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ATTENTION DEFICIT DISORDER (ADD) WITH AND WITHOUT HYPERACTIVITY: NEUROPSYCHOLOGICAL, ACADEMIC, AND PSYCHOSOCIAL CORRELATES OF ADD SUBTYPES IN CHILDREN

by

Joseph E. Casey

B. A. University of Windsor, 1978
M. A. Carleton University, 1983

A Dissertation Submitted to the Faculty of Graduate Studies through the Department of Psychology in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy at the University of Windsor

Windsor, Ontario, Canada 1993
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- Speech Communication: 0749
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- Agricultural: 0517
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- Early Childhood: 0518
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- Health: 0680
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- History of: 0520
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- Philosophy: 0422
- Religion: 0421
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- History: 0320
- History of: 0322
- History of: 0324

**SOCIAL SCIENCES**
- American: 0323
- Anthropology: 0324
- Business: 0326
- Economics: 0358
- General: 0329
- Accounting: 0372
- Banking: 0370
- Management: 0354
- Marketing: 0338
- Canadian: 0310
- Canadian: 0319
- Canadian: 0336
- Canadian: 0333
- Canadian: 0337
- United States: 0353
- History of: 0359

**PSYCHOLOGY**
- Psychology: 0525
- Personality: 0533
- Religious: 0527
- Social: 0534
- Sociological: 0530
- Social: 0529

**LINGUISTICS**
- Language: 0401
- Linguistic: 0429
- Comparative: 0429
- Modern: 0429
- Modern: 0429
- African: 0316
- American: 0332
- Asian: 0305
- Canadian (English): 0352
- French (French): 0352
- English: 0353
- German: 0311
- Latin American: 0312
- Middle Eastern: 0313
- Asian: 0314

### THE SCIENCES AND ENGINEERING

**BIOLOGICAL SCIENCES**
- Agriculture: 0473
- Agronomy: 0485
- Animal Science and Technology: 0475
- Animal Pathology: 0476
- Animal Nutrition: 0479
- Veterinarian: 0480
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- Agriculture: 0485
- Agricultural: 0749
- Analytical: 0486
- Biochemistry: 0457
- Inorganic: 0488
- Organic: 0490
- Pharmaceutical: 0491
- Physics: 0492
- Radiology: 0754
- Radiation: 0493
- Environmental: 0768
- Environmental: 0768
- Environmental: 0768
- Environmental: 0768
- Environmental: 0768
- Environmental: 0768
- Environmental: 0768

**PSYCHOLOGY**
- General: 0621
- Behavioral: 0622
- Clinical: 0628
- Developmental: 0620
- Experimental: 0623
- Industrial: 0624
- Personality: 0625
- Physiological: 0626
- Psychobiological: 0627
- Psychosomatic: 0628
- Social: 0631
ABSTRACT

The present study was designed to evaluate the external validity of Attention Deficit Disorder subtypes formed according to whether or not hyperactivity was present. The groups were compared on variables that reflected neuropsychological, academic, and psychosocial functioning. They were also compared on child and family history variables. Of particular interest was whether and to what extent the ADD subtypes could be distinguished on clinical neuropsychological measures that have been associated with "executive" or "frontal lobe" processes in adults. Sixty-two children with ADD+H and 22 children with ADD-H were selected from consecutive referrals to a hospital-based neuropsychology service.

Few significant differences emerged when the groups were compared on neuropsychological, academic, and child and family history variables. It was found that the ADD-H group correctly identified fewer items on the Underlining Test, a result that was consistent with the notion that children with ADD-H encounter difficulties on certain tasks that stress complex visual search and perceptual-motor speed. However, overall, there was no compelling evidence to suggest that children with ADD+H have greater deficiencies on tasks that have traditionally been associated with "executive" processes as compared to children with ADD-H, or
that learning disabilities are associated with one subtype more than the other.

Significant group differences were found on behavioural and emotional adjustment variables that were not used in the classification of the children. The pattern of differences was largely consistent with the results of previous studies. In general, both groups exhibited more problems of an internalized nature (e.g., social withdrawal, unhappiness) as compared to normative data, although these problems were more common in the ADD-H group. Externalized problems (e.g., conduct disorders, aggression) were less common in the ADD-H group as compared to the ADD+H group, being almost non-existent within the school setting. Among the children with ADD+H, approximately 30% exhibited externalized problems at home and 50% exhibited such problems at school. The findings related to behavioural and emotional adjustment provide some support for the validity of subtyping children with ADD according the presence or absence of hyperactivity.
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Finally, it is difficult for me to find the words that adequately express my gratitude to my wife, Jennifer. She has always been at my side, even during the most trying times. She has given me her love, patience, and support, even when there seemed to be little of these in return. She has always worked outside of the home to help pay the bills and has maintained a warm and spotless home for me and our four boys. Yes, indeed, she is a superwoman. I say to her, thank you from the bottom of my heart.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
</tbody>
</table>

CHAPTER

I

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Historical Antecedents</td>
<td>3</td>
</tr>
<tr>
<td>Demographic, Medical, Developmental, and Family History Characteristics</td>
<td>8</td>
</tr>
<tr>
<td>Social, Emotional, and Behavioural Characteristics</td>
<td>18</td>
</tr>
<tr>
<td>Efficacy of Stimulant Medication</td>
<td>25</td>
</tr>
<tr>
<td>Academic, Cognitive, and Neuropsychological Characteristics</td>
<td>27</td>
</tr>
<tr>
<td>Summary of Major Findings</td>
<td>55</td>
</tr>
<tr>
<td>Methodological Considerations</td>
<td>60</td>
</tr>
<tr>
<td>The Present Study</td>
<td>66</td>
</tr>
<tr>
<td>Hypothesis 1</td>
<td>71</td>
</tr>
<tr>
<td>Hypothesis 2</td>
<td>76</td>
</tr>
<tr>
<td>Hypothesis 3</td>
<td>80</td>
</tr>
<tr>
<td>Hypothesis 4</td>
<td>82</td>
</tr>
</tbody>
</table>
II  METHOD ......................................................... 85
    Subjects .................................................... 85
    Procedures .................................................. 85
    Measures ..................................................... 89
    Data Analyses .............................................. 91

III RESULTS ...................................................... 93
    Hypothesis 1: "Executive Processes" ............... 95
    Hypothesis 2: Academic Functioning ............... 112
    Hypothesis 3: Behavioural and
      Emotional Adjustment ............................. 119
    Hypothesis 4: Child and Family
      History Variables ................................. 125

IV DISCUSSION .................................................. 130
    "Executive" Processes ................................. 131
    Academic Functioning ................................. 138
    Behavioural and Emotional Adjustment ............ 141
    Child and Family History Variables .............. 145
    Summary of Conclusions .............................. 146

V  BIBLIOGRAPHY ................................................. 149
APPENDIX

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DSM-III Criteria for ADD</td>
<td>167</td>
</tr>
<tr>
<td>B</td>
<td>DSM-III-R Criteria for ADHD</td>
<td>170</td>
</tr>
<tr>
<td>C</td>
<td>Child Attention Profile</td>
<td>172</td>
</tr>
<tr>
<td>D</td>
<td>Normative Data for the CAP</td>
<td>174</td>
</tr>
<tr>
<td>E</td>
<td>Children's History Form</td>
<td>176</td>
</tr>
<tr>
<td>F</td>
<td>Rating of Handwriting Scale</td>
<td>196</td>
</tr>
<tr>
<td>G</td>
<td>The Underlining Test</td>
<td>199</td>
</tr>
</tbody>
</table>

VITA AUCTORIS                                   201
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tasks on Which Deficits Have Been Found</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>Demographic and Subject Selection Information by Group</td>
<td>94</td>
</tr>
<tr>
<td>3</td>
<td>Means and Standard Deviations on Psychomotor Measures</td>
<td>96</td>
</tr>
<tr>
<td>4</td>
<td>Pearson Correlation Coefficients Among Holes Test Variables</td>
<td>99</td>
</tr>
<tr>
<td>5</td>
<td>Pearson Correlation Coefficients Among Maze Test Variables</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Pearson Correlation Coefficients Among Higher-Order Variables</td>
<td>103</td>
</tr>
<tr>
<td>7</td>
<td>Means and (Standard Deviations) on Higher-Order Measures</td>
<td>104</td>
</tr>
<tr>
<td>8</td>
<td>Frequency and Percentage of LD by Group</td>
<td>113</td>
</tr>
<tr>
<td>9</td>
<td>Mean Standard Scores and (Standard Deviations) on the WRAT-R Subtests</td>
<td>114</td>
</tr>
<tr>
<td>10</td>
<td>Mean T Score and (Standard Deviations) on Selected Neuropsychological Variables</td>
<td>118</td>
</tr>
<tr>
<td>11</td>
<td>T Score Means and (Standard Deviations) on Measures of Behavioural and Emotional Adjustment</td>
<td>121</td>
</tr>
<tr>
<td>12</td>
<td>Frequency of Externalized Problems by Group</td>
<td>122</td>
</tr>
<tr>
<td>13</td>
<td>Frequency of Internalized Problems by Group</td>
<td>123</td>
</tr>
<tr>
<td>14</td>
<td>Frequency of Problems Related to the Child’s Family History</td>
<td>127</td>
</tr>
<tr>
<td>15</td>
<td>Frequency of Behavioural, Emotional, and Learning Problems Related to the Child’s Family History</td>
<td>128</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mean Performance of Both ADD Groups on Higher-Order Measures: Children with LD Excluded</td>
<td>106</td>
</tr>
<tr>
<td>2 Mean Performance of Both ADD Groups on the Underlining Test</td>
<td>109</td>
</tr>
<tr>
<td>3 Mean Performance of Both ADD Groups on the Underlining Test: Children with LD Excluded</td>
<td>110</td>
</tr>
<tr>
<td>4 Mean Number of Errors on the Underlining Test of Both ADD Groups and an Age-Matched Normative Sample</td>
<td>111</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Hyperactivity is regarded as one of the most common behavioural disorders of childhood, and it is one of the most common reasons why children are referred to mental health practitioners in the United States (Barkley, 1990; Ross & Ross, 1982). Prevalence estimates based on survey data vary widely, ranging from 1 to 20 percent depending on the method used to define the disorder (Trites, Dugas, Lynch, & Ferguson, 1979). Estimates derived from recent and methodologically more sophisticated studies (e.g., Lambert, Sandoval, & Sassone, 1978; Szatmari, Offord, & Boyle, 1989) suggest that the actual rate is probably between 1 and 6 percent. The revised third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) indicates that hyperactivity may occur in as many as 3 percent of children (American Psychiatric Association, 1987).

Many authors who have investigated the history of this disorder (e.g., Barkley, 1990; Ross & Ross, 1982; Schachar, 1986) credit pediatrician Sir George Frederic Still (1902) with providing, almost 90 years ago, the first description of a behaviour pattern in children that was akin to what is now commonly referred to as hyperactivity. Still described 20 cases in which problems with aggressiveness, resistance
to discipline, excessive emotionality, restlessness, fidgetiness, poor sustained attention, and the lack of inhibitory volition were major characteristics. By the 1930s and 1940s, studies focussing on the behavioural sequelae of brain damage in children and those demonstrating the efficacy of amphetamines in reducing disruptive behaviours in children began to appear, marking the beginning of an ever-increasing interest by clinicians and researchers in the core symptomatology, associated features, etiology, and treatment of hyperactivity. This early history, coupled with the dramatic increase in the number of investigations conducted over the last decade, have made hyperactivity the most well-studied psychiatric disorder of childhood (Barkley, 1990; Weiss, 1990).

Yet, despite its relatively frequent occurrence, its long history as compared to other psychiatric conditions of childhood, and the vast amount of information that has accumulated over the years, many questions still remain concerning virtually every facet of this disorder, from diagnosis to prognosis. While it is generally recognized that children with hyperactivity share developmentally inappropriate levels of inattention, impulsivity, and in many cases overactivity, many other aspects of their presentation--such as associated psychiatric disorders, family backgrounds, developmental courses, etiological factors, and responses to treatment--are quite varied
(Barkley, DuPaul, & McMurray, 1990). Consequently, one line of scientific inquiry has focused on identifying dimensions by which hyperactive children can be subtyped into more homogeneous groups. One approach has been to group hyperactive children according to whether their behavioral symptoms are primarily situational (i.e., occur in a single setting, such as at home or at school) or pervasive in nature (occur in all settings). Other studies have examined the clinical utility of subtyping hyperactive children according to whether or not they exhibit any evidence of aggression as a part of their presenting symptomatology (e.g., oppositionality, defiance, fighting).

From an evolving conceptualization of hyperactivity over the past 20 to 30 years, a third subtyping scheme has emerged that has enabled clinicians and researchers to group hyperactive children according to the degree to which motoric overactivity is present. However, to adequately understand this seemingly contradictory notion—-that there exists a group of "hyperactive" children who are not motorically overactive—-one must first consider the historical developments that have led to this typology's existence and which have served as the impetus for the present investigation.

**Historical Antecedents**

The earliest descriptions of hyperactivity as a recognized syndrome included a variety of symptoms. While
those most commonly recurring were excessive physical activity, impulsiveness, aggressiveness, poor learning in the presence of seemingly normal intelligence, clumsiness, "soft" neurological signs, low frustration tolerance, and poor peer relationships (Aman, 1984), the emphasis was on overactivity and impulsivity as the core symptoms. This emphasis was reflected in many of the syndrome labels of the day: "organic driveness" (Kahn & Cohen, 1934), "hyperkinetic syndrome" (Ounsted, 1955), "hyperkinetic behaviour syndrome" (Laufer & Denhoff, 1957), "hyperkinetic impulse disorder" (Laufer, Denhoff, & Solomons, 1957), "character impulse disorder" (Frosch & Wortis, 1954), "hyperexcitability syndrome" (Prechtl & Stemmer, 1962). The acceptance of overactivity as a symptom of a psychiatric disorder was formalized by the inclusion of a new diagnostic category in the DSM-II (1968): Hyperkinetic Reaction of Childhood.

However, the studies that followed, especially those conducted by Douglas and her colleagues in the early seventies, suggested that hyperactive children displayed as many problems related to sustained attention as they did to motoric overactivity (Douglas, 1972; Douglas & Peters, 1979). The importance of overactivity as the primary symptom of this disorder was diminished further by experimental findings that showed that measures of motoric activity level were unreliable in distinguishing hyperactive from normal children (Ross & Ross, 1982). This was
particularly the case when the comparisons were based on observations made during free-play unstructured situations (e.g., Barkley & Ullman, 1975). These findings contradicted the commonly held view of the sixties that hyperactive children were consistently far more active than their normal peers (Ross & Ross, 1982).

Paralleling these developments was the growing popularity of the Conners Parent and Teacher Rating Scales. The results of studies based on these scales served to bolster the relevance of inattention as a core symptom of hyperactivity; for example, factor analytic studies of the Conners Scales, particularly the teacher form, found that an independent "Inattention" factor emerged (Conners, 1969; 1970; Goyette, Conners, & Ulrich, 1978) and that this factor was often as sensitive in discriminating hyperactive children as was the Hyperactivity factor (Aman, 1984).

So influential were the results of these studies on the conceptualization of hyperactivity that with the publication of DSM-III in 1980, the core symptoms emphasized for diagnosis changed from motoric overactivity and impulsivity to inattention and impulsivity. Because the attentional difficulties of such children were considered prominent and virtually always present, the term "hyperactivity", as well as its variants, was replaced by a new diagnostic label: Attention Deficit Disorder (ADD; American Psychiatric
Association, 1980), a term which reflected this new emphasis.

Other changes introduced in DSM-III, namely, the multidimensional nature of the diagnostic criteria for ADD (i.e., inattention, impulsivity, and hyperactivity) and the de-emphasis of hyperactivity as an essential feature of the disorder, gave rise to two diagnostic subtypes. The diagnosis of "Attention Deficit Disorder with Hyperactivity" (ADD+H) required that all three core symptoms be present, whereas the presence of developmentally inappropriate levels of inattention and impulsivity in the absence of motoric overactivity defined "Attention Deficit Disorder without Hyperactivity" (ADD-H; see Appendix A for a complete presentation of the DSM-III criteria for each subtype). This method of subtyping children with ADD was advanced despite the lack of empirical evidence addressing its validity. Indeed, it was acknowledged in DSM-III that "it is not known whether they are two forms of a single disorder or represent two distinct disorders" (p. 41).

The first investigations designed to examine the validity of this typology began to appear in the early eighties. Although the results suggested that ADD+H and ADD-H children differed in some meaningful ways--most notably in their behavioural, academic, and social patterns (Shaywitz & Shaywitz, 1988)--the findings came too late to be considered in the DSM-III revision (Barkley, 1990).
Indeed, several changes introduced in the most recent the release of this diagnostic system (DSM-III-R, 1987) have made matters regarding this typology, particularly diagnosis, even more confusing. The tripartite diagnostic structure of DSM-III was abandoned in favour of a unidimensional category, termed Attention-deficit Hyperactivity Disorder (ADHD). Currently, to be given the diagnosis of ADHD, a child must exhibit any 8 of 14 symptom items that span all the areas of inattention, impulsivity, and hyperactivity (see Appendix B). ADD-H is no longer considered to be a distinct subtype. Instead, it is relegated to the ill-defined category of Undifferentiated ADD, a category for which no specific diagnostic criteria are given.

This is a residual category for disturbances in which the predominant feature is the persistence of developmentally inappropriate and marked inattention that is not a symptom of another disorder, such as Mental Retardation or Attention-deficit Hyperactivity Disorder, or of a disorganized and chaotic environment. Some of the disturbances that in DSM-III would have been categorized as Attention Deficit Disorder without Hyperactivity would be included in this category. (American Psychiatric Association, 1987; p. 95)

Whether or not ADD+H and ADD-H constitute valid subtypes remains unanswered. Studies addressing this issue have continued to appear in the literature, even since the publication of DSM-III-R with its new diagnostic structure for attentional disorders. Although plagued by methodological shortcomings, not the least of which have
involved definitional ambiguities and inconsistencies regarding the populations under study, the results of this research suggest that to discard the notion that ADD children can be subtyped according to their degree of motoric overactivity would be premature at this time.

The studies that have explored the validity of this typology can be grouped into four categories: Those that have examined group differences on the basis of (1) demographic, developmental, health, and family history characteristics; (2) social, emotional, and behavioural characteristics; (3) efficacy of stimulant medication; and (4) academic, cognitive, and neuropsychological characteristics. The literature related to each of these areas is reviewed in turn as background to the present study.

Demographic, Medical, Developmental, and Family History Characteristics¹

Relatively few investigations have been conducted with the explicit purpose of comparing children with ADD+H and ADD-H on demographic, medical, developmental, and family history variables. Nevertheless, important differences

¹The diagnostic labels and definitional criteria employed in the literature have differed among studies and from year to year. For the purpose of consistency, the DSM-III labels will be adopted throughout this review to denote children who have, or who have approximated, the DSM-III subtypes of ADD+H or ADD-H. However, this is not meant to imply that the DSM-III criteria were utilized to define the subtypes in the particular study being described.
between the ADD subtypes have been demonstrated from these few studies as well as from those that in the course of examining other aspects of ADD have provided evidence related to the characteristics included in this category.

One area in which the subtypes differ concerns the prevalence of each condition. The findings of epidemiological, clinical, and school-based studies of children are, for the most part, quite consistent in demonstrating that ADD+H occurs more frequently than ADD-H. At least two epidemiological studies have been conducted that have provided data on the prevalence of each subtype. The data from the Ontario Child Health Study, a province-wide epidemiological study designed to investigate the prevalence of four psychiatric disorders in children (conduct disorder, emotional disorder, ADD, and somatization) indicate that for nonreferred children aged 4-11 years ADD+H is four and one-half times more common than ADD-H (Szatmari, Offord, & Boyle, 1989). Diagnostic classification for each psychiatric disorder in this study was guided by the DSM-III criteria. Similar findings were reported by Shaywitz (1986; cited in Shaywitz & Shaywitz, 1988) who found that ADD+H occurred four times more frequently than ADD-H in an epidemiological sample of school children.

Ratios based on clinic samples and nonreferred school samples have ranged from 1.8:1 to 2.6:1. Most of the
clinic-based studies identified the ADD subtypes from samples of consecutively referred children utilizing the DSM-III criteria (Berry et al., 1985; Carlson et al., 1987; Frank & Ben-Nun, 1988; Lahey et al., 1987). However, a similar ratio (2.4:1) was obtained with a school sample of 2nd-, 3rd-, and 4th-grade boys rated by their teachers on the SNAP Checklist² (King & Young, 1982).

Only two groups of investigators found a greater frequency of ADD-H as compared to ADD+H (Lahey et al., 1984 and Barkley et al., 1990). Although the method by which potential subjects were identified for inclusion in the Lahey et al. study was unconventional and open to selection bias, the precise influences that might have given rise to a 1:2 ratio of ADD+H to ADD-H is unclear. However, there may have been an over-representation of learning disabled children in the ADD sample; if so, this may have preferentially inflated the number of children in the ADD-H group. This conclusion is based on the results of some studies (reviewed below) that have shown a higher frequency of learning disabilities among ADD-H as compared to ADD+H groups. In the Lahey et al. study, the ADD children were drawn from a pre-selected group of 2nd to 5th graders that, 

²The Swanson, Nolan, and Pelham (SNAP) Checklist is a teacher rating scale that is composed of the 23 items that constitute the DSM-III criteria for ADD (see Appendix A). A child is rated on a scale from 0 to 3 according to the degree to which each symptom is present: "not at all," "just a little," "pretty much," or "very much."
in turn, had been selected from a larger school-based population because they were experiencing some type of mild to severe behaviour or social problem. It is possible that some of the children in the ADD-H group exhibited attential difficulties that were secondary to a learning disability.

It is also possible that a sampling bias favouring the selection of children with learning disabilities (LD) influenced the results of the Barkley et al. (1990) study. In this study, like that of Berry et al. (1985), Carlson et al. (1987), and Lahey et al. (1987), the children were selected from consecutive referrals to a clinic setting. Averaged across the three studies cited above, the ratio of ADD+H to ADD-H is approximately 2:1. In contrast, Barkley et al. found a slightly lower prevalence of ADD+H to ADD-H (1:1.4) in their clinical sample. However, given that Barkley's clinics are specialized for the evaluation and treatment of children with learning and attential disorders, it is possible that those referred to these clinics are not representative of ADD children in general. Perhaps children with ADD-H pose more of a diagnostic dilemma to educators as compared to their hyperactive counterparts, thereby increasing the likelihood that they will be referred for specialized testing.

Although certain DSM-III criteria were used in the Barkley et al. study for the selection of subjects (e.g.,
age of onset and duration), the method used for determining the significance of the behavioural symptomatology was, and remains, unique in the research literature. In this study, the differentiation of ADD children was made on the basis of their scores on the Child Attention Profile (CAP) (Barkley, 1990). Rather than following the tripartite framework of DSM-III, the CAP yields scores on two factors that are considered to reflect more precisely the core features of ADD: Inattention and Overactivity. A major advantage of the approach used in the Barkley et al. (1990) study is that it does not require the features of impulsivity to be present in order to classify children as ADD-H. This is an important consideration given the evidence to suggest that impulsivity is a characteristic of children who are inattentive and motorically overactive, but not of children who are inattentive in the absence of overactivity. In addition, factor analytic studies have found that behaviour rating scale items related to impulsivity have higher correlations with an "Overactivity" or a "Hyperactivity" factor than with an "Inattention" factor (e.g., Lahey, Pelham, Schaugency, Atkins, Murphy, Hynd, Russo, Hartdagen, & Lorys-Vernon, 1988). In all of the studies that have used the DSM-III criteria to distinguish the subtypes, it is possible that the ADD-H groups were contaminated with subjects who might have otherwise been more appropriately classified as ADD+H. On the other hand, each of the ADD
groups in the Barkley et al. (1990) study may have been more homogeneous than those studied in previous research.

Several studies have also reported data on the gender composition of the ADD subtypes. In general, when the groups are drawn from nonreferred populations, the findings suggest that the ratio of males to females is larger among groups of ADD+H than ADD-H children. Szatmari et al. (1989) found a male to female ratio of 3:1 in the ADD+H sample and 1:1 in the ADD-H sample. In contrast, the difference in ratios between the two subtypes has not been nearly as large in samples drawn from clinic populations of consecutive cases. Lahey et al. (1987) found that the male to female ratio in their sample of children with ADD+H was 4.9:1, and in the children with ADD-H it was 3.4:1. However, a comparison of the subtypes based on the percentage of males in each group was nonsignificant. Also utilizing the DSM-III criteria for the identification of subjects, Berry et al. (1985) found that the two subtypes had a similar ratio of males to females (3.3:1 vs. 3.0:1). However, an exception to this pattern was demonstrated in the Barkley et al. (1990) study. Male to female ratios for the ADD+H and ADD-H groups was 13:1 and 8.6:1, respectively. Although not entirely consistent, the results, when taken together, suggest that there is a larger ratio of boys relative to girls in the ADD+H subtype as compared to the ADD-H subtype.
Other demographic variables for which data are available for each of the subtypes include age, race, and socioeconomic status (SES). No significant differences between the ADD subtypes have emerged with respect to race (Lahey et al., 1987) or SES (Barkley et al., 1990; Berry et al., 1985; Lahey et al., 1987). However, the evidence related to age suggests that children with ADD-H come to professional attention at a later age than do ADD+H children, a finding that is not surprising given the different manner in which children of each subtype present. The child with ADD+H is seen as behaviourally more disruptive and problematic than is the ADD-H child, especially within the classroom setting. This prompts parents or educators to seek professional assistance in understanding and treating the child's behaviour.

