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The relationship between child maltreatment and performance on measures of higher-order reasoning/executive functioning.

Michelle Anne Petherick-Giudice

University of Windsor

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THE RELATIONSHIP BETWEEN CHILD MALTREATMENT AND PERFORMANCE ON MEASURES OF HIGHER-ORDER REASONING/EXECUTIVE FUNCTIONING

By

Michelle A. Petherick-Giudice

B.A. University of Windsor, 1994

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

Windsor, Ontario, Canada

2000
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ABSTRACT

The goal of the present study was to compare maltreated and nonmaltreated male adolescents on measures of higher-order-reasoning and executive functioning. It was predicted that maltreated participants would evidence impaired performance on aspects of the measures considered dependent on systems within the left hemisphere. Thirty-two adjudicated male juvenile delinquents between the ages of 12 and 18 were assigned to either the maltreated (n=16) or nonmaltreated (n=16) group retrospectively through an extensive review of their histories. Archival Wisconsin Card Sorting Test (WCST) and Halstead Category Test (HCT) data were subjected to between groups t-tests for independent samples. Unexpectedly, the maltreated group significantly outperformed the nonmaltreated group on perseverative responding. Post-hoc within-group analyses suggested that maltreated children’s problem-solving style is characterized more by cognitive flexibility than adherence to a mental set. Results were discussed in terms of implications for future research; the importance of stringent methodology and the heterogeneity within the child maltreatment population were addressed.
ACKNOWLEDGEMENTS

Many individuals have contributed their time, support, and expertise to this project. I would like to thank Dr. David Reynolds for being a supportive mentor throughout my academic career. His encouragement regarding my initial interest in neuroscience during my undergraduate years was a large factor in my decision to continue my studies within this area of psychology.

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CHAPTER I
INTRODUCTION

Child maltreatment is a costly public health concern in terms of the emotional, physical, and financial consequences to the affected child and society at large. When compared to children with illnesses of similar severity, medical care for severely abused children is associated with higher hospitalization costs and a lower success rate (i.e. high mortality and morbidity rates) (Irazuta, McJunkin, Danadian, Arnold, & Zhang, 1997; Sullivan & Knutson, 1998). A recent upsurge of research interest in the issues surrounding child maltreatment has helped to draw attention to this serious problem. However, the body of work as a whole has been described as “fragmented, disorganized, and methodologically flawed” (Knutson & DeVet, 1995, p. 589). Carefully conducted research is still needed to clearly delineate the measurable outcomes of early childhood maltreatment.

Researchers have documented various suspected sequelae of child maltreatment (Ammerman, Cassisi, Hersen, & Van Hasselt, 1986; Chandy, Blum, & Resnick, 1997; Fergusson & Lynskey, 1997; Flisher et al., 1997; Green, 1983; Lamphear, 1985; Pollak, Cicchetti, Klorman, & Brumaghim, 1997;
Sullivan & Knutson, 1998). Potential adverse consequences of child abuse and neglect identified within the extant literature include (but are not limited to) global functional impairment, juvenile delinquency, emotional disturbances, aggression, post-traumatic stress disorder, depression, psychosocial disturbances, neurological dysfunction, neuropsychological impairment, academic impairments, and learning disabilities (e.g. Boney-McCoy & Finkelhor, 1995; Dodge, Pettit, Bates, & Valente, 1995; Famularo, Kinscherff, & Fenton, 1992; Fergusson & Lynskey, 1997; Flisher et al., 1997; Knutson, 1995; Malinosky-Rummell & Hansen, 1993; Perez & Widom, 1994; Solomans, 1979; Wissow, 1995). In retrospective analyses of hospital records, maltreatment has been correlated with behaviour disorders, speech and language disorders, and learning disabilities (Sullivan & Knutson, 1998).

As child maltreatment is increasingly recognized as a major public health concern, research on the epidemiology of abuse and neglect has burgeoned. However, estimates of the prevalence and incidence rate of abuse and neglect vary substantially between studies due to different inclusion criteria and reporting sources (Azar & Pearlmutter, 1993;
Knutson & Devet, 1995; Oates, 1986). Incidence rates reported by the Second National Incidence and Prevalence Study of Child Abuse and Neglect (NIS-2) were 15.9, 2.5 and 5.7 per 1000 children for neglect, sexual abuse, and physical abuse respectively (National Center on Child Abuse and Neglect, 1988; Cappelleri, Eckenrode, & Powers, 1993; Knutson & DeVet, 1995; Veltkamp & Miller, 1994). Despite a lack of definitional clarity and consistency which obscures epidemiological findings, it is clear that the rate of child maltreatment is of sufficient magnitude to warrant further study.

Definitions

Efforts to develop universally accepted definitions of child abuse or neglect have been thwarted by the varying mandates of disparate agencies and the ambiguity of the problem itself (Wolfe, 1987). Consequently, definitions vary depending on the purpose and theoretical inclination of the reporting party (e.g., legal, research, or clinical criteria). For the purpose of the present work, maltreatment (abuse or neglect) will be defined as acts of omission or commission on the part of a caretaker toward a
child that entail a significant risk of causing physical, developmental, or emotional harm (Veltkamp & Miller, 1994). Physical abuse can be specifically defined as acts of commission outside the realm of normal conduct that endanger the well being of a child. In contrast, neglect is defined as an act of omission or deficient care-taking that likewise entails substantial risk of harm for a child (Knutson & DeVet, 1995).

Effects of Early Experience

A substantial body of research has already outlined the crucial nature of neural development in early years and the effects that early experiences have on learning, behaviour, and health throughout the lifespan (McCain & Mustard, 1999). While researchers have identified a variety of negative outcomes associated with child maltreatment, the specific pathway leading from abuse/neglect to psychopathology remains a source of contention among investigators. Studies indicate that the frequency of maltreatment is highest among very young children (i.e., under the age of three) (Fox, Long, & Langlois, 1988; Gelardo & Sanford, 1987). As this age period represents a
time of dramatic and rapid neural development and skill learning, it is possible that critical periods of postnatal neurodevelopment are disrupted by harsh/negligent maltreatment (McCain & Mustard, 1999).

