and Combs, 2009) and naturalistic observations (Mezzacappa et al., 2001).

This finding may offer some support to the hypothesis that the frontal lobes and associated white matter pathways may be particularly sensitive to the effects of early abuse. Given that the frontal-executive system is late developing (post-infancy and into adolescence and early adulthood), it is unsurprising that it may be more sensitive to the effects of post-natal environmental influences than other brain systems. Ylvisaker & Feeney (2002) noted that the self-regulatory and metacognitive components of executive functioning have a long developmental trajectory, and that disruptions to this development (for example, in traumatic brain injury) can have significant social and learning consequences, that may become more problematic over time.

Ylvisaker and Feeney (2002) also cite Bronson's (2000) conditions for developing self-regulatory capacities, including early experiences of stable attachment, an organized and predictable physical and social environment, a sense of control over

events, and parenting interactions that model cognitive and self-regulatory development. It is evident that many of these factors are likely to be absent from neglectful and abusive home environments. The development of brain structures and connections in such environments may be impaired by chronic HPA-axis activation; this will be reflected in and associated with a failure to master skills required for appropriate behavioural and metacognitive self-regulation.

These deficits are likely to impact children's learning experiences and adaptation to the school environment, even when IQ is relatively well preserved. Children may struggle to do many tasks due to difficulties in planning an approach, initiating action, monitoring their execution of the task for errors, keeping track of their plan and relevant steps, and evaluating (and if necessary modifying) their performance at task completion. These difficulties may not be particularly evident in pre-school and early primary years, as young children may not be expected to complete these tasks independently. However, as children reach upper primary and high school years, they may begin to exhibit more serious educational limitations, as they are unable to independently achieve expected goals. This may result in behavioural responses such as a lack of motivation to attempt tasks, "acting-out" behaviours, school refusal and early school leaving; as well as poor academic outcomes. Research appears to indicate that such outcomes are common for children with maltreatment histories (e.g. Perez & Widom, 1994; Zolotor et. al., 1999; Shonk & Cicchetti, 2001).

The findings of this and other studies that executive functioning may be commonly impaired in maltreated children presents opportunities for research into rehabilitative interventions. In particular, it has been argued that models of self-determined learning can provide a framework for 'scaffolding' the learning of children with executive function impairments, by explicitly structuring learning stages such as goal-setting, planning, execution and evaluation/adjustment of plans (Ylvisaker & Feeney, 2002). Planned carer or teacher-supported interactions to help maltreated children develop such metacognitive approaches to tasks may help them to develop more organized approaches to learning, particularly if they are removed from settings with a high level of environmental threat, stress and unpredictability.

Importance of Executive Dysfunction for Social Development

The findings of impairment in executive functioning also has significance beyond the academic domain, as children with executive dysfunction are often observed to have

deficits in social reasoning and problem-solving, and in behavioural regulation. In this study, it was found that 71% of maltreated children scored in the clinically significant range on the Behavioural Regulation Index of the BRIEF. These limitations in modulating appropriate emotional and behavioural responses to situations may express themselves in terms of impaired social interactions, aggressive behavioural outbursts, or intense emotional distress at minor triggers.

Once again, research into attachment disorders and maltreatment suggest limitations in social and emotional self-regulation, associated with abnormal development of the right frontal and orbito-frontal regions (Balbernie, 2001; Shore, 2002; Carrion et. al., 2001). Balbernie (2001) argued that positive parental feedback was critical in establishing the orbito-limbic circuit that allowed children to recognize and regulate internal emotional states. The finding that children with histories of abuse and neglect lack such self-regulatory skills is therefore consistent with a model of disordered attachment impacting on fronto-limbic development.

This finding has implications for previous research indicating that children with maltreatment histories have high levels of internalizing and externalizing behaviour disorders (Tarren-Sweeney & Hazel, 2006; Sawyer et. al., 2007). It is noted that these behavioural difficulties have been shown in at least one study (Burns et. al., 2004) to emerge in later childhood, when non-maltreated young people might be experiencing significant frontal development and associated higher expectations for self-regulation.

A model for diagnosing and treating emotional and behavioural disorders in maltreated children should, therefore, take into consideration possible executive deficits. The impact of primary attachment issues and adverse experiences may be mediated by how successfully the child has learnt emotional and behavioural regulation skills. Once again, treatment may be considered in terms of rehabilitation or remediation of deficits in social-executive functions, through explicit education in identifying emotional states, learning to modulate levels of anger and distress, and developing social problem-solving skills.