In the clinical studies that have reported the mean age of the ADD subtypes, the ADD+H group is typically younger than is the ADD-H group. However, only two studies compared the groups statistically. Lahey et al. (1987) found that the average age at clinical presentation for ADD+H children was 8.65 years, and for ADD-H children it was 10.75 years, a difference that was statistically significant. In contrast, Barkley et al. (1990) found that the ADD subtypes did not differ significantly in age. The mean age of the ADD+H children was 8.3 years and that of the ADD-H children was 9.0 years. Although Berry et al. (1985) did not compare the
two subtypes on age, they did find a significant difference in age at presentation between boys and girls within each subtype. ADD+H girls presented on average at a younger age (9.3 years) than did ADD+H boys (10.3 years). The opposite pattern was observed in the ADD-H group, with the girls presenting significantly later (12.2 years) than did the boys (10.2 years). These findings would suggest that, at least to some extent, societal expectations regarding the conduct of boys and girls determine the age at which a particular child is likely to be referred for clinical evaluation.

Averaging the ages for each of the ADD subtypes across the three studies (Barkley et al., 1990; Berry et al., 1985; Lahey et al., 1987) indicates that the ADD+H children are seen in clinics at a younger age than are ADD-H children (8.5 years versus 10.1 years, respectively). While Barkley (1981) has suggested that the upper limit for the age of onset criterion be lowered (which in DSM-III-R is prior to 7 years of age), Shaywitz and Shaywitz (1988) have argued that doing so might result in a failure to identify children who would otherwise receive the diagnosis of ADD-H since many of these children do not exhibit their symptoms until they have been in school for several years.

Two studies have compared the ADD subtypes in terms of the children's medical and developmental histories. Frank and Ben-Nun (1988) found a greater occurrence of perinatal
and neonatal abnormalities in the ADD-H as compared to the ADD+H group (approximately 50% and 13% of the respective samples). The abnormalities surveyed included maternal bleeding in the first trimester, prematurity, evidence of neonatal asphyxia, significant fetal distress, and neonatal meningitis. In contrast, Barkley et al. (1990) found that the ADD subtypes did not differ from each other or from either of two comparison groups (an LD group and a normal control group) in the frequency of perinatal and neonatal medical complications such as toxemia, Rh incompatibility, duration or difficulties in labour, or health or weight of the child at birth. Furthermore, there was no significant difference between the four groups in terms of maternal health, the mother’s use of drugs during pregnancy, or prior number of pregnancies or miscarriages.

Barkley et al. (1990) found that during the early developmental period the ADD+H group was rated as significantly more active and persistent in their demands than the ADD-H, LD, and normal control (NC) groups. Both studies (Barkley et al., 1990; Frank & Ben-Nun, 1988) found that the ADD subtypes did not differ from each other with respect to early motor and language development. The frequency of early infections (e.g., ear, respiratory tract) or chronic illnesses (e.g., asthma) did not discriminate the two groups either. In addition, Barkley et al. found that neither hearing nor vision difficulties, difficulties with
toilet training, or the number of accidents, hospitalizations, or surgeries differentiated any of their groups. However, they did find that the ADD groups had a significantly greater proportion of children who were rated by their mothers as having had fair to poor motor coordination as compared to the LD and NC groups. Although the frequency was somewhat higher in the ADD-H (54%) than the ADD+H group (40%), this difference was not statistically significant.

Barkley et al. (1990) also found that several family history variables differentiated the ADD subtypes from each other and from the two comparison groups. There was a greater frequency of attention deficits and hyperactivity among the paternal relatives, and of substance abuse problems among the maternal relatives of the ADD+H children as compared to the other three groups. The ADD-H, LD, and NC groups did not differ from each other on these measures. Maternal relatives with aggressiveness and attention deficits in childhood were more common in the ADD+H group than in the LD and NC groups. The ADD-H group did not differ significantly from any of the groups in this respect. These findings are somewhat discrepant with those of Frank and Ben-Nun (1988) who found that the ADD groups did not differ in the incidence of family members with the diagnosis of ADD. However, it is not clear that a distinction between the diagnosis of ADD+H and ADD-H was made in the family
members. This factor coupled with the small sample size and the surveying of immediate family members only may have masked a difference on this measure.

In contrast to the increased frequency of externalized types of disorders found in the family histories of ADD+H children, Barkley et al. found that the maternal relatives of ADD-H children were more likely to experience anxiety disorders as compared to the other three groups of subjects. In addition, learning disabilities were found to be more common among the siblings of ADD-H and LD children than among the siblings of ADD+H and NC children. The four groups did not differ significantly in the incidences of depression, psychosis, mental retardation, antisocial behaviour, police arrests, failures to complete high school, and tic disorders among their relatives.

Social, Emotional, and Behavioural Characteristics

Perhaps the most consistent evidence to support the view that ADD+H and ADD-H are distinct disorders comes from studies that have examined the social, emotional, and behavioural correlates of each condition. It is also the results of this group of studies that have been the most strongly criticized, largely because of the tendency to confound the independent and dependent variables. This has usually involved researchers classifying ADD subtypes according to certain behavioural criteria (e.g., exceeding a cut-off score on a hyperactivity factor of a teacher-
completed behaviour rating scale) and then comparing the subtypes to each other on variables that are similar those employed to formulate the groups (e.g., a second teacher-completed behaviour rating scale). Utilizing a common source for the behavioural ratings as well as independent and dependent variables that are highly correlated with each other, will increase the probability that significant differences will be found. Despite these limitations, some important findings have emerged from these studies.

The first study to examine the psychiatric characteristics of children classified as ADD-H was that of Maurer and Stewart (1980). Based on a retrospective review of the clinic and hospital charts of a sample of children with ADD-H, they found that 60% had undersocialized conduct disorders, 20% had other specific psychiatric disorders (e.g., depression, socialized conduct disorder), and 20% were thought to comprise two overlapping groups, a group characterized by learning disabilities and another by a lack of motivation. Given that conduct disorders were commonly considered to be a correlate of ADD-H and because most of their sample exhibited such features, Maurer and Stewart concluded that their data did not support the notion that ADD-H was an independent syndrome, at least as defined in DSM-III. Rather, they suggested that the attentional deficits exhibited by the nonhyperactive children were secondary to learning disabilities or passivity.
Unfortunately, children with ADD-H were defined loosely as (1) those having "a history of problems with short attention span and difficulty finishing school work or projects" and (2) who were not hyperactive. A child was excluded as hyperactive only if the mother rated the child as "much more active than average," a criterion that likely resulted in a somewhat heterogeneous ADD-H group, some of whom might have otherwise been considered ADD+H.

The findings of subsequent studies examining the psychosocial and behavioural correlates of each subtype have not supported Maurer and Stewart’s (1980) conclusion that ADD-H is not an independent syndrome, whether identified by DSM-III criteria or not. This has also been the case regardless of whether the children were identified from a clinic sample or from a school-based sample. Each of these sampling approaches could be criticized on methodological grounds. Drawing from a school-based population may be viewed as inappropriate because the children identified may not be experiencing disturbances that are of a sufficient magnitude to be considered psychopathological in nature (i.e., the children do not exhibit maladaptive levels of the syndrome). On the other hand, clinic-based samples are subject to referral biases (Lahey & Carlson, 1991). Despite these considerations, the findings from these more recent studies involving both types of samples have been fairly consistent.
King and Young (1982) compared three groups of boys selected from a large population of 2nd, 3rd, and 4th graders. Based on teacher responses to the SNAP Checklist and a lenient application of the DSM-III criteria, 22 ADD+H and 9 ADD-H children were identified. As would be expected based on the definitional criteria employed, the two groups did not differ on the Inattention factor of the Conners Teacher Rating Scale (CTRS) but did on the Hyperactivity factor, with the ADD+H group scoring significantly higher than the ADD-H group. However, the ADD+H group obtained a significantly higher elevation on the Conduct Problem factor even though the SNAP does not include items referring to aggressiveness and conduct problem behaviour. Relative to a normal control group, the ADD-H group showed a significant elevation of the Inattention factor only.

Similar findings were reported by Lahey, Schaughency, Strauss, and Frame (1984) who also compared groups of children classified as ADD+H, ADD-H, and NC. To be included in the ADD-H group, a child had to equal or exceed a cut-off score of 1 SD above the normative mean (the deviant direction) on the Attention Problem-Immaturity factor of the Revised Behavior Problem Checklist (RBPC; Quay & Peterson, 1983). Those who obtained an elevation of 1 SD or more on both the Attention Problem-Immaturity factor and the Motor Excess factor were designated as ADD+H. When each of the ADD subtypes was compared to the NC group on the scales that
were not used for group classification, it was found that the children with ADD+H had significantly higher scores on the Conduct Disorder, Socialized Aggression, and Psychotic Behavior scales, whereas the children with ADD-H had significantly higher scores on the Anxiety-Withdrawal scale only. When the ADD subtypes were compared to each other, the ADD+H group was significantly more deviant on the Conduct Disorder and Socialized Aggression scales. Furthermore, 8 of the 10 ADD+H children obtained scores on the Conduct Disorder scale that exceeded the mean for a psychiatric sample reported in the RBPC manual. In contrast, none of the 20 ADD-H children obtained scores that even approximated this level (Lahey et al., 1984). When Lahey, Schaughency, Frame, and Strauss (1985) compared these same groups on the individual items that constitute the Attention Problem-Immaturity scale, they found that the ADD+H children were rated by their teachers as more irresponsible, sloppy, distractible, impulsive, less sluggish, more likely to answer without thinking, and faster finishing assignments than the ADD-H children.

The results of several clinic-based studies that have used a variety of means to define the ADD subtypes as well as to measure group differences have been in agreement with the findings described above. Regardless of whether the comparisons were based on the Conners Scales (Ackerman, Dykman, & Oglesby, 1983; Barkley et al., 1990; Lahey,
Schaughency, Hynd, Carlson, & Nieves, 1987), the RBPC (Barkley et al., 1990; Edelbrock, Costello, & Kessler, 1984), or the Yale Child Inventory (Berry, Shaywitz, & Shaywitz, 1985), the ADD+H children were invariably more aggressive and exhibited more problems with conduct than did the ADD-H children.

It has also been shown that children with ADD-H differ from their normal peers in areas other than attention. Increased levels of social withdrawal (e.g., Edelbrock et al., 1984; Lahey et al., 1984), tension or anxiety (e.g., Lahey et al., 1984; Lahey et al., 1987), and depression (e.g., Barkley et al., 1990; Lahey et al., 1987) have been reported which suggests that children with ADD-H are at greater risk for experiencing internalized types of emotional disturbance. For example, Lahey et al. (1987) found that 43% of their sample of children with ADD-H received codiagnoses of either anxiety or depressive disorders whereas this was the case for only 10% of the ADD+H children.

Although there is some evidence to suggest that the ADD subtypes are distinguishable on the basis of peer relationships, the findings have not been as convincing as those described above. In general, both groups are perceived more negatively by their peers when they are compared to control groups of nonADD children; for example, Carlson et al. (1978) and King and Young (1982) found that
ADD+H and ADD-H children received significantly fewer "most liked" and more "least liked" nominations compared to other children in the classroom. However, Lahey et al. (1984) found that their ADD+H group received more least liked nominations than did the ADD-H sample, who, in turn, received significantly more of such nominations than did the NC group. This suggests that if the two subtypes differ with respect to peer nominations, it is the ADD+H group that is least preferred.

Differences have also been observed between the ADD subtypes on self-report measures. Lahey et al. (1987) found that while both groups of children reported lower levels of self-esteem regarding their academic status as compared to their classroom peers, the self-esteem of the ADD-H group was significantly lower than that of the ADD+H group. When compared to the NC group, the ADD+H group also reported lower self-esteem in areas related to behaviour and popularity. In contrast, the ratings from children with ADD-H indicated lower self-esteem in areas related to physical appearance, anxiety, and happiness.

Taken together, the results of investigations examining the social, emotional, and behavioural characteristics of ADD+H and ADD-H children have provided some evidence to support the external validity of these subtypes.
Efficacy of Stimulant Medication

Establishing that a Group X Treatment interaction exists is a powerful demonstration of a typology’s external validity (Fletcher, 1985). In the context of ADD subtypes, this might take the form of reduced levels of inattention and overactivity in children with ADD+H following treatment with stimulant medication and little or no change on these parameters in children with ADD-H. While many studies have demonstrated the efficacy of stimulant drugs, especially methylphenidate, in modifying the behaviour of children with ADD+H, only two studies examined its effectiveness with ADD-H children. Of these two studies, only one compared the ADD subtypes directly.

Famularo and Fenton (1987) studied the academic performance of 10 children who met the DSM-III diagnostic criteria for ADD-H. School grades for science, reading, spelling, mathematics, and social studies were compared across three grading periods within a single school year. Children were placed on methylphenidate (with doses individually adjusted for maximal benefit and minimal adverse effects) for the second grading period only. Based on the mean grade point average for each of the grading periods collapsed across all of the school subjects, it was found that the group’s academic performance was significantly better during drug treatment (the second grading period) as compared to either of the nontreatment
conditions (first and third grading periods). Given that neither teachers nor parents were blind to the treatment conditions, Famularo and Fenton were careful to indicate that the results may have been affected by confounding factors such as teacher bias, student motivation, and parental encouragement. Nonetheless, the findings suggested that ADD-H children respond to stimulant medication and, as such, may not be distinguishable from their hyperactive counterparts.

This possibility was addressed directly in a well-controlled study by Barkley, DuPaul, and McMurray (1991). The ADD subtypes were compared in their response to three different doses of methylphenidate on parent and teacher ratings of behaviour, laboratory tests of ADD symptoms, and behavioural observations during academic tasks in a triple-blind, placebo-controlled cross-over design. The ADD groups did not differ significantly from each other on any of these psychometric measures in their response to methylphenidate. However, they did find that most (95%) of the ADD+H children were clinically judged to be positive responders to methylphenidate and most (71%) responded best to doses in the moderate to high range (10-15 mg bid). In contrast, children with ADD-H were judged to have had either no clinical response (24%) or responded best to the low dose (5 mg bid) of medication (35%).
Although both groups benefitted from the use of methylphenidate on the objective measures employed in this study, several lines of evidence led the investigators to conclude that ADD-H is not a subtype of ADD+H. Rather, it was seen as a distinctly separate disorder of attention that requires a separate diagnostic label and criteria for diagnosis. This conclusion was based on several findings: (1) the different degree of clinical responsiveness of each group to methylphenidate, (2) the baseline (pre-medication) differences that were observed between the two groups on several of the psychological tests and behavioural observations included in the study (to be discussed in the following section in conjunction with the results of the Barkley et al. [1990] study), and (3) the findings of other investigators that had accumulated to this point. It was suggested that the attentional deficits of the children with ADD+H are primarily with respect to behavioural disinhibition and poor vigilance or maintenance of effort, whereas children with ADD-H are most deficient in focussed or selective attention. The basis for this distinction is discussed in the following section.

**Academic, Cognitive, and Neuropsychological Characteristics**

The results of many studies have been reasonably consistent in demonstrating that children with ADD encounter significant learning problems in school. Based on a
definition of learning disabilities that requires both academic underachievement in a specific subject (e.g., reading) relative to chronological age and a significant discrepancy between actual achievement level and expected achievement (the latter being estimated on the basis of an individually administered intelligence test), recent studies have found that the prevalence of learning disabilities in ADD groups ranges from 9% (Halperin, Gittelman, Klein, & Rudel, 1984) to 25% (Barkley et al., 1990). So commonly have these disorders been found to overlap that both DSM-III and DSM-III-R regard academic underachievement as an associated feature of hyperactivity. However, the findings of studies that have attempted to differentiate the ADD subtypes on various measures of academic success have been mixed.

Defining ADD groups of boys according to DSM-III criteria, Edelbrock et al. (1984) found in their retrospective study that a greater percentage of the ADD-H group had been retained in grade (5 of 7 or 71.4%) than had the ADD+H group (3 of 18 or 16.7%), the percentage of the latter not differing significantly from a clinic control (CC) group. Based on a larger sample size and different diagnostic criteria, Barkley et al. (1990) found no difference between the ADD subtypes in terms of the percentage of children retained in grade (ADD+H: 31.7% and ADD-H: 31.9%). However, both ADD groups had significantly
more children who were retained in grade as compared to the 
normal control (NC) group (2.9%), but significantly fewer 
than the LD group (61.1%).

Barkley et al. (1990) also found that the two ADD 
subtypes did not differ in the percentage of children 
considered to be significantly delayed (i.e., LD) in reading 
(word recognition), spelling, or arithmetic. A child was 
classified as LD in one or more of these subjects if his or 
er her obtained score on that particular WRAT-R subtest was 
below the seventh percentile (i.e., 1.5 SD below the 
normative mean) and his or her achievement score was 
significantly discrepant with his or her academic potential 
(defined as an achievement score that was 15 or more 
standard score points lower than the obtained Full Scale IQ 
score on the WISC-R). The frequency of LD diagnoses between 
the two groups and among the three achievement areas ranged 
from 18.8% (percentage of ADD-H children who were reading 
disabled) to 26.2% (percentage of ADD+H children who were 
arithmetic disabled). Interestingly, neither of the ADD 
subtypes was different from the "LD" group in the percentage 
of children who were significantly delayed in either 
reading, spelling, or arithmetic.

Children were included in the LD group if they were 
referred for assessment of academic learning problems or 
were currently placed in an LD programme; had a history of 
difficulties in one or more school subject; had no history
of difficulties in school with inattention, overactivity, or impulsivity; and scored within 1 SD of the normative mean on both the Inattention and Overactivity scales of the CAP. This indicates that academic underachievement is as prevalent in children referred because of behavioural symptoms related to hyperactivity as in children referred because of symptoms related to poor academic performance. What is unclear is the mechanisms that might account for each group’s underachievement.

In contrast to these findings, the studies of Maurer and Stewart (1980), Famularo and Fenton (1987), and Hynd, Lorys, Semrud-Clikeman, Nieves, Huettner, & Lahey (1991) found higher percentages of LD children in their ADD-H samples (56, 40, and 60%, respectively) than those reported by Barkley et al. (1990). Unfortunately, the Maurer and Stewart study did not report the criteria used to define LD nor did it include any other groups for comparison purposes, not even an ADD+H group. The latter was also true for the Famularo and Fenton study. In addition, the sample sizes of the ADD-H groups in all three studies were quite small (9, 10, and 10 subjects, respectively).

As might be expected, Barkley et al. (1990) found that more ADD+H children were placed in a special class for children with behaviour disorders (12%) as compared to the ADD-H (0%), LD (5.6%), and NC (0%) groups. The latter three groups did not differ significantly from one another on this
measure. It was also found that significantly more ADD-H children (53.2%) were placed in an LD class than were ADD+H (34.1%) and NC children (2.9%). These findings differed from those of an earlier study (Carlson, Lahey, & Neeper, 1986) that found that the ADD+H and ADD-H groups were not significantly different in the percentages of children placed in classes for those with behaviour disorders (25% and 13%, respectively) or learning disabilities (75% and 87%, respectively); however, the pattern of the differences between the groups for both placements was the same as that found by Barkley and his colleagues (1990). In the Carlson et al. (1986) study, the high frequency of both ADD+H and ADD-H children in LD placements may have been due to the selection process utilized to identify potential subjects. Children who displayed overactivity and/or attention problems were nominated for participation by teachers of learning disabilities and behaviour disorders resource programmes.

Inconsistent findings across studies have also emerged when the subtypes are compared on teachers' ratings of the children's academic performance. Ackerman, Dykman, & Oglesby (1983) found that their ADD+H group received the lowest ratings on experimental items related to academic adjustment (work/study habit) when compared to groups of children with ADD-H, reading disabilities (RD), and a combined ADD+H and RD group, whereas the ADD-H group
received the highest ratings. However, because of the experimental nature of the items and the lack of accompanying normative data, as well as the failure to include a nonADD/RD control group, it is unclear whether or not the performance of the ADD-H group, although receiving the highest relative rating, was within normal limits.

The studies of Edelbrock et al. (1984) and Lahey, Schaugency, Strauss, and Frame (1984) both found that their ADD+H and ADD-H groups received lower teacher ratings of their school performance as compared to either a clinic control group (former study) or normal control group (latter study). When compared to each other, there was some suggestion that the ADD-H group may not have been performing as well as the ADD+H group. Edelbrock et al. found that the ADD-H group was rated significantly lower on a standardized measure of current academic performance (Child Behavior Checklist - Teacher Report Form; Edelbrock & Achenbach, 1984) than was the ADD+H group. Although Lahey et al. (1984) did not find this difference on an experimental scale of academic performance, they did find that the ADD-H group received lower ratings by physical education teachers regarding their sports performance than did the ADD+H and NC groups.

In general, while it appears that both subtypes perform below the level of their age-peers and that, perhaps, ADD-H children exhibit greater performance difficulties as
compared to ADD+H children, these results must be interpreted with caution because the studies either did not compare the groups directly on a measure of global intelligence (Ackerman et al., 1983) or did not report IQ data whatsoever (Edelbrock et al., 1984; Lahey et al., 1984). Thus, the possibility that differences in psychometric intelligence between the groups could account for the observed differences in academic performance cannot be ruled out.

Several studies have compared the ADD subtypes on standardized measures of academic achievement. None has found a significant difference between the ADD+H and ADD-H groups on reading or spelling achievement, although both groups obtained lower scores on these measures than did a NC group. This was the case in the Barkley et al. (1990) study which measured the children's level of achievement with the Wide Range Achievement Test-Revised (WRAT-R; Jastak & Wilkinson, 1984) and in the studies by Carlson et al. (1986) and Hynd et al. (1991) which utilized the Basic Achievement Skills Individual Screener (BASIS; Psychological Corporation, 1983). Although Ackerman et al. (1983) did not compare the ADD subtypes directly, inspection of the obtained standard scores for each ADD group (collapsed on gender) on a Reading-Spelling Index revealed that the standard score for each group was in the 102-103 range. The Reading-Spelling Index was a combined score based on the
Reading and Spelling subtests of the WRAT-R and the Gray Oral Reading Test.

The findings regarding arithmetic achievement have been less consistent. Using the WRAT-R, Barkley et al. (1990) found no difference between the ADD subtypes. Similarly, the data of Ackerman et al. (1983) suggest that these groups do not differ on the Arithmetic subtest of the WRAT-R. In contrast, Carlson et al. (1986) and Hynd et al. (1991) found that the ADD-H group obtained significantly lower scores on the BASIS Math subtest as compared to the ADD+H group.

Several studies have compared the ADD subtypes on measures of psychometric intelligence. These comparisons have been based on scores derived from the three summary scales (Verbal, Performance, and Full Scale) of the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974). The majority of the studies found that the ADD+H and ADD-H groups did not differ significantly from each other either in terms of VIQ, PIQ, or FSIQ (Barkley et al., 1990; Frank & Ben-Nun, 1988; Hynd et al., 1991; Hynd, Nieves, Connor, Stone, Town, Becher, Lahey, & Lorys, 1989; Lahey et al., 1987; Lorys, Hynd, & Lahey, 1990; Schaughency, Lahey, Hynd, Stone, Piacentini, & Frick, 1989). In all of these studies the two groups obtained scores on all three scales that were in the average range (standard scores of 95-108). Of the four studies that included a non-ADD control group (either normal or clinic control), all found that the ADD
subtypes demonstrated lower FSIQs than the control group (Barkley et al., 1990; Hynd et al., 1989; Lorys et al., 1990; Schaugency et al., 1989). However, the interpretation of this finding is complicated by the fact that the mean FSIQ for each of the control groups was 114, 106, 106, and 109, respectively. When the figures for the ADD groups and control groups are compared to the normative data of the WISC-R, it appears that it was the control groups that were unusual in terms of psychometric intelligence rather than the ADD groups. Also, an inspection of the standard scores for each of the ADD groups suggests that neither group had a significant mean VIQ–PIQ discrepancy.

In contrast to these findings are those of Carlson et al. (1986) who found that the ADD+H group obtained a significantly lower Full Scale IQ which was attributable to their lower scores on the Verbal Scale of the WISC-R as compared to the ADD–H group (85 vs 100). Although the ADD+H group also obtained a lower PIQ than the ADD–H group (95 vs 102), this difference was not statistically significant. The fact that the subjects were selected for study from an elementary-school learning disabilities and behaviour disorders population suggests that there was a higher proportion of children with a concurrent learning disability in this study as compared to studies in which the samples were culled from consecutive clinic referrals.
While a cursory review of the results might suggest that children with ADD do not perform as well as their non-ADD age-peers on measures of psychometric intelligence, a careful consideration of methodological factors suggest that such an interpretation is premature. Conversely, the results have been reasonably consistent in suggesting that children with ADD do not perform as well as non-ADD children on certain measures that reflect academic proficiency. The differences that do emerge between the ADD groups suggests that children with ADD-H encounter greater difficulties on some measures that reflect their academic skills. However, the underlying deficits that might give rise to this situation are unclear.