Increasingly, researchers have come to accept the notion that early experience (positive or negative) significantly affects the structure, organization, and activity of the brain (Pollak et al., 1997; Rogeness & McClure, 1996; Salamon Weiss & Wagner, 1998). Clearly, the central nervous system and concomitant cognitive abilities do not develop in isolation (Johnson & DeLuca, 1998). Genetic-environmental interactions affect the course of neurodevelopment. Although the sequence of neurodevelopment is primarily genetically predetermined, the manner in which the brain develops is also moderated by environmental input and dependent on early experiences (Glaser, 2000). In other words, early childhood experiences, whether enriched or aberrant, exert a pervasive influence on children’s psychological, cognitive, social, and behavioural development (McCain & Mustard, 1999).

For example, parenting style and parental personality have been shown to affect many aspects of child development
and attachment style. The parents are typically an infant's first and primary source of need fulfilment and skill development including but not limited to, nurturance, stimulation, problem-solving skills, and socialization (Johnson & DeLuca, 1998). Therefore, parental psychopathology, lack of responsiveness, or extremely harsh rearing practices can potentially have severe consequences for the development of adaptive skills in a child (Bremner et al., 1997; Crittenden, 1995). Specifically it has been suggested that parent-child interactions are essential for the internalization of problem-solving and self-regulation abilities (Moss, Gosselin, Parent, Rousseau, & Dumone, 1997; Moss & Strayer, 1990; Vygotsky, 1930/1978).

**Characteristics of Maltreated Children**

Detailed research on the relationship between early maltreatment and neuropsychological functioning is scarce. The few studies conducted have shown that early childhood experiences of physical abuse are associated with significant developmental delays, particularly in problem-solving ability (Aber, Allen, Carlson, & Cicchetti, 1989; Erickson, Egeland, & Pianta, 1989), attention (Friedrich,
Einbender, & Luecke, 1983; Nightingale & Walker, 1991) and verbal/psycholinguistic skills (Fox et al., 1988; Friedrich et al., 1983; Green, 1983; Hoffman-Plotkin & Twentyman, 1984; Ito, Teicher, Glod, & Harper, 1993; Kurtz, Gaudin, Wodarski, & Howing, 1993; Parish, Myers, Brandner, & Templin, 1985; Perry, Doran, & Wells, 1983; Rogeness, Amrung, Macedo, Harris, & Fisher, 1986). In addition to specific cognitive impairments, researchers have also indicated that repetition of grade levels, academic difficulties, and low educational goals are associated with a history of child maltreatment (Kurtze et al., 1993; Salzinger, Kaplan, Pelcovitz, Samit, & Krieger, 1984).

The problem-solving style of maltreated low-income children has been described as "outerdirected" (Aber et al., 1989). That is, these children tend to rely more on external sources of information than their own cognitive resources in problem-solving situations. With respect to verbal skills, researchers have found that maltreated children demonstrate impairments in language comprehension (Fox et al., 1988; Tarter, Hegedus, Winston, & Alterman, 1984), communication skills (Perry et al., 1983), expressive language (Morgan, 1979), and receptive
vocabulary (Perry et al., 1983). When compared on a variety of neuropsychological and personality measures, abused juvenile delinquents differed significantly from those who were not abused on Wechsler Adult Intelligence Scale (WAIS)/Wechsler Intelligence Scale for Children (WISC) comprehension and similarities subtests and obtained lower Verbal IQ (VIQ) scores (Tarter et al., 1984). In addition, similar trends were found for a number of other verbal and linguistic measures (e.g., verbal fluency, reading comprehension).

Neurological differences between abused and non-abused children have also been described (Ito et al., 1993; Ito, Teicher, Glod, & Ackerman, 1998; Salamon Weiss & Wagner, 1998). Adults with childhood histories of harsh physical abuse who developed post-traumatic stress disorder have been shown to have smaller left hippocampal volumes on magnetic resonance imaging scans. (Bremner et al., 1997). Furthermore, these individuals performed better than non-abused control participants on measures of visual memory but exhibited specific deficits on measures of verbal memory (Bremner et al., 1997).
Left-hemisphere electrophysiological abnormalities and reversed cerebral asymmetries have been found consistently in abused populations (Ito et al., 1993; Ito et al., 1998). Specifically, abused children evidenced an increased incidence of abnormal electrophysiology within the left frontal and temporal areas (Ito et al., 1993; Ito et al., 1998). In addition, abused children tended to have greater electroencephalogram (EEG) coherence (less cortical differentiation) within the left hemisphere relative to non-abused children (Ito et al., 1998). The normal finding of left<right coherence asymmetry was also completely reversed in the abused children. The researchers concluded that abused children exhibit indications of less left hemisphere cortical differentiation than non-abused children and implied that deficiencies in right and left hemisphere integration could result in misinterpretation of affective experiences and internal inconsistency.

The relationship between early child maltreatment and circumscribed electrophysiological abnormalities in conjunction with the scarcity of information about the cognitive risks associated with abuse/neglect suggests that further investigation of these variables is warranted.
While neuropsychological dysfunction within abused populations has been indicated, the body of research is meagre. The available research describes deficits in psycholinguistic and problem-solving skills (Aber et al., 1989; Erickson et al., 1989; Flisher et al., 1997; Ito et al., 1993; Tarter et al., 1984). However, the specific nature of these deficits is far from clearly delineated. Therefore, it is important to expand upon previous work in order to develop a more complete understanding of the role of early aberrant experiences on brain-behaviour relationships. To this end, the purpose of the present study was to extend the findings of Tarter et al. (1984) by comparing the performance of abused and non-abused juvenile delinquents on measures of executive type functioning and higher order reasoning.