Such rehabilitative work may also have implications for adult psychopathology arising from early adverse experiences, including borderline personality disorder. The links between borderline personality disorder and a history of maltreatment have been well documented in recent years (Graybar & Boutilier, 2002). There is also growing

evidence that many people with borderline personality disorder exhibit neuropsychological deficits in working memory, recall and executive functioning; as well as volumetric and metabolic changes in prefrontal cortex and limbic structures observable on neuroimaging (Minzenberg, Poole, & Vinogradov, 2008). A review of twenty-nine neuropsychological studies of BPD found that 83% of studies reported some neuropsychological deficits associated with prefrontal cortical functioning, most frequently involving response-inhibition and decision making difficulties. A majority of studies reviewed also identified visual and verbal memory impairments, and deficits in some aspects of attentional functioning (LeGris & van Reekum, 2006). Many of these recorded deficits are consistent with the weaknesses observed in maltreated children in this study.

Given that many people with BPD experience long-term engagement with psychiatric services as well as significant personal and relational distress, using neuropsychological measures in conjunction with behavioural and clinical observation may expand opportunities for early intervention with children with a history of maltreatment. Treatment can be informed by an understanding of the association between core neurological and cognitive deficits and their behavioural and social manifestations. Children at risk might benefit from explicit skills training, feedback and support in areas such as inhibition of inappropriate behaviours, identifying and regulating emotional states, and developing adaptive social problem-solving skills. These interventions, informed by attachment models and the critical context of consistent, positive adult relationships, may have a significant impact in helping maltreated children to achieve better mental health outcomes in adulthood.

Limitations of Findings

In considering the implications of these findings for practice and for future research, it is important to note that there were particular challenges in data collection that may limit the generality of the findings of this study. Many of these limitations reflect challenges in the recruitment of the participant groups, resulting in potential biases in the samples which may be reflected in the data collected.

Firstly, the children in the clinical group were recruited via referral from case managers and clinicians working within Take 2 Clincial services and Berry St home based care programs. This 'refer in' approach may have resulted in a screening out of higher functioning clients, for whom neuropsychological assessment may have been seen as unnecessary. The involvement with Take 2 as a service also meant

that children had already been noted as having clinical problems needing support; referral to this service is not standard for children in foster care. Take 2 clinicians were encouraged to refer all children within the appropriate age range, rather than only those with a perceived need for neuropsychological assessment. However, in reality many children in the study were identified as being in need of assessment.

The inclusion of the home-based care group within the clinical sample (this group represented 14 of the 28 participants) attempted to address the potential bias arising from referrals from a clinical service. Home based care services include children in a variety of kinship and non-kinship placements; many of the children seen through these services had not been receiving clinical support. The staff endeavoured to include as many children as they could gain consent for, regardless of clinical symptoms.

There were other barriers to accessing a broader spectrum of participants through the Take Two service. Firstly, the service operates on a state-wide basis, limiting personal contact between researchers and clinicians, and therefore making it difficult to ensure that all clinicians were aware of the goals of the study. Secondly, clinicians at times reported that the processes of obtaining consent from families operating under significant strain was difficult, and created a risk of damaging fragile clinical rapport. Thirdly, clinicians may have been screening out children who they perceived as too emotionally fragile or behaviourally disturbed to participate in a fairly lengthy and fixed research protocol.

Given these limitations, a cautious interpretation of the findings of this study is that results may reflect the functioning of a vulnerable subset of all children in foster care, many of whom may be presenting with some academic or behavioural limitations. However, the concordance between the findings of this study and others, which included a range of approaches to participant selection, suggests that the cognitive vulnerabilities observed are not an artefact of a skewed clinical group.

A second factor in the selection of the clinical group is the high ratio of male to female participants (22:6). This may partially reflect the fact that males display higher rates of externalizing behaviour, and may also be more vulnerable to academic difficulties. However, it should be noted that given the low number of female participants, the findings may less representative of the cognitive performances of all females in care.

Finally, the screening of the maltreated group did not include an assessment of the presence or absence of a diagnosis of post-traumatic stress disorder. It is noted in previous studies that post-traumatic stress disorder is associated with significant cognitive deficits; and some children within the clinical group may have displayed some clinical symptoms of this disorder. However, the study demonstrates that cognitive difficulties are prevalent within the sample regardless of PTSD symptomatology.

There were also potential biases in the recruitment of control group participants. Firstly, there were some barriers in obtaining permission from schools in the appropriate socio-economic bracket to promote the research. These were largely associated with limitations to school resources (including both space and administrative resources); however, a number of schools also perceived the topic as potentially too sensitive for families amongst their student population who may be at risk of involvement with care services, despite the emphasis on children participating specifically as control participants.

In schools which did promote the research, there was generally a low response rate from parents. While it is difficult to determine the causes of this, feedback from parents who called with enquiries indicated that a number of them were anxious about their children being associated with research addressing maltreatment. The lengthy information and consent form may also have presented a barrier for some parents of limited literacy.