Few studies have gone beyond the use of standardized measures of academic achievement and intelligence in an attempt to delineate potential differences between the subtypes in areas of cognitive or neuropsychological functioning. Typically, the studies that have done so have focussed only on certain areas of cognitive functioning, leaving large gaps in our understanding of the neuropsychological characteristics of each subtype. Yet, there is a growing body of literature based on studies of children with ADD+H that suggests ways in which the ADD subtypes may differ on neuropsychological measures. In particular, children with ADD+H have been found to be deficient in what are referred to as "executive functions."
These are considered to be "higher-order cognitive processes involved in organizing and monitoring thinking and behaviour" (Barkley, 1990). However, before presenting the results of these studies and their implications for the current investigation, those studies that have compared the subtypes directly on cognitive measures will be discussed.

The results of several studies have been fairly consistent in demonstrating that hyperactive children have longer mean reaction times, greater variability in performance, and make more errors of commission than do NC or CC groups on various measures using reaction time methodology (Barkley, 1991). However, only a few studies have been conducted that have attempted to differentiate the ADD subtypes on various reaction time measures and, for the most part, it has been found that the groups perform similarly.

Hynd et al. (1989) compared three groups of children (ADD+H, ADD−H, and CC) on a simple RT task and three speeded classification tasks. They found that none of the groups differed on the simple RT task and that the mean response time increased to a similar degree for all groups on the speeded classification tasks. On the most cognitively demanding task, both ADD subtypes obtained lower scores than the CC group, a difference that did not emerge when children with co-diagnoses (mostly conduct disorder) were eliminated from the analyses. In a subsequent study in which an
overlapping sample was examined, Lorys, Hynd, and Lahey (1990) found that intelligence was a confounding variable in that the ADD+H group was no longer significantly slower when they controlled for the children's Full Scale IQ.

In a series of experiments utilizing a more sophisticated methodological design based on a model of stages of information processing, Sergeant and Scholten (1985a,b) found that, although the ADD+H group was slower and less accurate than the NC group on a high-speed visual search task, their overall performance was not related to any of the stages of processing that were considered relevant to selective attention, that is, encoding, search, and decision. In contrast, the ADD-H group exhibited slower search rates than did the NC group, suggesting to the investigators that these children may be experiencing problems related to selective attention. They also found that the ADD+H group displayed more off-task behaviours than did the ADD-H and NC groups, but only during periods when there were no attentional demands being placed upon the children (i.e., between stimulus presentations).

A third difference emerged when the instructional set was manipulated. When the children were told to emphasize speed rather than accuracy or both speed and accuracy, the ADD+H group was significantly slower than the ADD-H and NC groups. It was suggested that the children with ADD-H are able to adjust their behaviour in accordance to
instructional demands in a manner similar to normal children whereas children with ADD+H may have a deficiency in the ability to deploy appropriate strategies to meet task demands, particularly under speeded conditions.

Utilizing the Continuous Performance Test (CPT), a task presumed to measure vigilance, Barkley et al. (1990) found that ADD+H, ADD-H, LD, and NC groups did not differ in the number of targets correctly identified. Like the results of Sergeant and Scholten (1985b), they found that the ADD+H group engaged in more off-task behaviour than the other three groups (in this case while doing the CPT). It was also found that the ADD+H group made more errors of omission and commission as compared to the LD and NC groups. Although the ADD subtypes did not differ significantly in terms of errors, it was noted that the ADD+H group made almost twice the number of commission errors as the ADD-H group.

Taken together, the findings of these studies, and of others summarized elsewhere (e.g., Barkley, 1991), indicate that RT measures can distinguish fairly reliably ADD children from normal children. However, they are less successful in discriminating ADD children from other clinical groups, and, especially, ADD subtypes from each other. In this regard, measures based on direct behaviour observations (e.g., of off-task behaviour) appear to be better discriminators. Nevertheless, there is a suggestion
that children with ADD-H may be somewhat more cognitively sluggish, this being interpreted as a deficiency in selective attention. This finding is consistent with behavioural studies that have demonstrated a more sluggish tempo among ADD-H groups (e.g., Lahey et al., 1985; Lahey et al., 1984). On the other hand, the tendency of children with ADD+H to make more errors of commission suggests the presence of deficits in behavioural inhibition and/or motor regulatory mechanisms.

Carlson et al. (1986) were among the first investigators to compare the ADD groups on cognitive measures other than those involving psychometric intelligence, academic achievement, and reaction time procedures. For the most part, they found the groups to be more similar than dissimilar. Both groups took longer than NC children (but were no different from each other) in completing the Stroop Color Distactor Test (Stroop, 1935) and an experimental rapid naming task in which they were required to name pictures of objects, letters, numbers, and simple words. Neither group differed from the NC group in the number of errors committed on each task, nor on measures of receptive and expressive language, drawing ability for geometric forms, and sustained visual attention, the latter being similar in format to Kagan's (1966) Matching Familiar Figures Test. The ADD-H group did make more errors on the latter task when matching nonlinguistic stimuli (Hebrew
characters). As discussed earlier, the ADD-H group obtained a lower score on the Math subtest of the BASIS, and the ADD+H group obtained a lower VIQ and FSIQ. However, the homogeneity of the groups in this study is questionable given that they were constituted on the basis of the SNAP Checklist with age of onset not being a consideration.

Similar to Carlson et al. (1986), Hynd et al. (1991) found that the ADD-H group encountered greater difficulties on the BASIS Math subtest. Unlike Carlson et al., they found that the ADD-H group was slower on rapid naming tasks than the ADD+H group. It was clear that the groups differed in terms of the percentage of children in each group who were considered to be learning disabled (60% of the ADD-H group and none of the ADD+H group). However, the extent to which the differential frequency of LD could account for the differences obtained on the tests and measures employed was not explored.

Frank and Ben-Nun (1988) compared the ADD groups on epidemiological data, neurological examination, and a variety of psychometric tests. They found the ADD+H group to perform less well on measures of visual-sequential memory, auditory association, handwriting and motor coordination (especially measures of diadochokinesisis and sequential finger movements). However, these differences may have simply been due to a greater degree of neurological impairment in the ADD+H group because it was also found that
this group had a significantly greater frequency of perinatal and neonatal abnormalities than the ADD-H group. This difference in the incidence of perinatal and neonatal abnormalities was not obtained by Barkley et al. (1990) who appeared to employ more rigorous criteria for inclusion and, especially in this case, exclusion.

Schaughency et al. (1989) compared ADD+H, ADD−H, and CC groups (the latter comprising mostly children with internalized disorders) on the Luria Nebraska Neuropsychological Battery - Children’s Revision (LNNB-CR; Golden, 1987) and the WISC-R. Both ADD groups obtained lower scores on the VIQ and FSIQ of the WISC-R than the CC group, but were no different from each other. No significant groups differences were found on any of the measures derived from the LNNB-CR. Comparisons included all of the clinical scales (Motor Skills, Rhythm, Tactile, Visual, Receptive Speech, Expressive Speech, Writing, Reading, Arithmetic, Memory, Intelligence), the right and left hemisphere scores, and the pathognomonic score. In addition to other reasons (e.g., small sample sizes), it was noted that the failure to detect any group differences may have been due to limitations inherent in the measures employed in this study to assess neuropsychological functioning. In this connection, an increasing number of researchers (e.g., Barkley, 1990; Benson, 1991; Mattes, 1980) have implicated deficiencies in so-called "frontal
lobe" functions as the common denominator explaining the
behaviour features of ADD+H (studies related to this view
are discussed below). Schaughency et al. indicated that in
the development of the LNNB-CR, items believed to be
sensitive to frontal lobe functioning were omitted from the
battery because it was thought that such functions did not
develop until adolescence or later. The LNNB-CR was
designed for children 8-12 years of age.

Based on a model by Tucker and Williamson (1984),
Lorys, Hynd, & Lahey (1990) predicted that children with
ADD+H would obtain lower scores on tasks sensitive to both
motor regulatory processes ("anterior processes") and
perceptual arousal ("posterior processes") whereas children
with ADD-H would exhibit difficulties primarily on tasks of
perceptual arousal ("perceptual responsivity"). Using a
"mini-battery" of tests and procedures drawn from specific
LNNB-CR items that were thought to relate to each of these
processes, Lorys et al. did not find support for the
anterior-posterior gradient hypothesis. Given that this
study also used the LNNB-CR, from a methodological
standpoint, it suffers from the same limitation as the
Schaughency et al. (1989) study discussed above. In
addition, Lorys et al. recognized the need for more
sensitive measures to adequately test the anterior-posterior
hypothesis given the vulnerability of the LNNB-CR to
possible ceiling effects. Because most of the items
selected from the LNNB-CR have a restricted scoring range, with many items relying on error scores, their concern regarding ceiling effects is quite legitimate.

Barkley and his colleagues (1990) compared three clinical groups of children (ADD+H, ADD-H, LD) and a normal control group on the WISC-R, WRAT-R, Continuous Performance Test, and the MFFT. They found that all three clinical groups obtained lower scores than the NC group on all of the subtests of the WRAT-R, but were no different from each other. The ADD-H group obtained significantly lower scores on the Coding subtest of the WISC-R than the other three groups. Both ADD groups made more errors of omission on the CPT than the LD and NC groups (but were no different from each other). With regard to errors of commission, the ADD-H occupied an intermediate position between the ADD+H group (with the most errors) and the LD and NC groups; however, they did not differ from the ADD-H group. None of the groups were distinguished on the MFFT (either time or error scores), a measure thought to tap impulsivity.

In an overlapping study (described to some extent above), Barkley et al. (1991) compared 23 children with ADD+H and 17 children with ADD-H who were entered into a controlled stimulant drug trial of methylphenidate on the CPT, MFFT, and the Wisconsin Selective Reminding Test (WSRT; Newby, 1989). Collapsing across the four drug conditions it was found that the ADD+H group made significantly more
errors of omission and commission on the CPT, suggesting greater difficulty with behavioural inhibition and vigilance, whereas the ADD-H group performed less well on a measure of verbal learning and memory derived from the WSRT (consistent long-term retrieval). Methylphenidate significantly reduced the number of omission errors on the CPT, but it did not affect the number of commission errors or any of the scores derived from the MFFT and WSRT. There was no significant Group X Drug Condition interaction on any of the measures.

In summary, the neuropsychological studies have provided some evidence suggesting that children with ADD+H exhibit their most obvious difficulties on measures that stress behavioural inhibition (e.g., errors of commission) and motor regulation (e.g., graphomotor production, motor coordination). In contrast, children with ADD-H encounter their most significant difficulties on measures that require rapid and rather automatic responding (e.g., RT measures, naming of pictured objects, letters, and so on under speeded conditions). Some researchers (e.g., Barkley, 1990) have attributed these performance problems to deficits in selective attention. While the Coding subtest of the WISC-R also seems to require the capacity to selectively attend and to perform under speeded conditions, it also involves, among other things, the ability to learn an unfamiliar task (Sattler, 1988). The poorer performance of children with
ADD-H on the Coding subtest and on the WSRT suggests that these children may also exhibit problems with certain aspects of learning and memory. Interestingly, certain subtypes of learning disabled children have demonstrated poor scores on these or similar tests (e.g., Rourke & Finlayson, 1978). These considerations, coupled with evidence from some studies demonstrating a higher frequency of LD in ADD-H groups, suggest that the learning and memory difficulties may be the result of a learning (information processing) disability rather than ADD-H per se. However, this possibility has not been adequately explored.

One of the methodological limitations of all of the neuropsychological studies, with the exception of those by Barkley and his colleagues (1990; 1991), concerns the use of the DSM-III criteria to define group membership. As discussed above, this confounds the inattention and overactivity factors which have been shown to be independent. Consequently, the ADD groups may not have been as homogeneous as what might have otherwise been the case. If this is so, group differences would be attenuated and, therefore, more difficult to detect.

Another shortcoming has been the failure by researchers, in general, to employ a theoretical framework to guide predictions concerning group differences. The study by Lorys et al. (1990) was a step in the right direction; however, it was subject to a different
limitation--the use of measures that were probably insensitive to group differences because of their psychometric properties. This rather atheoretical approach to examining potential group differences has prevailed despite a growing body of empirical and theoretical literature on hyperactivity (ADD+H) that suggests ways in which the two ADD groups might differ on neuropsychological measures.

Increasingly, clinicians and researchers have come to view ADD+H as a disorder of "executive processes." Barkley (1990) defined these as "higher-order cognitive processes involved in organizing and monitoring thinking and behaviour" (p. 78). This notion of a deficiency in executive processing seems to capture the fundamental nature of the behavioural deficits that children with ADD+H exhibit. Furthermore, the association of executive processes with the constructs of sustained attention and motor regulation seems reasonable. Other cognitive processes described as complex problem solving, planning, and strategy generation and implementation, especially in novel situations, have also been subsumed under the term executive functions. Several studies using a variety of psychological tests and procedures that are thought to tap these capacities have demonstrated executive processing deficits in children with ADD+H.
On a task similar to the game "20 Questions," Tant and Douglas (1982) found that hyperactive children used less efficient questions and strategies as compared to a group of children with a reading disability or a normal control group (the latter two did not differ significantly). In each of the conditions, the child's task was to determine which one of several pictures the experimenter was thinking of by asking questions that could only be given "yes/no" answers. The results were interpreted as suggesting that children with hyperactivity are less effective in generating strategies for solving complex problems.

The problem solving aspect of executive processing in children with ADD+H was also investigated by Hamlett, Pellegrini, and Conners (1987). Sixteen children diagnosed as ADD+H and 16 normal control children were required to sort cards into at least two but no more than seven groups, and to do so in a way that would help them to remember each one. On each card was a picture of a classifiable object with its name printed below it. After the cards were sorted and the child's recall of the items was tested, the child was asked to explain how to play the game (into a tape recorder) in such a way that it would be easy for a younger child to remember the items (the social communication task). Although the two groups did not differ in the time taken to sort the cards or in the number of items recalled, the ADD+H group scored significantly lower on measures related to the
social communication task. They provided less general information regarding the purpose of the game, the materials, and the rules; conveyed fewer appropriate strategies to organize and later recall the items (e.g., grouping the cards according to taxonomic or functional categories); and were rated as being less communicatively effective (defined as the degree to which the child's instructions allowed one to understand and play the game).

Voelker, Carter, Sprague, Gdowski, & Lachar (1989) also found evidence that children with ADD+H were not as effective in spontaneously generating strategies to optimize their performance on a verbal memory task as compared to group of normal control children. However, the performance deficiencies of the ADD+H group were dependent on the type of word list that they were required to learn. Four types of experimental word lists were employed that represented combinations on two dimensions: variation on semantic composition (acoustic vs semantic categories) and list organization (clustered by category vs unclustered). The ADD+H group recalled significantly fewer words only on the semantic-unclustered list. This list was characterized by low strategy salience and involved more effortful strategy implementation than the clustered list (Voelker et al., 1989). The ADD+H group did not differ from the NC group in their knowledge of memory strategies as conveyed through a structured interview. This finding, together with the fact
that the groups did not differ on the other word lists (especially, the semantic-clustered list), suggested that the children with ADD+H were aware of appropriate strategies to apply and that they spontaneously did so under conditions in which the strategies were made obvious and the effort required was minimal. Voelker et al. concluded that the findings were consistent with a production (or performance) deficiency rather than a mediational deficiency (or ability deficit).

Chelune, Ferguson, Koon, and Dickey (1986) compared 24 children with ADD+H with a group of 24 normal children matched on age and both maternal and paternal educational background on several tests ordinarily included in a neuropsychological evaluation, including measures that were presumed to be sensitive to frontal lobe functioning. They found that the ADD+H group, defined by DSM-III criteria, scored lower on the Number Recall subtest (a digit span task) of the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983) and made more errors on the Color Forms Test (Reitan & Davison, 1974; a task in which the child is required to follow a sequence by alternating between cues based on colour and shapes). On the Wisconsin Card Sorting Test (WCST; Heaton, 1981) they obtained fewer correct responses, achieved fewer categories, and committed more perseverative errors. Chelune et al. (1986) concluded that the results provided at least partial support for the
frontal lobe dysfunction hypothesis of ADD+H in that the groups did not differ on most measures reflecting general intelligence or mental processing (e.g., Peabody Picture Vocabulary Test-Revised [Dunn & Dunn, 1981], Word Order, Triangles, Gestalt Closure subtests of the K-ABC), but did exhibit deficiencies relative to the NC group on measures requiring sustained attention, cognitive flexibility, and the regulation of goal-directed activity through the use of feedback.

However, the findings of Chelune et al. (1986) were not supported by a recent study by Loge, Staton, and Beatty (1990). These investigators found no difference between children with ADD+H, as defined by DSM-III-R, and matched controls on the various measures of the WCST nor did they differ on measures of verbal and design fluency. However, the ADD+H group did exhibit impaired performances on tests of reading comprehension, verbal learning and memory, and on the Information, Arithmetic, Digit Span, Block Design, and Coding subtests of the WISC-R. Loge et al. noted that the failure to replicate the results of Chelune et al. may have been due to the inclusion of a less severely disturbed ADD+H group as compared to that in the Chelune et al. study. This view was supported by the near normal performance of the ADD+H group on a measure of impulsivity that had been previously found to differentiate children with ADD+H and normal children.
In addition to the deficiencies exhibited by children with ADD+H on measures of higher-order cognitive processing, other investigators have shown that these children also encounter considerable difficulties on a variety psychomotor tasks. A common example is the notorious difficulties that ADD+H children display with handwriting or penmanship (Barkley, 1990). Interestingly, the quality of their handwriting has been found to improve with the use of methylphenidate (e.g., Lerer, Lerer, & Artner, 1977).

It has also been found that they make more errors on paper and pencil and mechanical maze tests (Firestone & Martin, 1979; Milich & Kramer, 1984). The Maze Coordination Test is a measure of kinetic steadiness and, as part of the Kløve-Matthews Motor Steadiness Battery (Kløve, 1963), it is often incorporated in neuropsychological evaluations that are based on the Halstead-Reitan Batteries (Reitan & Davison, 1974). On this test, the child is required to negotiate a grooved maze without touching the sides with the stylus. The amount of time taken to complete the maze, the number of contacts with the sides of the maze, and the cumulative duration of the contacts is recorded. Firestone and Martin (1979) found that children with ADD+H made significantly more contacts and contacts of longer duration than the NC group.

Reitan and Boll (1973), also utilizing tests from the Halstead-Reitan Batteries, found that their behavioural
problem subgroup of children diagnosed as minimal brain
dysfunction (an early and probably less homogeneous
equivalent to ADD+H) performed similar to a NC group on more
basic measures of motor functioning (i.e., grip strength and
finger tapping), but they obtained lower scores on a measure
of motor coordination (Marching Test). Just as Lerer et al.
(1977) found improvements in the graphomotor productions of
ADD+H children during treatment with methylphenidate,
Knights and Hinton (1969) found that both the Maze duration
score and the Holes duration score (the latter a measure of
static steadiness) was significantly improved while the
children were on methylphenidate.

In a review of the cognitive deficits associated with
ADD+H, Douglas (1988) noted that hyperactive children have
been found to obtain lower scores on a variety of
perceptual-motor tests, including the Bender Visual Motor
Gestalt Test, the Porteus Mazes, and the Rey-Osterrieth
Complex Figure. She suggested that organizational factors
may play an important role in the poor performance of
children with ADD+H. Despite the strong evidence of certain
deficiencies in psychomotor functioning among children with
ADD+H, no study has attempted to distinguish the ADD
subtypes on such measures. This line of inquiry seems
especially relevant given that impairments involving motor
regulation and behavioural inhibition are among the core
features of ADD+H that are not considered to be characteristic of ADD−H.

Impairments in motor regulation, behavioural inhibition, and higher-order cognitive processes such as planning, organization, concept formation, and problem solving, all in the context of normal performance on measures of psychometric intelligence, have been well described in adults with brain damage involving the frontal lobes (e.g., Stuss & Benson, 1986). These findings, coupled with those based on experimental lesion studies involving animals, have led some researchers to postulate that ADD+H is a disorder that involves frontal or prefrontal lobe systems of the brain (e.g., Benson, 1991; Douglas, 1988; Mattes, 1980). Several recent neural imaging studies (PET scan and regional cerebral blood flow) of children with ADD+H or of adults who as children were considered to have ADD+H have provided some evidence to support this contention (e.g., Lou, Henriksen, & Bruhn, 1984; Lou, Henriksen, Bruhn, Børner, & Nielson, 1989; Zametkin, Nordahl, Gross, King, Semple, Rumsey et al., 1990). Thus, the view that these impairments in regulatory and higher-order cognitive processes in children with ADD+H might be related to dysfunctional frontal or prefrontal lobe systems of the brain provides a useful heuristic by which to develop predictions concerning potential differences between the ADD groups on neuropsychological measures.
Summary of Major Findings

The results of this review indicate that the ADD groups can be differentiated on many variables that span several independent domains. For the purpose of the present review, the research studies were grouped according to four categories: Those that have examined group differences on the basis of (1) demographic, developmental, health, and family history characteristics; (2) social, emotional, and behavioural characteristics; (3) efficacy of stimulant medication; and (4) academic, cognitive, and neuropsychological characteristics. Taken together, the findings support the notion, articulated by Barkley (1990), that "the evidence available to date compels us to begin considering ADD+/H and ADD/-H as separate and unique childhood psychiatric disorders and not as subtypes of an identical attention disturbance" (p. 91). Areas wherein differences have emerged are summarized below.

From the review of demographic variables, it was found that for the population of children in the early and middle childhood years the prevalence of ADD+H is approximately twice that of ADD-H. The ratio of boys to girls is smaller in ADD-H than ADD+H samples. Furthermore, children with ADD-H are on average approximately 1.5 years older than children with ADD+H when referred to mental health professionals.
Although differences between the groups in terms of early development were largely negative, it was found that children with ADD+H were rated by their mothers as being more active and persistent in their demands as compared to ADD-H children. Also, mothers of children with ADD-H tended to see their children as more incoordinated than those of ADD+H children. Admittedly, this difference did not reach statistical significance (Barkley et al., 1990), however, it was consistent with the finding that ADD-H children did not perform as well as children with ADD+H in physical education (as rated by their teachers).

Attentional deficits and hyperactivity have been found to be more common among the relatives of children with ADD+H whereas anxiety disorders were more common among the relatives of children with ADD-H. Of interest to the present study, the frequency of learning disorders was greater among the siblings of ADD-H and LD children than ADD+H children. This is one of several findings to suggest that there is a stronger relationship between ADD-H and LD than between ADD+H and LD. It is possible that the attentional deficits exhibited by ADD-H groups are more commonly a result of a primary learning disability as compared to ADD+H groups.

Children with ADD+H more frequently demonstrate problems related to conduct disorders (e.g., oppositionality, defiance, delinquency) and aggression than
children with ADD-H. On the other hand, ADD-H is more frequently associated with social withdrawal, anxiety, and depression. Lower levels of self-esteem related to academic status were reported by children with ADD-H as well as in areas related to physical appearance, anxiety, and happiness. In contrast, children with ADD+H reported lower levels of self-esteem related to their behaviour and popularity.

The results of drug studies have not provided strong evidence supporting the notion that ADD+H and ADD-H are distinct subtypes. That is, both groups of children have demonstrated somewhat similar responses to stimulant medication. However, it has been shown that more children with ADD+H are considered to be "responders" than children with ADD-H and that they respond best to doses of methylphenidate that are in the moderate to high range, whereas those children with ADD-H who do respond tend to do best with low doses of medication. While the presence of a Group X Treatment interaction would be strong support of the external validity of the ADD subtypes, it does not necessarily follow that the absence of such an interaction is evidence that the two groups do not represent distinct disorders. Furthermore, most would agree that ADD+H is a valid behaviour disorder and that children with ADD+H can be distinguished behaviourally from so-called "normal" children, yet it has been demonstrated that the latter also
show improvements on cognitive tasks following the administration of psychostimulant medication (e.g., Rapoport, Buchsbaum, Zahn, Weingartner, Ludlow, & Mikkelsen, 1978). Therefore, on both logical and empirical grounds, the failure to demonstrate a clear and differential Group X Treatment interaction or, for that matter, a common etiology to each subtype (so-called postdictive validity; Weiss & Hechtman, 1986) does not indicate that the typology is invalid.

The academic performance of both ADD groups has been found to be below that of the general population of children. Moreover, many of the studies have found few differences between the groups on a wide variety of measures reflecting proficiency in the school setting. Nevertheless, when differences have been found they have fairly consistently suggested that it is the children with ADD-H who are less successful in the academic arena. Some studies have shown that children with ADD-H are more frequently retained in grade, given LD designations, and placed in LD classes as compared to children with ADD+H. In addition, children with ADD-H have received lower teacher ratings of their academic and sports performance. Although the groups do not seem to differ from each other in their level of reading and spelling achievement, the ADD-H group has been found in some studies to perform poorer in arithmetic. Also, it appears that these differences cannot be accounted
for on the basis of different levels of global intelligence since most studies have shown that the ADD subtypes, in general, do not differ on measures such as the WISC-R. In the few studies where differences were found, it was the ADD+H group that obtained lower VIQ and FSIQ scores.