**Relationship between Child Maltreatment and Neuropsychological Dysfunction**

Why would early child maltreatment differentially affect areas within the left hemisphere? Researchers have suggested that children who grow up in homes devoid of proper care and in which the threat of physical abuse is
ever imminent may develop a stance of hypervigilance or "frozen watchfulness" as a defensive measure (Barahal, Waterman, & Martin, 1981; Dodge et al., 1995; Green, 1983; Martin & Beezley, 1977; Martin & Rodeheffer, 1976; Walsh, 1990). Such children remain perpetually alert for environmental presages to harsh events in order to develop avoidant or protective measures. Likewise, severely neglected children with nonorganic failure-to-thrive syndrome evidence extreme visual surveillance of their environments (Gelardo & Sanford, 1987). This constant heedfulness may favour the development of the right hemisphere at the expense of the left. The theorists who proposed this model suggested that this unbalanced neurodevelopment may account for the consistent finding of verbal deficits within samples of abused children (Walsh, 1990). Other researchers have also commented on the correlation between hypervigilant stances in abused children and subsequent language impairments (Green, 1983).

Left hemisphere dysfunction commonly uncovered in abused populations may be due to the differential development rate and growth spurts of the two hemispheres (Ito et al., 1998). As measured by EEG coherence and
phase, areas within the left hemisphere appear to develop earlier with a considerable growth spurt between the ages of three and six and approach adult development by five years of age (Thatcher, Walker, & Giudice, 1987). In contrast, development of bilateral areas within the right hemisphere is characterised by gradual maturation over time with a much smaller growth spurt between the ages of eight and ten (Thatcher et al., 1987). In addition, dendritic expansion within the left hemisphere exceeds that within the right hemisphere between the ages of 5 months and 6 years (Ito et al., 1998). Thatcher (1996; 1997) also suggests that hemispheric growth spurts or stages of cognitive development are related to the pruning of synaptic connections in order to meet environmental demands. While this process is considered adaptive, it is possible that extreme early conditions could result in unusual patterns of pruning that may interfere with later adaptive development (e.g., reversed cortical differentiation asymmetries between the hemispheres).
Theories of Self-Regulation and Hemispheric Specialization

Vygotsky

Linguistic processes are considered extremely important for the development of self-regulation (Vygotsky, 1934/1986). Vygotsky (1930/1978) wrote that through adult-child interactions, children's problem-solving style gradually evolves from relying solely on external guidance to reliance on internalized reasoning. Throughout this process, inner speech also develops out of social speech, allowing children to become less dependent on external sources of information (e.g., parents) and to refer increasingly to their own internally generated rules (Kopp, 1982).

Vygotsky (1978) also stresses the dynamic nature of the relationship between speech and behaviour. Initially, speech is a response or accompaniment to problem-solving behaviour but with development, speech serves more of a planning function, allowing the child to analyze potential responses before implementation. Once children are able to utilize speech as a planning tool, they "acquire an independence with respect to their concrete surroundings;
they cease to act in the immediately given and evident space” (Vygotsky, 1930/1978, p. 28).

Another theory related to Vygotsky’s work suggests that impairments in working memory, self-regulation, internalization of speech, and goal directed behaviour are consequences of a primary deficit in behavioural inhibition associated with dysfunction within the prefrontal area (Barkley, 1997). Deficits in these cognitive skills are accompanied by impairments in internally generated rule-governed behaviour and a greater degree of behavioural control linked to external environmental events.

**Goldberg and Costa: The Novelty-Routinization Hypothesis**

A recent theory regarding the differential roles played by the two hemispheres in general and by the two prefrontal lobes in particular is especially interesting in the context of cerebral dysfunction in children with histories of maltreatment (Goldberg & Costa, 1981; Goldberg & Poddell, 1995a,b). Goldberg and Costa’s (1981) influential model described the differences between the hemispheres in terms of their ability to deal with task
novelty/familiarity and the use of cognitive strategies. Cognition and behaviour involve the acquisition and storage of a repertoire of organizational strategies, which can subsequently be utilized to deal with similar classes of stimuli appropriately. Goldberg and Costa (1981) suggested that the extent to which these codes are applicable to ongoing stimuli is dependent on the differential functions of the two hemispheres. More specifically, after reviewing neuroanatomical research and finding an asymmetry in the ratio of gray to white matter between the hemispheres with relatively more white matter in the right hemisphere, Goldberg and Costa (1981) concluded that the right hemisphere is oriented toward the processing of novel stimuli, assembling new descriptive systems, and appears to be superior at handling informational complexity/task novelty. They also reported data that implied a greater number of areas of specific sensory and motor functions in the left hemisphere and concluded that this hemisphere is likely better equipped for the storage of descriptive systems and has a greater capacity for intensive focus within a single mode of representation and responding to task familiarity.
Goldberg and Podell: Lateralization in the Frontal Lobes

More recently, Goldberg and Podell (1995a,b) reviewed research that allowed them to further develop their conception of hemispheric specialization by focusing on anterior asymmetries. Goldberg and Podell (1995a,b) suggested that behaviour can be guided in two important ways: by internal contingencies stored in working memory or by external contingencies related to environmental changes. Recent research has suggested that these two behaviour guidance systems may be lateralized within the prefrontal cortex; the left prefrontal cortex appears to be necessary for cognitive control based on internal contingencies within working memory (behavioural responding based on internal rules) whereas the right prefrontal cortex is critical for cognitive control through external environmental contingencies (flexible responding to environmental changes).

Ordinarily, the two behaviour guidance systems work co-operatively and forge a dynamic balance between internally and externally based cognitive control. However, if there is unilateral damage or dysfunction to
the prefrontal cortex, one behavioural system may operate unchecked, leading to one of two types of extreme behavioural tendencies. Right hemisphere prefrontal damage (RHP) tends to result in perseveration (repeated application of the same mode of responding) due to the unchecked influence of the left hemisphere and the lack of right hemisphere control. Alternatively, left hemisphere prefrontal damage (LHP) produces environmentally dependent behaviour due to the unchecked influence of the right hemisphere and reduced cognitive control of the left hemisphere. LHP results in an inability to generate or adhere to internal strategies or plans to guide behaviour, and instead behaviour seems arbitrarily controlled by ongoing environmental changes.