Overall, although the children did not differ significantly from the clinical group in socio-economic status, they performed generally at a level consistent with or slightly above population norms. In particular, it was noted that control children consistently scored above the population mean on verbal measures. This may reflect a bias for parents to select in children with clear verbal-academic strengths to participate in the study; those with academic or behavioural vulnerabilities may have selected out due to the concerns noted above.

It was noted in this study that children in the maltreated and control groups differed significantly in age, with the maltreated children as a group being on average slightly older. In making decisions regarding an approach managing this difference, it was note that older children would generally be expected to show greater cognitive

development, and relative weaknesses in the clinical group performance comparative to the control group would therefore be unlikely to be age-related. Given the direction of the difference, a decision was made not to control for age in data analysis. It is possible that in groups of equivalent age, the magnitude of deficits on some variables may have been even greater. In addition, age based variations were corrected for by the use of normative standard scores for dependent variables in the analysis.

A final limitation in this study is that the overall numbers are limited relative to the high number of cognitive variables under consideration. In this study, Bonferroni-adjusted significance levels were used to control for the increased risk of Type I errors due to multiple comparisons. However, it is acknowledged that this correction may increase Type II errors, with possibly significant differences between variables being missed. In addition, the calculation of effect sizes allowed for further demonstration of the degree of difference between groups, with the evidence of large effect sizes on many group differences supporting the validity of the findings.

Implications of Findings for Practice

This study provides evidence for the hypothesis that children in protective care due to multiple-type maltreatment are at significant risk of impaired cognitive functioning. The findings lend support to previous research conducted with other maltreatment groups (including patients with PTSD and children with specific maltreatment histories such as sexual abuse) that cognitive deficits are common in these children. There is a growing consensus that such deficits may be associated with altered neurological development, triggered by experiences of chronic stress and deficits in primary attachments which are critical for early learning.

Given these vulnerabilities, there are many implications for children entering or receiving out-of-home care. In the first instance, prevention should always be a goal. Many parental risk factors for abuse are well-documented, and in some cases, supports can be developed to help those parents at risk of abuse and neglect to develop stronger attachments and better capacity to care for their children. However, there are also many systemic barriers to this, including lack of funding, difficulty in identifying parents at-risk, and parental reluctance to participate in programs that may involve the scrutiny of authorities or perceived risk of their children being removed.

For children who are entering care, knowledge of risks of cognitive deficits may lead to more frequent screening for such disorders. This may be particularly beneficial in cases where there are other behavioural or emotional indicators of maladjustment, such as school refusal, disruptive classroom behaviours, or extreme emotional reactivity in home and school settings. Assessments may provide important information for helping to plan management and intervention strategies for children.

In considering placements, informative assessment of cognition may lead to more effective planning and support of placements. Children with learning and particularly executive deficits may have greater difficulty with transitioning into a new living environment. They may struggle to assimilate multiple types of information, as well as complex new rules and routines. They may have difficulties modifying their behaviour in a new setting, and may be prone to reacting in extreme ways to the inevitable stresses of adjusting to a new family and environment. Establishing an environment that is predictable and calm, and finding carers who can be informed and educated on the child's cognitive needs, may make a difference in the success of the placement. Further, minimizing change and working towards providing the child with stable and permanent attachment figures is likely to be critical in the success of other cognitive remediation strategies.

In reference to children's classroom adjustment, an awareness of cognitive difficulties may help to guide teacher's responses to challenging behaviours, and to frame appropriate supports for maltreated children. Children with a maltreatment history are likely to struggle with some aspects of academic curriculum, and may need additional classroom support or in some cases modified curriculum. They are also likely to require help with some of the metacognitive tasks of learning, such as planning and organizational strategies for problem solving and assignments, independently initiation of tasks, and monitoring work for errors.

As noted above, the findings also have implications for therapeutic practice, particularly in working with children with complex problems with self-regulation of behaviour and emotion. An understanding of these difficulties in reference to brain-behaviour relationships could significantly impact therapeutic approaches. Children with a history of maltreatment may need specific intervention focussed on building skills for social interaction and emotional regulation. Corrective approaches to behaviour should also keep in mind the broader goal of facilitating the development

of inhibitory control, as well as targeting more specific presenting behaviours of concern.

Recommendations for Further Research

This research highlights some gaps in the understanding of the development of cognition in maltreated children. However, as noted above, there were some limitations to the data collected in this study. Firstly, this study was limited in scope to a specific group of maltreated children, who may be considered at high risk for cognitive impairment due to the severity of their abuse exposure and referral to clinical services. Further study might seek to tap into a less selected sample of children, for example those who have received notifications but not necessarily been removed or placed in care. However, the practicalities of accessing such a group are difficult, and it is clear that children presenting with maltreatment histories frequently also bring a range of risk factors.