Whether or not the groups differ neuropsychologically remains largely unexplored; however, some differences have been demonstrated. The results of reaction time studies suggest that ADD-H is associated with more sluggish responding, a finding that is thought to be related to a deficit in selective attention. There is also evidence to suggest that these children exhibit difficulties with some aspects of verbal learning and memory. Conversely, children with ADD+H tend to make more errors of commission during task execution (suggesting that they are more impulsive), they do not adjust well their behaviour to meet instructional demands, and they demonstrate more difficulty with visual-sequential memory, handwriting, and motor

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1Many researchers (e.g., McNellis, 1987; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991) have adopted the view that attention, rather than being a unitary construct, consists of several elements or components. Typically included among these are (a) arousal or alertness, (b) selective or focussed attention, and (c) sustained attention or vigilance. In general, arousal refers to a physiological state of readiness for activity. Mirsky et al. (1991) define selective attention as the ability to focus on or select target information from any array for enhanced processing, whereas sustained attention is defined as the capacity to maintain focus and alertness over time. Mirsky et al. (1991) also include shift as another element of attention and define it as the ability to change attentive focus in a flexible and adaptive manner.
coordination. Many authors (e.g., Barkley, 1990; Douglas, 1988) view the attentional deficits associated with ADD+H as being related primarily to sustained attention rather than selective attention. The results of additional studies focusing only the ADD+H subtype suggest that many of the cognitive and behavioral difficulties that these youngsters exhibit are related to problems in executive processes, sustained attention, motor regulation, and behavioral inhibition. The findings from various independent lines of research have converged to suggest that the symptoms of ADD+H may be the manifestations of dysfunction in frontal lobe systems. This association between the features of ADD+H and the functions that are ordinarily thought to be dependent upon frontal lobe systems provides an empirically-based theoretical framework by which to formulate hypotheses regarding subtype differences on neuropsychological measures.

**Methodological Considerations**

Several limitations of virtually all of the studies conducted to date involve the use of the DSM-III criteria for assigning subjects to the ADD subtypes. The first limitation of DSM-III, as mentioned above, concerns its clinically-derived three factor structure of ADD symptoms: Inattention, Impulsivity, and Hyperactivity. The major problem lies in the features that are considered to be central to ADD-H. In order for children to be classified as
ADD-H according to the DSM-III system, they must exhibit 3 of the 5 symptoms listed under the Inattention dimension and 3 of the 6 symptoms listed under the Impulsivity dimension (e.g., acts before thinking). Thus, ADD-H is viewed as a disorder of both attention and impulse control. However, several factor analytic studies have demonstrated that items related to impulsivity have higher correlations with those related to hyperactivity than inattention (Hart, Lahey, Hern, Hynd, Frick, & Hanson, 1990; Healy, Halperin, Newcorn, Wolf, Pascualvaca, O'Brien, Morganstein, & Young, 1987; Lahey et al., 1988; the first two papers are reviewed in Lahey & Carlson, 1991). Moreover, clinical studies involving children with ADD-H have shown that these children exhibit few, if any, symptoms of impulsivity (Berry et al., 1985; Lahey et al., 1987; Maurer & Stewart, 1980). Thus, it appears that a two-factor conceptualization of ADD more accurately reflects the nature of ADD-H. These factors have been referred to by some (e.g., Lahey & Carlson, 1991) as "hyperactive-impulsive" and "inattentive-disorganized."

A second limitation of DSM-III involves the lack of normative data by which to determine whether or not a particular symptom is present to a clinically-significant degree. No objective criteria (e.g., empirically-derived cutoff scores) are provided to quantify statements such as "often exhibits..., easily distracted, and shifts excessively from..." Therefore, studies that have utilized
the DSM-III criteria to determine group membership without including standardized behaviour rating scales have relied exclusively on clinicians’ judgements regarding the significance of each symptom, rendering the results subject to experimenter bias (e.g., Frank & Ben-Nun, 1988).

Despite these limitations of the DSM-III system, it still represents a considerable improvement over the methods used in studies conducted prior to its introduction. However, even since its publication, some researchers have applied only leniently the DSM-III criteria; for example, using Pelham’s version of the SNAP Checklist, King and Young (1982) did not require that the children included for study meet the DSM-III criterion for age of onset. Therefore, the children constituting each of the ADD subtypes in these studies may be quite different than those of other studies that adhere to the DSM-III criteria.

A related shortcoming of some studies (e.g., Hynd et al., 1991; Maurer & Stewart, 1980) concerns the use of DSM-III criteria to determine the incidence of LD within each of the ADD subtypes. Like with ADD, the criteria for Specific Developmental Disorders (a broad category that encompasses disorders related to learning and language) are imprecise and open to interpretation. This is demonstrated well in the (single) criterion for Developmental Reading Disorder:

Performance on standardized, individually administered tests of reading skill is significantly below the
expected level, given the individuals schooling, chronological age, and mental age (as determined by individually administered IQ test). In addition, in school, the child's performance on tasks requiring reading skills is significantly below his or her intellectual capacity (APA, 1980; p. 94).

Again, the use of certain terms, such as "significantly below," as well as the absence of actuarial criteria require that clinical judgement be used in order to determine the presence or absence of learning disorders in the ADD groups. Moreover, these criteria do not consider whether the achievement problems are primarily the product of an underlying central processing deficiency related to the acquisition of a particular academic skill (e.g., a reading disability associated with a auditory-linguistic deficit) or the result of chronically inadequate attention to classroom instruction. Making such a distinction is in keeping with more recent and refined definitions of learning disabilities. It is well illustrated in the definition proposed by the Interagency Committee on Learning Disabilities (Kavanagh & Truss, 1988):

Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities, or of social skills. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance), with socioenvironmental influences (e.g., cultural differences, insufficient or inappropriate instruction, psychogenic factors), and especially with attention deficit disorder, all of which may cause
learning problems, a learning disability is not the direct result of those conditions or influences (p. 550-551).

The empirical methods by which ADD and LD were defined in the studies conducted by Barkley and his colleagues (e.g., Barkley et al., 1990; Barkley et al., 1991) represent significant improvements over those used by others that have relied on the DSM-III criteria. However, a potential shortcoming of the Barkley studies relates to the absence of neuropsychological data to substantiate the incidence of LD in each of the ADD subtypes. The importance of this issue was discussed above in relation to defining a learning disability according to DSM-III criteria only, without consideration for the neuropsychological correlates of LD.

Another problem evident in many studies involves the failure to indicate whether or not the subjects were being treated with stimulant medication at the time that they were studied (e.g., Berry et al., 1985; Carlson et al., 1985; Frank & Ben-Nun, 1988; Hynd et al., 1991; Hynd et al., 1989; Lahey et al., 1989; Schaughency et al., 1989; Sergeant & Scholten, 1985ab). It seems reasonable to assume that the subjects included in clinic-based studies were not on medication given that they were being referred for diagnostic evaluation and, presumably, treatment formulation. However, it is not uncommon for children to be placed on medication by a family physician, pediatrician, or psychiatrist prior to the completion of a thorough
psychological evaluation. Given that the most visible changes are likely to be decreased levels of motoric activity and, perhaps, impulsivity, it stands to reason that some of the children with ADD-H may have been inappropriately included in the ADD-H group.

Several other methodological limitations are apparent in the studies that have examined the academic, cognitive, and neuropsychological correlates of each ADD subtype. One such problem involves the use of small sample sizes (e.g., Hynd et al., 1991; Sergeant & Scholten, 1985ab). Another problem has been the lack of IQ data in some studies that have found differences on certain measures related to academic performance (e.g., Edelbrock et al., 1984; Lahey et al., 1984) or cognitive processes (e.g., Sergeant & Scholten, 1985ab). In such situations, it is difficult to determine the extent to which different levels of global intelligence account for the observed differences on the measures of interest. The importance of including some standardized measure of global intelligence in a study that is designed to evaluate group differences on neuropsychological variables is well recognized within the neuropsychological literature (e.g., Parsons & Prigatano, 1978).

Only one study has compared the ADD subtypes on a battery of neuropsychological tests that was designed to assess the principal functions that are thought to be dependent upon the integrity of the central nervous system
(i.e., Schauhency et al., 1989), and its findings were largely negative. However, as indicated above, the generalizability of the results is questionable given the limitations inherent in the measures used (i.e., LNNB-CR). The fact that so few studies have attempted to differentiate the ADD subtypes on neuropsychological variables is surprising given the accumulating evidence to suggest that ADD+H may be a disorder with a neuropsychological component, one that is related to higher-order executive processes. Moreover, no study to date has taken a comprehensive approach that integrates developmental, cognitive, behavioural, social, and neuropsychological measures in evaluating the distinctiveness of these ADD subtypes.

The Present Study

The present investigation was designed to address many of the limitations characteristic of previous research. One of the major problems in the past has been the manner in which the ADD subtypes were defined. By using the CAP scale (Barkley, 1990) in the present study, the children with ADD were grouped in a way that is consistent with the two-factor structure of ADD (inattention and overactivity). To date, only the studies of Barkley and his colleagues (1990; 1991) have adopted such an approach. In addition, the significance of the symptoms in the present study were based on normative data (see Appendix D) rather than clinical judgements regarding the meaning of such terms as "often"
and "excessive." Other major methodological advantages of
the present study included adequate sample sizes for each of
the groups and the exclusion of children who were on
medication during any phase in which the clinical and
neuropsychological data were collected.

There were four principal purposes to the present
investigation. The first was to determine whether and to
what extent the ADD groups could be dissociated on clinical
neuropsychological measures that are considered to emphasize
"executive" processes. Specific predictions regarding group
differences were guided in part by the work of Douglas
(1988). Table 1 summarizes the types of tasks on which she
considers children with ADD+H to be deficient. It is clear
that many of these tasks are related to executive processes
and that many tests and procedures that are ordinarily
incorporated in a comprehensive neuropsychological
evaluation stress one or more of these functional areas. In
the battery of tests employed in the present study, tasks
involving perceptual search, logical search, memory, and
motor control and perceptual motor abilities were
represented. However, tasks involving monitoring and
automated reaction time were not (see Table 1); therefore,
predictions related to these areas could not be included in
the present study.

The second line of inquiry relates to the association
of LD and ADD. Although the findings have been mixed, there
Table 1. Tasks on Which Deficits Have Been Found

Monitoring tasks and automated reaction time tasks:
- Deploying continuous, careful, and sustained attention to ongoing stimuli
- Inhibiting responses to inappropriate stimuli
- Inhibiting responses at inappropriate times

Perceptual search tasks:
- Conducting an organized, exhaustive, intensive, and focussed search of task stimuli
- Ignoring irrelevant stimuli
- Inhibiting responses to irrelevant stimuli

Logical search tasks:
- Clarifying task demands
- Generating and evaluating possible problem-solving strategies
- Generating and evaluating possible solutions
- Inhibiting premature, inadequate responses

Memory tasks:
- Processing task stimuli adequately
- Generating and applying effective rehearsal strategies
- Generating and applying effective retrieval strategies

Motor control and perceptual motor tasks:
- Guiding, controlling movement
- Inhibiting inappropriate movement
- Carrying out a careful perceptual analysis of complex figures
- Drawing accurate reproductions of complex figures

Note. From Douglas (1988).
is some suggestion that there may be a stronger relationship between LD and ADD-H than between LD and ADD+H. While it is clear that both ADD groups encounter difficulties with learning in school, the mechanisms underlying these difficulties and the possibility that they may differ for each group have not been adequately explored.

The present study examined the incidence of LD in each ADD subtype in two ways. The first method, as used in some of the previous studies, involved defining LD as a score on an achievement test (e.g., WRAT-R Reading subtest) below a certain centile rank and a significant discrepancy between learning potential (as estimated by an IQ test such as the WISC-R) and achievement level on that particular test (e.g., WRAT-R Reading subtest). The second approach, which was considered to be more refined and informative, involved examining how many of the children in each of the ADD groups exhibited either direct or indirect evidence of deficiencies in the central processes that are related to academic skill development (e.g., reading difficulties related to an auditory-linguistic deficiency or to a sound-symbol matching deficiency). This definition is more consistent with current conceptualizations of LD. Furthermore, this neuropsychological approach to the definition of LD may explicate the mechanisms underlying the academic problems of each ADD group. Some investigators (e.g., Carlson, 1986) have suggested that the poor academic functioning of
children with ADD+H may be related to LD rather than to some other factors (e.g., chronic inattention) and that this possibility warrants further study. In addition, others have suggested that the features of ADD, at least in some children, may be secondary to LD (e.g., Cunningham & Barkley, 1978). Given the evidence discussed above, it may be that children with LD are disproportionately represented in the ADD-H group as compared to the ADD+H group.

The extent to which the difficulties that children with ADD+H exhibit on cognitive tasks are related to an underlying LD is unclear. For example, some children who demonstrate outstanding academic underachievement in reading and spelling also demonstrate difficulties on several other tasks, including those that stress verbal memory abilities. However, certain verbal memory problems have also been demonstrated in children with ADD+H. It has been suggested (e.g., Barkley, 1990; Douglas, 1988) that the memory problems exhibited by children with ADD+H are the result of deficiencies in higher-order executive processes involved in the strategic organization of information for effective retrieval, rather than to an encoding deficit per se. Thus, a third purpose of this study was to compare the ADD subtypes on neuropsychological variables once children with learning disabilities are removed from each group. This would provide an opportunity to compare the neuropsychological characteristics (e.g., memory) of the ADD
groups with the influence of processing deficiencies related to LD removed.

A fourth purpose of this study was to compare the ADD subtypes on other variables related to the child’s history and behaviour that have been shown in past research to differentiate the groups. In this way, the findings from three of the four principal areas reviewed (with the exception of the efficacy of stimulant medication) could be integrated within a single study. In addition, the analysis of these variables would serve as a cross-validation of those findings reported in the literature, particularly those that relate to the Barkley et al. (1990) study.

With these purposes in mind, several hypotheses were formulated. For more information regarding the dependent variables specified in the hypotheses and the tests and measures from which they are derived, the reader is referred to Chapter 2, Chapter 3, and the Appendix.

Hypothesis 1

The first set of hypotheses involved neuropsychological variables related to executive processes. The predictions tested were grouped according to three neurobehavioural domains: (1) fine psychomotor control, (2) higher-order cognitive processes, and (3) complex perceptual search. The tests and measures related to these neurobehavioural domains correspond most closely to Douglas’ (1988) (1) "motor control and perceptual motor tasks" (first two items), (2)
"logical search tasks" and "memory tasks," and (3) "perceptual search tasks," respectively. These are listed in Table 1.

It was predicted that the ADD+H group would obtain lower scores than the ADD-H group on measures of fine psychomotor control. The measures included for analysis were (1) ratings of handwriting, (2) measures of static steadiness, and (3) measures of kinetic steadiness.

**Hypothesis 1a.** The first measure of fine motor control involved the child's handwriting. It was predicted that the ADD+H group would receive ratings on a scale modified from Lerner et al. (1977) that would reflect more difficulties with legibility as compared to the ADD-H group (the Rating of Handwriting Scale is presented in Appendix F).

**Hypothesis 1b.** The Graduated Holes Test is a measure of static steadiness that is included as part of the Klove-Matthews Motor Steadiness Battery. It requires that a child hold a stylus in a series of progressively smaller holes (for 10 seconds each) without touching the edge. The number of contacts with the edge of the hole and the cumulative duration of the contacts are recorded. The dominant hand is tested first, then the nondominant hand (Rourke, Fisk, & Strang, 1986).

This task stresses the ability to exercise inhibitory motor control. Given that this is regarded as one of the characteristic deficiencies associated with ADD+H, it was
predicted that this group would obtain lower scores on measures of static steadiness than the ADD-H group. The Contacts and Duration scores for the dominant and nondominant hands were entered as dependent variables in a MANOVA.

**Hypothesis 1c.** The Maze Test is also from the Kløve-Matthews Motor Steadiness Examination. The child is required to run a stylus through a grooved maze without touching the walls of the maze. The maze does not contain any blind alleys. The number of contacts with the walls of the maze, the cumulative duration of the contacts, and the total time taken to negotiate the maze are recorded. The dominant hand is tested first, then the nondominant hand (Rourke et al., 1986).

Similar to the Graduated Holes Test this task also stresses the ability to inhibit inappropriate movements. In terms of steadiness, this is reflected in the child’s Contacts and Duration scores. Since the child is explicitly instructed (with demonstration) in the speed at which he or she is required to negotiate the maze, this speed measure is also a reflection of the child’s ability to modulate his or her motor behaviour according to the instructions of the examiner. Given that there is more active (kinetic) involvement on the part of the child as compared to the Graduated Holes Test, these Maze measures may be evaluating
different aspects of inhibitory motor control. As such, the Holes Test and the Mazes Test were analyzed separately.

It was predicted that the ADD+H group would obtain lower scores on the Contacts and Duration scores of the Maze Test as compared to the ADD-H group. The Contacts and Duration scores were both entered as dependent variables in a MANOVA to test group differences.

A potential confound of the Maze Test concerns the speed at which a child negotiates the maze. Shorter completion times may afford fewer opportunities to make errors. Indeed, it was predicted that the ADD+H group would be quicker to complete the mazes. A MANOVA was conducted to test this prediction. If the groups differ on this measure, then the Contacts and Duration scores would be analyzed by a MANCOVA with Speed as the covariate.

Hypothesis 1d. It was predicted that the ADD+H group would obtain lower scores than the ADD-H group on measures reflecting higher-order cognitive processes. Usually, tests of higher-order cognitive processing are considered to involve some or all of the following qualities: cognitive organization, concept formation, reasoning, strategy generation, and the capacity to deal with novel, abstract, or otherwise complex information (Rourke et al., 1983). The following six measures were selected as dependent variables that were considered to stress higher-order cognitive processes: Category Test (Reitan & Davison, 1974), Tactual
Performance Test (Reitan & Davison, 1974), Block Design subtest of the WISC-R (Wechsler, 1974), Verbal Fluency Test (Knights & Norwood, undated), Arithmetic subtest of the WRAT-R (Jastak & Wilkinson, 1984), and the continuous long term retrieval (CLTR) score from the Buschke Selective Reminding Test (BSRT; Buschke, 1974).

**Hypothesis 1e.** It was predicted that the ADD+H group would obtain lower scores than the ADD-H group on the Underlining Test, a series of subtests that was designed to assess speed and accuracy of visual discrimination for various kinds of verbal and nonverbal visual stimuli that are presented among similarly-appearing distractor items (Rourke et al., 1986; see Appendix G for a description of this test). This hypothesis relates to Douglas’ (see Table 1) observation that children with ADD+H are impaired on measures that require an organized, exhaustive, intensive, and focussed search of task stimuli. Two scores are recorded for each subtest: the net correct (number of target stimuli underlined minus the number of incorrect items underlined) and the total incorrect (number of incorrect items underlined or errors of commission). The latter may be viewed as a measure of impulsivity. Thus, it was predicted that the ADD+H group would make significantly more errors of commission than the ADD-H group on the Underlining Test.
**Hypothesis 2.**

The second set of hypotheses concern variables related to academic functioning. Areas of interest include the frequency with which the children have been retained in grade, their average performance in school subjects, and the extent to which learning disabilities are associated with each group. The following hypotheses were based on the suggestions from the literature that children with ADD-H experience greater difficulties in academic functioning than children with ADD+H.

**Hypothesis 2a.** It was predicted that more children in the ADD-H group would have been retained in grade as compared to the ADD+H group. This information was provided by the teacher on the CBCL-TRF. The data were analyzed by a chi-square test.

**Hypothesis 2b.** It was predicted that the ADD-H group would not perform as well as the ADD+H group in school subjects. The item relevant to this hypothesis was from the CBCL-TRF. Each child's performance in each academic subject is rated by the teacher on a 5-point scale (far below grade, somewhat below grade, at grade level, somewhat above grade, and far above grade). The child's mean raw score is transformed to a T score based on the normative data of the CBCL-TRF. The performance of the two groups were compared by ANOVA.
**Hypothesis 2c.** This hypothesis concerned the frequency of LD in each group. The approach adopted by Barkley et al. (1990) was to compare the number of children in each group who were considered to fit a "legislative" definition of LD for each academic subject evaluated on the WRAT-R. To be considered LD in a particular subject, say reading (word recognition), a child was required to score below the seventh centile (1.5 SD) on the WRAT-R reading subtest and demonstrate a significant discrepancy (15 standard score points) between his or her FSIQ and reading achievement score. However, relying exclusively on this more or less "level-of-performance" approach to the definition of LD does not reflect adequately the conceptualization of learning disabilities as disorders that result from certain central processing deficiencies. Thus, a distinction was not made in the Barkley et al. (1990) study, or for that matter in any other study, between a learning problem (possibly the result of chronic inattention, environmental deprivation, or some other factor) and a learning disability (the result of a central processing deficiency).

A better approach is to define LD in terms of patterns of performance on academic achievement tests that have been shown to be associated with certain patterns of neuropsychological functioning. One classificatory system that is particularly relevant in this regard involves the constitution of subtypes of children with LD based on their
patterns of reading, spelling, and arithmetic abilities and
deficits as measured by the WRAT (e.g., Rourke, 1982; Rourke
& Finlayson, 1978; Rourke & Strang, 1978). Several studies
have supported the validity of this system as a means by
which to classify children with LD (see Fletcher [1985a] for
a review). Based on these considerations and the findings
of Barkley et al. (1990), it was expected that from a
legislative definition the groups would not differ in the
proportion of children who were considered to be LD in each
academic subject. For the present study, the number of
children in each group that performed below the 7th centile
on the Reading, Spelling, and Arithmetic subtest of the
WRAT-R (analyzed separately) were compared by a chi-square
test.

A second approach was to compare the ADD groups in
terms of the frequency with which the children fit the three
WRAT subtypes. Thus, the groups were compared in terms of
the proportion of children (1) who were deficient in all
three subject areas evaluated with the WRAT-R (RSA subtype);
(2) who were deficient in reading and spelling, but who
perform relatively better in arithmetic (RS subtype); and
(3) who were better in reading and spelling, but who
performed poorly in arithmetic (A subtype). If there is a
greater frequency of LD caused by information processing
deficiencies in children with ADD-H, then it was expected
that there would be a greater proportion of the ADD-H group
who would fit one of the three WRAT subtypes of LD as compared to the ADD+H group.

Hypothesis 2d: Comparing the performance of each group on neuropsychological measures that reflect central processing deficiencies associated with LD is another means by which the ADD groups can be compared. By far, the most common subtypes of LD based on the WRAT typology are the RSA and RS subtypes. Several neuropsychological measures are often impaired in children who fit these two subtypes. Typically, children in these subtypes exhibit difficulties with auditory-linguistic tasks that involve sound blending, sound segmentation, and short-term verbal memory. They also obtain lower scores than normal controls on measures of finger agnosia and dysgraphesthesia (although the lower scores on the latter measures are seen primarily at younger ages). Given that children with ADD-H may have a greater percentage of children who are LD because of an information processing deficiency, it was predicted that the ADD-H group would demonstrate greater impairments on auditory-linguistic and tactile-perceptual measures that are related to LD than the ADD+H group.

In this situation, the two groups were first compared on auditory-linguistic measures (i.e., the Auditory Closure Test, Auditory Analysis Test, Sentence Memory Test). They were first compared on these measures in isolation because of the strong relationship between these measures and a
combined reading and spelling disability. A second analysis was conducted that included with the auditory-linguistic tests measures of finger agnosia and dysgraphesthesia from the Reitan-Kløve Sensory-perceptual Examination. Finally, the proportion of children in each group who were below a certain cutoff on the auditory-linguistic measures listed above were compared by a chi-square test. The cutoff score for each measure was determined by the performance on these measures of a nonhyperactive RD group drawn from the same clinic. A subject was considered to exhibit a processing deficiency if his or her performance was at or below 0.5 SD of the mean score of the nonhyperactive RD group.

**Hypothesis 3**

The third set of hypotheses concerned variables related to the behavioural and emotional adjustment of the children included in the study. The predictions contained in this section were limited to those variables that have been shown to discriminate the two ADD groups.

**Hypothesis 3a.** It was predicted that the ADD+H group would be rated by both teachers and parents as exhibiting greater difficulties with conduct disorders and aggression as compared to the ADD-H group. The significance of the group differences for each behavioural domain (i.e., conduct disorder and aggression) was determined in two ways. First, the groups were compared in terms of their mean elevations on the Conduct Disorder factor of the CTRS and the
Aggression factor of the CBCL-TRF. Statistical significance was determined by a MANOVA with each factor score (T score) entered as a dependent variable. Second, the groups were compared in terms of the number of children that exceeded a specific cutoff score on each factor. This would provide an indication of the extent to which clinically significant conduct disorders or problems with aggression were present. It was predicted that the ADD+H group would have a greater proportion of children with significant elevations on behavioural rating scales related to conduct disorders and aggression than the ADD-H group. These data were analyzed by a chi-square test. These same procedures were conducted on the parents' ratings of the children's behaviour on the Conduct Disorder and Aggression factors of the CPRS and the CBCL-PRF.