Numerous other researchers have commented on the importance of linguistic processes for the self-regulation of behaviour and the acquisition of rule-governed behaviour (Joseph, 1982; Luria, 1980; Nauta, 1971). That is, without the internal speech that is characteristic of the left hemisphere, behaviour may "become inextricably tied to its immediate consequences" (Wilson & Herrnstein, 1985, p. 205).
Rationale

Child maltreatment is associated with a plethora of psychopathological symptoms in adolescence and adulthood. In addition, researchers have found evidence for abnormal electrophysiology and structure within the left hemisphere in individuals with a history of early maltreatment. Finally, while there is a lack of neuropsychological research within this population, the few studies that have been conducted have indicated psycholinguistic and problem-solving deficits. The specific nature of cognitive impairments associated with maltreatment is presently unclear.

The current work was designed to extend the research on the neuropsychological profile associated with child maltreatment through the assessment of higher order reasoning skills and executive-type functioning within a sample of maltreated juvenile delinquents. As dysfunction within the left hemisphere has been implicated in studies of child maltreatment, the theories of hemispheric specialization outlined earlier would suggest that this population may have difficulty using internally represented rules to guide problem-solving behaviour and may
demonstrate susceptibility to interference by external environmental shifts.

In short, the current study is concerned with investigating the extent to which male adolescents with childhood histories of abuse or neglect can be differentiated from those without such a background on measures of higher-order reasoning and cognitive flexibility. The Wisconsin Card Sorting Test (WCST) (Heaton, Chelune, Talley, Kay, & Curtiss, 1993) and the Halstead Category Test (HCT) are the most typically used measures of cognitive flexibility, concept formation, and problem solving skills in neuropsychological assessments. It is expected that abused/neglected participants (Group A/N) will exhibit a distinct pattern of performance on these two measures relative to individuals (Group N A/N) without a history of abuse or neglect. In order to develop more specific hypotheses, it would be instructive to briefly review the measures employed.
Measures Description

Wisconsin Card Sorting Test (WCST)

Researchers have suggested that the WCST is a measure of abstraction ability, deduction of rules/concepts using evaluative feedback, set maintenance, and cognitive flexibility (Fisher, DeLuca, & Murji, 1998; Fisher & DeLuca, 1997; Heaton et al., 1993; Spreen & Strauss, 1998). Various scores in addition to the overall score of total errors (TE) are derived from the WCST. The most typically studied scores include categories completed (CC) (total number of sorting principles achieved), trials to first category (TTFC), and TE. Additional theoretically interesting scores include conceptual level responses (CONLEV) (percentage of responses indicative of insight into the sorting rules), failure to maintain set (FTMS) (ability to maintain the correct sorting principle once attained), learning to learn (LTL) (average increase in conceptual efficiency with each successive category obtained), non-perseverative errors (NPER) (errors that are not indicative of perseveration), perseverative errors (PER) (perseverative responses that are incorrect), perseverative responses (PERR) (persistent responding
according to a sorting rule despite feedback that the principle is no longer in effect) (Spreen & Strauss, 1998) (See Table 1).

Early studies provided support for the utility of the WCST for identifying frontal lobe dysfunction (Drewe, 1978; Robinson, Heaton, Lehman, & Stilson, 1980). In addition, laterality effects were noted in these studies. When patients with frontal lobe damage were divided into left frontal (LF) and right frontal groups (RF), clear differences in performances on the WCST emerged. Specifically, RF patients were more likely to make perseverative errors whereas the errors of LF patients were more nonperseverative in nature (Drewe, 1978; Robinson et al., 1980). Thus, the NPER score may be differentially sensitive to LF damage while a lowered PER score may reflect RF dysfunction. Goldberg and Podell (1995a,b) and Barkley (1997) suggested that individuals with LF damage would have difficulty adhering to internally generated strategies or principles resulting in behaviour that is more dependent on external events.
Table 1.

Description of Wisconsin Card Sorting Test Scores

<table>
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<tr>
<th>Score</th>
<th>Description</th>
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<tr>
<td>Conceptual Level Responses (CONLEV)</td>
<td>Percentage of responses suggesting insight into correct sorting principles. Obtained anytime subject makes 3 consecutively correct responses</td>
</tr>
<tr>
<td>Failure to Maintain Set (FTMS)</td>
<td>Ability to maintain correct sorting principle. Obtained anytime subject makes 5 consecutively correct responses followed by an error prior to achieving a category</td>
</tr>
<tr>
<td>Learning to Learn (LTL)</td>
<td>Average change in conceptual efficiency with each successive category</td>
</tr>
<tr>
<td>Perseverative Responses (PERR)</td>
<td>Responses indicative of perseveration</td>
</tr>
<tr>
<td>Perseverative Errors (PER)</td>
<td>Perseverative responses that are also errors</td>
</tr>
<tr>
<td>Nonperseverative Errors (NPER)</td>
<td>Total number of errors that do not indicate perseveration.</td>
</tr>
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Halstead Category Test (HCT)

The HCT is considered a measure of abstraction and concept formation ability, flexibility in novel and complex problem solving, and the ability to profit from experience (Reitan & Wolfson, 1993; Spreen & Strauss, 1998). While the HCT is sensitive to a number of cerebral disturbances, it does not appear to have any consistent association with specific location or laterality of brain dysfunction (Spreen & Strauss, 1998). However, the HCT has a strong visual-spatial component and correlates highly with several Performance IQ (PIQ) subtests on Wechsler tests of psychometric intelligence (Lezak, 1995; Spreen & Strauss, 1998). Although the measure is divided into several subtests, typically, only a single composite error score is interpreted.

WCST and HCT: Comparisons

Although both of these measures are often inappropriately used interchangeably as tests of frontal lobe functioning, the two actually show only a modest amount of common variance and likely assess distinctly different aspects of abstraction ability and concept
formation (Fisher, DeLuca, & Rourke, 1997; Perrine, 1993). Differences between these two tests are due to contrasts in test administration, stimulus presentation, and scoring procedures. Specifically, the HCT requires more perceptual abstraction abilities and incorporates a stronger visual-spatial component than does the WCST (Bond & Buchtel, 1984; Lezak, 1995). In addition, Bond and Buchtel (1984) suggested that the HCT has a greater level of complexity and difficulty than the WCST due to its multidimensional nature. Whereas the stimuli presented in the WCST are constant, the stimuli in the HCT change often.