There may also be usefulness in seeking to delineate further the effects of different dimensions of maltreatment on neuropsychological functioning. This study used a naturalistic sample of children with multiple types of maltreatment; however, it may be found that certain tests are specifically impacted by the experience of certain abuse types, as suggested by Nolin and Ethier (2007). Comprehensive study of the relationship between abuse type and cognitive outcome needs to deal with specific methodological constraints; in particular, the difficulty of selecting research subjects with "pure" abuse-type exposure, given the frequency of neglect and emotional abuse as a background for more physically invasive abuse acts. In addition, little research has attempted to address other factors such as age of onset (often difficult to determine in cases of neglect) and severity of abuse in relation to cognitive outcome. Such questions may require much larger scale studies than have previously been conducted.

Another avenue of research may be to investigate the presence of specific brain development risk factors in maltreated children. Such risk factors might include drug and alcohol exposure in utero, or physical abuse involving blows to the head. Delineating the effects of these risks from the more global experience of exposure to extreme stress may assist in better characterizing the population.

Further, there is more research to be done in the complex relationship between psychopathology, particularly ADHD and PTSD symptoms, and cognitive profiles. The work done by DeBellis et. al. (2009) suggests only minor differences in neuropsychological test performance between maltreated children with and without PTSD; however, this study notes again the limited numbers involved and the weakness of PTSD criteria for diagnosing children. It may be useful to conduct further studies including control groups of children without maltreatment histories, but meeting diagnostic criteria for PTSD or ADHD. This would help determine the specificity of neuropsychological deficits to maltreatment and its effects on brain development.

The mixed findings regarding memory functioning in this and other studies also points to a need for more carefully framed research into this area. Selection of appropriate measures to assess the best current models of memory is needed. Such models should include evaluation of encoding new information, immediate and delayed recall and the effects of interference, and the benefits of cues for retrieval of information. Further research may also consider the effects of maltreatment on implicit as well as explicit memory, and on the recall of emotionally salient material compared to more emotionally neutral stimuli. Such research is particularly relevant in examining the developmental trajectory of memory in individuals with maltreatment histories, given that many adults with such histories report and display specific memory impairments.

Finally, there is a need for research into interventions for maltreated children based focussing on remediation and rehabilitation of impaired cognitive skills. The current research suggests that cognitive deficits may impact on many of the manifestations of poor adjustment displayed by maltreated children, particularly in educational and social domains. However, it remains to be seen if these findings can form the basis for more efficacious therapeutic intervention than is available through current approaches.

Conclusion

This study set out to characterize the cognitive functioning of a group of maltreated children currently in protective care in Victoria, Australia. The study hypothesised that specific deficits would be displayed in overall cognition (FSIQ) and in verbal cognitive abilities, working memory, attentional control and executive functioning.

The findings of the study indicated that maltreated children did present with a range of impairments in comparison to the selected control group and population norms. These impairments were evident in both verbal and perceptually based IQ tasks, in verbal memory and auditory working memory, in divided attentional capacities, and in parent/carer ratings of behavioural executive dysfunction.

Whilst this study acknowledges limitations in scope and power, it adds to the growing body of literature documenting neuropsychological deficits in the development of children with maltreatment histories. This parallels the recently documented evidence from imaging studies of abnormalities in brain structure and function arising from early experiences of maltreatment. Consistent findings in regard to IQ and attentional/executive impairments are particularly notable in this field, and have implications for the school based performance, placement adjustment and mental health of children. Such deficits, if left unacknowledged, may contribute to long term poor adjustment and in some cases frank psychopathology. However, awareness of potential cognitive consequences of abuse, and appropriate assessment of individuals at risk, may lead to better therapeutic outcomes.

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Appendix 1

DEMOGRAPHIC QUESTIONNAIRE

Participant name:_____Research ID: _____

Date of Testing: _____

Date of Birth _____

Current Age: _____

Gender: *M   F*

Current School Year Level: _____   Grades Repeated? _____

Cultural Background: _____

Does child speak a language other than English: *N   Y (specify)* _____

First language spoken at home: _____

Occupation: (Mother) _____ (Father) _____

Medical History:

Has the child ever had any serious illnesses?

   Major injury? (e.g. head injury)

   Major infection (e.g. meningitis)

   Period of hospitalization?

   Prolonged period of medication (including current medications)?

   Other significant events or health issues?

Appendix 2

Ethical approval for this study was obtained from the following agencies:

1. Victoria University Human Research Ethics Committee
2. Department of Human Services Human Research Ethics Committee
3. Berry St Victoria
4. Department of Education and Early Childhood Development

The approval forms are attached on the following pages.