Hypothesis 3b. It was predicted that children with ADD-H would exhibit greater problems with social withdrawal, anxiety, unhappiness, and depression as compared to children with ADD+H. Factor scores based on teacher ratings are provided for social withdrawal (CBCL-TRF), anxiety (CBCL-TRF), and unhappiness (CBCL-TRF: Child Behavior Profile). T scores for these three variables were entered as dependent variables in a MANOVA. The relative frequency of significant elevations for each factor combined were analyzed by a chi-square test. Factor scores based on parent ratings are provided for social withdrawal (CBCL-PRF)
and depression (CBCL-PRF). These variables were analyzed in the same manner as that described for the teacher ratings.

Hypothesis 4

The last set of hypotheses involved child and family history variables. The variables for analysis were selected to reflect those areas in which differences between the ADD subtypes have been found in previous research studies.

Hypothesis 4a. The first hypothesis concerned the child's level of activity as a baby. It was predicted that there was a greater incidence of children with ADD+H who were rated by a parent as being significantly more active as a baby as compared to the ADD-H group. The significance of this prediction was determined by a chi-square test. The items relevant to this prediction are from the Children's History Form (CHF; p. 7).

Hypothesis 4b. The second set of hypotheses concerned the child's history of motor coordination difficulties. While such difficulties have been reported in both ADD groups, the findings in the literature suggests that children with ADD+H encounter more difficulties with fine motor coordination whereas children with ADD-H encounter more difficulties with gross motor coordination. Thus, it was predicted that the ADD+H group would have a greater frequency of children who are rated by a parent as exhibiting "poor handwriting" and as being "clumsy using his/her hands" than the ADD-H group. Ratings on these two
items are from the CHF (p. 18). It was also predicted that the ADD-H group would have more children than the ADD+H group who were rated (1) as clumsy in walking; (2) as having had "motor coordination difficulties such as confusion in regard to left or right-handedness, frequent falling, awkwardness;" and (3) as performing less well in athletic activities. These items are from the CHF (p. 8 and 18). These data were analyzed by chi-square tests.

**Hypothesis 4c.** This set of hypotheses focussed on the family history of behavioural and emotional problems. It was predicted that the parents of the children with ADD+H would report significantly more problems of an externalized nature among relatives than would the parents of the ADD-H group (i.e., hyperactivity, aggression, arrests). On the other hand, the parents of the children with ADD-H would report significantly more problems of an internalized nature among relatives than would the parents of the ADD+H group (i.e., anxiety and depression). Items relevant to these predictions are from the CHF (p. 12).

Finally, it was predicted that the siblings of the children with ADD+H would have a greater frequency of symptoms related to hyperactivity (i.e., inattention, impulsivity, overactivity) as reported by a parent than the siblings of ADD-H children. In addition, it was predicted that the siblings of children with ADD-H would have a greater frequency of symptoms related to LD than the ADD+H
group. Items related to these predictions are from the CHF (p. 12 & 13). Each of these predictions will be tested by chi-square analysis.
CHAPTER II

METHOD

Subjects

The subjects for the present study were drawn from the clinical data base compiled in the Division of Neuropsychology at Henry Ford Hospital, Detroit, Michigan. The Division of Neuropsychology evaluates children with a broad spectrum of disorders, although most are referred because they are exhibiting problems related to their behaviour and/or academic performance. The majority of the children are administered a comprehensive neuropsychological evaluation that is designed to assess the principal areas of human functioning considered to be directly relevant to the integrity of the central nervous system. As part of the evaluation process, information is routinely gathered regarding the child’s medical, developmental, and academic histories. A parent (usually the mother) is interviewed and asked to complete several behaviour rating scales. Whenever possible, teacher’s ratings of the child’s behaviour are obtained through the use of several standardized questionnaires.

Procedures

In order to be considered for the study, a child had to meet the following criteria:
(1) be between the ages of 6 years 0 months and 11 years 11 months;

(2) have a Full Scale IQ of at least 80 on the WISC-R at the time of evaluation;

(3) be the biological child of the current parent(s);

(4) have no evidence of deafness, blindness, severe language delay, cerebral palsy, epilepsy, head injury, autism, or psychosis as determined by both historical and clinical information;

(5) have had completed as part of their evaluation the Child Behavior Checklist - Teacher Report Form (CBCL-TRF; Achenbach & Edelbrock, 1986);

(6) was not treated with stimulant medication during the period in which the data were collected.

In part, the groups were formed based on their scores on the Child Attention Problems scale (CAP; Barkley, 1990). This scale was designed to provide an empirical means by which to subtype ADD children into those with and those without hyperactivity. The 12 items that constitute the CAP (see Appendix C) were derived from the Inattentive, Nervous-Overactive, and Aggressive Scales of the CBCL-TRF. According to Barkley et al. (1990), the seven items that comprise the Inattention Scale and the five items that comprise the Overactivity Scale of the CAP were selected for loading highest on their respective scale while
demonstrating low correlation with the other of these two
scales. The normative data for the CAP are derived from the
normative sample of the CBCL-TRF. The reliability and
validity of the CAP appear to be satisfactory. Barkley et
al. (1990) reported that the internal consistency (split-
half) of the CAP was .84, the test-retest reliability over a
2-week interval was .96, and the interrater reliability for
boys ages 6-11 years was .77. It was also reported that it
significantly discriminated referred from nonreferred
children and was highly sensitive to dose effects of
stimulant drugs with ADD children. Also, its two scales
were found to correlate highly (> .90) with similar scales
from the ADD-H Comprehensive Teacher Rating Scale (Ullmann,
Sleator, & Sprague, 1984).

Children were selected for study if, in addition to
meeting the aforementioned selection criteria, they met the
criteria specific to one of the ADD groups. To be included
in the ADD+H group, children were required to meet the
following criteria:

(1) complaints of problems related to disruptive behaviours
    as reported by a parent at the time of referral;
(2) these problems present for at least 6 months;
(3) onset of these problems prior to 7 years of age;
(4) a score greater than the 93rd centile (1.5 SD) on both
    the Inattention and Overactivity Scales of the CAP.
Children in the ADD-H group were required to meet the following criteria:

1. current complaints of problems related to inattention as reported by a parent;
2. these problems present for at least 6 months;
3. onset of these problems by 7 years of age or Grade 2;
4. a score greater than the 93rd centile (1.5 SD) on the Inattention Scale of the CAP and a score below the 84th centile (1 SD) on the Overactivity Scale.

In order to obtain empirically-based cutoff scores for the neuropsychological variables that are related to a reading disability, a group of nonhyperactive RD children was selected from the same clinic population from which the ADD groups were selected. In order to be included in the RD group, a child was required to meet the following criteria:

1. complaints of academic problems at the time of referral;
2. scores on the Reading and Spelling subtests of the WRAT-R less than or equal to the 16th centile;
3. a FSIQ that was 15 or more standard score points greater than the child's better achievement score on either the Reading or Spelling subtest of the WRAT-R;
4. scores on both scales of the CAP less than or equal to the 84th centile.
Measures

The tests and measures from which the dependent variables were derived were grouped into 3 areas: (1) child and family history measures (2) behavioural and emotional measures; and (3) academic, cognitive, and neuropsychological measures.

Academic, cognitive, and neuropsychological measures.
The academic, cognitive, and neuropsychological variables of interest were selected from the following tests and procedures that are routinely administered to the children evaluated through the Division of Neuropsychology at Henry Ford Hospital (specific variables to be analyzed are discussed within the context of the hypotheses):

(a) WRAT-R (Jastak & Wilkinson, 1984), Reading, Spelling, and Arithmetic subtests

(b) Peabody Individual Achievement Test (PIAT; Dunn & Markwardt, 1970), Reading Comprehension subtest

(c) WISC-R (Wechsler, 1974)

(d) Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981)

(e) Reitan-Indiana Neuropsychological Test Battery (Reitan & Davison, 1974; for children ages 5-8 years)

(f) Halstead Neuropsychological Test Battery for Children (Reitan & Davison, 1974; for children ages 9-14 years)

(g) Kløve-Matthews Motor Steadiness Battery (Kløve, 1963)

(h) Reitan-Kløve Sensory-perceptual Examination (Reitan, 1984)

(i) Tests for Lateral Dominance (Harris, 1947; Miles, 1929)

(j) Auditory Closure Test (Kass, 1964)
(k) Auditory Analysis Test (Rosner & Simon, 1971)
(l) Sentence Memory Test (Benton, 1965)
(m) Verbal Fluency Test (Knights & Norwood, undated)
(n) Underlining Test (Rourke & Gates, 1980)
(o) Buschke Selective Reminding Test (Buschke, 1974; Fletcher, 1985b; Izaak Walton Killam Hospital, undated)

**Behavioural and psychosocial measures.** Data related to this category were provided by the parent (usually the mother) at the time of the child's visit to the clinic. While the child was being examined, the parent was given a packet of questionnaires to complete in the waiting area. Several questionnaires related to the child's behavioural and psychosocial adjustment. These included (1) the Personality Inventory for Children-Revised (Wirt, Lachar, Klinedinst, & Seat, 1984); (2) the Child Behavior Checklist - Parent Report Form (CBCL-PRF; Achenbach & Edelbrock, 1983); (3) the revised Conners Parent Rating Scale (CPRS; Goyette et al., 1978); and (4) the Burks' Behavior Rating Scales (Burks, 1977). In addition, several rating scales were also completed by a teacher familiar with the child. These usually included (1) the Child Behavior Checklist - Teacher Report Form (CBCL-TRF; 1986); the revised Conners Teacher Rating Scale (CTRS; Goyette et al., 1978); and the Burks' Behavior Rating Scales (Burks, 1977). Only the measures that were related to the present hypotheses were examined.

**Child and Family History Measures.** Among the materials given to the parent to complete was a detailed questionnaire
(Children’s History Form; see Appendix E) related to the mother’s and child’s history surrounding the pregnancy and delivery; the child’s developmental, medical, and academic history; and the family’s history of psychiatric problems. In addition, the parent was interviewed using a semi-structured format.

Data Analyses

Frequency data were analyzed by the chi-square test of association. The other analyses were based on parametric statistics, most of which involved standardized scores. Such scores (e.g., T scores) are usually the values reported for the behaviour rating scales. For the neuropsychological measures, the conversion of raw scores to standardized scores were based on normative studies conducted with these measures. The majority of the neuropsychological scores analyzed were derived from the measures incorporated in the Halstead-Reitan Neuropsychological Batteries. The raw scores were converted to T scores using the norms of Knights and Norwood (1980). Normative data for the other neuropsychological measures were based on their respective normative studies. These are referenced with the listing of each test. Whenever appropriate, multivariate analyses of variance (MANOVAs) were performed in order to determine the significance of group differences on composite measures that were thought to reflect underlying constructs. Also,
MANOVAs reduce the number of statistical comparisons and, thereby, minimize the risk of committing a Type 1 error.
CHAPTER III

RESULTS

Approximately 800 children received neuropsychological assessments at Henry Ford Hospital (HFH) between January 1988 and December 1991. Of these children, approximately 390 had as part of their assessment data results from the CBCL-TRF. One hundred and fifty of the 390 either did not meet the first set of selection criteria (see p. 88) or had incomplete data sets, the latter usually because at least one of the items from the CBCL-TRF was left blank. Of the remaining 240 children, 62 met the criteria for ADD+H group and 22 met the criteria for the ADD-H group. Although HFH is located in a large urban area, 90% of the subjects who met inclusion criteria were from the surrounding suburban areas. Eight of the subjects in the ADD+H group were from the urban area whereas none of the subjects in the ADD-H group were from the urban area.

Data involving demographic variables and selection criteria are presented in Table 2. As expected, the ADD+H group scored significantly higher on the CAP Overactivity Scale, one of the measures that was used to define the groups. However, the groups did not differ significantly on the CAP Inattention Scale. The ADD-H group was
Table 2

Demographic and Subject Selection Information by Group

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>F/\chi^2</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>62</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Boy/Girl</td>
<td>51/11</td>
<td>17/5</td>
<td>0.26</td>
<td>.62</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8.5</td>
<td>9.3</td>
<td>4.30</td>
<td>.05</td>
</tr>
<tr>
<td>SD</td>
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<td>1.5</td>
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</tr>
<tr>
<td>Grade*</td>
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<td>2.4</td>
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<tr>
<td>SD</td>
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<td>1.4</td>
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<td></td>
</tr>
<tr>
<td>FSIQ (WISC-R)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>103.5</td>
<td>107.7</td>
<td>1.99</td>
<td>.17</td>
</tr>
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<td>SD</td>
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<td></td>
</tr>
<tr>
<td>Mother’s Educ. b</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>12.6</td>
<td>13.6</td>
<td>3.13</td>
<td>.09</td>
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<tr>
<td>SD</td>
<td>2.2</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Father’s Educ. c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>13.4</td>
<td>13.8</td>
<td>0.25</td>
<td>.87</td>
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<td>SD</td>
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<tr>
<td>Family Composition</td>
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<tr>
<td>1- /2-Parent Home 8/54</td>
<td>0/22</td>
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<td>3.14</td>
<td>.08</td>
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<tr>
<td>CAP-Inattention</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>12.3</td>
<td>12.8</td>
<td>2.45</td>
<td>.13</td>
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<tr>
<td>SD</td>
<td>1.3</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAP-Overactivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8.5</td>
<td>1.1</td>
<td>615.35</td>
<td>.0002</td>
</tr>
<tr>
<td>SD</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Child Attention Profile.

* ADD+H: n = 61.
* ADD+H: n = 58; ADD-H: n = 21.
* ADD+H: n = 43; ADD-H: n = 18.
significantly older than the ADD-H group, a finding that
might be expected given the slightly more liberal age of
onset criterion used for the ADD-H group; however, they did
not differ significantly in terms of grade placement. The
groups did not differ significantly in the ratio of
boys/girls (4.6:1 vs 3.4:1), WISC-R FSIQ, the mother’s years
of education, or the father’s years of education.

Very similar results were obtained when the demographic
and subject selection variables were analyzed after children
with RS and RSA disabilities were removed from each group.
The ADD groups did not differ significantly in terms of age,
grade placement, FSIQ, mother’s or father’s years of
education, or or on the CAP Inattention scale. As expected,
they differed significantly on the CAP Overactivity scale, $F$
(1,61) = 521.59, $p < .0001$.

Hypothesis 1: "Executive Processes"

Predictions under hypothesis 1 were grouped into three
categories: (1) fine motor control, (2) higher-order
cognitive processes, and (3) complex perceptual search. The
variables related to psychomotor performance are presented
in Table 3. These included measures of handwriting quality,
static steadiness, and kinetic steadiness.

The child’s first five words spelled on the WRAT-R
Spelling subtest constituted the handwriting sample to be
rated. Ratings on the first seven items of the Handwriting
Scale (see Appendix F) were summed to yield a total score
Table 3

Means and (Standard Deviations) on Psychomotor Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1.74)</td>
<td>(1.56)</td>
</tr>
<tr>
<td>Handwriting</td>
<td>3.93</td>
<td>3.66</td>
</tr>
<tr>
<td>Holes Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DT</td>
<td>51.70</td>
<td>51.73</td>
</tr>
<tr>
<td>DC</td>
<td>49.50</td>
<td>49.42</td>
</tr>
<tr>
<td>NT</td>
<td>47.80</td>
<td>47.62</td>
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<tr>
<td>NC</td>
<td>44.79</td>
<td>44.33</td>
</tr>
<tr>
<td>Maze Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DT</td>
<td>56.88</td>
<td>59.95</td>
</tr>
<tr>
<td>DC</td>
<td>57.81</td>
<td>62.17</td>
</tr>
<tr>
<td>DS</td>
<td>51.32</td>
<td>45.35</td>
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<tr>
<td>NT</td>
<td>54.41</td>
<td>55.40</td>
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<tr>
<td>NC</td>
<td>53.24</td>
<td>54.33</td>
</tr>
<tr>
<td>NS</td>
<td>51.76</td>
<td>49.42</td>
</tr>
</tbody>
</table>

Note: Standard deviations are presented in parentheses; DT = Dominant-hand Time; DC = Dominant-hand Contacts; DS = Dominant-hand Speed; NT = Nondominant-hand Time; NC = Nondominant-hand Contacts; NS = Nondominant-hand Speed; ADD+H: \( n = 58 \); ADD-H: \( n = 21 \).

ADD+H: \( n = 59 \); ADD-H: \( n = 22 \).
(range 0-14). Since item (h) "Poor overall legibility" likely represents an amalgam of items (a) through (g), and, therefore, highly correlated with the total score, it is not included in the total score used in the present study. However, it is included separately as an estimate of overall legibility. Lerer et al. (1977) also included item (i) "Letter reversals or inversions" as part of their rating scale. However, this item was not included in the present analyses because reversals and inversions tend to be associated with LD (especially in older children) rather than with motor control problems.

The ratings were conducted by two Honours B.A. level psychology graduates who were uninformed to the details of the study. Most importantly, they were unaware of each subject's group membership and the size of each group. Samples of handwriting and operational definitions were provided as guides for evaluating the child's handwriting on each item.

Based on the entire sample of ADD children, an interrater reliability of .77 was obtained on the Handwriting Scale (sum of items [a] through [g]). For the purpose of data analysis, each subject's score was the combined total of items (a) through (g) for each rater (range 0 to 28). In general, the handwriting ratings were low for the ADD sample resulting in a positively skewed
distribution of scores (γ = 1.35). A transformation¹
(Glass & Hopkins, 1984) of the original scores resulted in
scores that were more normally distributed (γ = 0.20). A
one-way ANOVA on the transformed scores was not significant,
$F(1,77) = 0.38, \ p < .55$.

Item (h) "Poor overall legibility" of the Handwriting
Scale was used to rate each subject's handwriting based on
all of their productions on the WRAT-R Spelling subtest,
rather than the first five spelling items only. The
subject's score was the combined total for each rater (range
0-4). Seventy percent of the cells (2 X 5) had expected
counts that were less than five indicating that the chi-
square may not be valid. Therefore, the groups were
compared in terms of the number of subjects who received
scores of zero and the number who received scores of 1 or
more. A chi-square based on this grouping of the frequency
counts was significant, $\chi^2 (1, N = 79) = 9.70, \ p < .002$.
For the ADD+H group, 65.5% (38 of 58) received a total score
of zero and 34.5% (20 of 58) received a score of one or
more. In contrast, all of the subjects in the ADD-H group
received a score of zero.

A MANOVA involving all four variables of the Holes Test
was not statistically significant, $F(4,76) = 0.004, \ p
< 1.0$. The means and standard deviations for the variables

¹ $y = \sqrt{x} + \sqrt{x+1}$
on the Holes Test are presented in Table 3. Correlation coefficients among the variables of the Holes Test are presented in Table 4.

The correlations between the Dominant Time and Dominant Contact scores and the Nondominant Time and Nondominant Contact scores were fairly high ($r = .71$ and $.72$, respectively), suggesting that these variables may be redundant. For this reason, a MANOVA was conducted with only the Right and Left Contact scores included as dependent variables. The Contact measures were selected because the groups scored lower on these than on the Time measures. The result of this analysis was not significant, $F (2, 79) = 0.003, p < .998$.

Correlations among the measures of the Maze Test revealed that the Time and Contact measures for the Dominant and Nondominant hands were highly correlated ($r = .91$ and $.82$, respectively; see Table 5). Because of this, two MANOVAs were conducted, one with all four measures serving as dependent variables and another based on the Dominant- and Nondominant-Hand Contact scores as dependent variables. Neither MANOVA was significant ($F (4, 76) = 1.19, p < .32$ and $F (2, 79) = 2.06, p < .14$, respectively).

A MANOVA involving the Speed measures from the Maze Test indicated that the groups were not significantly different on these measures, $F (2, 79) = 2.32, p < .11$. However, an inspection of Table 3 revealed that the ADD-H
Table 4

Pearson Correlation Coefficients Among Holes Test Variables

<table>
<thead>
<tr>
<th></th>
<th>DT</th>
<th>DC</th>
<th>NT</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT</td>
<td>.59</td>
<td>.53</td>
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<td></td>
</tr>
<tr>
<td>NC</td>
<td>.36</td>
<td>.59</td>
<td>.72</td>
<td></td>
</tr>
</tbody>
</table>

Note: DT = Dominant-hand time; DC = Dominant-hand contacts; NT = Nondominant-hand time; NC = Nondominant-hand contacts.
<table>
<thead>
<tr>
<th></th>
<th>DT</th>
<th>DC</th>
<th>DS</th>
<th>NT</th>
<th>NC</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td></td>
<td>.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td></td>
<td></td>
<td>-.22</td>
<td>-.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td></td>
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<tr>
<td>NT</td>
<td>.52</td>
<td>.59</td>
<td></td>
<td>-.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>.30</td>
<td>.47</td>
<td>-.26</td>
<td></td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td>-.23</td>
<td>-.32</td>
<td>.74</td>
<td>-.24</td>
<td>-.24</td>
<td></td>
</tr>
</tbody>
</table>

*Note: DT = Dominant-hand time; DC = Dominant-hand contacts; DS = Dominant-hand speed; NT = Nondominant-hand time; NC = Nondominant-hand contacts; NS = Nondominant-hand speed.*
group appeared to be somewhat slower than the ADD+H group in completing the mazes with the dominant hand. The ANOVA on the Dominant-hand Speed measure approached significance, $F(1, 80) = 3.89, p < .06$, with lower scores being demonstrated by the ADD-H group. Because there was a tendency for the groups to perform differently on at least one of the Speed measures, a MANCOVA was conducted using the Contact measures as dependent variables and the Dominant-hand Speed and Nondominant-hand Speed measures as covariates. The MANCOVA was not significant, $F(2, 77) = 1.64, p < .21$.

Correlations among the "higher-order" measures are presented in Table 6. The highest correlation among these measures was between Block Design and Verbal Fluency ($r = .39$). Thus, the correlations among these variables were sufficiently small to suggest that none was redundant.

Because the abilities measured by some of these tests (e.g., verbal fluency, verbal memory, arithmetic achievement) have been shown to be impaired in the RSA and RS subtypes of children with LD, two MANOVAs were conducted: one involving all subjects from both groups, the other involving only those subjects who did not exhibit the RSA or RS WRAT patterns. The first analysis is more characteristic of previous research studies in that it does not control for learning disabilities among the subjects with ADD. Perhaps the ADD subtypes are distinguishable on measures of higher-order cognitive processing; however, the overlap that each
Table 6

Pearson Correlation Coefficients Among Higher-Order Variables

<table>
<thead>
<tr>
<th></th>
<th>CAT</th>
<th>TPT</th>
<th>BD</th>
<th>VF</th>
<th>ARIT</th>
<th>CLTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
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<td></td>
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</tr>
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<td>VF</td>
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<td>-.01</td>
<td>.39</td>
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<td></td>
</tr>
<tr>
<td>ARIT</td>
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<td>.06</td>
<td>.32</td>
<td>.27</td>
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<td></td>
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<tr>
<td>CLTR</td>
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<td>.27</td>
<td>.03</td>
<td>.19</td>
<td>.23</td>
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</table>

Note: CAT = Category Test; TPT = Tactual Performance Test; BD = Block Design; VF = Verbal Fluency; ARIT = Arithmetic subtest from the WRAT-R; CLTR = Consistent Long Term Retrieval.
Table 7

Means and (Standard Deviations) on Higher-Order Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Subjects(^a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category Test</td>
<td>55.29</td>
<td>(9.82)</td>
</tr>
<tr>
<td>TPT</td>
<td>55.43</td>
<td>(3.90)</td>
</tr>
<tr>
<td>Block Design</td>
<td>50.36</td>
<td>(11.47)</td>
</tr>
<tr>
<td>Verbal Fluency</td>
<td>39.75</td>
<td>(8.65)</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>43.69</td>
<td>(10.94)</td>
</tr>
<tr>
<td>CLTR</td>
<td>52.52</td>
<td>(11.11)</td>
</tr>
</tbody>
</table>

ADD Subjects without LD\(^b\)

<table>
<thead>
<tr>
<th>Measures</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category Test</td>
<td>56.54</td>
<td>(8.60)</td>
</tr>
<tr>
<td>TPT</td>
<td>56.20</td>
<td>(3.79)</td>
</tr>
<tr>
<td>Block Design</td>
<td>50.87</td>
<td>(11.52)</td>
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<td>Verbal Fluency</td>
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</tr>
<tr>
<td>Arithmetic</td>
<td>45.94</td>
<td>(11.10)</td>
</tr>
<tr>
<td>CLTR</td>
<td>52.75</td>
<td>(10.84)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are presented in parentheses; TPT = Tactual Performance Test; CLTR = Consistent Long Term Retrieval measure from the Buschke Selective Reminding Test.

\(^a\) ADD+H: \(n = 56\); ADD-H: \(n = 21\).

\(^b\) ADD+H: \(n = 42\); ADD-H: \(n = 18\).
group shares with LD children and their associated
europsychological deficiencies may mask such group
differences. While it was possible that the ADD groups
would not differ on the first MANOVA for this reason, it was
predicted that the ADD-H group would obtain lower scores
when the RSA and RS subjects were excluded from the second
analysis.