In comparison to the HCT, the WCST is also distinguishable in the degree of information provided by the examiner. Whereas HCT instructions provide clear and explicit feedback throughout the duration of the test, the instructions for the WCST are deliberately vague. Another related attribute of the WCST relative to the HCT is the periodic changing of the categorizing principle without warning. The HCT appears to have a strong conceptualization component and has been described as a measure of higher order reasoning (Fisher et al., 1997; Perrine, 1993). In contrast, the WCST is strongly
associated with attribute identification, is less conceptually difficult, and is often described as a measure of "executive functioning" (Fisher et al., 1997; Perrine, 1993). Based on the amount of external information provided, the HCT can be considered more of an externally driven test and the WCST more internally driven (Fisher et al., 1997).

Statement of Hypotheses

This investigation was designed to compare the performance of male adolescents with and without a history of child abuse/neglect on the HCT and WCST. The predominance of neuropsychological and electrophysiological evidence within the literature implicates dysfunction within the anterior portions of the left hemisphere in maltreated children. Based on the relevant neuropsychological literature, electrophysiological findings, and hemispheric specialization theories, it was predicted that group A/N (history of abuse/neglect) would be impaired on components of the measures examined that provided minimal external guidance and were more dependent on left hemisphere systems relative to group N A/N (no
history of abuse/neglect). In contrast, no significant differences were expected between the groups on those variables that incorporated substantial external guidance or that were considered more dependent on systems within the right hemisphere. Based on theories proposed by Goldberg and colleagues (Goldberg & Costa, 1981; Goldberg & Poddell, 1995a,b), subjects with left-hemisphere dysfunction should have particular difficulty maintaining set without external guidance and their behaviour would likely be governed more by external events than by internally generated rules. In addition, it was expected that relative to nonmaltreated subjects, maltreated participants would not demonstrate an increase in conceptual efficiency over the course of tasks due to a tendency to lose set. However, no differences were predicted between the groups for level of conceptual reasoning as individuals with left hemisphere dysfunction are not expected to have difficulty with concept formation but rather in maintaining the application of the concept over time.
Specifically, it was predicted that:

1. Group A/N would exhibit particularly impaired performance relative to group N A/N on WCST FTMS, NPER, and LTL.

2. Group A/N and NA/N would exhibit relatively equivalent performance on PERR, PER, and CONLEV.

3. The two groups would obtain relatively equivalent performance on HCT total errors due to the novelty of the stimuli, substantial external guidance, and a strong visual-spatial component.
CHAPTER II
METHOD

Subjects

Subjects were taken from an archival database of 96 adjudicated juvenile delinquents in a medium security state-run training school in the United States. Exclusionary criteria included a history of traumatic brain injury and FSIQ outside the range of 75 to 115 as measured by the Wechsler Intelligence Scale for Children - Revised (WISC-R) or the Wechsler Adult Intelligence Scale - Revised (WAIS-R). Archival WCST and HCT data from 32 subjects ranging in age from 12 to 18 were analyzed. All of the subjects were right-handed males and the group means were compared for FSIQ and age. Participants were divided into two groups based on an extensive review of interview and history information: Group A/N (evidence of early abuse/neglect, n=16); Group NA/N (no evidence of abuse/neglect, n=16). Due to the small number of subjects, it was not possible to compare subtypes of maltreatment; Group A/N was comprised of individuals who had suffered physical abuse, sexual abuse, and/or physical neglect.
Measures

Wisconsin Card Sorting Test (WCST)

This test requires the subject to match up to 128 stimulus cards to four constant master cards. The four master cards are comprised of: 1) a red triangle, 2) two green stars, 3) three yellow crosses, and 4) four blue circles. The stimulus cards are similar to the key cards but vary in colour, shape, and number. The examinee is instructed to match each successively presented stimulus card to one of the four master cards and is given feedback each time regarding the correctness of the matching. Once the examinee has made ten consecutive correct matches according to the initial correct categorizing rule, the criterion principle is altered without warning. The test continues in this manner until the child achieves six correct shifts in principle or uses all 128 cards. Concepts are presented twice each in the order of colour, form, and number (Heaton et al., 1993). The subject is never apprised of the correct sorting rules, the order of their presentation, or the number of consecutively correct sortings required before the principle is altered.
Six WCST variables described earlier were examined in this investigation, namely: 1) Conceptual Level Responses (CONLEV); 2) Failure to Maintain Set (FTMS); 3) Learning to Learn (LTL); 4) Perseverative Responding (PERR); 5) Perseverative Errors (PER); 6) Non-perseverative Errors (NPER). Normative data provided by Heaton et al. (1993) were employed to determine levels of performance for WCST variables LTL and FTMS. For the other WCST variables, normative data were obtained from the WCST computer scoring system (Heaton, Curtiss, & Tuttle, 1993). A cut-off T score of 40 (M=50; SD=10) was utilized with scores 40 indicating impaired performance. Higher scores implied better performance across all variables.

Halstead Category Test (HCT)

Participants aged twelve through 14 were administered the intermediate version of the test consisting of six subtests while those aged 15 to 17 were given the adult version with seven subtests. This measure involves the presentation of stimulus figures (i.e. shapes, letters, designs) projected on a screen. Below the screen and directly in front of the examinee is a response board consisting of buttons labelled 1, 2, 3, and 4. They are
instructed to observe the stimulus presented on the screen, decide which number the stimulus suggests to them, and push the corresponding response button. A correct response issues a bell sound while a harsh buzz is emitted after an incorrect response. The examinee is only allowed one response per stimulus item regardless of the correctness of their response. He/she is informed that the rule for matching may be the same or different across subtests. They are also advised that once they discern the correct principle, continued use of the rule should engender correct responses within a subtest despite differences in stimuli characteristics (e.g. from numbers to figures). However, the examinee is never informed of the correct sorting principle for any subtest (Reitan & Wolfson, 1993). In determining levels of performance for the HCT, normative data provided by Knights and Norwood (1980) and Fromm-Auch and Yeudall (1983) were utilized for those subjects up to age 14 and over 15 respectively. T-scores ≤ 40 (mean = 50; SD = 10) will indicate impaired performance with higher scores indicating better performance.
CHAPTER III

RESULTS

In order to determine if male adolescents with histories of abuse/neglect as distinct from those without such a history demonstrated impairment on measures of higher-order reasoning and executive functioning, the HCT and WCST performances of the A/N and N A/N groups were compared via t-tests for independent samples. Prior to conducting these analyses, however, group means were compared for general intellectual functioning and age. There were no significant differences between the groups in terms of WISC-R/WAIS-R FSIQ (A/N mean FSIQ = 90 [SD = 8.39]; N A/N mean FSIQ = 86 [SD = 9.12] or age (A/N mean age = 15.19 [SD = 0.75; N A/N mean age = 15.63 [SD = 1.31].

With respect to the first hypothesis, contrary to expectations, no significant differences were found between the groups on the WCST variables of FTMS, LTL, and NPER (See Table 2). However, the mean FTMS score for the A/N group (M = 1.31) was higher than that for the N A/N group (M = 0.69) \[t(30 = -1.09, p = .283].\] Although not statistically significant, this difference is particularly
Table 2

Means and Standard Deviations for Maltreated (A/N) and Nonmaltreated (N A/N) Groups on the Wisconsin Card Sorting Test (WCST) and Halstead Category Test (HCT)

<table>
<thead>
<tr>
<th>Test</th>
<th>(A/N)</th>
<th>(N A/N)</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>WCST (T Scores)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERR *</td>
<td>52.25</td>
<td>10.82</td>
<td>44.56</td>
<td>10.23</td>
</tr>
<tr>
<td>PER</td>
<td>51.50</td>
<td>11.37</td>
<td>44.06</td>
<td>10.44</td>
</tr>
<tr>
<td>NPER</td>
<td>48.06</td>
<td>10.83</td>
<td>43.75</td>
<td>9.96</td>
</tr>
<tr>
<td>LTL</td>
<td>46.82</td>
<td>5.57</td>
<td>44.75</td>
<td>10.96</td>
</tr>
<tr>
<td>FTMS</td>
<td>42.26</td>
<td>12.61</td>
<td>47.23</td>
<td>13.12</td>
</tr>
<tr>
<td>CONLEV</td>
<td>48.31</td>
<td>10.42</td>
<td>42.06</td>
<td>10.34</td>
</tr>
<tr>
<td>HCT (T scores)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE</td>
<td>39.89</td>
<td>12.41</td>
<td>36.61</td>
<td>15.71</td>
</tr>
</tbody>
</table>

Note. PERR = Perseverative Responses; PER = Perseverative Errors; NPER = Non-perseverative Errors; LTL = Learning to Learn; FTMS = Failure to Maintain Set; CONLEV = Conceptual Level Responses.

* p < .05
interesting from a profile perspective (See Figure 1). That is, while the A/N group outperformed the N A/N group on all other variables examined, they performed more poorly than the N A/N group on FTMS.

Contrary to predictions, a significant difference was found for PERR, with the A/N group demonstrating superior performance [$t(30) = 2.06, p < .05$]. Given this, it was not surprising that there was a nonsignificant trend toward better performance of the A/N group as compared to the N A/N group on PER [$t(30) = 1.93, p = .063$]. As predicted, no significant difference was found between the groups on WCST variable CONLEV.

As predicted, group A/N did not differ significantly from group N A/N on the Total Error index of the HCT [$t(30) = .65, p > 0.05$]. However, the performance of both groups on this variable was indicative of impaired performance relative to test norms (A/N group mean TE = 39.89 [SD = 12.41]; N A/N group mean TE = 36.61 [SD = 15.71] (Fromm-Auch & Yeudall, 1983; Knights & Norwood, 1980).

Post-hoc analyses were conducted to determine if relative strengths and weaknesses existed within each of the subject groups. For the A/N group, t-tests for paired-
Figure 1. Mean t-scores for the Maltreated (A/N) and Nonmaltreated (N A/N) Groups. Wisconsin Card Sorting Test: PERR = Perseverative Responses; PER = Perseverative Errors; NPER = Nonperseverative Errors; LTL = Learning to Learn; FTMS = Failure to Maintain Set; CONLEV = Conceptual Level Responses. Halstead Category Test: TE = Total Errors
samples indicated that A/N subjects performed significantly better on PERR as compared to FTMS \([t(15) = 3.77, \ p < .01]\) and LTL \([t(13) = 2.399, \ p < .05]\) and PER relative to FTMS \([t(15) = 3.445, \ p < .01]\). In addition, CONLEV performance was significantly higher than LTL within the A/N group \([t(13) = 2.413, \ p < .05]\). In contrast, similar analyses yielded no significant differences between the variables for the N A/N group.
CHAPTER IV
DISCUSSION

The present study does not strongly support a distinction between maltreated and nonmaltreated male adolescents on measures of higher-order reasoning and executive functioning as measured by the WCST and HCT. Although it was expected that maltreated participants would exhibit difficulty on tasks dependent on systems within the left hemisphere (i.e. FTMS, LTL, and NPER) relative to those without such a history, significant differences were not obtained. The sole significant difference that emerged from the data suggested that the maltreated group performed in a superior manner on a variable considered dependent on systems within the right hemisphere, namely, PERR.

It should be noted that unexpectedly, the A/N group outperformed the N A/N group on all measures analyzed except FTMS; a finding that is in direct opposition to prevailing assumptions of the effects of maltreatment within research and lay populations (Hoffman-Plotkin & Twentyman, 1984; Kurtz et al., 1993; Parish, 1985; Perry et al., 1983; Salamon Weiss & Wagner, 1998; Salzinger et al., 1984.)
While the explanation for the maltreated group's superior performance on all other variables examined is not immediately apparent, the single lower FTMS score for the maltreated group does stand out from a profile perspective. Although the lack of significance precludes making strong conclusions regarding this finding, difficulty maintaining set is consistent with Goldberg and Podell's (1995a,b) predictions of the behavioural consequences of left prefrontal dysfunction. Furthermore, it would be concordant with previous research suggesting that maltreated children display evidence of adverse neural development primarily circumscribed within areas of the left hemisphere including differences in hippocampal and temporal lobe volume (Bremner et al., 1997) and EEG frontotemporal abnormalities (Ito et al., 1993; Ito et al., 1997).