Means and standard deviations for the higher-order
variables are presented in Table 7. A MANOVA based on the
six higher-order measures was not significant, \( F (6, 70) = 0.727, p < .64 \). Both groups performed in the normal range
on the Category Test, TPT, Block Design subtest of the
WISC-R, and the CLTR measure. On the other hand, both the
children with ADD+H and those with ADD-H encountered more
difficulty with the Arithmetic subtest of the WRAT-R and,
especially, the Verbal Fluency Test when compared to the
normative means.

Because a child's performance on one or more of these
variables could be influenced by a learning disability, a
MANOVA on the higher-order variables was also conducted
after a group of LD children were excluded from each of the
ADD groups. Two criteria were used to define a child as
having a learning disability: (a) scores on both the Reading
and Spelling subtests of the WRAT-R less than or equal to
1.5 SD below the norm and (b) a FSIQ that was 15 or more
standard score points greater than the mean score for the
Reading and Spelling subtests of the WRAT-R. The means and standard deviations for each ADD group with these LD subjects excluded are presented in Table 7. The MANOVA on the higher-order measures was not statistically significant, $F(6,53) = 0.68, p < .68$. Figure 1 illustrates the performance of each group on these variables (LD subjects excluded). The rank order was based on the mean performance of the entire ADD sample for each of the variables.

The third set of predictions under Hypothesis 1 involved measures of complex perceptual search. The ADD groups were compared on a composite measure involving the mean T score for each subject on subtests 1-13. A one way ANOVA approached significance, $F(1,80) = 3.61, p < .07$; however, this tendency for the ADD+H group to perform better than the ADD-H group was contrary to the prediction that the ADD+H group would obtain lower scores. The ADD+H group ($n = 60$) obtained a mean T score of 41.6 ($SD = 6.8$) and the ADD-H group ($n = 22$) obtained a mean T score of 38.4 ($SD = 7.0$).

Because it has been shown that children with reading disabilities perform especially poorly on those subtest that involve the discrimination of letter sequences (e.g., Rourke & Orr, 1977), it was possible that the performance of the ADD groups would be confounded by the inclusion of children with RD. This may mask group differences associated with visual search per se. Therefore, the two ADD subtypes were also compared after children defined as RSA or RS were
Figure 1. Mean Performance of Both ADD Groups on Higher-order Measures: Children with LD Excluded.
removed from the groups. When these children who were defined as LD were excluded from the sample, it was again found that the ADD+H tended to perform better than the ADD-H group, \( F (1,61) = 4.07, p < .06 \). The ADD+H group (\( n = 42 \)) obtained a mean \( T \) score of 42.7 (\( SD = 7.1 \)) and the ADD-H group (\( n = 17 \)) obtained a mean \( T \) score of 38.2 (\( SD = 6.8 \)).

Data related to each group's performance on the subtests of the Underlining Test are presented in Figures 2 and 3.

Because of the low number of errors of commission overall (with many children committing no errors on some subtests), the average number of errors for the 13 subtests was transformed in order to better approximate a normal distribution of scores. The transformation, \( Y' = \log_{10}(Y+1) \), is recommended when some scores are zero or very small (Kirk, 1982). The pre- and post-transformation measure of skewedness was 6.05 and 0.27, respectively. Based on the transformed scores, the groups did not differ significantly, \( F (1,79) = 0.27, p < .62 \). The mean transformed score for the ADD+H group was 0.72 (\( SD = 0.42 \)), and for the ADD-H group it was 0.67 (\( SD = .30 \)). Moreover, the groups did not differ significantly when they were compared once the children with LD were excluded from the analysis, \( F (1,60) = 0.01, p < .92 \). The mean transformed scores for the ADD+H and ADD-H groups were 0.68 (\( SD = .37 \)) and 0.70 (\( SD = 0.26 \)), respectively. Figure 4 presents the mean number of raw score errors for each of the groups.
Figure 2. Mean Performance of Both ADD Groups on the Underlining Test.
Figure 3. Mean Performance of Both ADD Groups on the Underlining Test: Children with LD Excluded.
Figure 4. Mean Number of Errors on the Underlining Test of Both ADD Groups and an Age-matched Normative Sample.
Hypothesis 2: Academic Functioning

Several variables that reflect academic functioning were analysed. The first involved the proportion of children in each ADD group that were retained in grade at least once. It was found that 16 of the 62 children with ADD+H (25.8%) had been retained at least once, with a similar proportion (6 of 22 children or 27.3%) being observed among the children with ADD-H. This small difference was not statistically significant ($\chi^2 (1, N = 84) = 0.02, p < .90$).

The groups were also compared in terms of their mean performance in academic subjects. The groups did not differ significantly in teacher ratings of their performance as reported on the CBCL-TRF, $F (1, 81) = 0.71, p < .41$. The mean $T$ score for the ADD+H group was 37.7 ($SD = 9.14$) and for the ADD-H group it was 39.7 ($SD = 9.77$). Both groups were performing more than 1 $SD$ below the normative mean.

The groups were also compared in terms of the frequency of LD. Three approaches to defining LD were used to compare the groups. The first two approaches used as part of the criteria for defining LD both (1) a score less than or equal to a certain cutoff on one or more achievement tests (as compared to the normative mean) and (2) a discrepancy between WISC-R FSIQ and achievement on the achievement test(s) in question. The first approach applied these criteria to each academic subject sampled by the WRAT-R. To
be considered LD, the subject was required to obtain an achievement score that was less than or equal to 1 SD below the normative mean and an IQ-Achievement discrepancy of 15 or more standard score points in favour of the IQ. The groups did not differ in the frequency of LD for reading, spelling, or arithmetic using these criteria (see Table 8). The mean performance of the ADD groups on each of the WRAT-R subtests is presented in Table 9.

The second approach to defining LD involved grouping the children according to their patterns of performance on the reading, spelling, and arithmetic subtests of the WRAT-R. Children were defined as delayed in reading, spelling, and arithmetic (RSA subtype) if their standard scores on each of these subtests of the WRAT-R was less than or equal to 1.5 SD below the normative mean and their mean performance on all of the achievement measures was 15 or more standard score points less than their FSIQ. Children were considered to be reading and spelling delayed (RS subtype) if their standard scores on each of these subtests of the WRAT-R was less than or equal to 1.5 SD below the normative mean, their Arithmetic subtest standard score was no less than 1 SD below the normative mean, and their mean performance on the Reading and Spelling subtests was 15 or more standard score points less than their FSIQ. In order to be considered delayed in arithmetic, children were required to obtain an Arithmetic standard score that was
Table 8
Frequency and Percentage of LD by Group

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>(\chi^2)</th>
<th>(p &lt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LD For Each</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subject Separately</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading %</td>
<td>19/62</td>
<td>4/22</td>
<td>1.27</td>
<td>.27</td>
</tr>
<tr>
<td></td>
<td>30.7</td>
<td>18.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelling %</td>
<td>17/62</td>
<td>4/22</td>
<td>0.74</td>
<td>.40</td>
</tr>
<tr>
<td></td>
<td>27.4</td>
<td>18.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arithmetic %</td>
<td>8/62</td>
<td>3/22</td>
<td>0.01</td>
<td>.94</td>
</tr>
<tr>
<td></td>
<td>12.9</td>
<td>13.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LD by</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WRAT-R Subtypes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSA %</td>
<td>7/62</td>
<td>1/22</td>
<td>0.86</td>
<td>.36</td>
</tr>
<tr>
<td></td>
<td>11.3</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS %</td>
<td>5/62</td>
<td>1/22</td>
<td>0.30</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>8.1</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A %</td>
<td>1/62</td>
<td>0/62</td>
<td>0.36</td>
<td>.56</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>13/61</td>
<td>2/22</td>
<td>1.56</td>
<td>.22</td>
</tr>
<tr>
<td><strong>Neuropsychological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALD %</td>
<td>12/61</td>
<td>2/22</td>
<td>1.29</td>
<td>.27</td>
</tr>
<tr>
<td></td>
<td>19.7</td>
<td>9.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** RSA = Reading, Spelling, and Arithmetic disability; RS = Reading Spelling disability; A = Arithmetic disability; ALD = Auditory-Linguistic Disorder.
Table 9

Mean Standard Scores and (Standard Deviations) on the WRAT-R Subtests

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>F</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>87.2</td>
<td>95.5</td>
<td>3.17</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>(19.9)</td>
<td>(15.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelling</td>
<td>86.6</td>
<td>90.1</td>
<td>0.68</td>
<td>.42</td>
</tr>
<tr>
<td></td>
<td>(18.1)</td>
<td>(14.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arithmetic</td>
<td>89.4</td>
<td>89.9</td>
<td>0.01</td>
<td>.92</td>
</tr>
<tr>
<td></td>
<td>(16.2)</td>
<td>(13.2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard deviations are presented in parentheses.
less than or equal to 1.5 SD below the mean, to obtain standard scores on both the Reading and Spelling subtests that were no less than 1 SD below the normative mean, and to obtain an Arithmetic score that was 15 or more points below their FSIQ (A subtype).

The groups did not differ statistically in the frequency of WRAT-R RSA, RS, or A subtypes. When the subtypes were added together, the frequency of children with LD in the ADD+H group was approximately twice that of the ADD-H group. However, this difference was not statistically significant, \( \chi^2 (1, N = 84) = 1.56, p = .21 \). These results are presented in Table 8.

The third approach involved comparing the performance of the groups on selected neuropsychological measures. First, the percentage of children in each group who exhibited deficiencies on three auditory-linguistic measures that have been associated with a combined reading and spelling disability was compared. A child was considered to have a auditory-linguistic processing disorder if he or she obtained (1) a score on the Auditory Closure Test less than a T score of 44.9; (2) a score on the Sentence Memory Test less than a T score of 43.7; (3) a score on the Auditory Analysis Test less than a T score of 34.3; and (4) a PIQ standard score greater than or equal to 85. The cutoff scores for the three auditory-linguistic measures were based on the performance of a group of 10 nonhyperactive, learning
disabled children. These subjects represented all of the children from the Ford Hospital clinic who met the selection criteria outlined in the Method section.

Based on these considerations, 12 of 61 children (19.7%) in the ADD+H group were considered to have an auditory-processing disorder and 2 of 22 children (9.1%) in the ADD-H group were considered to have such a disorder (see Table 8). Although there was over twice the percentage of children with an auditory-linguistic disorder in the ADD+H group, this difference was not statistically significant.

The groups were also compared in terms of their mean performance on selected neuropsychological variables. Overall, there was a tendency for the ADD+H group to obtain lower scores on the auditory-linguistic measures as compared to the ADD-H group, $F (3,79) = 2.71, p < .06$. Because of the marginal nature of this difference, ANOVAs were conducted. These analyses indicated that the ADD+H group obtained significantly lower scores on the Auditory Closure Test ($F (1,81) = 4.40, p < .05$) and the Auditory Analysis Test ($F (1,81) = 7.20, p < .01$). The groups did not differ on the Sentence Memory Test, $F (1,81) = 1.09, p < .31$. These scores are presented in Table 10.

The MANOVA comparing the two groups on the larger subset of neuropsychological variables related to a combined reading and spelling disorder was not statistically significant, $F (6,73) = 1.69, p < .14$. The mean scores for
Table 10

Mean T scores and (Standard Deviations) on Selected Neuropsychological Variables

<table>
<thead>
<tr>
<th>Measures</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auditory-Linguistic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory Closure</td>
<td>44.11 (9.71)</td>
<td>49.64 (12.79)</td>
</tr>
<tr>
<td>Sentence Memory</td>
<td>48.13 (12.72)</td>
<td>51.36 (11.77)</td>
</tr>
<tr>
<td>Auditory Analysis</td>
<td>40.67 (11.84)</td>
<td>48.49 (11.36)</td>
</tr>
<tr>
<td><strong>Auditory-Linguistic and Other</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory Closure</td>
<td>43.94 (9.77)</td>
<td>49.64 (12.79)</td>
</tr>
<tr>
<td>Sentence Memory</td>
<td>48.03 (12.87)</td>
<td>51.36 (11.77)</td>
</tr>
<tr>
<td>Auditory Analysis</td>
<td>40.95 (12.06)</td>
<td>48.49 (11.36)</td>
</tr>
<tr>
<td>Finger Agnosia</td>
<td>42.07 (16.26)</td>
<td>44.91 (16.60)</td>
</tr>
<tr>
<td>Astereognosis</td>
<td>48.33 (10.00)</td>
<td>45.93 (13.51)</td>
</tr>
<tr>
<td>Underlining #11</td>
<td>36.79 (12.25)</td>
<td>38.07 (10.26)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are presented in parentheses; finger agnosia and astereognosis are based on performance with the right hand.

a ADD+H group, n = 61; ADD-H group, n = 22.
b ADD+H group, n = 58; ADD-H group, n = 22.
each group on these measures are presented in Table 10.

**Hypothesis 3: Behavioural and Emotional Adjustment**

The first set of variables to be analyzed involved measures reflecting externalized forms of psychopathology. A MANOVA based on the Conduct Disorder factor of the CTRS and the Aggression factor of the CBCL-TRF was statistically significant, $F (2,79) = 21.46, p < .0002$. Univariate analyses indicated that the ADD+H group obtained greater elevations on both the Conduct Disorder factor ($F (1,80) = 22.88, p < .0002$) and the Aggression factor ($F (1,80) = 42.96, p < .0002$).

Because there was a tendency for a greater number of children in the ADD+H group to come from single-family homes (see Table 2) it was possible that this had some influence on the greater degree of conduct- and aggression-related problems in this group. For this reason, the groups were also compared on teacher ratings after the eight children in the ADD+H group who came from single-family homes were excluded from the analysis (all eight children came from homes where the mother was the single parent).

Again, the groups were found to be significantly different on both the Conduct Disorder factor ($F (1,72) = 26.74, p < .0001$) and the Aggression factor ($F (1,72) = 44.79, p < .0001$). The ADD+H group obtained mean $T$ scores of $70.5$ ($SD = 17.5$) and $69.2$ ($SD = 8.8$) on the Conduct Disorder and Aggression factors, respectively. The scores
for the ADD+H group were virtually identical to those obtained when the children from single-family homes were included in the group (see Table 11). These data indicate that the scores for the ADD+H group on these measures of externalized problems were not elevated by the inclusion of children who were living with one parent only.

Similar results to the teacher ratings were obtained when the parent ratings were analyzed. A MANOVA based on the Conduct Disorder factor of the CPRS and the Aggression factor of the CBCL-PRF was significant, $F (2,77) = 3.26, p < .05$. Univariate analyses indicated that the ADD+H group obtained higher scores on both the Conduct Disorder factor ($F (1,78) = 4.28, p < .05$) and the Aggression factor ($F (1,78) = 6.49, p < .02$). These data are presented in Table 11.

The percentages of children in each group who obtained significant elevations on each of the externalized factors and on both factors were also compared. These comparisons were made for both the teacher and parent ratings. A $T$ score of 1.5 SD or more above the normative mean was considered to be a significant elevation and suggestive of clinically significant problems in areas sampled by the factor. Based on teacher ratings, there were significantly more children in the ADD+H group who obtained scores that equalled or exceeded the cutoff on the Conduct Disorder factor, Aggression factor, and on both factors together as
Table 11

T Score Means and (Standard Deviations) on Measures of Behavioural and Emotional Adjustment

<table>
<thead>
<tr>
<th>Measures</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Standard Deviations)</td>
<td></td>
</tr>
<tr>
<td><strong>Externalized-Teacher Ratings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Disorder</td>
<td>68.74</td>
<td>(17.38)</td>
</tr>
<tr>
<td>Aggression</td>
<td>68.61</td>
<td>(8.58)</td>
</tr>
<tr>
<td><strong>Externalized-Parent Ratings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Disorder</td>
<td>63.07</td>
<td>(13.60)</td>
</tr>
<tr>
<td>Aggression</td>
<td>66.20</td>
<td>(8.88)</td>
</tr>
<tr>
<td><strong>Internalized-Teacher Ratings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Withdrawal</td>
<td>62.74</td>
<td>(7.03)</td>
</tr>
<tr>
<td>Anxious</td>
<td>59.34</td>
<td>(5.83)</td>
</tr>
<tr>
<td>Happy</td>
<td>61.00</td>
<td>(8.25)</td>
</tr>
<tr>
<td><strong>Internalized-Parent Ratings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Withdrawal</td>
<td>63.80</td>
<td>(8.53)</td>
</tr>
<tr>
<td>Depression</td>
<td>62.95</td>
<td>(7.02)</td>
</tr>
</tbody>
</table>

**Note:** Standard deviations are presented in parentheses; the higher the score the greater the degree of disturbance.
compared to the ADD-H group (see Table 12).

Based on parent ratings, the groups did not differ in the proportion of children who obtained elevations on the Conduct Disorder factor; however, there were proportionately more children in the ADD+H group who obtained significant elevations on the Aggression factor. The groups did not differ in the percentage of children with significant elevations on both scales.

The second set of variables to be analyzed under Hypothesis 3 involved measures reflecting internalized forms of behavioural and emotional adjustment problems. Teacher ratings on the Social Withdrawal and Anxious factors of the CBCL-TRF and the Happy factor of the Child Behaviour Profile were used as dependent variables. The scores on the Happy factor were transformed so that high scores reflected unhappiness and vice versa. In this way, all the variables were keyed in the same direction to represent abnormal functioning. The MANOVA was statistically significant ($F$ (3,78) = 7.40, $p < .0003$), with the ADD-H group exhibiting a higher score on the combination of these measures. Univariate analyses revealed that the ADD-H group received significantly higher ratings on the Happy ($F$ (1,80) = 6.47, $p < .02$) and Social Withdrawal ($F$ (1,80) = 16.77, $p < .0002$) factors. The groups were not statistically different on the Anxious factor ($F$ (1,80) = 0.00, $p < .97$). These data are presented in Table 11.
Table 12

Frequency of Externalized Problems by Group

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>$\chi^2$</th>
<th>$p &lt;$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Externalized-</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teacher Ratings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Disorder %</td>
<td>38/62</td>
<td>1/21</td>
<td>21.02</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>61.3</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggression %</td>
<td>37/62</td>
<td>0/22</td>
<td>23.47</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>59.7</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both Factors</td>
<td>31/62</td>
<td>0/22</td>
<td>17.43</td>
<td>.001</td>
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<tr>
<td></td>
<td>50.0</td>
<td>0.0</td>
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<td></td>
</tr>
<tr>
<td><strong>Externalized-</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parent Ratings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct Disorder %</td>
<td>23/62</td>
<td>6/22</td>
<td>0.69</td>
<td>.406</td>
</tr>
<tr>
<td></td>
<td>37.1</td>
<td>27.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggression %</td>
<td>32/62</td>
<td>6/22</td>
<td>3.88</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>51.6</td>
<td>27.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both Factors %</td>
<td>18/62</td>
<td>5/22</td>
<td>0.33</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>29.0</td>
<td>22.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The frequency is based on the number of cases that equalled or exceeded 1.5 SD above the normative mean.
Table 13

Frequency of Internalized Problems by Group

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>( \chi^2 )</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internalized- Teacher Ratings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Happy</td>
<td>25/62</td>
<td>12/22</td>
<td>1.33</td>
<td>.249</td>
</tr>
<tr>
<td>%</td>
<td>40.3</td>
<td>54.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxious</td>
<td>11/62</td>
<td>4/22</td>
<td>0.00</td>
<td>.964</td>
</tr>
<tr>
<td>%</td>
<td>17.7</td>
<td>18.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Withdrl</td>
<td>21/41</td>
<td>15/22</td>
<td>7.81</td>
<td>.006</td>
</tr>
<tr>
<td>%</td>
<td>33.9</td>
<td>68.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>5/62</td>
<td>2/22</td>
<td>0.02</td>
<td>.882</td>
</tr>
<tr>
<td>%</td>
<td>8.1</td>
<td>9.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internalized- Parent Ratings</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Withdrl</td>
<td>28/62</td>
<td>13/22</td>
<td>1.26</td>
<td>.262</td>
</tr>
<tr>
<td>%</td>
<td>45.2</td>
<td>59.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>22/62</td>
<td>7/22</td>
<td>0.10</td>
<td>.757</td>
</tr>
<tr>
<td>%</td>
<td>35.5</td>
<td>31.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>16/62</td>
<td>6/22</td>
<td>0.02</td>
<td>.894</td>
</tr>
<tr>
<td>%</td>
<td>25.8</td>
<td>27.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The frequency is based on the number of cases that equalled or exceeded 1.5 SD above the normative mean.
Parent ratings on the Social Withdrawal and Depression factors from the CBCL-PRF were analyzed by a MANOVA. The groups were not significantly different based on the combination of these variables, $F(2,79) = 0.13$, $p < .883$. These data are presented in Table 11.

The groups were also compared in terms of the proportion of children within each group who exhibited significant elevations on each of the factors for both the teacher and parent rating scales. Based on teacher ratings, there were proportionately more children in the ADD-H group that were considered to be socially withdrawn than in the ADD+H group. On the other hand, the groups did not differ in the proportion of children who obtained significant elevations on the Happy or Anxious factors, nor did they differ in the proportion of children who obtained significant elevations on all three factors. None of the comparisons involving the parent ratings were significant. Data related to the frequency of internalized problems are presented in Table 13.

**Child and Family History Variables**

The last hypothesis involved variables derived from parental reports regarding the child’s family history. The first prediction under this hypothesis was that the ADD+H group would be rated by a parent as being more active as a baby. Ten of 59 children with ADD+H were rated as hyperactive whereas 2 of 22 children with ADD-H were so
rated. This difference was not statistically significant (see Table 14).

The second prediction concerned the child's history of motor coordination difficulties. The groups did not differ significantly on measures that reflected problems of a more fine motor nature. These comparisons were based on the percentage of children who were considered by a parent to have poor handwriting or to be clumsy using their hands. These data are presented in Table 14.

The results involving the history of gross motor problems were mixed. The groups did not differ in the percentage of children who were considered to have motor coordination difficulties such as confusion in regard to left or right-handedness, frequent falling, or awkwardness. However, there was a tendency for a greater percentage of children in the ADD+H group to be rated as being "clumsy in walking". In spite of this latter finding, the ADD+H group was rated as performing better athletically. These data are presented in Table 14.

The third set of variables involved the family history of behavioural and emotional problems, and the percentage of siblings with LD and ADD. The percentages of immediate family members that were reported to have either externalized or internalized problems were quite low, making statistical comparisons inappropriate for these data. The frequency of these problems are presented in Table 15. At
Table 14

Frequency of Problems Related to the Child’s Family History

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
<th>$\chi^2$</th>
<th>$p &lt;$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity Level</td>
<td>10/59</td>
<td>2/22</td>
<td>1.66</td>
<td>.45</td>
</tr>
<tr>
<td>%</td>
<td>17.0</td>
<td>9.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handwriting$^a$</td>
<td>45/61</td>
<td>15/22</td>
<td>0.25</td>
<td>.63</td>
</tr>
<tr>
<td>%</td>
<td>73.8</td>
<td>68.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clumsy Hands$^a$</td>
<td>11/61</td>
<td>5/22</td>
<td>0.23</td>
<td>.64</td>
</tr>
<tr>
<td>%</td>
<td>18.0</td>
<td>22.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clumsy Walking$^b$</td>
<td>14/60</td>
<td>1/22</td>
<td>3.80</td>
<td>.06</td>
</tr>
<tr>
<td>%</td>
<td>23.3</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awkward$^b$</td>
<td>15/57</td>
<td>5/21</td>
<td>0.05</td>
<td>.83</td>
</tr>
<tr>
<td>%</td>
<td>26.3</td>
<td>23.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athletic$^b$</td>
<td>18/62</td>
<td>13/22</td>
<td>6.36</td>
<td>.02</td>
</tr>
<tr>
<td>%</td>
<td>29.0</td>
<td>59.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Items that were considered to reflect predominantly fine motor skills.

$^b$ Items that were considered to reflect predominantly gross motor skills.
Table 15

Frequency of Behavioural, Emotional, and Learning Problems Related to the Child's Family History

<table>
<thead>
<tr>
<th>Measure</th>
<th>ADD+H</th>
<th>ADD-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Immediate Family Members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>6/62</td>
<td>2/22</td>
</tr>
<tr>
<td>%</td>
<td>9.7</td>
<td>9.1</td>
</tr>
<tr>
<td>Aggression</td>
<td>1/62</td>
<td>1/22</td>
</tr>
<tr>
<td>%</td>
<td>1.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Arrests</td>
<td>0/62</td>
<td>0/22</td>
</tr>
<tr>
<td>%</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Anxiety</td>
<td>3/62</td>
<td>1/22</td>
</tr>
<tr>
<td>%</td>
<td>4.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Depression</td>
<td>4/62</td>
<td>1/22</td>
</tr>
<tr>
<td>%</td>
<td>6.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Siblings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LD</td>
<td>12/62</td>
<td>3/22</td>
</tr>
<tr>
<td>%</td>
<td>19.4</td>
<td>14.3</td>
</tr>
<tr>
<td>ADD</td>
<td>1/62</td>
<td>3/21</td>
</tr>
<tr>
<td>%</td>
<td>1.6</td>
<td>14.3</td>
</tr>
</tbody>
</table>

Note: LD = Learning Disabilities; ADD = Attention Deficit Disorder.
least on visual inspection, the groups appear to be quite similar on these measures.