Although the WCST is the most commonly used clinical test of executive functioning, it is possible that the FTMS variable does not adequately tap the dimension of set maintenance in subjects who have difficulty with concept formation. The manner in which this score is derived requires the subject to establish a set before set
maintenance can be assessed (i.e. subject must get 5 consecutively correct and then make an error); it is difficult therefore, to measure this dimension of executive functioning in individuals who do not achieve a mental set in the first place. Other, more experimental measures of set maintenance may be more sensitive to this skill in individuals with concept formation difficulties (e.g., Cambridge Neuropsychological Test Automated Battery [CANTAB]).

Although not predicted, findings of significantly superior performance of the maltreated group on PERR and the trend toward better performance on PER are also consistent with theories discussed earlier that stressed that the hypervigilance associated with early abuse or neglect could facilitate right hemisphere development at the expense of the left (Walsh, 1990). The ability to respond flexibly to changes in the environment is considered dependent on systems within the right hemisphere. Thus, individuals with "over-developed" right hemispheres would not be expected to have difficulty with cognitive or behavioural flexibility and the inhibition of inappropriate perseverative responses. While a
hypervigilant stance may be adaptive in a stressful home environment, it may result in impaired performance in situations where set maintenance is essential (e.g., school).

Both the maltreated and nonmaltreated groups performed below age-appropriate levels on an overall score of the Halstead Category Test but did not significantly differ from one another. Although the issue of neuropsychological functioning of juvenile delinquents was not specifically addressed in the current study, the results suggest that as a group, juvenile delinquents exhibit difficulty on a measure of higher-order reasoning relative to age-based norms. This finding is consistent with other studies that have found evidence of abstraction and concept formation impairments in juvenile delinquents (Montagu, 1980; Voorhees, 1981).

Post-hoc within-group analyses conducted on WCST variables in the maltreated group uncovered a number of significant differences between measures including perseveration and set maintenance, perseveration and increased conceptual efficiency, and conceptual reasoning
and efficiency. In contrast, no significant findings were found for the nonmaltreated group. Taken together, these results suggest that within their own neuropsychological profile, the maltreated group's problem-solving style seems characterized to a greater degree by cognitive flexibility rather than adherence to a mental set. In addition, these individuals may not benefit from repeated exposure to the task due to their distinctive approach to the test. It is possible that as a function of task duration, the flexibility that dominates the maltreated group's problem-solving style becomes maladaptive. As the measure becomes more routine and set maintenance is required for successful task completion, maltreated groups may continue to alter their response strategies. As discussed earlier, this pattern is congruent with theories regarding hypervigilance and extreme environmental sensitivity observed clinically in maltreated children.

There are a number of potential explanations for the scarcity of significant impairments within the sample studied. First, it is possible that maltreated juvenile delinquents do not differ systematically from non-maltreated juvenile delinquents on measures of higher-order
reasoning and executive functioning. An earlier study found circumscribed verbal deficits in a similar sample (Tarter et al., 1984). Perhaps maltreatment within a juvenile delinquent population is associated with verbal impairments alone with problem-solving and reasoning skills intact. Although studies utilizing agency and community-based samples of maltreated children have found reasoning and problem-solving impairments within these populations, it is possible that maltreated male juvenile delinquents differ in some important way from children identified through other means (Aber et al., 1989; Erickson et al., 1989). It would not be prudent to generalize the present findings to populations of children who are identified as abused or neglected through social service or medical agencies, as the features of maltreatment may differ in the two types of samples.

Alternatively, some researchers contend that cognitive deficits found within maltreated populations are likely due to low socioeconomic status (SES) and deprived family circumstances common within these groups, rather than
maltreatment per se (Nightingale & Walker, 1991). As it was not possible to control for SES in this study, the possibility remains that the effects of SES at work within both maltreated and delinquent populations may have contributed to non-significant findings.

Another possibility is that maltreatment does not differentially affect areas within the left hemisphere but results in variable neural presentations and behavioural outcomes (Flisher et al., 1997). While the bulk of evidence within the relevant literature implies that left hemisphere prefrontal/temporal dysfunction is associated with maltreatment, there are alternative theories (Bremner, 1997; DeBellis et al., 1999; Little, 1998). DeBellis et al. (1999) found that maltreated children with PTSD evidenced generally smaller intracranial and cerebral volumes and larger lateral ventricle volume than matched non-maltreated participants. Brain volume was positively correlated with age of maltreatment onset and negatively correlated with duration of abuse. In contrast to previous research using EEG technology, DeBellis et al. (1999) did not find reversals of the normal anatomical right>left asymmetry (Ito et al., 1993; Ito et al., 1997). A recent
case study (Little, 1998) describes the treatment of a young adult with a history of childhood maltreatment and a diagnosis of nonverbal learning disabilities (NLD), a disorder associated with right hemisphere dysfunction and a neuropsychological presentation opposite that predicted for those with left hemisphere dysfunction. If various types of brain dysfunction and behavioural outcomes associated with maltreatment were represented in the study, the probability of finding significant differences based on predictions of left hemisphere dysfunction would be unlikely.

Yet another explanation can be found in the limited control that could be exerted with archival data from juvenile delinquency files; methods for group assignment and control of confounding variables were less than optimal. Although every effort was made to ensure the groups were as "pure" as possible with respect to the presence or absence of maltreatment histories, a dependence on file review may have led to errors in classification. The most likely source of error is in the classification of children as neither abused nor neglected since a lack of reporting in the files does not necessarily mean
maltreatment did not occur. Likewise, reporting biases are also possible for individuals within the A/N group who may have thought that reporting a history of maltreatment would improve their chances within the court system.

It was not feasible in the present study to account for a number of important social variables that have been suggested to influence the effects of child maltreatment including SES (Gelardo & Sanford, 1987; Kurtz et al., 1993; Nightingale & Walker, 1991), familial factors (e.g. parental alcoholism, criminality, psychiatric conditions) (Fergusson & Lynskey, 1997; Friedrich & Einbender, 1983; Gelardo & Sanford, 1987; Tarter et al., 1984; Walsh, 1990), child characteristics (e.g. prematurity, temperament) (Dodge et al., 1995) and parental social isolation (e.g. divorce/separation, lack of social supports) (Fox et al., 1988; Gelardo & Sanford, 1987; Green, 1983; Solomons, 1979). Furthermore, circumstances surrounding the maltreatment of participants such as age of occurrence (Erickson & Egeland, 1987; Friedrich & Einbender, 1983), duration (Malinosky-Rummell & Hansen, 1993), severity (Malinosky-Rummell & Hansen, 1993), perpetrator information (Malinosky-Rummell & Hansen, 1993), medium of abuse
(Ammerman et al., 1986), and specific type of abuse/neglect inflicted (Erickson & Egeland, 1987) were not available for analysis and may have obscured potential differences.

Future research designed to delineate neuropsychological profiles of maltreated children should attempt to control many of these confounding variables; characteristics of maltreatment (e.g. type, duration, severity) should be defined and systematically evaluated. Maltreatment is most likely to occur before the age of five (Fox et al., 1988; Friedrich & Einbender, 1983; Gelardo & Sanford, 1987) during a critical stage of neural and cognitive skill development (Bingham & Harmon, 1996; Salamon Weiss & Wagner, 1998). More importantly, the developmental or learning stage that the child is in during maltreatment may influence the types of difficulty he/she later encounters. That is, if severe abuse or neglect takes place during critical language acquisition periods or at the optimal time for establishment of attachment to caregivers, children may evidence linguistic impairments or an unhealthy quality of attachment respectively (Erickson & Egeland, 1987; Salamon Weiss & Wagner, 1998). Research has suggested that children who are maltreated early in
life perform more poorly on cognitive measures than those who experience abuse or neglect at an older age (Ammerman et al., 1986; Erickson & Egeland, 1987). Future research, therefore, should strive to take the effects of early (i.e. before the age of 5) versus later abuse as well as developmental stage into account.

It is likely that subtypes of maltreatment (e.g. physical abuse, sexual abuse, emotional neglect, and physical neglect) present with different neuropsychological ability structures and overall developmental outcomes. Preliminary research has reported such differences; abused children tend to present with severe socioemotional impairment (juvenile delinquency and aggression) while neglected children predominantly exhibit substantial academic failure and cognitive impairment (Ammerman et al., 1986; Kurtz et al., 1993; Rogeness et al., 1986). Neglect is thought to be much more prevalent than other types of maltreatment and probably the most threatening to adequate child development (Eckenrode, Laird, & Doris, 1993; Egeland & Erickson, 1987; Friedrich, 1983; Wissow, 1995). An important goal of upcoming research will be to delineate
the neuropsychological and socioemotional profiles associated with specific subtypes of maltreatment.

It will also be essential to consider diagnoses secondary to maltreatment. In particular, PTSD has been implicated as a key component in the outcome of maltreated children and abused/neglected children who present with cognitive and neurological dysfunction (Green, 1983). It is likely that unusually high levels of stress, regardless of the source are detrimental to neural development in very young children resulting in ineffective stress response styles and coping behaviour in later life (Bremner, 1999; DeBellis et al., 1999; McCain & Mustard, 1999). For example, both animal and human research has demonstrated that adults who were poorly nurtured when young sustain high levels of stress hormones long after a stressful situation has abated (McCain & Mustard, 1999). Chronic and extreme stress has also been linked with memory impairments, hyperarousal, reduced capacity to process new sensory information, and suppression of the immune system (McEwan, 1998). An interesting area of future research would be the comparison of children who survived significant stress from trauma as diverse as war, natural
disasters, illness, or third-world orphanages with those who have PTSD subsequent to maltreatment. In any case, the duration and severity of abuse/neglect as well as the nature of the relationship between the perpetrator and victim may be related to the presentation of PTSD and should be taken into account (Malinosky-Rummell & Hansen, 1993).

The most promising avenue for understanding the consequences of early maltreatment is prospective, longitudinal research that tracks a birth cohort from pregnancy to adulthood and permits researchers to address questions regarding the directionality of effects. Several of these projects (e.g., Minnesota Mother-Child Project; Child Development Project, Harvard Child Maltreatment Project) are currently underway and preliminary findings are beginning to emerge (e.g. Erickson & Egeland, 1987; Aber et al., 1987; Dodge et al., 1995). Another interesting area of inquiry is the attempt to explain why many children reared in highly adverse circumstances do not seem to be affected by the limitations of their environments (Fergusson & Lynskey, 1996). Investigators search for "protective" factors that seem to
mitigate the effects of early harsh experiences. This relatively recent approach to the study of maltreatment may prove important for the development of preventative approaches and treatments for high-risk and maltreated children respectively.

In conclusion, current developmental models of the association between child maltreatment and cognitive consequences are not yet comprehensive enough to account for the heterogeneity of outcomes. The effects of abuse and neglect on neuropsychological functioning may vary substantially depending on a multitude of personal, psychological, social, and familial variables. A strength of the present study was the development of specific predictions using current developmental/neurological theories. Until recently, most of the research on child maltreatment was atheoretical and continued theory-driven research is sorely needed within this area to dispel myths regarding the effects of maltreatment (Aber et al., 1987). Thus, it will be important for future researchers interested in the effects of maltreatment to systematically isolate and differentiate the various outcomes and sources of maltreatment using developmental theories as guidelines.
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VITA AUCTORIS

Michelle Petherick-Giudice was born on September 13, 1971, to Edward and Judith Petherick (nee Knox), in Peterborough, Ontario. In June of 1990, she graduated from Norwood District High School and in June of 1994, she was conferred the degree of Bachelor of Arts with Honours at University of Windsor. After spending two years employed as a brain injury rehabilitation therapist at Parkwood Hospital Brain Injury TEACH Program, she enrolled in the doctoral program in child-clinical neuropsychology at the University of Windsor. She completed her practicum requirements at University Psychiatric Center in Detroit, Michigan.