The groups did not differ in the percentage of children who were considered from the parent’s report to have one or more sibs with a learning disability, $\chi^2 (1, N = 83) = 0.27, p < 0.61$. There was a significantly greater percentage of children with ADD-H who had a sib with ADD, $\chi^2 (1, N = 83) < 0.03$. Because 50% of the cells had expected counts less than five, Fisher’s Exact Test was performed. This was also significant ($p < .05$). However, the incidence of sibs with ADD in each group was so low that the difference between the groups is probably not meaningful.
CHAPTER IV

DISCUSSION

This investigation was designed to examine the external validity of ADD subtypes (grouped according to the presence or absence of motoric overactivity) while taking into consideration many of the limitations characteristic of previous studies. Rather than relying exclusively on DSM-III or DSM-III-R criteria, the present study incorporated an empirical (normative) means by which to classify children within each of the subtypes. Other advantages of the present study included a larger sample size than in most other studies of this nature, the clear exclusion of children that may have been on psychoactive medication during any time in which the data were collected, and the similarity of the groups on key demographic and subject characteristic variables such as the parents' education level, FSIQ, and level of inattention. In general, the findings suggest that the ADD subtypes can be distinguished on behavioural and psychosocial variables that were not used in the formation of the groups, but that they are similar to each other on most neuropsychological, academic, and family history variables.
"Executive Processes"

One of the principal purposes of this study was to determine whether and to what extent subtypes of children with ADD could be dissociated on clinical neuropsychological measures that are considered to emphasize "executive" processes. Overall, only a few of the statistical comparisons between the groups were significant. These results suggest that children with ADD+H and children with ADD-H are more similar than dissimilar in the development of their executive processes.

For the most part, the groups did not differ on measures reflecting their fine psychomotor skills. Both groups obtained similar ratings on the quality of their handwriting when it was based on their written spelling of words that were relatively familiar to the children. Also, the ADD groups performed remarkably similarly on measures of upper extremity motor steadiness. This was evident on the Holes Test and the Maze Test, measures that emphasizes static and kinetic steadiness, respectively.

The only difference to arise between the groups on the steadiness measures that even approached significance involved the time taken to complete the Maze Coordination Test with the dominant hand (always tested first). Even though the ADD-H group tended to be somewhat slower than the ADD+H group, both groups performed within the average range on this measure. These results do not support the
hypothesis that the ADD+H group would complete the mazes in a hurried fashion, which would suggest problems with motor regulation on this measure.

The ADD subtypes also performed similarly on higher-order cognitive measures whether or not children with LD were excluded from the groups. This suggests that the groups do not differ in those higher-order abilities that are thought to be mediated primarily by frontal or prefrontal lobe systems. However, it could be argued that these tests do not, or cannot, adequately measure higher-order cognitive functions related to frontal lobe systems in 6- to 11-year-old children—at least as these functions are understood by the findings of neuropsychological studies involving adult subjects. This is because these functions are not considered to be sufficiently developed in children between these ages. According to Piaget's theory of cognitive development, the capacity to think in the abstract, to reason logically, and to test predictions based on hypotheses does not begin to develop until roughly 11 to 15 years of age. Given these considerations, a better method by which to evaluate the "frontal lobe" hypothesis would be to conduct a longitudinal study. Children classified as ADD+H and ADD-H in early childhood could be tested on higher-order measures at the time of identification and then again when they are well into their adolescent years.
An interesting pattern emerged when the tests of higher-order abilities were rank ordered to reflect highest to lowest scores (collapsing across groups). When compared to their age-peers in the general population (based on normative data) both groups performed approximately in the high average range on the Category Test and the Tactual Performance Test. On the other hand, both groups obtained scores in approximately the lower end of the average range on the Verbal Fluency Test and the Arithmetic subtest of the WRAT-R. The Category Test and TPT are similar in that both provide immediate and ongoing external feedback to the child regarding their performance. In contrast, the Verbal Fluency Test and the Arithmetic subtest provide little, if any, ongoing external feedback. These two groups of measures also differ in the degree of active physical participation required on the child’s part and the number of sensory modalities involved in the tasks, these being greater for The Category Test and TPT than for the Verbal Fluency and Arithmetic subtests. That children with ADD+H are considered to function best in situations that involve the use of different modalities, are action-oriented, and that provide immediate and frequent feedback (Barkley, 1990) is consistent with these results. However, the present findings suggest that these considerations are also important for children with ADD-H.
Finally, because one of the principal deficiencies of children with ADD+H involves behavioural disinhibition, it was predicted that the children ADD+H group would make more errors of commission on the Underlining Test. However, it was found that the groups did not differ in the number of commission errors made, and that this was the case whether or not children with LD were excluded from the groups. This inability to distinguish the groups on commission errors is consistent with the recent findings of Barkley et al. (1990), even though the tasks used in the two studies differed. The findings of this study in conjunction with those of Barkley et al. (1990) suggest that children withADD-H are likely to make as many errors on cognitive tasks that require rapid processing as do their hyperactive counterparts.

The ADD groups did differ on a few of the neuropsychological variables. One such variable was from the Underlining Test. The mean number of items correctly underlined by each group was below average, a finding that is consistent with Douglas’ (1988) view that children with ADD exhibit deficits on certain perceptual search tasks. However, the fact that the ADD-H group found significantly fewer target items than did the ADD+H group was contrary to what was predicted to occur. This finding cannot be explained on the basis of the ADD-H group making more errors or having a greater incidence of LD because the groups were
not different on these variables. However, the present finding appears to be consistent with the notion, presented by Barkley et al. (1990), that children with ADD-H may be especially deficient on tasks that stress complex perceptual-motor speed.

While a deficiency in perceptual-motor speed might at a glance explain why the ADD-H group was somewhat slower than the ADD+H group with the dominant hand on the Maze Test, the fact that the ADD-H group completed the maze with the nondominant hand in the same amount of time as the ADD+H group suggests that this explanation is inadequate for this situation. If true, it would be expected to apply equally to the performance of each hand on the Maze Test. Moreover, even though the ADD-H group was marginally slower, their mean score was well within the average range—hardly a score that would represent a deficiency. Perhaps the slower performance of the ADD-H group on this measure reflects an active attempt to sacrifice speed for accuracy, an approach that may be more difficult for the motorically-driven child with ADD+H. Clearly, additional research is needed to explicate the relationship between these ADD subtypes and their performance on various tasks that emphasize perceptual-motor speed.

Another difference between the groups involved their performance on one measure of their graphomotor skills. There were more children in the ADD+H group than the ADD-H
group who were judged to exhibit some difficulty with the overall legibility of their handwriting when the ratings were based on all of the WRAT-R spelling items, and not just the first five items. This difference between the groups was found even when children with a RS disability or a RSA disability were excluded from the analysis. Thus, it appears that this difference in overall legibility is not due to the greater percentage of children with learning disabilities in the ADD+H group. The greater problems with handwriting legibility that the children with ADD+H exhibited likely involved the later items of the Spelling subtest (since the groups did not differ in their graphomotor performance when they were compared on the first five items). These considerations coupled with the average range scores of both groups on motor steadiness measures with the dominant hand suggest that the group difference in overall legibility is not the result of a deficiency simply in the mechanics (i.e., motor aspects) of handwriting in the ADD+H group. Perhaps, the children with ADD+H encounter greater difficulty on measures of fine motor control when the task stresses simultaneous cognitive processing of unrelated material.

In general, the findings related to the neuropsychological variables are consistent with those reported in a very recently published study by Barkley, Grodzinsky, and DuPaul (1992). They compared 12 boys with
ADD+H, 12 boys with ADD-H, 11 boys with LD, and 12 boys designated as community control subjects on nine measures that were considered to tap frontal lobe functions: Continuous Performance Test, Grooved Pegboard Test, Controlled Word Association Test, Hand Movements subtest from the Kaufman Assessment Battery for Children, Porteus Mazes, Rey-Osterrieth Complex Figure, Stroop Color-Word Test, Trail Making Test, and the Wisconsin Card Sorting Test. They found that the ADD groups did not differ significantly from each other on any of the 26 variables derived from these tests.

In addition to increasing sample sizes, Barkley et al. (1992) suggested that group differences on neuropsychological variables might emerge if investigators

(a) adopted a more consistent and empirical method of establishing the diagnosis of ADD and classifying the subtypes in place of DSM-III item lists; (b) used clinically deviant subjects; (c) controlled for the effects of LD, CD, and other co-morbid disorders on the neuropsychological measures; (d) focused on the more severely impaired childhood than adolescent ADD population; (e) concentrated on a finer analysis of the types of errors made on tests of inhibition; and (f) included measures of focused attention and perceptual-motor speed rather than just measures of the more global frontal lobe functions evaluated here. (p. 184)

The majority of the considerations raised by Barkley et al. (1992) were either fully or partially addressed in the present study. Even under these circumstances, the ADD subtypes did not differ on most of the neuropsychological variables.
Academic Functioning

A variety of measures were employed to assess the academic functioning of the two groups. Overall, very few significant differences between the groups emerged. There was no significant difference between the groups in terms of the number of children retained in grade. Approximately one-quarter of each group had repeated a grade at least once. This retention rate is considerably greater than one would expect in the general primary school population. Barkley et al. (1990) found that 2.9% of their normal control group had been retained in grade. On average, children in both groups were reported by teachers to be performing below their age-peers in academic subjects, with no significant difference being observed between the groups. Also, the groups did not differ in the frequency of learning disabilities, regardless of which method was used to define the disability. However, the proportion of children in the ADD+H group who had learning disabilities involving reading and spelling was 1.5 to 2 times greater than the proportion in the ADD-H group. This pattern of performance on language-related achievement tests is consistent with the significantly lower scores that the ADD+H group obtained on two of the three auditory-linguistic measures examined in this study.

Overall, these results do not support the notion that there is a stronger association between ADD-H and LD than
between ADD+H and LD. The finding that the ADD subtypes were not distinguishable on most measures of academic functioning is consistent with the majority of related studies conducted to date. The failure of a clear and consistent relationship to emerge from this and other studies suggests that the differences that have been observed between the ADD subtypes on academic measures are likely related to extraneous factors. Referral patterns and subject recruiting methods may be important ones in this regard.

It is interesting to note that the incidence of learning disabilities in the two groups was lower when they were defined in ways that either directly (i.e., neuropsychological test results) or indirectly (i.e., WRAT-R subtypes) incorporated basic processing deficiencies as part of the diagnostic considerations. Of course, this would be expected given the use of more stringent criteria. Thus, it appears that the incidence of learning disabilities in children with ADD is lower than that which is suggested by the results of most related studies published to date. As in the present study, when "legislative" criteria are used to define LD, the incidence of LD in children with ADD is approximately within the range of 20% to 30%. This is considerably higher than the 5% to 10% prevalence rate estimated for the general school-age population (Interagency Committee on Learning Disabilities, 1987). However, the
present findings also indicated that the incidence of learning disabilities associated with central processing disorders (17% in the present study) in children with ADD is greater than the Interagency's (1987) prevalence estimates.

Taken together, these findings and those of Barkley et al. (1990) suggest that most children with ADD (approximately 70%) are achieving academically at age-appropriate levels. In addition, the present findings suggest that those children with ADD who are exhibiting problems with academic achievement constitute a mixed group. It appears that some of the children who are seen in the clinic setting are encountering difficulties acquiring the basic academic skills of reading and spelling because of an interaction between an underlying auditory-linguistic processing deficiency, possibly related to central nervous system dysfunction, and excessive inattention. Other children may be delayed primarily because of their chronic inattention to classroom instruction. A third group of children may be underachieving because they have an auditory-linguistic processing deficiency only; that is, without a significant degree of inattention also being present. However, this latter group of children seem to be relatively rare, at least in the clinic setting. From a clinical standpoint, it is important to assess the relative contributions of these factors in children with ADD and co-existent underachievement so that an appropriate remedial
plan can be formulated that targets the child's central processing deficiencies as well as his or her behavioural difficulties related to inattention and overactivity. 

**Behavioural and Emotional Adjustment**

The predictions regarding the pattern of behavioural and emotional adjustment problems for each of the ADD subtypes were largely supported by the present results, particularly those based on teacher ratings. T score means indicated significant problems with conduct and aggression among the children with ADD-H. The elevations on scales reflecting these factors were beyond 1.5 SD above the normative mean. In contrast, the ADD-H group obtained scores that were well within the average range. The magnitude of these differences suggested that there was a greater proportion of children with ADD+H who were exhibiting clinically significant levels of externalized disturbance as compared to the ADD-H group. The results of the nonparametric analyses supported this view. Fifty percent of the ADD+H group were considered to exhibit significant problems related to both conduct and aggression. In marked contrast, none of the children in the ADD-H group obtained scores that that would be considered clinically significant based on teacher ratings.

A very different pattern emerged on teacher ratings that reflect internalized forms of behavioural disturbance. Although both groups obtained scores that were approximately
1 or more SD above the normative mean, the ADD-H group was rated as significantly more socially withdrawn and less happy as compared to the ADD+H group. Of the ADD-H group, 68% attained what might be considered clinically significant elevations on the Social Withdrawal scale of the CBCL-TRF whereas 34% of the ADD+H group attained such elevations. The results of teacher ratings suggest that among the measures reflecting internalized problems it is the tendency toward social withdrawal that best distinguishes the children with ADD-H from those with ADD+H. Nevertheless, it is important to recognize that there remained a fairly large proportion of children with ADD+H who obtained very low scores on the Happy scale of the CBCL-TRF (40%) and who were considered to exhibit clinically significant elevations on the Social Withdrawal (34%) scale. Thus, while the ADD-H group was virtually without serious externalizing problems within the school setting, it was not the case that children with ADD+H were without serious problems of an internalized nature. These results suggest that children with ADD, regardless of subtype, are at increased risk of experiencing internalizing problems, with ADD-H children being particularly vulnerable.

When the behaviour ratings were based on the experiences of the parents, the children with ADD+H were again found to exhibit significantly more externalizing problems as compared to the children with ADD-H. However,
it was only on the Aggression scale that the ADD+H group obtained a significantly greater proportion of children who might be considered to exhibit a clinically meaningful degree of disturbance. Interestingly, a large proportion of both the ADD+H and ADD-H groups demonstrated significant elevations on the Conduct Disorder and the Aggression scales combined (29% and 23%, respectively). When the teacher and parent ratings are compared for the ADD-H group, it is clear that the children with ADD-H are exhibiting more externalized problems at home than at school.

In contrast to the clear differences that were obtained on teacher ratings of internalized problems, the groups were found to be comparable when the parents' perceptions based on these variables were analysed. The parents of children with ADD-H did not view their children to be as withdrawn socially as did the teachers of such children, a finding that might relate to the differences in the social environments in which the ratings were made. The opportunities and expectations for social interaction with age-peers is greater in the classroom than it is in the home. Consequently, the tendency to shun others will be more noticeable and considered more unusual in the classroom setting.

Overall, the findings based on measures of behavioural and emotional adjustment are quite consistent with those reported in the literature (e.g., Barkley et al., 1990;
Edelbrock et al., 1984; Lahey et al., 1984). In addition, the findings support the view that (1) clinically significant attentional problems place children at increased risk of exhibiting pervasive internalized problems and externalized problems in the home and (2) that the coexistence of hyperactivity with these attentional problems increases the likelihood and severity that aggression and conduct problems will also be present (Barkley et al., 1990).

These results indicate that children with ADD+H and those with ADD-H appear quite different from a behavioural and an emotional standpoint. Indeed, a double dissociation was evident from the teachers’ perceptions of these two groups of children. Children with ADD+H exhibited greater difficulties of an externalizing nature whereas children with ADD-H exhibited greater difficulties of an internalizing nature. These findings provide some support for the external validity of this ADD typology. Within the context of the present study, these results are important because they lend credence to the neuropsychological findings. In other words, the inability to distinguish the ADD groups on most neuropsychological variables considered to reflect executive processes was not due to a general inability to distinguish the groups on nonclassificatory variables. The patterns of the results on measures of behavioural and emotional adjustment are consistent with
those generally reported in the literature and suggest that the groups in the present study were comparable to those in other recent studies, particularly those of Barkley and his colleagues.

**Child and Family History Variables**

For the most part, the ADD subtypes were found to be quite similar on variables related to the child's history. The clearest difference between the groups concerned athletic performance. Nearly 60% of the children with ADD-H were rated as fair or poor in athletic performance as compared to approximately 30% of the ADD+H group. Similarly, Barkley et al. (1990) found that their ADD-H group did not perform as well as their ADD+H group in physical education. However, overall, the results based on the family history variables do not provide compelling evidence that children with ADD-H encounter greater difficulties with gross motor coordination and that children with ADD-H encounter greater difficulties with fine motor coordination.

The similarity of the groups on ratings of "handwriting" and "clumsiness using the hands" is consistent with the neuropsychological findings related to motor coordination and steadiness. Taken together, the various sources of information in the present study related to motor coordination suggest that the differences that are observed between the ADD subtypes may be secondary to the greater
physical activity level of the child with ADD+H and its
effects on both gross motor skill development and the
perceptions of others than to an intrinsic motor deficiency
in one group or the other.

The results related to the frequency of behavioural,
emotional, and learning problems in the relatives of ADD
children are difficult to interpret, in many instances
because of what appears to be artificially low endorsement
rates. This problem likely resulted from an exclusive
reliance in the present study on a self-report format to
acquire such historical information and the inability (in
terms of failing to recognize or remember) or an
unwillingness of parents to report certain problems.
However, bearing this in mind, the groups appeared to be
more similar than different on family history variables.

Summary of Conclusions

1. Children with ADD+H and those with ADD-H do not appear
to be distinguishable on neuropsychological variables
that are thought to reflect executive or higher-order
processes that have been associated with frontal lobe
systems in adults.

2. While both groups of children exhibit difficulties on
certain tasks that emphasize complex visual search and
perceptual-motor speed, children with ADD-H seem to
have a greater degree of difficulty.
3. Children with ADD-H, similar to those with ADD+H, seem to function better on cognitive tasks when they are provided with (a) immediate and ongoing feedback, (b) multimodal input, and (c) active task involvement.

4. Most children with ADD achieve academically at age-appropriate levels. However, as a group they have an increased risk of academic underachievement as compared to their age-peers in the general school-age population.

5. Learning disabilities do not appear to be associated with one subtype of ADD more than the other. The differences that have been reported in the literature regarding academic achievement may be the result of extrinsic factors such as referral or selection biases.

6. Approximately 17% of children with ADD exhibit auditory-linguistic processing deficiencies. Previous studies have shown that these deficiencies are associated with difficulties in mastering the basic academic skills of reading and spelling. The present findings suggest that there is a subgroup of children with ADD who are failing to achieve at age-expected levels because of an underlying auditory-linguistic deficiency that is associated with their excessive inattention.

7. Because children with ADD may have a heightened risk of having a central processing deficiency that may affect
academic functioning, it is important that these abilities be assessed in those children with ADD who are demonstrating academic underachievement. In this way, processing deficiencies can be identified and then targeted for remediation as part of a broader intervention programme that is designed to deal with the features of ADD.

8. Children with ADD have an increased risk of exhibiting internalized disturbances, with a greater risk occurring among children with ADD-H.

9. In children with ADD-H, problems related to aggression and conduct are very unusual in the school setting, but they are observed in the home. In children with ADD+H, externalized problems are common and are more pervasive.
BIBLIOGRAPHY


hyperactive and nonhyperactive children. *Journal of Abnormal Child Psychology*, 3, 231-244.


behavioral characteristics of clinic-referred children. 
Journal of the American Academy of Child and Adolescent 
Psychiatry, 26, 718-723.
Lahey, B. B., Schaughency, E. A., Strauss, C. C., & Frame, 
C. L. (1984). Are attention deficit disorders with 
and without hyperactivity similar or dissimilar 
disorders? Journal of the American Academy of Child 
Psychiatry, 23, 302-309.
Prevalence of hyperactivity in elementary school 
children as a function of social system definers. 
American Journal of Orthopsychiatry, 48, 446-463.
syndrome in children. Journal of Pediatrics, 50, 
463-474.
Hyperkinetic impulse disorder in children’s behavior 
problems. Psychosomatic Medicine, 19, 38-49.
of methylphenidate on the handwriting of children with 
minimal brain dysfunction. Journal of Pediatrics, 91, 
127-132.
Performance of children with ADHD on tests sensitive to 
frontal lobe dysfunction. Journal of the American


APPENDIX A

DSM-III Criteria for Attention Deficit Disorder
The child displays, for his or her mental and chronological age, signs of developmentally inappropriate inattention, impulsivity, and hyperactivity. The signs must be reported by adults in the child's environment, such as parents and teachers. Because the symptoms are typically variable, they may not be observed directly by the clinician. When the reports of teachers and parents conflict, primary consideration should be given to the teacher reports because of greater familiarity with age-appropriate norms. Symptoms typically worsen in situations that require self-application, as in the classroom. Signs of the disorder may be absent when the child is in a new or one-to-one situation.

The number of symptoms specified is for children between the ages of eight and ten, the peak age range for referral. In younger children more severe forms of the symptoms and a greater number of symptoms are usually present. The opposite is true of older children.

A. Inattention. At least three of the following:

(1) Often fails to finish things he or she starts
(2) Often doesn't seem to listen
(3) Easily distracted
(4) Has difficulty concentrating on schoolwork or other tasks requiring sustained attention
(5) Has difficulty sticking to a play activity

B. Impulsivity. At least three of the following:

(1) Often acts before thinking
(2) Shifts excessively from one activity to another
(3) Has difficulty organizing work (this not being due to cognitive impairment)
(4) Needs a lot of supervision
(5) Frequently calls out in class
(6) Has difficulty awaiting turn in games or group situations

C. Hyperactivity. At least two of the following:

(1) Excessively runs about or climbs on things
(2) Has difficulty sitting still or fidgets excessively
(3) Has difficulty staying seated
(4) Moves about excessively during sleep
(5) Is always "on the go" or acts as if "driven by a motor"
D. Onset before the age of seven.

E. Duration of at least six months.

F. Not due to schizophrenia, affective disorder, or severe or profound mental retardation.

---

DSM-III Diagnostic Criteria for Attention Deficit Disorder without Hyperactivity (APA, 1980, p. 44).

The criteria for this disorder are the same as those for Attention Deficit Disorder with Hyperactivity except that the individual never had signs of hyperactivity (criterion C).
APPENDIX B

DSM-III-R Criteria for Attention deficit-Hyperactivity Disorder

Note: Consider a criterion met only if the behaviour is considerably more frequent than that of most people of the same mental age.

A. A disturbance of at least six months during which at least eight of the following are present:

(1) often fidgets with hands or feet or squirms in seat (in adolescents, may be limited to subjective feelings of restlessness)
(2) has difficulty remaining seated when required to do so
(3) is easily distracted by extraneous stimuli
(4) has difficulty awaiting turn in games or group situations
(5) often blurts out answers to questions before they have been completed
(6) has difficulty following through on instructions from others (not due to oppositional behaviour or failure of comprehension), e.g., fails to finish chores
(7) has difficulty sustaining attention in tasks or play activities
(8) often shifts from one uncompleted activity to another
(9) has difficulty playing quietly
(10) often talks excessively
(11) often interrupts or intrudes on others, e.g., butts into other children's games
(12) often does not seem to listen to what is being said to him or her
(13) often loses things necessary for tasks or activities at school or at home (e.g., toys, pencils, books, assignments)
(14) often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrill-seeking), e.g., runs into street without looking

Note. The above items are listed in descending order of discriminating power based on data from a national field trial of the DSM-III-R criteria for Disruptive Behaviour Disorders.

B. Onset before the age of seven.

C. Does not meet the criteria for a Pervasive Developmental Disorder.
APPENDIX C

Child Attention Profile
CHILD ATTENTION PROFILE

INATTENTION

4. Fails to finish things he/she starts
8. Can't concentrate, can't pay attention for long
17. Daydreams or gets lost in his/her thoughts
22. Difficulty following directions
72. Messy work
78. Inattentive, easily distracted
100. Fails to carry out assigned tasks

OVERACTIVITY

10. Can't sit still, restless, or hyperactive
15. Fidgets
41. Impulsive or acts without thinking
53. Talks out of turn
93. Talks too much

Ratings are as follows:

0 = Not True (as far as you know)
1 = Somewhat or Sometimes True
2 = Very true or Often True
APPENDIX D

Normative Data for the CAP
## NORMATIVE CUTOFF POINTS FOR THE INATTENTION, OVERACTIVITY, AND TOTAL SCORES FOR THE CAP

<table>
<thead>
<tr>
<th>Cutoff points</th>
<th>Total (1100)*</th>
<th>Boys (550)</th>
<th>Girls (550)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>69th centile</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>84th centile</td>
<td>6</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>93rd centile</td>
<td>8</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>98th centile</td>
<td>11</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

### INATTENTION

### OVERACTIVITY

| Median | 0 | 1 | 0 |
| 69th centile | 1 | 2 | 1 |
| 84th centile | 4 | 4 | 2 |
| 93rd centile | 6 | 6 | 5 |
| 98th centile | 8 | 8 | 7 |

### TOTAL SCORE

| Median | 2 | 4 | 1 |
| 69th centile | 6 | 7 | 4 |
| 84th centile | 10 | 11 | 8 |
| 93rd centile | 14 | 15 | 11 |
| 98th centile | 19 | 20 | 16 |

Note: From Barkley (1990).

* Number in parentheses are sample sizes.
APPENDIX E

Children’s History Form
DIVISION OF NEUROPSYCHOLOGY
HENRY FORD HOSPITAL
2799 West Grand Boulevard
Detroit, Michigan 48202
Telephone: 876-2526

CHILDREN'S HISTORY FORM

Please fill out the form to the best of your knowledge. If some questions are not applicable to your child, write in N.A. If you need more space or wish to make an additional comment, please attach a separate sheet.

1. REFERRAL INFORMATION
   Referred by _______________________________________
   Reason for Consultation _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________
   _______________________________________

II. GENERAL INFORMATION
   Child's Name _______________________________________
   ___________ First _______ Middle _______ Last _______
   Birthdate ___________ Age _______ Religion ___________
   Address _______________________________________
   Number and Street City, State and Zip
   Telephone _______________________________________
   Name of Child's School _______________________________________
   Address of School _______________________________________
   Telephone _______________________________________
   Grade _______ Teacher _______________________________________
   Parents:
   Mother's Name _______________________________________
   ___________ First _______ Middle _______ Last _______
   Address (if different from child's) _______________________________________
   Number and Street Telephone _______________________________________
   City, State and Zip
III. PREGNANCY

List all of mother's pregnancies in order, including the patient. If a pregnancy ended in miscarriage, state at which month.

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Length of Pregnancy (months)</th>
<th>Birth Weight</th>
<th>Sex</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

(If more space is needed, use reverse side of paper)

Was the child planned?

What was the mother's health during pregnancy with the patient?

Was she nervous and apprehensive; unusually happy; moody; other reactions?

Describe.
Did the mother have any of the following during pregnancy with the patient?

<table>
<thead>
<tr>
<th>Condition</th>
<th>Dates/Duration</th>
<th>Describe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Blood Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swollen Ankles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>German Measles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flu</td>
<td></td>
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<tr>
<td>Other Virus Infections</td>
<td></td>
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<tr>
<td>Toxemia</td>
<td></td>
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</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
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<tr>
<td>High Temperatures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RH/Other Blood Problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headaches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent Abdominal Pains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent Lower Back Pains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive Fatigue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Accidents/Falls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any chronic illness(es) such as diabetes, kidney infection, thyroid, etc.? Describe.

Medications Taken During Pregnancy:

<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
Any hospitalizations during pregnancy?

When? ________________ Why? ________________

Treatment ________________________________

Any threatened miscarriage or early contractions? ________________________________

Describe ________________________________________________

How much weight was gained during pregnancy ________________________________

Any other unusual conditions/complications? Describe ________________________________

What were the mother’s activities during pregnancy? ________________________________

Did the mother feel that the living situation or events in the home were comfortable during this period? Describe ________________________________

What was father’s attitude toward mother being pregnant? Describe ________________________________

_________________________________________________________

Any Additional Comments:

_________________________________________________________

IV. BIRTH HISTORY

Name of Hospital ____________________________________________

Approximately how long was labor? _____________________________ hours

Was labor difficult or easy? ________________ Describe__________________________

Was labor induced? ________________ Why? ________________________________

How? ________________________________________________

Were forceps used? ________________ Why? ________________________________

Did mother have a Ceaasarian Section? ________________ Why? ________________________________

Were any medications given during childbirth? _________ What kind? ________________________________

_________________________________________________________

Was anesthesia used during childbirth? ________________ What kind? ________________________________

Why? ________________

Was this a multiple birth? ________________ How many? ________________________________

What part of the baby was born first? ________________________________
Any bruises? Where? 
Any birthmarks? Where? 
What was the baby's color at birth? i.e., normal, blue, yellow, etc. 
If the baby was yellow (jaundiced), did he receive:
  Oxygen How long? 
  Transfusions How long? 
  Phototherapy (lights) How long? 
Did the baby have any breathing problems? Explain 
Did the baby breathe spontaneously and easily? If no, explain 
Was the cord wrapped around the baby's neck? 
Did the baby cry quickly? 
Was there anything exceptional in the baby's condition such as injury, paralysis, excessive crying, need of oxygen or other medical assistance? Explain 
Was the baby placed in an incubator or special crib? If yes, why? 
How early or late was the birth from the expected delivery date? 
What was the baby's weight at birth? 
How long after birth was the baby taken home? 
Any other complications before the baby was taken home? 
What was father's attitude toward the birth of the child? 
Was father at the hospital during the birth of the child? 
Did the mother have convulsions, hemorrhages, infections, unusual nervousness, tears, or anything else at or soon after childbirth? 

Any Additional Comments:
V. DEVELOPMENTAL HISTORY

Was the baby breast-fed, bottle-fed or receive both types of feeding?

If combined feeding, at what age was transfer from breast to bottle made?

If bottle-fed, were there difficulties in finding a suitable formula? Describe______________________________

If breast-fed (partially or completely), did the mother experience any difficulty with: Scanty milk supply, nursing painful, cracked or inverted nipples, etc.? Describe______________________________

Does the mother recall the baby's response to nursing? Active, eager, had to be encouraged? Describe______________________________

What were the mother's feelings about the nursing experience? Describe______________________________

Which type of feeding was used? Demand_______ Time Schedule ________?

When the baby vomited, was he apt to bring up his food in small amounts, or did it come up in large quantities and with force? Describe______________________________

Did the baby have any difficulty sucking as an infant?_____________________________________

Did the baby have any difficulty chewing?________________________________________________

Were there times when the baby had frequent spells of colic, constipation, or diarrhea? At what ages? How was it handled? Explain____________________________________

What attitude or mood did the baby seem to express most of the time? For example: Happy; smiling and laughing; "cuddly"; whiny; seemed in pain, sad, "old?" Describe____________________________________

Did the baby fail to grow normally? Describe____________________________________

Did the baby fail to gain weight? Describe____________________________________

Did the baby drool past two and a half?____________________________________

Was the baby different in any way from brothers and sisters? Describe____________________________________

Did anyone assist the mother in the care and responsibility of the baby during infancy?____________________________________
Was the baby limp? Describe

Was the baby stiff? Describe

Did the baby show any unusual trembling? Describe

Generally babies vary in regard to the amount of activity they show. Which of the following do you think would most nearly describe your baby during the first few months of his life? (please check)

____ Showed a great deal of activity, such as squirming, wiggling, kicking, and otherwise moving about so that it caused concern or difficulty.

____ Showed very little physical activity, not even showing any increase in movement, interest or response when hungry or when played with.

____ Showed vigorous activity when awake and when played with but was equally often observed playing quietly and generally relaxed.

Other. Describe

During the baby's first year of life was there anything (even if it had nothing to do with the baby) that caused unhappiness or anxiety, or placed the mother or father under special strain? Describe

Each child has his own individual sleeping pattern. Describe some of your child's sleeping habits, such as: Thumb-sucking; rocking; requiring a special toy, blanket or other object.

Did the baby sleep alone in a room? ________ If not, with whom did he share it? ________ At what age? ________ For how long a period? ________

Did baby sleep alone in a bed? ________ If not, with whom did he share it? ________ At what age? ________ For how long a period? ________

Were there any periods when the child habitually awoke crying and any periods in which he had to be held or rocked in order to fall asleep? ________

At what age? ________ What else would soothe or quiet the child? Describe
**Motor Milestones:**
Age sat alone for a sustained period of time? __________
Age stood? __________
Age crawled? __________
Age took first steps? __________
Age walked unaided __________
Age tied shoes? __________
Age fed himself? __________
Age pedaled a tricycle __________
Age rode a bicycle? __________
Age dressed himself? __________
Age swam? __________

**Language Milestones:**
Age spoke first words, e.g. dada, mama, bye-bye? __________
Age spoke in simple phrases? __________
Age exhibited good sentence structure __________
Did your child have any difficulty in learning to talk or have any speech problems? __________
At what age? __________ Describe __________

Which hand does your child prefer? Right ______ Left ______
Age established __________
Does your child switch hands? Yes _______ No _______

Were there any attempts to change left-handedness to right-handedness? _______
If so, what attempts were made? ____________________________
Were they made at home? ________ At school? ________ Both? ________

Has the child ever had any motor coordination difficulties such as confusion in regard to left or right-handedness, frequent falling, awkwardness? _______
If so, describe ______________________________________

How does your child perform athletically? ________________________________
Toileting:
How old was the child when toilet training was started?____________________
What methods were used? (State whether child was placed on a receptacle or "toidy" seat; how frequently; how long was he left there; what was done if the child was unsuccessful; whether enemas or suppositories were used; whether he cried or struggled).
Were training methods made difficult for any physical reasons, such as constipation, diarrhea, etc.?
At what age was bowel control established?____________________ Were there any relapses and under what circumstances did these occur. At what ages?
______________________________________________________

Does the child soil at this time?______________________________
What training methods were used to teach the child bladder control?
At what age did the child stop wetting himself at night?____________________
At what age did the child stop wetting himself in the daytime?____________________
Were there any relapses?____________________ At what age?____________________
Does the child still wet himself?______________________________

What were the child's reactions and attitudes toward toilet training?
______________________________________________________

VI. MEDICAL HISTORY
Has your child had meningitis or encephalitis?_____ If so, at what age?________
Has your child had a head injury?_____ If so, at what age?__________
Describe______________________________
Has your child lost consciousness?_____ If so, why?________________________
For how long?__________ At what age?

Has your child had any significant injuries?_____ If so, what?
At what age?____________________________________________________

Has your child ever had high or prolonged fevers?_____ If so, at what age?____
Did he have frequent ear infections? If so, at what age? ________________________________

Does your child have any visual defects? If yes, describe ______________________________

How long? __________________________________________________________________________

Does your child have any hearing defects? If yes, explain ________________________________

How long? __________________________________________________________________________

Does your child suffer from heart disease? If yes, explain ________________________________

Does he have asthma? Medications _____________________________________________________

Has your child had seizures? If so, age of first seizure _________________________________

Has your child been hospitalized? If yes, at what age Why? _______________________________

List any other illnesses or accidents the child has had. State age at which occurred, how long each illness lasted, what treatment was given, and if there were any unusual reactions or after effects:

<table>
<thead>
<tr>
<th>Illnesses</th>
<th>Age</th>
<th>Treatment Given</th>
<th>Reactions</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

(If you need more space, please use the back of this paper.)

Did the child have any operations such as: Circumcision, Tonsillectomy, adenoidectomy, etc. State:

Age at which operation occurred. ______________________________________________________

Was child hospitalized and for how long? _______________________________________________

Was recovery uneventful, or were there complications such as vomiting, high fever, etc.  __________________________________________________________________________________________
<table>
<thead>
<tr>
<th>Operations</th>
<th>Age</th>
<th>Hospitalization</th>
<th>Complications</th>
</tr>
</thead>
</table>

What was child told about operation beforehand?

What reaction did child show afterwards, that is, fearfulness, temper tantrums, increased shyness?

Child's attitude toward doctor before and after operation?

(Please use other side of paper, if you need more space.)

Does your child frequently complain of:

- Headache? Yes__ No__
- Weakness? Yes__ No__
- Dizziness? Yes__ No__
- Nausea? Yes__ No__
- Stomachaches? Yes__ No__
- Chronic Constipation Yes__ No__
- Chronic Diarrhea Yes__ No__
- Other? Yes__ No__
- What?____________________

List any medications that your child has taken in the past for more than a month (include dosage given and reason it was taken):

__________________________________________________________

Is the child on any medications at the present time?______ If so, what kind and for what was it prescribed?________________________
Has your child ever had:

Eye Exam

<table>
<thead>
<tr>
<th>Yes</th>
<th>Date</th>
<th>Findings</th>
</tr>
</thead>
</table>

Ear Exam

<table>
<thead>
<tr>
<th>Yes</th>
<th>Date</th>
<th>Findings</th>
</tr>
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</table>

EEG

<table>
<thead>
<tr>
<th>Yes</th>
<th>Date</th>
<th>Findings</th>
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</table>

Special Medical Tests

<table>
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<tr>
<th>Name</th>
<th>Date(s)</th>
<th>Findings</th>
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<tr>
<th>Name</th>
<th>Date(s)</th>
<th>Findings</th>
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Consultation with Medical Specialists

<table>
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<tr>
<th>Name</th>
<th>Date(s)</th>
<th>Findings</th>
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</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Date(s)</th>
<th>Findings</th>
</tr>
</thead>
</table>

Has anyone in the patient's family had any of the following?

<table>
<thead>
<tr>
<th>Neurological disease</th>
<th>Yes</th>
<th>Who?</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seizures (epilepsy)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing problems?</td>
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<td></td>
<td></td>
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<tr>
<td>Visual problems?</td>
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<td></td>
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<tr>
<td>Emotional problems?</td>
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<tr>
<td>Mental problems?</td>
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<tr>
<td>Slowness in talking?</td>
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<td></td>
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<tr>
<td>Slowness in walking?</td>
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<td>Hyperactivity?</td>
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<tr>
<td>Learning problems?</td>
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<td></td>
<td></td>
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<tr>
<td>Similar problems to patient?</td>
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<tr>
<td>Does any disease run in the family?</td>
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<tr>
<td>What?</td>
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VII. BEHAVIOR AND SOCIAL HISTORY

People Living in Home with Patient:

Name ___________________________ Relationship ______________________
Age _______ Education (years) _______ Occupation _________ Health ______
Handedness _______ School or Behavior Problems ________________________

Name ___________________________ Relationship ______________________
Age _______ Education (years) _______ Occupation _________ Health ______
Handedness _______ School or Behavior Problems ________________________

Name ___________________________ Relationship ______________________
Age _______ Education (years) _______ Occupation _________ Health ______
Handedness _______ School or Behavior Problems ________________________

Name ___________________________ Relationship ______________________
Age _______ Education (years) _______ Occupation _________ Health ______
Handedness _______ School or Behavior Problems ________________________

Name ___________________________ Relationship ______________________
Age _______ Education (years) _______ Occupation _________ Health ______
Handedness _______ School or Behavior Problems ________________________

(If more space is needed, use reverse side of paper.)
Patient's Brothers and Sisters Living Outside the Home:

Name_________________________ Address___________________________
Age______Education (years)_______Occupation_________________ Health______
Handedness_____School or Behavior Problems______________________________

Name_________________________ Address___________________________
Age______Education (years)_______Occupation_________________ Health______
Handedness_____School or Behavior Problems______________________________
(If more space is needed, use reverse side of paper.)

Have there been or are there currently any significant conflicts:

Between the parents? Yes____ No___________
Describe______________________________

Between the child and parents? Yes ____ No___________
Describe_____________________________

Between children? Yes____ No___________
Describe_____________________________

Does the child seem to have a closer attachment to one parent than the other?______ Which one?___________ Were there any changes in his attachments and if so, when did they occur?

Has the child ever required his parents or others to do things for him which he was capable of doing for himself? Describe.
Has the child ever had any frightening experiences? Describe the experience, his age and his reaction.

How was the child prepared for the birth of brothers and sisters?

By whom? ____________ How did he respond?

Does your child have difficulty getting along with children his own age? Yes ______ No ______ Describe ____________________________

Does your child have difficulty getting alone with adults? Yes ______ No ______ Describe ____________________________

Currently, does he prefer playing with children of his own age? ____________________________

Older? ______ Younger? ______ One or two friends? ____________

Many of them? ______ Are his friends among his own social group, or children the parents did not expect him to choose? ____________________________

How does (s)he occupy himself? ____________________________

What methods have you used in disciplining?

Spanking ____________________________

Withholding of privileges ____________________________

Withholding of approval and show of affection ____________________________

Other, describe ____________________________

How does the child respond to discipline?

Has discipline been frequently necessary?

Who ordinarily disciplines the child?
Have the parents and/or relatives agreed with each other on methods of discipline and privileges or have there been disagreements, describe.

During the early years of the child's life, was either parent frequently away or out of the home? (business trips, hospital, military service) Describe.

Has the child ever expressed fear of: darkness, dogs, trains, or had frightening dreams? At what age? Did these fears cause any special problems? Describe.

Has the child ever had daydreams, fantasies or imaginary companions?

At what age?

Daydreams

Fantasies

Imaginary companions

Has the child ever lost any person with whom he seemed to have a close relationship, such as father, mother, sister, brother, grandparents, or others? At what age? Who? Explain

Has the child ever seemed reluctant, or objected to being left in the care of others? Describe.

Did the child have any pre-school or school experiences such as nursery or kindergarten in which separation from home was difficult for him?
Has the child had any emotional, adjustment or behavioral problems? Yes____
No____ Describe__________________________________________________________

Has the child ever screamed?____ Stamped ______ Thrown things?____
Thrown himself on the floor?____ Hurt others?____ Hurt himself?____
Held his breath?____ Banged his head on things?____ Withdrew?____
Describe the physical appearance of the child during these periods.

Did he seem to know what he was doing?____ How early did they occur at
first?____ At what age did the child have them most frequently?____
How often did they occur?____ At what age did they stop?____
By whom were these handled: By mother?____ By father?____
By nursemaids?____ By others?____

Does your child ever eat paint, paper, etc.? Yes____ No____

Has the child ever had angry outbursts, temper tantrums, or other kinds of behavior
which caused you concern? Describe.

Under what circumstances did they seem to occur most frequently?

What were the child's and the parents' reaction to thumb-sucking; masturbating;
nail-biting?

<table>
<thead>
<tr>
<th>Child</th>
<th>Parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thumb-sucking</td>
<td></td>
</tr>
<tr>
<td>Masturbating</td>
<td></td>
</tr>
<tr>
<td>Nail biting</td>
<td></td>
</tr>
</tbody>
</table>
Check the ones that describe your child:

Shy?______ Immature?____ Well-behaved?____ Impulsive?____

More active than other children?______ Clumsy using his hands?______

Clumsy in walking?____________________

Does the child or did the child ever have: (Check)

Poor handwriting?______ Sleep problems?____ Toe walking?____

Blank spells?______ Falling spells?____ Thumb sucking?____

Tics or twitching?______

Difficulty staying with one activity for a reasonable length of time?____

Average intelligence?__________________________

VIII. SCHOOL HISTORY

Did the child attend nursery school or a preschool program?______ If so, give the age started.______ Describe any problems_____________________________

_____________________________

At what age did the child begin school?______ If he began later than six, why?

_____________________________

Describe any problems_____________________________

Has your child ever been retained in one or more grades?______ If so, which grades?

______ Why?_____________________________

_____________________________

Is the child in a special education class?______ If so, what kind?______

_____________________________

When was the child placed there?_____________________________

Does the child receive any special services in school (resource room, tutoring, remedial reading, speech, etc.)?______ If yes, what services?

_____________________________

For how long?_____________________________

Have you gotten any help privately for your child?______ If so, what sort?

_____________________________

By whom? _______________________________

When?________________________ How often?_____________________________
Has your child ever skipped one or more grades? If so, which grades? Why?

Does your child spend a lot of time studying? How much?

Briefly discuss your child's study habits.

Circle the word which best describes your child's grades throughout his school experience.
Superior  Above average  Average  Below average  Failing

In a few words, describe your child's attitude toward school when he first started.

What is his current attitude?

Has school reported current problems with: (check)
Reading?  Describe
Spelling?  Describe
Writing?  Describe
Arithmetic?  Describe
Behavior?  Describe
Social adjustment?  Describe
Attention span?  Describe
Following directions?  Describe

Can you say anything else that might help us understand and help your child?

Name of person filling out this form

Relationship to child

Date
APPENDIX F

Rating of Handwriting Scale
Rating of Handwriting Scale

0 1 2  (a) Inconsistent letter size and shape
0 1 2  (b) Poor spacing between letters
0 1 2  (c) Poor placement of letters on line
0 1 2  (d) Tremulousness
0 1 2  (e) Erasures or reworkings (writeovers)
0 1 2  (f) Heavy pencil pressure
0 1 2  (g) Mix of uppercase and lowercase letters
0 1 2  (h) Poor overall legibility
0 1 2  (i) Letter reversals or inversions

Ratings are as follows:

0 = Not at All or to a Small Degree
1 = Sometimes or to Some Degree
2 = Often or to a Large Degree

Exceptions:

(g) 0 = 0-1; 1 = 2; 2 = 3+. If all words are capitalized, do not count these as occurrences.

(i) 0 = 0-1; 1 = 2; 2 = 3+. 
APPENDIX G

The Underlining Test
The Underlining Test

These tests are intended to assess speed and accuracy of visual discrimination for various kinds of verbal and nonverbal visual stimuli presented singly and in combination. For each subtest the child is required to locate and underline the target stimulus which is interspersed among similar distractors. The net score for each subtest is the total number of targets correctly underlined minus the number incorrectly underlined (i.e., errors of commission) within the allotted time.

SUBTEST 1: SINGLE NUMBER. The child is required to underline the number 4 each time it appears on a printed page containing a random sequence of 360 single numbers. An example of the number to be identified is printed at the top of the page. A short practice test is given. **Time:** 30 seconds.

SUBTEST 2: SINGLE GEOMETRIC FORMS. The child is required to underline a Greek cross with a pencil each time it appears in random sequence among a series of 235 geometric forms, including squares, stars, circles, and triangles, and so forth. The forms are about 6 mm in height. **Time:** 30 seconds.

SUBTEST 3: SINGLE NONSENSE LETTER. A single nonsense letter is interspersed among 10 structurally similar nonsense letters in a random sequence of 126 letters. **Time:** 30 seconds.

SUBTEST 4: GESTALT FIGURE. The figure to be identified is a diamond about 8 mm in height containing a square which in turn contains a diamond. This figure is interspersed among similar figures in a random sequence of 168 figures. **Time:** 60 seconds.

SUBTEST 5: SINGLE LETTER. The letter "s" is interspersed among 360 random letters. **Time:** 30 seconds.

SUBTEST 6: SINGLE LETTER IN SYLLABLE CONTEXT. One hundred sixty-two four-letter nonsense syllables are presented, 47 of which contain the letter "e". The child is required to underline each syllable containing "e". **Time:** 45 seconds.

SUBTEST 7: TWO LETTERS. The letters "b" and "m" are interspersed among 360 randomized letters. **Time:** 45 seconds.

SUBTEST 8: SEQUENCE OF GEOMETRIC FORMS. Four geometric forms (triangle, Greek cross, circle, crescent) are presented in various orders for a total of 65 "syllables."
The child is required to underline only the groups with the order triangle, cross, crescent, and circle. **Time:** 60 seconds.

**SUBTEST 9: FOUR-LETTER NONSENSE SYLLABLE, UNPRONOUNCEABLE.**
The child is required to underline a four-letter nonsense syllable ("fsbm") interspersed among 146 four-letter nonsense syllables. All syllables are made up of the consonants f, s, b, and m, which renders them unpronounceable. **Time:** 60 seconds.

**SUBTEST 10: FOUR-LETTER NONSENSE SYLLABLE, PRONOUNCEABLE.**
This task is the same as in the previous subtest except that it involves the identification of a pronounceable nonsense syllable ("narp") instead of an unpronounceable nonsense syllable. This syllable is interspersed among other nonsense syllables made up of the letters n, a, r, p. **Time:** 60 seconds.

**SUBTEST 11: FOUR-LETTER WORD.** The word "spot" is interspersed among 146 four-letter syllables made up of the letters s, p, o, t. **Time:** 60 seconds.

**SUBTEST 12: UNSPACED FOUR-LETTER WORD.** The word "spot" is interspersed among the letters s, p, o, t, in various orders, with no syllable spacing. **Time:** 60 seconds.

**SUBTEST 13: SINGLE NUMBER.** This task is exactly the same as that involved in the first subtest except that the number to be underlined is 5 instead of 4.

**SUBTEST 14: SINGLE RECTANGLE.** This child is required to underline a series of identical rectangles, approximately 1 cm by 0.5 cm. **Time:** 30 seconds.

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**Note:** Modified from Rourke, Fisk, and Strang (1986).
VITA AUTORIS

Joseph Emile Casey was born on February 26, 1955 in Windsor, Ontario. He is the son of Emile and Albertine Casey. In June of 1974, he graduated from F. J. Brennan Secondary School and began an undergraduate programme at the University of Windsor in the fall of that same year. He graduated with Bachelor of Arts (Honours) degree in Psychology in May of 1978. He continued his education at Carleton University in Ottawa, Ontario where he received a Master of Arts degree in Physiological Psychology in 1983. After spending several years employed as a psychometrist in neuropsychology at University Hospital in London, Ontario, he returned to the University of Windsor to enrol in the doctoral programme in clinical neuropsychology.

He was married to Jennifer Sherman on July 14, 1979. They have four sons: Jonathan, Patrick, Michael, and Adam.